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PROCEEDINGS OF THE 17th INTERNATIONAL CONFERENCE ON GROUP DECISION AND NEGOTIATION

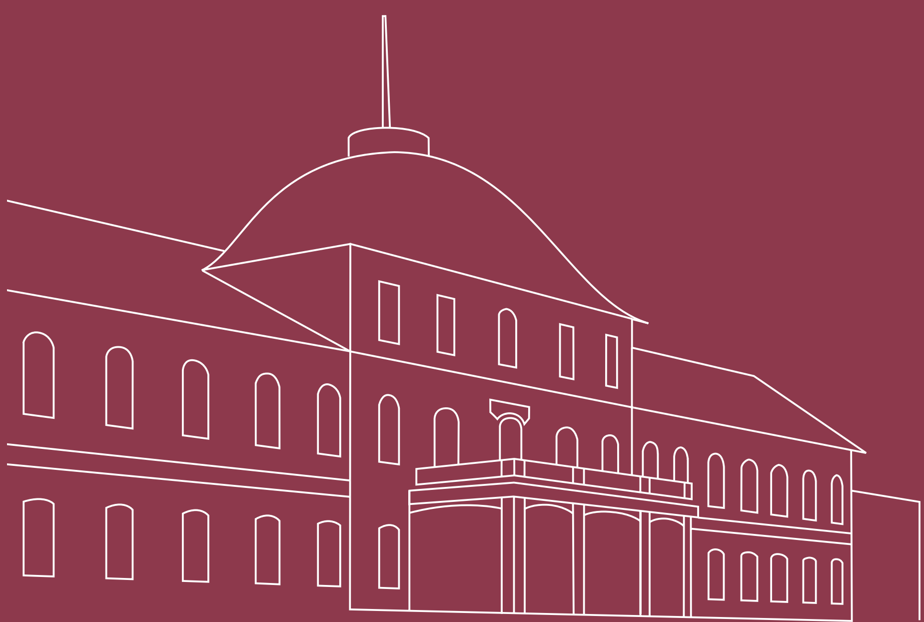
edited by

Mareike Schoop

University of Hohenheim

D. Marc Kilgour

Wilfrid Laurier University



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Preface

The field of Group Decision and Negotiation focuses on decision processes with at least two participants and a common goal but conflicting individual goals. Such processes can be performed in an intra-organisational as well as an inter-organisational context. They consist of complex processes, including preference elicitation, preference adjustment, proposals and counter-proposals, and choice. Communication and decision making are key to Group Decision and Negotiation processes; sophisticated support for these functions is thus a central objective of the field.

Research areas of Group Decision and Negotiation include electronic negotiations, the role of emotions in group decision and negotiations, preference elicitation and decision support for group decisions and negotiations, micro-processes of group decision making support, and conflict resolution principles.

The 17th International Conference on Group Decision and Negotiation (GDN 2017) continues the long history of GDN conferences as the primary forum for researchers and practitioners in the fields of group decision and negotiation. GDN 2017 is a truly international conference, with participants from Europe, the Americas, Asia, Africa, and Oceania. Especially in times of global conflict and uncertainty, the state-of-the-art research on dealing with conflicts in a cooperative and integrative way is more important than ever.

The proceedings are published in two volumes. The first volume contains the keynote papers and the full papers chosen in a blind review process [1]. The current second volume contains 55 short papers also chosen in a rigorous blind review process.
These papers are organised in seven streams that demonstrate the variety of research successes presented at GDN 2017:

- The stream on *General Topics in Group Decision and Negotiation* includes papers covering a broad range of topics from across the GDN field, from formal foundations to practical applications.
- The *Conflict Resolution* stream analyses strategic conflicts between individuals and groups in diverse application areas. The role of information technology in general, and dedicated systems in particular, are assessed.
- The *Emotions in Group Decision and Negotiation* stream examines the subjective and inter-subjective role of emotions affecting group decisions and negotiations.
- The *Negotiation Support Systems and Studies* stream focuses on electronic negotiations using several systems and tools, and includes system designs and laboratory and field studies analysing e-negotiations, mediation, and facilitation.

- The *Preference Modelling for Group Decision and Negotiation* stream focuses on approaches supporting groups of negotiators and decision makers in eliciting goals and preferences and on scoring systems for assessing offers.
- The *Micro-Processes of Group Decision Making Support* stream is concerned with an in-depth understanding of what occurs in the milieu of group decision-making processes, in particular in micro-processes, i.e. the relationships between the social, behavioural, and the material entities.
- The *Student* stream is the first of its kind for GDN conferences. It addresses papers on all topics of Group Decision and Negotiation authored by Bachelor or Master students to encourage early research experiences for junior researchers.

Organising an international conference on Group Decision and Negotiation certainly requires many negotiations among many parties, and a great deal of cooperative group decision making. We are very pleased at how well the conference has come together and would particularly like to thank:

- the three keynote speakers Wendi Adair, Matthias Jarke, and Dov Te'eni, for providing stimulating, innovative, and challenging research insights;
- the conference chairs, for regular interactions and advice;
- the organising chairs and the organising committee, for their work in putting together this splendid conference;
- the authors of the 94 papers submitted to the conference and the doctoral consortium;
- the members of the programme committee and the reviewers, for providing careful feedback and comments on all papers;
- Springer, for providing the funds for the Best Paper Awards;
- the University of Hohenheim and the Faculty of Business, Economics, and Social Sciences, and especially their research area on "Negotiation Research - Transformation, Technology, Media, and Costs (NegoTrans)" for their support and for making it possible for the conference to take place in a beautiful venue - Hohenheim castle;
- Hohenheim Management Development e.V., and Unibund, for their generous financial support.

Stuttgart and Waterloo, August 2017

Mareike Schoop and D. Marc Kilgour

[1] M. Schoop and D.M. Kilgour (Eds.): Group Decision and Negotiation – A Socio-Technical Perspective, Lecture Notes in Business Information Processing, LNBIP 293, Springer, 2017.

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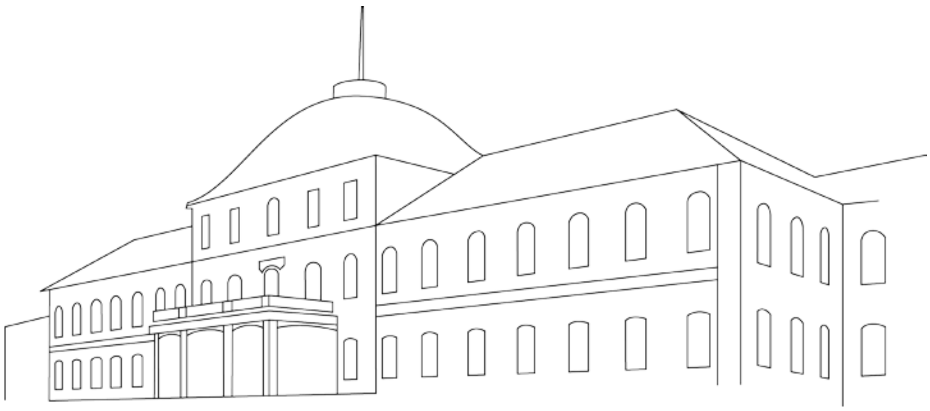

University of Hohenheim

Managing the Discount Decisions for Buyer, Supplier and Carrier: A Game Theoretic Approach

Ginger Y. Ke[1] and James H. Bookbinder[2]

[1] Faculty of Business Administration, Memorial University of Newfoundland, St. John's, Newfoundland and Labrador, Canada A1B 3X5 gke@mun.ca
[2] Department of Management Scieneces, University of Waterloo, Waterloo, Ontario, Canada N2L 3G1 jbookbinder@uwaterloo.ca

Abstract:
Despite the fact that quantity discounts have been broadly examined in decisions on the sale or purchase of goods, the analysis of coordinating the discount decisions for the retailer (buyer), the wholesaler (supplier), and the public transportation service provider (LTL carrier) is still in its infancy. This research presents a game theoretic approach to coordinate the three supply chain members' decisions on discount policies, when the demand is sensitive to the change in price. The significant improvements to each party and to the entire supply chain resulting from the discount coordination are demonstrated under various situations.
Keywords: Supply Chain Coordination; Game Theoretic Approach; Discount; LTL carrier; Shipment Consolidation

1 Introduction

Coordinating the relationships among the SC members leads to achieve the benefits of overall goals with joint efforts. Among various coordination mechanisms that have been studied in the literature, the quantity discount is one of the most powerful tools.

Transportation, though vital in connecting supply chain partners, has been usually ignored or assumed fixed when those firms make decisions on purchasing and re-supply of stock. In the past few decades, many scholars have realized the importance of transportation's impact on inventory decisions. Those researchers have been working on helping a buyer determine its replenishment policy, given both the quantity and transportation discounts. Despite all the efforts having been put into those discounts, the existing research takes the buyer's point of view. Few studies integrate decisions by the carrier into their investigation.

Moreover, current literature in the pricing of transportation and logistics services is extremely limited. Most existing papers analyzed the transportation pricing based upon the market data, rather than assisting carriers in determining their transportation prices or/and discounts. The relationships among the supply chain members have been entirely ignored.

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To fill this gap in literature, the main purpose of the present research is to coordinate the discount decisions of *all* SC members, a retailer (buyer), a wholesaler (supplier/vendor), and an outside transportation service provider (LTL carrier), in the case of demand that is dependent on price. More specifically, the coordination problem is formulated as a game-theory-based optimization model.

2 Model Development

This research considers a decentralized three-player supply chain, where a single buyer purchases one product from a given supplier, and an LTL common carrier is responsible for transporting those goods from supplier to buyer. The market demand for this product is deterministic but sensitive to the price fluctuations.

Both the buyer and supplier are assumed to employ the Economic Order Quantity (EOQ) model, which computes the order quantity that minimizes the total holding cost and ordering cost. Providing a good indication of replenishment poicies for situations with relatively stable demand, this inventory model has been extensively used in many relevant papers, such as [6–8, 10–12], to name a few.

Furthermore, we assume that the carrier maintains a regular dispatching schedule with a base-cycle length of T; and the carrier's dispatching schedule is not impacted by the supplier's shipments. The transportation (vehicle) capacity of each dispatch cannot be exceeded after adding in those shipments.

All players are assumed able to estimate the relevant information from the operation patterns of other parties, such as demand, particular cost parameters, retail and wholesale prices, and freight rate. All parties also act wisely, i.e. they would accept the chance to gain more profit whenever and wherever possible.

Our analysis starts at the point that the market is in equilibrium, such that both the supplier and carrier respectively charge standard prices for the product and transportation. The buyer orders the product at the EOQ level, and determines her retail price according to the cost structure.

Let A_B and h_B be the buyer's order processing cost and inventory holding cost, respectively. Before any discount, the buyer's profit is

$$\pi_{B0} = R_0(d_0) - p_0 d_0 - \frac{1}{2} Q_0 h_B - \frac{d_0}{Q_0} A_B. \tag{1}$$

Particularly, $R_0(d_0) = x_0(d_0)d_0$ is the annual profit, $p_0 d_0$ is the purchasing cost, $Q_0 h_B/2$ is the inventory holding cost, $(d_0/Q_0)A_B$ is the ordering cost, where $Q_0 = \sqrt{2A_B d_0/h_B}$ is the EOQ, and $x(d)$ is the inverse demand function. Now let us move to the stage that all discounts have been offered and the SC has achieved a new stable status. The buyer's profit is

$$\pi_B = R(d) - pd - \frac{1}{2} Q h_B - \frac{d}{Q} A_B, \tag{2}$$

where p is the discounted wholesale price and $R(d) = x(d)d$. To maximize this profit, the buyer's order quantity can be calculated as $q_B = \sqrt{2A_B d/h_B}$.

For the supplier, A_S and h_S are respectively the order processing and inventory holding costs. The profit gained from this specific buyer before the discount is

$$\pi_{S0} = (p_0 - v)d_0 - \frac{1}{2}Q_0 h_S - \frac{d_0}{Q_0}A_S - wf_N d_0. \tag{3}$$

With the discount, the supplier's profit is

$$\pi_S = (p - v)d - \frac{1}{2}Qh_S - \frac{d}{Q}A_S - dwf_V. \tag{4}$$

Thus the supplier's optimal order quantity that maximizes π_S is

$$q_S = \sqrt{2A_S d/h_S}. \tag{5}$$

We assume $A_S/h_S > A_B/h_B$ and $h_S < h_B$ for the supplier and buyer [3, 4, 9, 13]. Therefore, we must have $q_B < q_S$. From the supplier's point of view, the reason to offer the quantity discount is to encourage the buyer to increase the order quantity to q_S, so that the supplier's profit can be maximized.

Now consider the carrier. Before any discount, the profit gained from this pair, supplier and buyer, is

$$\pi_{C0} = wf_N d_0 - \frac{d_0}{Q_0}F, \tag{6}$$

where w is the product's unit weight; f_N is the carrier's original freight rate; and F is the fixed cost to dispatch a vehicle. Note that, at this point, the carrier directly sends out the supplier's shipments whenever they have been received. So no corresponding inventory cost is incurred. By offering the transportation discount, the carrier induces the supplier to send out shipments based on carrier's dispatch schedule, so that those shipments can be consolidated with the carrier's regular loads. Therefore, after discount, the carrier's profit from shipments made by this supplier is

$$\pi_C = dwf_V - \frac{1}{2}nTdwr_w - \frac{1}{nT}g, \tag{7}$$

where r_w is the holding cost per unit item per time period, which explicitly refers to the expense associated with in-transit inventory [2]. Specifically, the latter is a surrogate for the disutility experienced by a customer whose order must wait a certain period of time (the time for consolidation) before that order is dispatched [8].

Note also that the consolidation of shipments enables saving of the fixed transportation costs related to each dispatch. This is exactly the motivation for the carrier to offer a transportation discount. However, we introduce a new parameter g, which refers to the costs regarding material handling or the making of one more stop at the buyer. Given that $g \ll F$, the term g/nT is significantly smaller than the other two terms. Hence we can see that π_{C1} is a monotonically decreasing function with respect to n, and thus, the carrier would like to induce the supplier to slightly increase the time between shipments and choose the smallest n value. Therefore, the best value of n can be found by solving

$$n - 1 < \frac{q_S}{Td} < n. \tag{8}$$

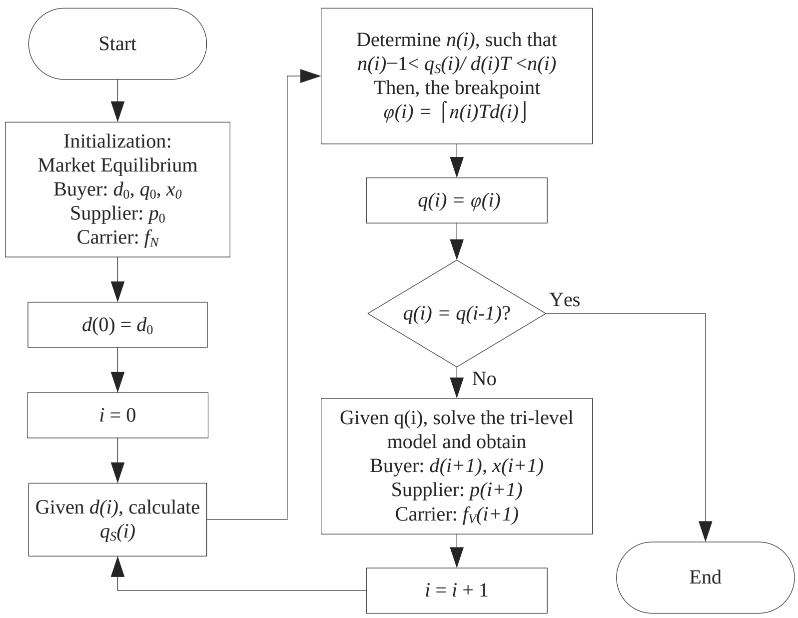

Fig. 1. A heuristic solution procedure for determining the discount schedules

3 A heuristic solution procedure

Multi-level mathematical programming problems are extremely difficult to solve. In fact, even a two-level linear programming model has been proved to be NP-hard [1, 5]. Therefore, solving a tri-level nonlinear model requires the development of an effective and efficient approximate computational approach. Here we propose a heuristic solution procedure to determine the discount schemes for the supplier and carrier. The major idea of this procedure is to start from the initial market equilibrium before any discount, then update each member's decision with the preferred transportation schedule (quantity) until convergence. To be specific, our heuristic contains the steps in Figure 1.

4 Numerical Experiments

In this section, we conduct a series of numerical experiments based on the linear demand function, which has been regularly used in the marketing and economics literature. Table 1 lists the major results, which indicate the system profit can be improved by introducing proper discount schemes for the buyer, supplier, and carrier. Each player's individual profit can also benefit from the discounts, especially the carrier (profit increased by more than 80%).

In addition, sensitivity analyses are carried out to further illustrate the robustness of the proposed model and provide additional managerial insights.

Table 1. Major results

		Initial Equilibrium	With Discount	Percentage Change
Demand (units)		1,289	1,385	1.07%
Price	Retail ($/unit)	68.56	68.07	-0.71%
	Wholesale ($/unit)	60.80	60.09	-1.17%
	Freight ($/cwt)	32.66	30.45	-6.77%
Profit	Buyer ($)	6,624	7,509	14.6%
	Supplier ($)	14,606	17,864	22.3%
	Carrier ($)	21,050	38,204	81.5%
	System ($)	42,280	63,577	50.4%

Herein, we specifically discuss the system profit gained from the discounts under the various levels of (1) the slope of demand curve (b), (2) the buyer's inventory holding cost (h_B), (3) the supplier's inventory holding cost (h_S), and (4) the carrier's holding cost (r_w), with all other parameters remaining the same. Major findings include:

- As the price elasticity of demand increases, there is enhanced improvement in the system profit due to discounts. Therefore, the price elasticity of demand is a major motivation for all SC parties, especially the carrier, to offer discounts.
- The improvement in the system profit gained by the discounts rises, as
  - the buyer's inventory holding cost increases;
  - the supplier's inventory holding cost increases; or
  - the carrier's holding cost decreases.

The sensitivity analyses demonstrate that our model and solution procedure are robust with respect to various changes in demand and cost structure. The benefit of coordinating the retail, wholesale, and transportation discounts is obvious.

5 Conclusions

Coordinating supply chains with quantity discounts has been widely investigated in the literature. But the major attention was paid to the party who receives the discount. The present research is the first work to fill this gap by presenting a game theoretic approach to enable that coordination, and to assist all relevant supply chain members in making their corresponding discount decisions. We studied three discounts: 1) the retail discount that the buyer offers to end customers, 2) the wholesale discount offered by the supplier to buyer, and 3) the transportation discount offered by the carrier to supplier. To solve the tri-level model effectively and efficiently, we developed a heuristic solution procedure, which can be employed by each member of the supply chain, to establish his/her discount scheme. A series of numerical experiments, based on a linear demand curve, were conducted to illustrate the practicality of the proposed models and heuristic procedure. Our results reveal that the coordination of discounts yielded significant improvements to each party.

Our future research will focus on incorporating the demand uncertainty in the coordination of discount schemes for multiple supply chain members. Starting from a single-period model, the situation will be extended to consideration of demand that is both price-dependent and stochastic.

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Partition Dependence Bias in Group Forecasting

Simon Kloker, Tim Straub, Tom Zentek, and Christof Weinhardt

Karlsruhe Institute of Technology (KIT), Forschungszentrum Informatik (FZI)
simon.kloker@kit.edu, straub@fzi.de, zentek@fzi.de, weinhardt@kit.edu

Abstract. Prediction Markets are a tool for group forecasting that is recently gaining popularity in companies to support decision making. In contrast to single expert judgements, group forecasts have the advantage of being less biased than their solitary counterparts, which have the disadvantage of being subject to singular opinions. However, some cognitive biases, such as partition dependence, still occur systematically also in Prediction Markets. In this research-in-progress we approach this problem from a Dual-process Theory perspective and argue that the market complexity is moderating information processing and therefore the occurrence of the partition dependence bias. First evidence of a preliminary experiment supports our hypothesis that increased complexity, introduced by a LMSR market compared to a poll, reduces partition dependence bias.

1 Introduction

Forecasting future events and their outcomes is essential in managerial and political decision-making. Forecasts can be made using either statistical models or by using human forecasters; both methods, it has to be noted, coming with certain biases. In recent years new methods, which forecast by relying on the wisdom of the crowd, have emerged. Such are e.g. Prediction Markets, which are suggested and used for corporate decision making [5, 18]. They provide a simple and convenient way of revealing and aggregating information accumulated by a large set of people by adding gamification elements to forecasting tasks. This is one reason why they are used in large companies like Yahoo [22], Google [8], or Microsoft [1]. Moreover, Prediction Markets are suitable for various contexts. In contrast to single expert judgments, group forecasts have the advantage to be less biased by individual differences [33]. However, some cognitive biases, such as partition dependence, still occur systematically in Prediction Markets [27]. The occurrence of cognitive biases in human estimations often has nothing to do with the subject's intellectual capacity, but arguably lies with the "slothful nature" of systematic processing and the use of heuristics and mental shortcuts [12]. According to the Dual-process Theories (DPTs) which have their roots in psychology and social sciences research, humans achieve better results if they were to consider problems with more effort and deductively [36].

In current work we want to address the occurrence of cognitive biases in Prediction Markets from a Dual-process Theory perspective. The fundamental

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idea of the DPTs is that there are two different kinds of thinking, of which one is unconscious, fast, automated, and effortless and the other is (at least partially) conscious, slow, and strenuous (induces high cognitive load) [9]. Mental shortcuts and cognitive biases are much more likely to happen in heuristic processing.

After a short introduction on Prediction Markets, partition dependence, and the Dual-process Theory, an experiment design is presented that uses market complexity as moderator between the two types of processing. The underlying research question is: *A more complex market mechanism encourages the use of systematic processing and therefore reduces partition dependence bias.*

2 Related Work

2.1 Prediction Markets, Biases, and Partition Dependence

Prediction Markets are defined as markets where participants trade contracts on the basis of probable outcomes of future events [15]. The prices in such markets can be interpreted as aggregate probability forecasts of the possible outcomes [34]. Prediction Markets have shown impressive accuracy, for example in forecasting elections [14], even if for the last two popular political events the forecasts failed (Great Britain leaves the European Union and US Presidential Elections 2016)[1]. Despite on accuracy, research on Prediction Markets was done regarding motivation [20], manipulation [3], market mechanisms [6], interface design [19] and combination with other methods [13].

Diverse authors discuss and explain some of the forecasting errors that appear systematically with the occurrence of (cognitive) biases in Prediction Markets [2, 7, 8, 21, 23, 27, 35]. Cognitive biases are basically the result of heuristics in human information processing and decision making [30]. The simple aggregation of numerous individual opinions is, then, meant to reduce the influence of cognitive biases, as many of them may average out [33]. However, there is still a long list of biases that occur in Prediction Markets, such as the favorite-longshot bias (tendency to overvalue longshots and undervalue favourites) [23, 26], confirmation bias (tendency to ignore conflicting information) [7, 24], or the overconfidence bias (overestimation of own's skills or result) [2].

Partition dependence is also a cognitive bias that proved to be robust in Prediction Markets [28]. Partition dependence is "[...] the tendency for the specific partition of the state space to influence judged probabilities" [28, p. 11779]. This usually leads to a distribution of probability estimations with a tendency towards uniform distribution [11]. As events with multiple outcomes have to be presented as a set of different stocks in Prediction Markets, they are very prone to this bias.

There are different explanations why each bias occurs based on market mechanism, market liquidity, information spread, or motivation of participants. For example the favourite-longshot bias can be explained by low liquidity that leads to the situation, that in the border areas orders does not get matched, which

[1] Predictions of of polls and betting markets did not much better.

can again be explained with the prospect theory [26]. Other explanations argue with the composition of the field of participants [10], the motivation of the participants, and subsequently incentives [25]. Yet, there is not a clear explanation for all biases in Prediction Markets, but it is shown that warning messages reduces some biases significantly. This already suggests that they happen during the information processing and estimation formation of each individual [33].

2.2 Heuristic Systematic Model

Essentially, previous work that regarded the role of judgment in forecasting and dealt with heuristics and biases focused on self-judgment [17]. Group decision making or crowd-based forecasting is only rarely discussed. However, the initiator of the Good Judgement Project states that in his view "[...] the heuristics- and biases perspective still provides the best first-order approximation of the errors that real-world forecasters make and the most useful guidance on how to help forecasters bring their error rates down." [29, p. 204]

The occurrence of biases is usually explained with the use of heuristics and mental shortcuts during reasoning. When discussing deductive reasoning the idea of two fundamentally different kinds of thinking in human information processing and reasoning is considered since the 1970 [9] and is called Dual-process Theory. The basic concept is that there are two different kinds of thinking [9] from which one is unconscious, fast, automated, and easy and the second is (at least partly) conscious, slow, and effort-full (induces high cognitive load). In Information Systems mainly two DPTs are considered: The Elaboration Likelihood Model (ELM) and the Heuristic Systematic Model (HSM) [32]. Both are variants of the dual-process approach whereas the ELM already suggests its use in the context of information filtering and processing and the HSM is indicating the differentiation between heuristic and systematic processing of information. The HSM is a promising approach to explain the occurrence of biases. It is argued that so-called "heuristic cues" trigger heuristic processing. An example of such a heuristic cue is the partition of the state space.

There are several moderators that can initiate or reinforce systematic (deductive) processing. One such moderator comes in the form of warnings [33]. In addition, expertise, personality, motivation, or external factors such as incentives, time pressure, or task complexity can be considered as moderators. In effect, anything that can influence cognitive capacity or effort can be considered as a possible candidate for the role of moderator [32]. Recently [6] considered the market mechanism (and therefore market complexity) as a moderator of cognitive load. The authors are arguing that the underlying market mechanism has an huge influence on the cognitive load imposed on the participant. According to their classification, cognitive load/complexity is driven by the factors pricing, timing, revisiting and benefit.

3 Method

To evaluate our research question, we developed an online experiment and ran a preliminary test on a small sample. The experiments design is based on [28] and contains three forecasting tasks[2]. In each task, all participants had to estimate the probability of the outcome of an event (continuous variable) falling into certain, predefined intervals. In the case of [28] the forecasting task was conducted on a Prediction Market with a continuous double auction. Our participants faced randomized either as a poll (hidden market design) or a posted-price Prediction Market with a market maker, Logarithmic Market Scoring Rule, LMSR [16]. Participants were assigned randomized to either type. We chose the latter market mechanisms for comparison, as the two interfaces can be designed similarly. In addition to the setting where participants traded alone, a setting where all participants traded in the same market was conducted[3]. According to the understanding of [31], we consider the LMSR market mechanism as more complex compared to the poll, seeing as the estimation has to be mapped into prices first, and then, the trading mechanism has to be understood to calculate which trades can be expected to have a positive outcome. In the classification of [6] this would mean to alter the pricing from "fixed" or "no pricing" to "dynamic pricing", and, therefore, the LMSR market comes along with higher cognitive load.

For each setting (poll or LMSR) and question, we had two distinct and exhaustive partitions of the state space that were shifted by one interval. This is illustrated in Fig. 1, where X is the state space and i are the intervals. The outer

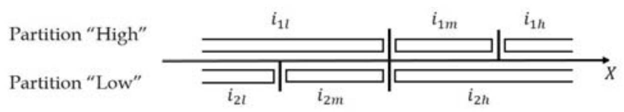

Fig. 1. Schematic partition of the state space and shift between the treatments

intervals (with subscript l or h) are open to the outer sides. In total, there were six treatment groups in which the participants were given three forecasting tasks in a randomized order (between-subject design). The measure of partition dependence pd_x can be calculated by comparing the mean of probabilities assigned to each interval $p(i)$ to the overlapping intervals, e.g. $pd_x = (p(i_{2l})+p(i_{2m}))-p(i_{1l})$.

Similar to [28] we asked for an initial estimation and a final estimation of the absolute value before and after the forecasting task. After the tasks, the participants performed a primary process test which is based on [4], to test whether the dominant type of processing can be measured. Last, we asked about demographics and the participant's general knowledge of the predicted topics.

[2] In our case three economic figures
[3] We refer to the three settings later with "Poll", "Lmsr1", and "Lmsr2"

Based on the considerations above, we formulate following hypotheses: *H1:* The value for partition dependence is lower in the LMSR treatments compared to the poll treatment. *H2:* The portion of systematic processing is higher in the LMSR treatments compared to the poll treatment. *H3:* High experience and knowledge leads to a lower value of partition dependence.

4 Implementation

The participants were asked to forecast the value of three economic figures. The chosen forecasting tasks and partitions for each question can be seen in Table 2. The "midpoint" of the intervals was chosen by the current value, approximately one week before the experiment started. The width of the intervals was chosen by an educated guess of a student in the field of economics, regularly observing this prices, with the instruction that the probability for the two inner intervals should be approximately 50%. Therefore the width of the intervals should not be ill-sized in a dimension, where results should be affected significantly. The task for our preliminary experiment was opened at the 9^{th} December 2016 and closed at the 19^{th}. Students from a university group[4], whose primary purpose is to talk and exchange about stock markets, were invited. Therefore we can assume knowledge about the topics and trading in general. Roughly 300 students were invited from which we received 50 valid answers (participation rate = 20%). The students were incited by three amazon vouchers assigned according to the forecast performance.

Before the participants started with the forecasting tasks, they had to read the full instructions and answer two control questions to prove that they understood the task and if applicable how to trade reasonably.

In the poll setting, the intervals were presented as rows in a table in the first column. The second column included input forms to insert the estimated probability that the event outcome will fall in the interval. In the posted-price market setting the intervals were also presented in the first column, the second presented the current price, and the third the current stocks in the participant's depot. In a fourth column the handles to buy and sell were provided. In addition the trade of "bundles" was possible with two more buttons below the table. A text below the table indicated the current money available. Besides this the screens looked similar. Screens are appended in Fig. 2 and Fig. 3 in the appendix.

After the forecasting tasks, the participants had to solve five "images" of the primary process test by [4], which we displayed each after another. The length of the online experiment depended on the setting. It took between roughly 4 min (poll) and 7 min (market), also potentially depending on how quick participants understood the market.

[4] "Boersen Initiative Karlsruhe e.V."

5 Evaluation

As some participants did not finish the task, the distribution of participants over treatments is not completely equally and reported in Table 3 in the appendix. The results for the partition dependence are reported in Table 1.

First, we compared the partition dependence in the three settings. We used a one-tailed Wilcoxon rank sum test to evaluate whether the partition dependence effect is significant. However, yet our sample is missing statistical power due to its small size. Here we observed that the partition dependence was less in Lmsr2 (around 0.01, no partition dependence) compared to the Poll treatment (around 0.15, weak partition dependence). This finding would, then, support our hypothesis *H1*. Strong partition dependence also occurred in the Lmsr1 setting (around 0.23). This is opposed to our hypothesis *H1* and is an unexpected outcome when contrasted to Lmsr2. It indicates that there must have been yet another factor influencing the results. We presume that this was the so-called anchoring and adjustment bias. In the Lmsr1 treatment, the participants were shown an initial pricing of 33ct for each stock. This priming may have been overloading the effect of the prior ignorance of partition dependence and, subsequently, have led to the strong occurrence of the shift in the estimations. As in Lmsr2 the participants faced the estimation of their predecessor, this effect did not take place.

Table 1. Values for Partition Dependence split by Setting and Task. Significance in column "pd" is tested with a one-tailed Wilcoxon test. $(p > 0.05 : ns; p \leq 0.05 : *; p \leq 0.01 : **, p \leq 0.005 : ***)$

Setting	mean(pd)		Task	pd
			Diesel	0.118
Poll	0.153		Deutsche Bank	0.175*
			DAX-30	0.167
			Diesel	0.250**
Lmsr1		0.227	Deutsche Bank	0.292***
	0.127		DAX-30	0.139***
			Diesel	0.061
Lmsr2		0.012	Deutsche Bank	-0.050
			DAX-30	0.024

Second, the results show that the partition dependence bias is distinctly less visible (in all settings for the task) where participants reported most knowledge and experience. This keeps in line with [11], who argues that participants that are particularly knowledgeable in a certain field will experience less or no partition dependence in that area. Therefore we feel support for our hypothesis *H3*.

We also evaluated the number of times that the initial estimation differed from the estimation in the main task. This was the case when the highest probability was not assigned to the interval into which the initial estimation falls. The high occurrence in our data is a clear sign of the presence of partition dependence, as in such instances "[...] markets are affected by a pervasive bias towards an ignorance prior probability distribution" [27]. In the Poll setting, this occurred in 13 out of 22 cases (59%) far more often than in the Lmsr settings (7 out of 28, 25%). The latter, then, excludes that the results were subject to a sample bias.

As the N in our preliminary experiment is low, we should not yet over interpret the trends, but still derive that the hypothesis *H1* and *H3* may hold in a follow-up experiment, if we manage to prevent the priming by the initial prices and anchoring effects.

We were not able to evaluate *H2* as the data of the primary process test showed no significant effect into any direction. Most participants would have been classified into the systematic processing category. However, participants seemed to choose pictures consistently of either the heuristic or the systematic category. The test of [4] should, actually, be regarded as a personality measure. As heuristic and systematic "thinker" where more or less equally distributed over the Poll and the Lmsr treatments, we conclude that our experiment could not take enough influence to be registered by this personality measure directly after the experiment.

6 Conclusion

The preliminary experiment gave several insights into the way in which partition dependence and market complexity interact. We were able to demonstrate the existence of the partition dependence bias in a posted-price market and a poll as [28] did for a continuous double auction market. Also, the comparison of Poll vs. Lmsr2 supports our underlying hypotheses that a more complex market mechanism reduces partition dependence bias. We cannot, however, say for sure if this effect is moderated by the portion of systematic processing according to the HSM yet. Our conclusion is nonetheless supported by trends found in our preliminary data.

It is necessary to point out that we cannot exclude the occurrence of an anchoring effect from our intervals or initial prices, seeing as the data seems to support its existence. The latter needs to be considered in a further experimental design. It may be helpful to set an anchor intentionally to ensure that all participants are at least biased with the same anchor. To reduce anchoring by the partition, [27, 28] is suggesting, and arguing, to brief the participants that other participants may see other intervals. We may also forgo the Lmsr1 treatment or hide initial prices.

A limitation is that we could not yet say for sure, which "type" of processing our participants used during the experiment. To solve this problem, we may, in the future, consider measuring pupil dilation. Another clear limitation is the small N and the narrow demographic spectrum of the participants. Though with this drawbacks, we were nonetheless able to draw meaningful conclusions and insights from this preliminary experiment that we are now able to include in a follow-up experimental design.

Even if we cannot yet fully verify our hypotheses, we have arguably shown first supporting evidence. Also, we demonstrated a remarkably strong influence of partition dependence in a forecasting task. This can, then, be regarded as a recommendation to forecasters and decision makers: It is necessary to be aware of partition dependence and to consider its influence when designing forecasting tasks.

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7 Appendix

Table 2. Three forecasting tasks with partitions.

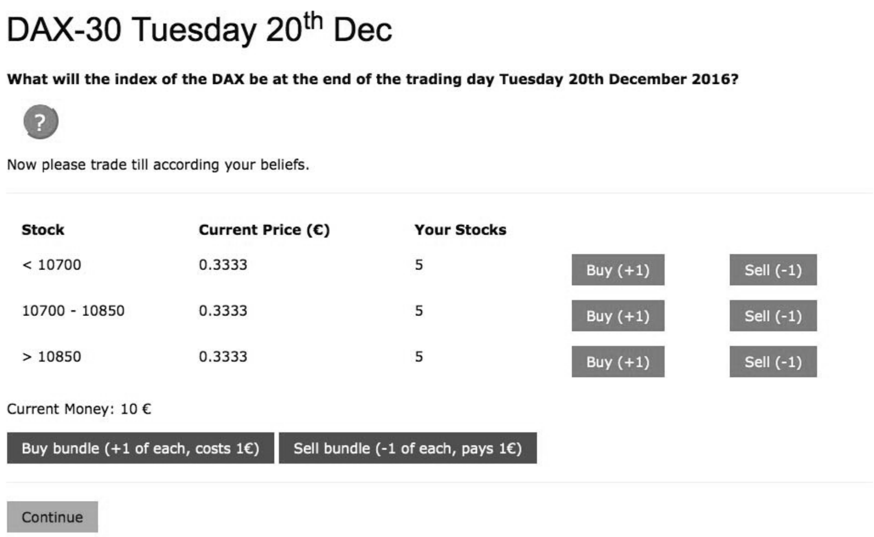
Question	Partition					
What will the price of one litre Diesel (Aral, Durlacher Allee 46) be at 12:00 AM on Tuesday 20th December 2016?	High		<1.075	1.075 - 1.09	>1.09	€/l
	Low	<1.06	1.06 - 1.075	>1.075		€/l
What will the value of the "Deutsche Bank" stock be at the end of the trading day Tuesday 20th December 2016?	High		15.5	15.5 - 17	17	€
	Low	<14	14 - 15.5	15.5		€
What will the index of the DAX-30 be at the end of the trading day Tuesday 20th December 2016?	High		<10850	10850 - 11000	>11000	Points
	Low	<10700	10700 - 10850	>10850		Points

Table 3. Number of Participants per Treatment

Setting	Partition	N(=50)
Poll	High	9
	Low	13
Lmsr1	High	5
	Low	10
Lmsr2	High	4
	Low	9

Fig. 2. Poll setting (DAX-30)

Fig. 3. Market setting (DAX-30)



The 'Initiator Effect': Evidence for an Inherent Seller Outcome Advantage in Asking Price Framed Negotiations

Liuyao Chai and Colin Clark

Department of Management Studies,
University of Aberdeen Business School,
Edward Wright Building, Dunbar Street, Aberdeen,
Scotland, United Kingdom, AB24 3QY.
liuyaochai@abdn.ac.uk

Abstract. In this study of 326 two-person negotiations involving the sale/purchase of a car advertised for sale at a specific asking price, sellers tended to outperform buyers and they did so largely because the specific pre-negotiation asking price had exerted a series of constraints on their initial negotiation behavior. Sellers who repeated their advertised price as their first asking price during their negotiation tended to obtain a better outcome than sellers who did not. Sellers who further repeated their advertised/first announced asking price as their next asking price(s) tended to obtain the best outcomes of all. This price framed negotiation context, and the 'initiator effect' it generated, predominantly accounted for our findings that, contrary to much of the previous negotiation research literature (where buyers regularly outperform sellers), there also was no general outcome advantage for first asking/offer price announcers or for buyers who had opened with a strong/low first asking price.

Keywords: initiator effect, negotiation, uncertainty, framing, anchoring.

1 Introduction

One of the most common—if not *the* most common—of all forms of business negotiations are those which are instigated by a seller's 'invitation (or 'offer') to treat' that includes a specific asking price. (By 'specific' we mean that a single asking/selling price, rather than a price range, is stated and that this price does not have a qualifying phrase—e.g., 'or nearest offer', 'offers over' or 'offers in the region of'—attached to it.) Such prices are widespread in the advertisements employed to sell motor vehicles and real estate. In the building, construction and home improvement/repair trades, price-based tenders and quotes for the provision of work to be done or services to be rendered, once proffered, are then regularly negotiated. Discounts off prices provided by prospective suppliers of requested goods or services are often asked for and, after some negotiation, may eventually be given to individuals, companies (e.g., supermarket chains), government agencies, health service providers, etc. In many countries and cultures bargaining over the stated or

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'ticket' price of an item on offer is an accepted (if not expected) feature of almost every form of buying and selling, especially on street markets and in retail stores. Each of these contexts and cases share one important, negotiation relevant quality: the written, advertised or oral pre-negotiation announcement of a specific asking price sends a clear and unequivocal signal about the seller's aspiration price to a potential buyer that, with very few exceptions, places a socially obligating upper bound on the final outcome price the seller can hope for, can initially ask for and can thus subsequently obtain during any negotiation that may ensue.

Given that such pre-announced asking price framed negotiations are so prevalent in the 'real world', it is surprising that most researchers have concentrated on examining those situations where negotiations are conducted *without* a specific asking price having been pre-announced by the seller. Characteristically, in these studies the seller's (and often the buyer's) aspiration price is *not* made available to their 'opponent(s)', or it is vague, or it is absent altogether, and both the seller and buyer are thereby placed in a situation of relatively heightened mutual uncertainty [e.g., 1-3].

A notable exception to this tendency can be found in the research conducted into the asking prices of real estate vendors. In these studies, though, the focus has firmly been on examining: i) the personal, environmental, social and economic factors that influence sellers' choice of a particular listed/asking price; and/or: ii) the relative impact of various types of 'listed' or advertised asking price strategies—e.g., whether the listed asking price ends in a rounded figure (e.g., £8,500) or is a more precise (and, occasionally, a relatively higher or lower) price than a rounded price (e.g., £8,501 or £8,495) [e.g., 4-6]. We are not aware of any studies that have examined the general impact that specific asking prices *per se* have on negotiation behavior and outcomes.

This paper attempts to rectify this lacuna by examining the influence of a very common form of specific, pre-negotiation asking price (i.e., a specific *advertised* price) in a very common negotiation scenario—the sale/purchase of a used car. Our findings show that the pre-negotiation announcement of a specific asking price by sellers tended to: i) cast a huge and influential shadow over their initial negotiation behavior; ii) had a major impact on the outcomes participants tended to obtain (and, in particular, tended to generate a substantial outcome advantage for sellers); and: iii) reversed, negated or significantly compromised three of the most frequently replicated 'classic' findings reported by those researchers who have examined other, far less common, negotiation contexts and scenarios.

1.1 Study Conducted

Our dataset comprises 652 participants who took part in a two-person negotiation exercise involving the sale/purchase of a used car. The bulk of this data was collected—at three British universities and on eight separate occasions—from: i) six groups of postgraduate (MBA and MSc) business students; ii) one group of postgraduate law students; and: iii) one group of undergraduate business students. On two other occasions we collected data from groups of professional sales/purchasing negotiators (some of whom were now managers of such negotiators) employed at: i) a major European supplier of offshore oil and gas equipment; and: ii) a multi-national motor vehicle manufacturer and retailer. Collectively, these participants—though predominantly British, Chinese, Indian or Nigerian—were from 60 different countries, aged between 19-62 years (*M* = 25.1 years) and had a stated level of "negotiation-involving employment experience" that ranged from zero (68.9%) to 29 years (*M* = 0.94 years). 333 (51.1%) participants were male and 319 (48.9%) female.

Before each of these ten classroom-based negotiation sessions, a 'General Information' handout was sent to the participants describing the car on offer, details of the sale, and the exercise objective (i.e., "Your task is to negotiate with the other person in your group and reach the best possible mutually agreed deal for the sale/purchase of this car."). Importantly, this handout also mentioned that the potential buyer of the car in question was responding to an advertisement the seller had placed in a motor trader magazine—an advertisement which included a *specific* asking price for this car (i.e., "£8,500.").

At the beginning of each negotiation session, participants were randomly allocated the role of the seller or buyer of the car in question, given a 'Confidential Information' handout to read (which included additional and private information pertinent to their particular buyer or seller role), and asked to make "final preparations" for their negotiation. Participants were then randomly placed into buyer-seller dyads and provided with a 'Negotiation Prices' form that was pre-formatted so as to enable them to easily keep a record, during their negotiation, of: i) every asking/offer-related price that was mentioned; ii) the order in which these prices were mentioned; iii) whether it was the buyer or seller who had mentioned each price; and: iv) the final, agreed 'outcome' price at which the car had been sold/purchased. To help standardize the conditions faced by all participants, the same instructor delivered (from a script) the same exercise instructions to each cohort of participants, and the length of time participants were given to read their confidential information handout (40 minutes) and to negotiate with each other (50 minutes) was also the same. Seven dyads did not reach an agreement and had been excluded from our initial dataset, thus leaving the 326 dyad dataset we analysed.

Embedded within the handouts each participant received was a variety of information designed to encourage an outcome settlement within a £1,500 positive and fully overlapping 'zone of *probable* agreement' (ZOPA) that ranged, for buyers *and* sellers, from £8,500 to £7,000. That is, £8,500 was the seller's optimum aspiration price *and* the buyer's walk-away price, and £7,000 was the seller's walk-away price *and* the initial boundary point of the buyer's optimum aspiration price. However, aside from the fact that buyers could readily deduce the seller's aspiration price/maximum possible £8,500 selling price (via the latter's advertised asking price), the information about the seller's walk-away price as well as the buyer's aspiration and walk-away prices was 'confidential' and was made explicit only to the negotiating party for whom it directly concerned.

Of course, this exercise-generated £1,500 ZOPA often differed from the actual 'bargaining zone' established by each dyad as a result of the discrepancy between the seller's first *orally* announced asking price and the buyer's (invariably lower) first announced offer price. Nevertheless, confirmation that the instruction materials for this negotiation exercise had successfully influenced participants to orient to this ZOPA came from the findings that: i) 562 (86.2%) of the 652 participants' first asking/offer prices fell within or on the £8,500–£7,000 boundary points of this zone; ii) the 90 (13.8%) exceptions to this tendency comprised buyers whose first offer price was <£7,000; iii) only 9 (2.8%) of the 326 final outcomes were outside this ZOPA; and: iv) all 9 of these outcomes were <£7,000, the lowest being £6,500.

1.2 Non-Normality of the Dataset

A preliminary inspection of our dataset revealed that the frequency distributions of the first oral asking/offer prices of the sellers and buyers were severely non-normal and significantly differed from one another in terms of their range, shape and location relative to the ZOPA. (As we will see, this was partly a result of the 'initiator effect'.) Consequently, we employed the following non-parametric statistical measures in our study: i) Mann-Whitney *U* tests when investigating sub-group based non-categorical differences in our dataset; ii) Spearman's *rho* when conducting correlation tests; iii) Cliff's delta/*d* (rather than Cohen's *d*) when calculating the effect size estimates for our *U* test results [7]; iv) the non-parametric Levene's test when evaluating the relative levels of variance in the variables compared in the *U* tests [8-11]; and: v) Mann-Whitney adjusted two one-sided tests (TOST) of equivalence to determine the level of similarity between compared samples that were $p \geq .05$ in our *U* tests [12-14]. (Note: i) $\alpha = 0.05$ for all tests reported as being 'significant'; and: ii) whenever we report that two samples were 'not significantly different from one another', these samples were both $p \geq .05$ in the initial *U* test comparison and, in the follow-up TOST test, were deemed significantly equivalent to one another by virtue of being both $p < .05$ *and* within a pre-specified ±10% ZOPA margin level.)

2 Initial Findings

The preliminary inspection of our dataset also revealed two findings that were in marked contrast to what has previously and regularly been reported by negotiation researchers: i) sellers tended to significantly outperform buyers; and: ii) those participants who announced the first oral asking/offer price during their negotiation did not tend to obtain significantly better outcomes.

2.1 Sellers Outperformed Buyers

Negotiation researchers have repeatedly shown that buyers tend to outperform sellers [e.g., 15-20]. In our dataset, however, sellers significantly outperformed buyers (*Mdn* = 60.8% vs. 39.2%). (Note: all 'outcome' measures in this study—unless stated otherwise—refer to the *median percentage of the ZOPA* the tested participant groups tended to obtain as their final, agreed negotiation settlement price.) Sellers were also significantly more likely than buyers to obtain an outcome better than the 50%/£7,750 mid-point of the ZOPA for this negotiation exercise ($n_{sellers}$ >£7,750 = 211/64.7% vs. n_{buyers} <£7,750 = 108/33.1%).

2.2 First Asking/Offer Price Announcers Did Not Tend to Obtain Significantly Better Outcomes

Another common finding by researchers is that those persons who announce the first asking/offer price in their negotiation (‘FPAs’) are significantly more likely to obtain better outcomes than those persons who do not announce the first asking/offer price (‘non-FPAs’) [e.g., 1-3, 24-28]. In our dataset, however, the outcomes obtained by FPAs and non-FPAs (*Mdn* = 50.0% vs. 50.0%) were not significantly different from one another. A Spearman’s *rho* test also indicated that non-FPAs’ first asking/offer prices were not significantly associated with the first asking/offer prices of their FPA opponents and that the correlation between the first asking/offer prices of these two groups was only of a negligible strength (r_s = -.077).

Much of the research cited above has also shown that the outcome enhancing ‘anchoring effect’ of being the first asking/offer price announcer in a negotiation tends to occur irrespective of whether the FPAs were buyers or sellers [e.g., 3]. In our dataset, though, this was not the case. Although FPA sellers tended to obtain a significantly better outcome than non-FPA buyers (*Mdn* = 61.2% vs. 38.8%), seller *non*-FPAs also tended to obtain a significantly better outcome than FPA buyers (*Mdn* = 60.8% vs. 39.2%). Furthermore, tests comparing the outcomes obtained by: i) FPA and non-FPA sellers; and: ii) FPA and non-FPA buyers were, in both cases, not significantly different from one another. In short, in the pre-announced specific asking price framed negotiation context we examined the seller or buyer role the participants played typically had a greater impact on their outcome than whether they had been the FPA or the non-FPA in their negotiation.

Why were our findings so different from other studies that have consistently shown that FPAs typically obtain a better outcome than non-FPAs and that buyers typically outperform sellers? Put simply, none of the aforementioned studies examined negotiations that included a specific, pre-negotiation announcement of the seller’s asking price. We now show that the specific pre-negotiation asking price information (via which our negotiations had ostensibly been initiated and framed) generated a set of constraints on the sellers that, in turn, tended to provide them with a significant *and inherent* outcome advantage over their buyer opponents, and did so regardless of whether the sellers had been the FPA or non-FPA in their negotiation.

3 ‘Initiator Effect’ Findings

In our dataset the specific, £8,500 pre-negotiation asking price tended to constrain sellers, in a variety of ways, from announcing a first asking price *during* their negotiation that was both above and below this asking price.

First, specific pre-negotiation asking prices, like other types of expressed interactional ‘positions’ more generally, are typically imbued with a socially obligating ‘promissory’ expectation that the ‘position-taking’ interactant ordinarily should not and will not depart from their previously expressed interactional position [29]—e.g., that, in the negotiation context we examined, the sellers should not ask a higher price than their advertised price for what they are attempting to sell. In our dataset no seller orally announced an asking price that was over £8,500.

Second, with regard to the specific pre-negotiation asking price also discouraging sellers from announcing a lower first asking price during their negotiation, the sellers were significantly more likely than chance to have orally announced a first asking price of £8,500 (i.e., their advertised price) rather than a lower asking price. 208/63.8% sellers did so and 118/36.2% did not. (Only 163/50.0% sellers would have done so if they had announced this first asking price by chance alone.) This finding suggests that most £8,500 opening sellers engaged in such repetition because they recognized that any lowering of the specific advertised asking price in their first orally announced asking price would have the character of being a concessionary departure from their advertised asking price and would therefore be liable to be treated by their buyer opponent as a weakening of their initial/advertised negotiating position. Moreover, because the specific asking price framed negotiations we studied tended to influence the majority of sellers to open at (and thus repeat) their pre-negotiation asking price as their first oral asking price, most of the sellers ended up creating—by accident or design—an initial, *orally expressed* negotiation position that restated their advertised asking price and, by doing so, strengthened their optimum first negotiation position. Such £8,500 opening sellers not only tended to obtain a significantly better outcome than <£8,500 opening sellers (*Mdn* = 66.3% vs. 56.8%), they also tended to obtain the best negotiation outcomes of all the participant groups we have examined so far, and they did so regardless of whether they were the FPA or non-FPA during their negotiation (*Mdn* = 64.0% vs. 66.7%).

However, both the level of significance and the effect size estimate for the aforementioned test (comparing the outcomes obtained by £8,500 and <£8,500 opening sellers) were unexpectedly small: p = .015; z = -2.43; Cliff's d = .162. This lack of what we anticipated to be a much larger and stronger outcome difference was largely the result of another important way in which the specific pre-negotiation asking price discouraged sellers from announcing a lower first asking price during their negotiation. Not only was the range of first asking prices of the sub-optimum (<£8,500) opening sellers significantly narrower than the range for the first offer prices of those buyers who had opened at an equivalently sub-optimum price (i.e., >£7,000), sub-optimum opening sellers' first asking prices were also significantly more likely to be located closer to their advertised/optimum opening asking price (i.e., £8,500) than the sub-optimum buyers' opening first offer prices were to their own £7,000 optimum opening asking price borderline: <£8,500 sellers: range = 96.7%-33.3% of the ZOPA (i.e., from £8,450−£7,500), *Mdn* range = 16.7%; <£7,000 buyers: n = 172; range = 97.2%-6.7% of the ZOPA (i.e., from £7,042−£8,400), *Mdn* range = 46.7%). This, we believe, was the main reason why even the relatively weaker sub-optimum (<£8,500) opening sellers generally benefited from the initiator effect; they also tended to significantly outperform their buyer opponents (*Mdn* = 56.8% vs. 39.2%) and, again, did so regardless of whether they were the FPA or non-FPA in their negotiation (*Mdn* = 55.0% vs. 60.0%).

We now report the results of two additional sets of tests that provide further evidence of a general outcome enhancing initiator effect for the sellers we studied.

3.1 First Asking Price Repetitions *during* a Negotiation

Because repetitions of the specific £8,500 pre-negotiation asking price predominantly accounted for the sellers' 'initiator effect' outcome advantage, we hypothesized that: i) those participants (i.e., sellers *and/or* buyers) who repeated their first oral asking/offer price as their *next* asking/offer price(s) (hereafter 'repeaters') would tend to obtain better outcomes than those participants who did not; and, more specifically: ii) that £8,500 opening seller repeaters—by virtue of also having repeated their pre-negotiation advertised asking price—would tend to obtain better outcomes than all the other seller and buyer repeater groups. Those participants who repeated their first *oral* asking/offer price (*n* = 73/11.2%) tended to obtain a significantly better outcome than non-repeaters (*Mdn* = 64.7% vs. 46.7%). However, whilst seller repeaters (*n* = 45) tended to obtain a significantly better outcome than seller non-repeaters (*Mdn* = 70.0% vs. 60.0%), there was no significant difference between the outcomes that buyer repeaters (*n* = 28) and buyer non-repeaters tended to obtain (*Mdn* = 41.7% vs. 37.5%). Furthermore, with regard to sellers: i) £8,500 opening repeaters (*n* = 30) tended to obtain a significantly better outcome than £8,500 opening non-repeaters (*Mdn* = 71.7% vs. 63.3%); and: ii) <£8,500 repeaters (*n* = 15) tended to obtain a significantly better outcome than <£8,500 non-repeaters (*Mdn* = 66.7% vs. 56.7%). Also, the outcomes that FPA and non-FPA seller repeaters, £8,500 FPA and £8,500 non-FPA non-repeaters, and <£8,500 FPA and non-FPA non-repeaters tended to obtain were, in each test, not significantly different from one another. Thus, sellers in general, and £8,500 opening sellers in particular, tended to improve their negotiation outcome by repeating their first announced asking price; buyer repeaters did not and, because of the absence of anything akin to a specific, pre-negotiation *offer* price, buyers could not.

3.2 The Impact of First Asking/Offer Prices on Negotiation Outcomes

A third, commonly repeated research finding is that those negotiators who open with a strong (or extreme) first asking/offer price tend to obtain significantly better outcomes than those negotiators who do not [e.g., 25, 30-36]. The findings we have reported above raise the possibility that the significant difference between the outcomes that £8,500 and <£8,500 opening sellers tended to obtain may actually have been the result, in some important part, of the fact that £8,500 opening sellers had simply opened their side of their negotiation with a higher/stronger asking price. We hypothesized that, if this was the case, then: i) similarly strong opening *buyers* would also be likely to obtain the same (high) level of outcome as their £8,500 opening (strong) counterparts; and: ii) similarly weak opening *buyers* would also be likely to obtain the same (reduced) level of outcome as their <£8,500 opening (weak) seller counterparts. In our dataset the direct buyer equivalents of the two strong and weak opening seller groups were those buyer groups that had opened with a first offer price of £7,000 and >£7,000 respectively. This is because both of the strong seller and buyer groups had opened *on* their respective ZOPA borderline and both of the weak seller and buyer groups had opened *within* the ZOPA.

To eliminate the outcome enhancing advantage sellers tended to obtain by repeating their first *orally* announced price, we examined only those participants (i.e., sellers *and* buyers) who had not engaged in such repetition. Strong (£8,500 opening) sellers (*n* = 178) tended to obtain a significantly better outcome than their equivalently strong (£7,000 opening) buyer counterparts (*n* = 58) (*Mdn* = 63.3% vs. 42.2%). In addition, the outcome that £8,500 opening FPA sellers tended to obtain was not significantly different from the outcome that £8,500 opening non-FPA sellers tended to obtain (*Mdn* = 60.0% vs. 60.0%), and the outcome that £7,000 opening FPA buyers tended to obtain was not significantly different from the outcome that £7,000 opening non-FPA buyers tended to obtain (*Mdn* = 43.0% vs. 41.3%). Similarly, the relatively weaker (<£8,500 opening) sellers (*n* = 103) tended to obtain a significantly better outcome than their equivalently weaker (>£7,000) opening buyer counterparts (*n* = 151) (*Mdn* = 56.7% vs. 30.0%) and, again, they did so regardless of whether they were the FPA or non-FPA in their negotiation.

Another test confirmed our finding that the strength of a participant's first asking/offer price was *not* the principal basis for the sellers' general outcome advantage. When we added the strongest group of <£7,000 opening buyers (*n* = 89, *Range* = £6,950-£2,400, *Mdn* = £6,000) to our previous group of strong £7,000 opening buyers—and thereby created a situation where 60.5% of these 147 buyers had opened with a (significantly) *stronger* first price than the £8,500 sellers—the ≤£7,000 opening buyers still did not tend to obtain a significantly better outcome than the £8,500 opening sellers: ($Mdn_{sellers}$ = 63.3% vs. Mdn_{buyers} = 60.0%). In short, our findings suggest that the outcome enhancing 'initiator effect' was not simply, solely or primarily the result of the majority of the sellers having announced the strongest possible (£8,500) asking price as their first orally announced asking price.

4 Conclusion

In the specific, pre-negotiation asking price framed negotiations we examined the 'initiator effect' generated a significant general outcome advantage for sellers, particularly for those sellers who repeated their advertised asking price as their first oral asking price. By making further repetitions of their specific, pre-negotiation asking price/first oral asking price, £8,500 opening sellers tended to obtain the best outcomes of all participants. On average, such seller repeaters obtained an outcome that was: i) 15% better than what sellers in general and non-repeating £8,500 opening sellers tended to obtain; ii) 25% better than what buyers in general tended to obtain; and: iii) 38% better than what ≥ £7,000 opening buyers (*n* = 236) tended to obtain.

Our study also provides evidence which casts some doubt on the generalizability and practical efficacy of three of the most commonly repeated and, indeed, 'classic' negotiation findings to what is probably the most common general business negotiation scenario in the 'real world'—specific asking price framed negotiations. At the very least, we hope to have shown that such negotiations and, more specifically, the wording of the information via which both real-life and research simulated negotiations are instigated and framed, merit further consideration from researchers.

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A Tool for Mapping the Integrative Postures of a Management Team

Sonia Adam-Ledunois[1], Sébastien Damart[2]

[1]University of Rouen, NIMEC (EA 969), Rouen, France
[2]Paris Dauphine University, PSL Research University, DRM (UMR CNRS 7088), Paris, France

sonia.ledunois@univ-rouen.fr, sebastien.damart@dauphine.fr

Abstract. Many studies have examined the roles of managers in organizations. However, very few have drawn explicitly on the concept of integration, which can be usefully deployed, to describe part of managers' functional roles. The purpose of the article is to propose a way of characterising the integrative postures of managers through a mapping tool. This research is concerned with managers' ability to make an entity cohesive while at the same time, accepting the need to differentiate the elements of which it is made up (for example, the various sub-components of an organisation or a team), an ability that is addressed in an heterogeneous literature through the concept of integration. We assume that this kind of ability and orientation has an impact on how managers solve problems and how they should intervene in the various problem-solving processes within the organization. The management team, composed of the organization main unit managers, may be in different configurations depending on each manager integrative skills. Mapping these skills could help recommending the assignment of roles to managers within working groups as well as in the management team. This is the main intention of the mapping tool we propose in this research. Before presenting the tool, we first introduce a literature overview that helps us to identify the dimensions that enable us to characterize a management integrative skill. Second, we present our mapping tool. Then, we propose an analysis of the mapping obtained with our tool, showing that it can highlight various configurations that lead to differentiated recommendations on the managers' roles within an organization.

1 Integration as a key role in groups

Team members have roles. There is an abundant literature on group dynamics that has identified these roles within groups or teams. In this work, to our knowledge, the concept of integration has been little used. The traditional typology of the roles of the members of a group identifies categories of roles [1–3]. Some of them concern the construction of the team and the maintenance of its collective orientation. However, the notion of integration is not really mentioned. However, another literature has, as we shall see below, long ago identified integration as a fundamental part of the manager's activity. We must therefore mobilize this work in order to develop a method for assessing and mapping the integration capacities of members of a team of managers.

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1.1 Integration as part of managers' roles

Our research helps to define better what the role of integration within a team means. Integration is an old management theme and is present in most of the pioneering contributions of this field [4] (or in negotiation field [5]). According to the most traditional approach, integration is a mechanism consisting in satisfying the requirements linked to the mutual interdependence of the subcomponents of a group in an environment that on the contrary forces a certain level of differentiation between them [6]. Integration can be taken in the sense of the coherence of the organization in a context of perpetual transformation.

Integration is a dynamic that can be based on a cultural substrate, an integrating element, designed to develop an identity of sight and a common sense. In this perspective, the manager can be the guarantor of the transmission of organizational culture and value to the different subcomponents of the organization [7]. The manager thus seeks belongingness around shared values and, more broadly, a consensus on what is valued or, conversely, rejected within the group. Managers also play this facilitating or accompanying role in driving change and organizational transformation [8], a phase in which it is important to 're-freeze' cultural and organizational referents.

The concept of integration also reappears when one considers that one of the prerequisites for bringing coherence to the system is to know the organizational system and to be fully aware of its functioning, in particular the interdependencies between subcomponents of the organization. The manager, as an agent of performance improvement processes, must therefore be capable of a broad view of the organization, not reduced to the sub-component of which he/she is responsible [9, 10]. The manager develops a knowledge of the system (in the sense of interacting components forming a whole), its objectives, its stakes in terms of activity and social and political relations [11–13].

Integration can also be taken in the sense of the activity leading to the creation of links and facilitating and securing the processes of cooperation in the organization [14]. The manager is therefore a developer of an environment in which collaborations are facilitated. The manager develops the relationships he/she maintains with the members of the team, in order to develop the sharing of objectives [15]. He/she can also develop relationships with other managers to create linkages and facilitating social support [16]. In the case of cross organizational linkages, the manager plays the role of a boundary spanner [17].

Finally, we mention one philosophical approach to the concept of integration that seems to represent a synthesis of these different acceptations. It is advanced by M. P. Follett in a series of seminal contributions in management and group processes [18, 19]. Integration is a two-dimensional process because it (1) recognizes differences in each and each individual's contribution to overall goal levels and (2) builds on the necessary interdependence of each of the components of a whole. Integration refers to the social process of encountering, confronting and unifying the desires and interests of various parties; it is neither the making of a quantitative compromise nor the result of a distributive negotiation that one of the stakeholders would win. Integration is a qualitative creative process [20]—the confrontation of differences (or, conflict) is sought in order to generate new ideas, and thus a collective mind, feeling and will.

1.2 Evaluating integrative postures

Our research also aims to answer the question of how the capacity of a manager to take the role of integrator in the sense defined above can be appreciated. This question is partially answered in the literature. In the following, we read these answers through the two perspectives that M.P. Follett summarized.

The first perspective (we call dimension D_1) leads to see the integrative manager, as being aware of the interdependencies between problems and team members and being aware of how to fertilize the relationships between each of the components of the organization: thus, the different units in the organization are "decompartmentalized" and the reasoning of the manager mobilizes them all. When managers are able to do so, they show some ability for *systemic* reasoning as opposed to more *analytic* way of thinking.

Research informs us how to evaluate the capacity of integration, according to this first perspective. [21] proposes a method based on cognitive mapping techniques to determine the nature of the potential contributions of a group member to a process of problem structuring. Essentially, one contribution to the structuring of a problem can come from an ability to introduce ideas diversity into the exploration of the problem or the ability to deepen the exploration of certain themes related to the problem.

According to a second dimension (we call dimension D_2), the integrative manager is capable of repositioning the unit of which he/she is responsible in a more global context: the whole organization, the institution or society as a whole; thus the coordination in the organization is naturally guaranteed when the collective objective is fully shared. When a manager has this skill, he/she sees problem through a *holistic* prism instead of a more *individualistic* perspective.

Research that has paid attention to the collective or individual orientation of group members helps to assess part of the D_2 dimension of integration. The orientation towards the team refers to the "shared understanding of the extent to which a team emphasizes learning or performance goals, and, consequently, helps to facilitate group decision-making, collaborative problem solving, and intragroup coordination that maintain the group emphasis on learning or performance goals" [22]. Much research has focused on the relationship between this type of orientation and other variables, both organizational and collective, such as performance or outcomes [23–25], or creativity [26]. Some of these works use proxies that evaluate collective orientation by the level of familiarity of team members with the overall objectives and objectives of other team members or their perception of the level of competition or compatibility between these different levels of objectives.

2 Presentation of a tool mapping managers' integrative capabilities

The analysis tool that we propose aims at the characterization of the integrative postures of each member of a management team. These postures are represented according to dimensions D_1 and D_2. This representation takes the form of a mapping constructed from the discourses that the managers make to talk about the organization, its components and also how they analyze the problems the organization faces.

2.1 Building managers' cognitive maps: a first preliminary step

The tool is fed by a preliminary work of building cognitive maps of the members of the management team. A cognitive map is a tool used to model and analyze an individual's discourse and consists in the reconstruction of discourse in the form of causal relations between concepts, variables or ideas [27]. Traditionally, the cognitive map takes the form of a graph representing a network made up of nodes (representing concepts, variables, ideas) and arcs joining these nodes (representing causal links between concepts, variables, ideas) [28, 29]. Since cognitive maps are a technique often used in analyzing the discourse of managers and managers [30–33], it seems to us that the technique is particularly adapted to the purpose of our tool.

Cognitive maps we use are based on interviews aimed at eliciting the mental representations that a manager builds about a given problem. The choice of the problem to be explored depends on the level of agreement on the existence of the problem. Naturally, the problem explored in the interviews must be the same for each manager we interview. The interviews are semi-directive and are conducted on the basis of an interview grid that allows us to discuss systematically the following topics: the interviewee's itinerary, the functions of the manager, the general situation of the organization and the specific problem explored.

Conventionally, cognitive maps are obtained by encoding transcribed discourses. The coding consists in transforming the transcriptions of the interviews in the form of ideas, called "concepts" in relation to each other. Thus, the causal relations are detected in the transcriptions and entered on a software (yed, software in open source).

Several precautions are taken at this stage. Firstly, each map is constructed from a double coding of the transcriptions of interviews, carried out by two separate analysts in order to limit the occurrence of interpretation biases. Then, the maps take as much as possible the terminology and the words used by the interviewees. Finally, obvious causal links, given the knowledge of the context by the analysts, but which the interview manager would not have evoked are not coded and inserted into the cognitive map.

2.2 Classifying managers' representations: a second preliminary step

On each map, the same systematic analysis is conducted. It is based firstly on the calculation of indicators used conventionally in such a methodological framework

[28]: degree of centrality of variable concepts (number of incoming or outgoing links to or from a concept), internal degree (number of links incoming to a concept) and external degree (number of links out coming the concept). The complexity of the reasoning is thus studied and chains of reasoning are uncovered for each manager interviewed. The individual cognitive maps do not allow direct comparison of the positions of the managers on the two dimensions D_1 and D_2. There is a need to develop a common scale for comparing managers and indicators.

One of the objectives of the tool concerns the position of the manager in relation to his/her professional environment, his/her ability to grasp more or less broadly problems, in short his/her degree of openness. This involves identifying the transversal links (between professional categories, services, units, departments, etc.) that the manager establishes. There is also a need to identify different levels of environment in the discourse of each manager. For this purpose, we refer to the environment according to 6 levels (see Table 1), linked to each other and ranging from a micro level (the individual level) to a macro level (the macro-environment). A thematic analysis of the type proposed by [49] makes it possible to classify the concepts of each manager (on each map) in these 6 classes. This thematic analysis is carried out by double coding, again, to limit the biases of interpretation of the analyst.

Table 1. 6 levels from individual to environment

Levels	Meaning
External environment	Level reflecting what is outside the organization's boundaries, the external environment: the societal environment (demographics, behaviors, technological evolutions, etc.), the environment of the sector and its actors, its regulatory mechanisms (standards, legislation, guardianship, etc.).
Meta Organization	The level refers to institutions related to the organization: group-venture relationships, a network of organizations (without any centralization) or relationships between entities belonging to one same group.
Organization	Level reflecting the organization itself, considered as a homogeneous block
Extended silo	Sub components of the organization with a consequent distance from the manager (units to which the manager does not belong, other professional categories, etc.)
Nearby silo	Sub components of the organization to which the manager belongs (his/her own unit, his/her own professional category, etc.)
Individual	Self-centered level representing personal interests (it includes intimate and private issues)

This classification is questionable because others could be used with more or less the same number of categories. To this criticism, we answer that the scale could be adapted to the context and here we present a kind of generic categorization. The classification makes it possible to assign the elements of discourse of the individuals (the concepts on the map) to the levels of references on which they are centered. The concepts are thus sorted according to whether they refer to the environment, the meta-organization, the organization, the extended silo, the nearby silo or the individual.

2.3 Mapping managers on the two dimensions

The tool produces a mapping of managers positioning them on a two-axis plan. The axis I_1 (corresponding to the dimension D_1, the continuum *systemic* vs. *analytic*) can be described as the intensity of the interdependencies that managers perceive in their discourse between the concepts they have stated. The method of calculating the position on axis I_1 is as follows: let d_i^- and d_i^+ be respectively the internal and external degrees of the concept *i*. Let *n* be the number of concepts evoked by the manager. Then the position on axis I_1 is simply one minus the average absolute difference between d_i^- and d_i^+. The higher is this indicator, the less simplistic are the reasoning chains on the managers' cognitive map.

The axis I_2 (corresponding to the dimension D_2, the continuum *holistic* vs. *individualistic*) can be described as the positioning of the managers according to the levels of the classification described above. The calculation method for indicator corresponding to axis I_2 is as follows. The position of a manager on axis I_2 is the average of the levels of the classification (a scale of 1 to 6) weighted by the maximum degrees of centrality of the concepts of each level of the classification.

Crossing the positioning on the two axis lead us to obtain a mapping of managers. (cf. figures 1&2), the position informing us on the double dimension of integration.

It makes it possible to see, as it appears in the discourse, how well the manager connects ideas (axis I_1 or dimension D_1) and how a manager is able to relocate his/her role and the problems of the organization in a wider context. The mapping does not produce a ranking of the best team members of the management team. Indeed, the positioning at the top right on the mapping could mean a positioning of great value but in reality if all the managers are located on this same quadrant, then the managerial group is probably unbalanced.

3 Analysis provided by the mapping tool

The mapping tool provides two levels of analysis. The first level concerns the analysis of each manager integrative posture and the detection of some possible integrative relay. The second level of analysis concerns the overall configuration in which the management team is.

3.1 Managers level of analysis

Using our mapping technique, one manager is positioned on a two-dimensional plane (D_1 and D_2). There are several scenarios appearing (see figure 1).

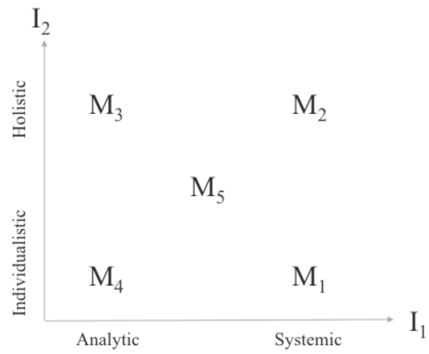

Fig. 1. 4 integrative postures

A manager could be located in the bottom right quadrant (manager M_1) has a clear systemic way of reasoning. Problem solving is approached regarding the situation in its complexity and trying not to reduce it by partitioning the problem into sub-problems. However, the manager limits his/her analysis to a local scale, possibly centered on his/her very close environment. This differentiates him/her from the manager M_2 located at the top right quadrant. M_2 broadens his/her field of analysis by integrating, in a holistic approach, the environment possibly very far from him/her. The M_3 manager located in the top left quadrant is an analytical strategist who has a broad scope of analysis but who simplifies problems by partitioning them. The M_4 manager is no less good. He/she has a mode of reasoning which gives primacy to the ground, the environment close (the team more than the external environment) and the simplification of problems.

The interest of this mapping is to show combinations of postures. Each position on the mapping has its limitations and advantages. It would be a bit simplistic to think that only the manager M_2 is interesting. He/she is somewhat potentially disconnected from the local levels of analysis. On the other hand, it is useful to set up heterogeneous management teams on integrative postures. Some managers in intermediate positions, such as the manager M_5, then play the role of integration relay between other managers (M_2 and M_4 for example) to enrich the process of problem solving.

3.2 Towards a typology of configurations

The second level of analysis consists in studying the configuration to which the management team belongs. We mainly identify 4 situations (cf. figure 2).

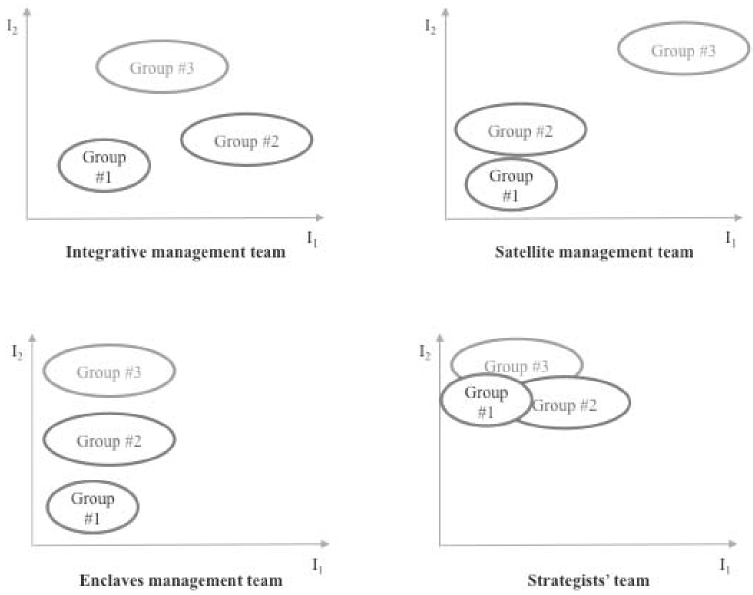

Fig. 2. 4 types of management team configurations

Integrative team: managers deal with issues consistent with their level of responsibility and function within the organization. Managers of group #1 (local managers) are task-oriented and self-centred. Managers of group #2 (middle managers) address coordination issues with respect to individual and local issues. Managers of group #3 (top managers) are open to their environment and make the connection with the internal issues with the relay of managers of group #2. The basic recommendation there is the mixing of managers in working groups. Managers working group work if and only if, the integration relays exist.

Enclave team: each manager addresses issues at a level consistent with his / her responsibilities. The ability of cooperation is totally atrophied; managers are very focused on their entity or business, unaware of the links between their own issues and those of other enclaves. Integration relays are therefore lacking. The different enclaves operate in silos, unconnected with each other. If the top management for example is able to understand global issues and adopt a real strategic vision of the organization, it is disconnected with local constraints and challenges. In this case, the intervention of external agent for problem structuring (vs. solving) could be a smart way to re-introduce complexity in analysis.

Satellite team: the managers of group #3 occupy an elevated position on the right-hand side of the mapping and they are alone there. This corresponds to an awareness of the comprehensiveness of situations and a perfect ability to perceive the interdependence between the different variables of its internal and external environment. Other managers have a narrow and confined vision of their own entity or business scope, without awareness of interdependencies. In this type of configuration, the transverse processes of cooperation are absent. The managers of group #3 are the

central core through which operates integration; they alone support the implementation of internal cooperation mechanisms, descending type of mechanisms.
Strategists' team: each manager has knowledge about global concerns; operational issues are not considered. The operationalization is anarchic since it has been abandoned by the different categories of managers. Local managers are away from their teams; operators must take ownership of the issues neglected by their context and assume some responsibilities (in a non official way). Mutual informal adjustment mechanisms emerge. Regarding global issues, tensions situations or situations of conflict can arise between different categories of manager, all occupying the same territory. The legitimacy of management in its function is tarnished, other managers interfering with problem solving processes theoretically assigned to the top management.

4 Conclusion

Naturally several questions quickly emerge from such a mapping. This is a photo realized instantly. The position of managers on the mapping has no reason to remain stable over time. Learning phenomena lead managers to evolve, becoming aware of the complexity of situations or on the contrary becoming aware of the possibilities of segmenting different categories of problems.

This leads to the perspective of being able to simplify the procedure used to build the mapping, looking for a less time consuming procedure that enables to draw the mapping very fast and very frequently.

One last point concerns the uses that could be made of this tool. Other uses of the mapping may be found. We did not explore for example uses in human resources management: recruitment, training needs identification, etc. However we insist on the fact that the tool focuses on the integrative dimension of managerial work, which is part of the manager job. Moreover, the mapping tool does not take into account the various influence of the environment on the integrative skills. It only gives a photo of them without any possibility to highlight the various influences on them.

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Application of a Hybrid Delphi and Aggregation-Disaggregation Procedure for Group Decision-Making

Andrej Bregar

Informatika d.d., SI-2000 Maribor, Slovenia
andrej.bregar@informatika.si

Abstract. The paper introduces and applies a hybrid procedure for group multi-criteria decision analysis that consolidates a moderated Delphi process with an autonomous aggregation-disaggregation mechanism. It defines appropriate metrics, operators and algorithms to operationalize all steps of the hybrid procedure. The research is based on the assumption that both consolidated approaches can lead to synergistic effects when properly combined. It justifies the hybrid procedure by assessing it with a preliminary qualitative study, which compares the three approaches with regard to a universal framework for the evaluation of group decision-making methods and systems.

Keywords: Multiple criteria decision analysis; Group decision-making; Delphi procedures; Aggregation-disaggregation of preferences

1 Introduction

A wide variety of approaches to individual and group decision-making exist. Two of them are the Delphi technique [15] and the aggregation-disaggregation analysis [14, 18], which are based on diverse core principles. Delphi is a technique of creative thinking, group problem solving and asynchronous communication. It aggregates the opinions of individual group members over several consecutive iterations based on the provided feedback. The disaggregation analysis is based on the presumption that the decision is already known, so it aims at constructing a preference model from global holistic judgements. It has been initially designed for multi-criteria decision analysis in non-group settings, however it was latter applied to many group decision-making problems as well [16, 17]. Although the two approaches are substantially different in concepts, and consequently exhibit fairly unrelated properties, it is the key assumption of the presented research study that they can be, at least to some extent, efficiently combined to lead to synergistic effects. The research goal is hence to introduce and apply an iterative hybrid procedure for quantitative group multi-criteria decision analysis that consolidates an autonomous aggregation-disaggregation algorithm with a moderated Delphi process. Additional goals of the paper are:

1. to operationalize steps of the hybrid procedure by defining appropriate algorithms, operators and metrics, where the focus is on preference specification, preference aggregation, analysis of (dis)agreements, sensitivity/robustness analysis,

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communication, and adjustment of parameters and holistic decisions based on preference disaggregation and relaxation of constraints;
2. to compare the synergistic hybrid procedure with a generic autonomous and fully automated group aggregation-disaggregation procedure, and a generic moderated Delphi procedure that is adapted to multi-criteria decision analysis;
3. to justify the synergistic hybrid procedure by means of a preliminary qualitative efficiency evaluation with regard to a universal framework for the assessment of group decision-making methods and systems [4].

Some aspects of the study have already been presented in the past [3]. This paper, however, (1.) defines the approach completely and thoroughly, (2.) fully operationalizes the hybrid procedure algorithmically and methodologically, and (3.) provides an application of the procedure. Moreover, although research results have been partially presented at a previous conference, they are not available in any publication.

The rest of the paper is organised as follows. Section 2 presents the generic Delphi and aggregation-disaggregation procedures, respectively. Because these procedures are existing approaches to group decision-making, Section 2 also includes a literature review. In Section 3, the hybrid procedure is defined and operationalized. It is applied in Section 4, while Section 5 makes a preliminary comparison of the three approaches and specifies a model to evaluate their efficiency. Finally, Section 6 concludes the paper with a brief summary, some remarks and directions for further work. It should be noted that several details on the hybrid procedure are omitted as a consequence of the length limit of a short paper.

2 Review of literature on consolidated existing approaches

2.1 Delphi method and Delphi processes

Delphi is a structured technique of creative thinking, group problem solving, and asynchronous communication [12, 15]. It is primarily designed to predict future events, but it can be adopted for different purposes, such as identification of alternative solutions, specification of common goals and values, information gathering, and multi-criteria decision-making. Its key characteristics are anonymity of the participants, structured information flow of contributions made by the individuals, regular feedback, moderation, facilitation, and asynchronous interaction [19]. In a Delphi organised process, judgements of individual group members are aggregated over several consecutive iterations, so that participants can modify and unify their opinions on the basis of the provided feedback. Delphi hence consists of a sequence of questionnaires, in which statistics are calculated based on the answers of the last iteration. Compiled statistical information allows each group member to analyse, reconsider and improve personal judgements. In addition, a human facilitator is actively involved to aid group members in understanding their common objectives, and to help identify and eliminate conflicts.

The most common statistical and predictive metrics in Delphi are the measures of central tendency, such as the median, left quartile and right quartile. These metrics can present deviations of alternatives and preferential parameters with regard to the group of decision-makers in the case when Delphi is applied to multi-criteria decision analysis based on numerical preferences. In this way, statistical measures indicate the common opinion of the group and the direction in which the group is heading. Collective learning is also enabled by giving the focus on judgements that are the primary source of disagreements. The perception of statistical measures of central tendency is a part of a broader analysis of judgements, which should be aided by a moderator and thoroughly supported in a computer based Delphi process with advanced techniques for interactive sensitivity analysis and visualization, such as presented in [7, 13].

2.2 Aggregation-disaggregation analysis

The disaggregation approach is confronted with problems from the opposite direction as the traditional multi-criteria decision-making paradigm [18]. It is based on the presumption that the decision is already known, so it tries to find a rational basis underlying this decision in the form of a preference model. By answering the question "How should the preferential model of the decision-maker be specified, so that it would result in the same decision as the one that is already made?", the disaggregation analysis aims at building a multi-criteria model from global preferential judgements regarding a limited subset of referential alternatives which the decision-maker is able to unambiguously evaluate. The reference set of alternatives consists of real decisions providing necessary information on the problem-solving heuristics. It can be a set of available, fictitious or past alternatives.

However, the disaggregation analysis does not suffice to reach any decision, since it merely induces preferential information in the form of input parameters. For this reason, it has to be combined with the process of preference aggregation. The aggregation-disaggregation approach thus introduces two diametral and interchanging phases that (1.) construct a preference model from global holistic judgements (preference structures) of decision-makers that pertain to a limited referential set of evaluated alternatives, and (2.) synthesize induced preferential information into the decision that is valid for an arbitrary set of non-referential alternatives. Iterativeness of aggregation and disaggregation phases has the effect of deepening the individual's knowledge and improving his comprehension of preferences, so it allows for constructive learning [10, 11]. Although the aggregation-disaggregation analysis originates from the domain of individual multi-criteria decision analysis, it has also been applied to group decision-making [6, 8, 9, 16, 17].

In contrast to the Delphi procedure, the aggregation-disaggregation procedure for group decision-making exhibits a higher degree of autonomy. The decision-makers have to specify only initial values of preferential parameters and constraints on these parameters. Afterwards, the decision support system is able to autonomously identify, analyse and resolve discrepancies among group members. In most cases, it can achieve a full automatic convergence towards a consensual solution by iteratively adjusting preferential parameters of contradictive group members within the defined constraints, and in accordance with the collective opinion of the decision-making group. Statistical experiments have shown a high ability of autonomous guidance, conflict resolution, and convergence of opinions [4, 5] for a consensus seeking aggregation-disaggregation analysis based procedure, which has been introduced within the scope of our past research work [6]. It is essential for such a procedure to implement appropriate metrics to identify (dis)agreements in the decision-making group, and to assess the robustness of individual judgements [2].

3 Hybrid procedure

A major weakness of the Delphi procedure is that it requires considerable cognitive effort and intensive manual problem solving from the human moderator and decision-makers. The main drawback of the autonomous aggregation-disaggregation procedure, on the other hand, is that in some cases it is not able to automatically converge towards a consensual solution due to large discrepancies in the decision-making group and too strict constraints on preferential parameters. For this reason, we propose the synergistic hybrid procedure which consolidates both approaches by, presumably, removing their weaknesses and emphasizing their strengths. The hybrid procedure is outlined on Figure 1. Mathematical definitions of algorithms, operators and metrics are excluded as they would exceed the scope of a short paper.

The aggregation, disaggregation and Delphi phases/steps are complementary in the hybrid procedure. They interchange sequentially and iteratively in order to efficiently utilize the concepts of autonomous consensus seeking, constructive learning, problem and preference structuring, computer aided synchronous and asynchronous communication, and decision analysis. At first, the hybrid procedure tries to find the concensual solution automatically with regard to the constraints on preferential parameters, robustness of preferences and alternatives, uniformity and discrepancies among group members, and the direction into which the group is heading. If a complete consensus is not possible, it provides the decision-makers with metrical and statistical data, as well as analytical capabilities. The decision-makers are able to thoroughly analyse and communicate the parameters of the problem situation in a moderated session, and consequently improve their knowledge, comprehension and judgements. They can actively approve or reject adjustments that are autonomously proposed by the decision support system, and modify their individual values, either in the form of preferential parameters or reconsidered holistic decisions, in order to conform to the majority opinion, or to slightly force the collective opinion to move into a different, possibly more promissing direction.

If at least one group member is willing to conform to the majority opinion during the Delphi phase, the procedure continues with the disaggregation phase in which it attempts to infer new values of preferential parameters by obeying the constraints that were preliminary set by the decision-makers. In the case that the solution is not feasible, it is the decision-makers' turn to relax the constraints. When the constraints are successfully relaxed, the disaggregation analysis is performed again for the changed setting, otherwise the aggregation and Delphi phases are iteratively repeated.

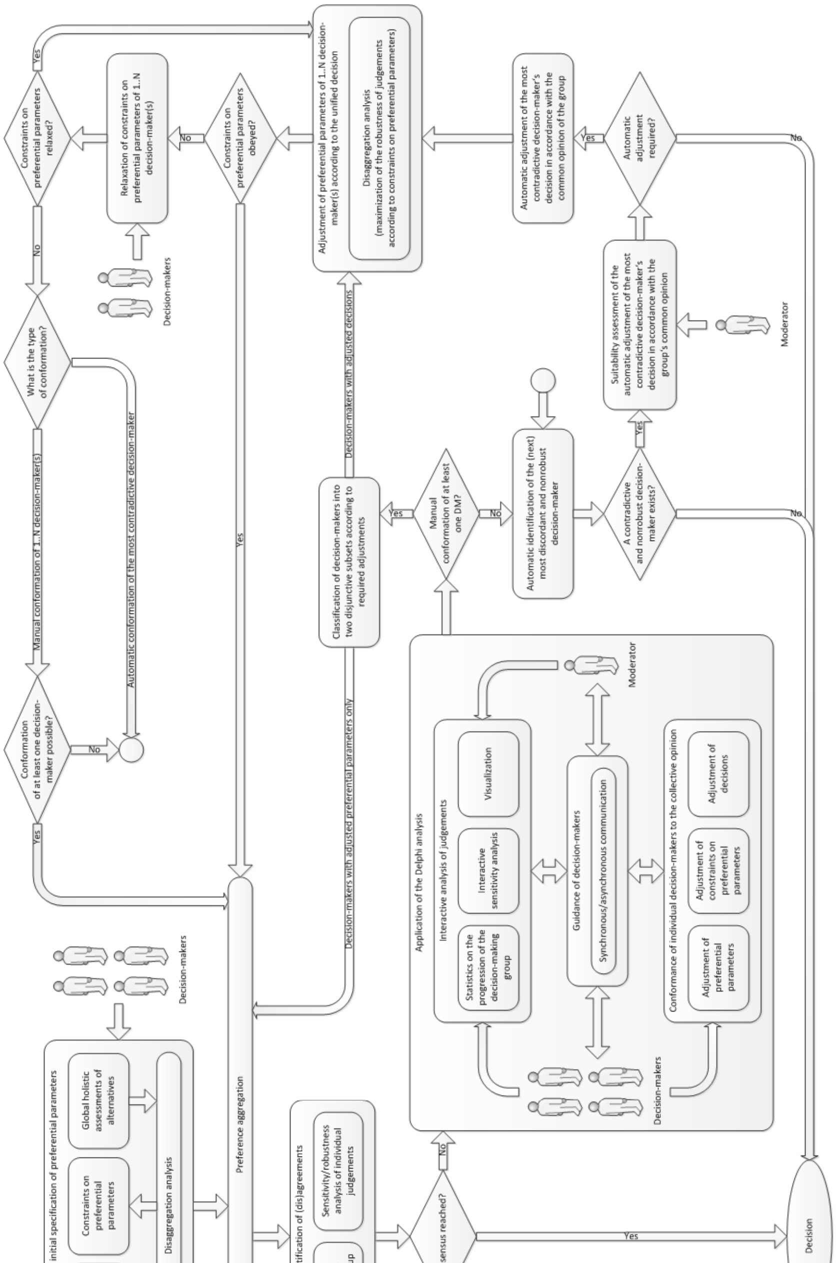

Fig. 1. Hybrid procedure

If no group member is willing to conform during the Delphi phase, the hybrid procedure autonomously determines the most discordant decision-maker with non-robust preferences. The moderator is given the opportunity to approve the suitability of this individual to align with the group. According to the moderator's decision, the group member may be skipped, and the next most discordant one chosen for conformation.

The procedure eventually ends with a consensus, a satisfactory compromise, or without a commonly accepted solution. However, it can be argued that the possibility of the least desirable last outcome is substantially smaller as in the case of the generic Delphi procedure or the generic aggregation-disaggregation procedure. Moreover, the hybrid procedure applies several complementary mechanisms that enhance the quality of the problem solving process, even if an unanimous decision cannot be reached.

4 Practical example

This section provides a brief example on the application of the proposed procedure. Some of the key concepts are presented with regard to the first iteration of the group decision-making process. A broader and more thorough presentation would exceed the scope of a short paper. It can be obtained upon a request from the author.

The goal of the decision-making process is to collectively select a subcontractor for a software development project. The decision-making group consists of six decision-makers, who represent middle management, domain analysts and technical experts. They are able to choose from the set of eight alternatives. For clarity, only five criteria are considered, which include costs, required time, number of successfully completed referential projects, experience with similar applications, and suitability of technology and architecture. All criteria are quantitative. If a non-boolean criterion is not directly measurable, as for example experience with similar applications, it is assessed on a numerical scale of [0, 100]. Preferences are elicited in the form of an outranking model, however the specified values and constraints of preferentail parameters are omitted in this section. After the aggregation of initial preferences, the decision support system calculates metrical and statistical data based on a number of metrics as the input to the Delphi and disaggregation phases.

The first subset of metrics deals with the unanimity of the decision-making group. Two types of metrics are computed. The degree of consensus pertains to an alternative, so that it shows how much uniformity there is among all group members with regard to the evaluation of this single alternative. The agreement degree expresses to what extent an individual decision-maker is concordant with all other members of the group. The consensus and agreement degrees are summarized in Table 1 and Table 2.

Table 1. Consensus degrees.

Alternative	a_1	a_2	a_3	a_4	a_5	a_6	a_7	a_8
Degree of consensus	0.333	0.000	0.333	0.667	0.333	1.000	0.667	0.333

Table 2. Agreement degrees.

Decision-maker	DM_1	DM_2	DM_3	DM_4	DM_5	DM_6
Degree of agreement	0.338	0.188	0.538	0.388	0.388	0.538

The robustness degrees in Table 3 indicate to what extent the values of preferential parameters must be modified for different decision-makers so that rankings or assignments of alternatives, respectively, are forced to change.

Table 3. Robustness degrees.

Alternative	DM_1	DM_2	DM_3	DM_4	DM_5	DM_6
a_1	1.000	0.263	0.434	0.145	1.000	0.608
a_2	0.443	0.399	0.225	0.102	1.000	0.020
a_3	1.000	0.053	1.000	0.000	1.000	0.742
a_4	0.413	0.194	0.202	0.092	0.246	1.000
a_5	0.357	0.345	0.044	0.115	0.321	0.436
a_6	1.000	0.541	1.000	0.366	1.000	1.000
a_7	1.000	0.288	0.422	0.172	1.000	0.231
a_8	0.172	0.724	0.263	0.408	0.142	0.439

Based on the agreement and robustness degrees, the decision support system can autonomously determine which decision-makers should be asked to conform to the collective opinion of the group. As it is presented in Table 4, the decision-makers are ordered by the descending suitability for conformance, from the one whose judgements are the most contradictive, and are not based on sufficiently robust preferential information. The details for the most discordant decision-maker are shown in Table 5, where alternative a_2 is considered as moderately robust, and hence not approprite for reevaluation.

Table 4. Conformations of decision-makers.

Rank order of DMs for conformation	DM_2	DM_4	DM_1	DM_5	DM_3	DM_6
Reevaluation of alternatives feasible	Yes	Yes	Yes	Yes	Yes	Yes

Table 5. Parameters of the disaggregation analysis for the most discordant decision-maker.

Alternative	a_1	a_2	a_3	a_4	a_5	a_6	a_7	a_8
Value	0.688	0.725	0.600	0.750	0.700	0.267	0.588	0.900
Degree of robustness	0.263	<u>0.399</u>	0.053	0.194	0.345	0.541	0.288	0.724
Degree of agreement	0.200	0.400	0.200	0.000	0.600	1.000	0.000	0.600
Reevaluation required	Yes	No	Yes	Yes	No	No	Yes	No

It is possible that only a few, or even none, of the decision-makers are capable or willing to conform to the group, at least according to the results of autonomous calculation. In such cases it is crucial to additionally observe and analyse the statistical Delphi measures of central tendency, and to manually reconsider and readjust personal preferences with the aid of moderated communication. Tables 6 to 8 present the Delphi statistics for the first iteration of the decision-making process.

Table 6. Central tendency measures for criteria weights.

Criterion	x_1	x_2	x_3	x_4	x_5
Min	0.100	0.050	0.100	0.200	0.100
Max	0.400	0.300	0.250	0.300	0.300
Mean	0.242	0.183	0.167	0.217	0.192
SD	0.093	0.085	0.055	0.037	0.061

Table 7. Central tendency measures for cardinal assessments of alternatives.

Alternative	a_1	a_2	a_3	a_4	a_5	a_6	a_7	a_8
Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.316
Max	0.688	0.725	0.600	0.750	0.886	0.267	0.588	0.900
Mean	0.286	0.342	0.212	0.364	0.467	0.089	0.260	0.644
SD	0.258	0.278	0.248	0.232	0.321	0.115	0.208	0.235

Table 8. Central tendency measures for rankings of alternatives.

Alternative	a_1	a_2	a_3	a_4	a_5	a_6	a_7	a_8
Min	2	3	4	2	1	4	4	1
Max	5	6	8	7	4	8	7	2
Median	5	4	6	3	3	7	5	1

After the adjustments are confirmed by the moderator and decision-makers in the Delphi phase, the decision support system infers new values of preferential parameters in the disaggregation phase. If consensus is not reached in the current iteration, a new subsequent iteration is started. Table 9 shows that the decision-making process converges towards a near consensual solution in seven iterations.

Table 9. Convergence of opinions towards the consensus.

Iteration	1	2	3	4	5	6	7
Total consensus	0.458	0.625	0.750	0.792	0.833	0.875	0.917

5 Comparison and preliminary evaluation of approaches

Figure 2 presents a phase based comparison of procedures. It shows that the design of all three approaches utilizes almost the same key decison-making phases. In this regard, the procedures are directly comparable. Delphi lacks the disaggregation phase, while the aggregation-disaggregation analysis does not support any communication mechanisms and manual analytical capabilities. The hybrid procedure consolidates and unifies all phases, which could lead to synergistic effects.

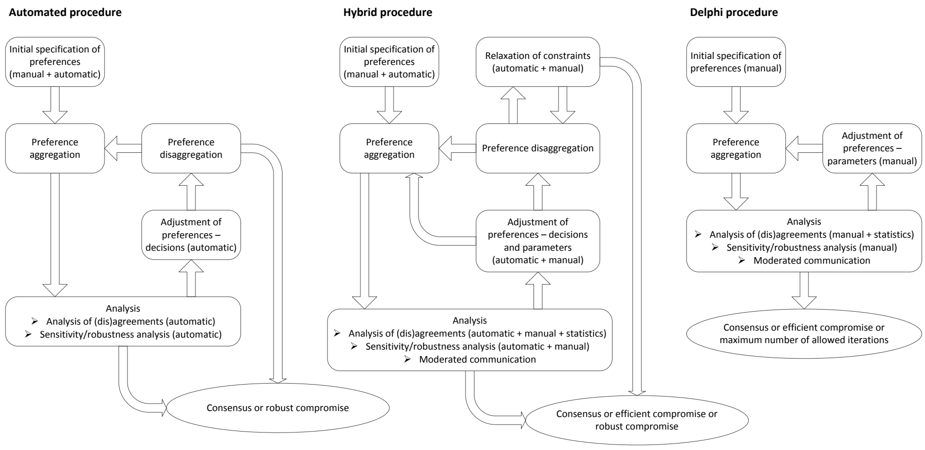

Fig. 2. Phase based comparison of procedures

In order to assess the efficiency of the proposed hybrid procedure and to justify its application, the general framework for the evaluation of group decision methods and systems [4] may be used. A preliminary descriptive comparison of the three approaches has already been made with regard to many criteria that deal with ability of autonomous guidance, conflict resolution, convergence of opinions, fairness, communication efficiency, asynchronous interaction, complexity of analysis, credibility and thoroughness of analysis, accuracy and validity of output data, robustness, problem abstraction, focus on problem solving, and ability to learn.

6 Conclusion

Group multi-criteria decision-making processes may be supported either by the Delphi method or by the aggregation-disaggregation analysis. It was shown that both approaches can be combined. The proposed hybrid procedure is designed to result in the synergy of all key concepts of both "philosophies", in such a way that majority of drawbacks are overcome, while benefits are emphasized. However, although a relevant set of assessment criteria was identified, the hybrid procedure was only assessed preliminary in a less formal descriptive manner. For this reason, its efficiency will be more thoroughly evaluated with a simulation study and a case based study of real-life decision-making problems within the scope of further research work.

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Exploring Global Assimilation and Impacts of Collaborative Information Technologies

Deepinder S. Bajwa[1], L. Floyd Lewis[1], Graham Pervan[2], Vincent S. Lai[3]

[1]Western Washington University, Bellingham WA 98225, USA
[2]Curtin University, Perth, Western Australia 6845
[3]Chinese University of Hong Kong, Hong Kong

Deepinder.bajwa@wwu.edu, Floyd.lewis@wwu.edu, Graham.Pervan@cbs.curtin.edu.au, vslai@cuhk.edu.hk

Abstract: This paper reports on a global study investigating the assimilation and impacts of Collaborative Information Technologies (CITs). We identify four states in the assimilation of CITs including: limited assimilation, lagging assimilation, focused assimilation, and pervasive assimilation. Our aggregate analysis of data collected from 607 organizations in Australia, Canada, Hong Kong, and the US provides the state of global CIT assimilation. Furthermore, we found significant differences in perceived organizational impacts of CITs between limited and pervasive assimilation states. Implications of our findings are discussed for research and practice.

Keywords: collaboration information technologies, assimilation, impacts.

1 Introduction

Information Technology (IT) enabled collaboration continues to gain popularity in organizations around the globe. Commonly known as Collaborative Information Technologies (CITs), these applications can support teams (co-located or virtual) working together to accomplish common tasks irrespective of time, distance, and organizational barriers. The global market for CITs was estimated to reach almost $20 billion by 2015, resulting in a CAGR of 10.4% (http://www.marketsandmarkets.com/Market-Reports/web-conferencing-388.html). Future forecasts for some regions (U.S., Germany, UK, Italy, Russia, China, India, Japan, South Korea, Brazil, Mexico, Saudi Arabia, UAE, and South Africa) are equally promising as predictions suggest a 13% CAGR from 2016 to 2024, exceeding $8.5 billion by 2024 in these regions (https://www.gminsights.com/industry-analysis/collaboration-software-market). Over the years, CITs have received a lot of attention from practitioners and academic researchers (for a review, see [3] and [4]). However, despite their widespread reach and growing popularity, exploring CIT assimilation and their organizational level impacts have not been globally researched. Our research attempts to fill this void.

There are many CITs available on the marketplace. Our study focused on four clusters of CITs that include:

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- *Conferencing technologies* (for example, GoToMeetings, WebEx, MS office Live Meeting, CU-SEEME, Evoke, Skype, Windows Live Messenger, AIM, etc.)
- *Technologies supporting online communities* (for example, Intranets, Listservers, Newsgroups, Blogs, eGroups, Open Topics, etc.)
- *Proprietary groupware* (for example, IBM Lotus Notes when used beyond email, Novell Groupwise, Oracle Collaboration Suite, MS SharePoint, etc.), and
- *Electronic meeting systems* (GroupSystems, MeetingWorks, Facilitate.com, etc.).

2 Study Methodology

In the first phase, we undertook case studies to understand more about collaboration, how CITs were used in organizational settings, and their potential impacts. Next, we deployed the approach suggested by Sethi and King [5] to develop a survey instrument. This included an extensive review of the literature to identify CIT impacts (case studies, practitioner reports, and empirical studies of CITs). The first phase provided inputs to the second phase where we developed a survey instrument to assess CIT assimilation and their potential impacts on organizations. In the third phase, the survey instrument was pilot tested in three organizations. Feedback from the pilot test was used to slightly modify the survey instrument for clarity of the item measures. In the fourth phase, data was collected in four global regions including, Australia, Canada, Hong Kong, and the USA over a period of 4 years.

The survey instrument was mailed to the CIOs of the top 500 Australian organizations. In Hong Kong, it was mailed to the highest ranking MIS manager in the top 400 organizations. In Canada and the USA, an electronic mailing was sent to member organizations of Ziff Davis, Inc. A cover letter accompanying the survey identified the broad purpose of the study and requested the recipients to forward the survey to the person most knowledgeable about IT-supported collaboration in their respective organizations. Clear instructions and definitions of terms and concepts were provided on the survey to assist and guide respondents. Multiple mailings and reminders were sent out to boost response rates in all the regions. We received responses from 73 organizations in Australia, 55 organizations in Canada, 94 organizations in Hong Kong, and 385 organizations in the USA (see figure 1).

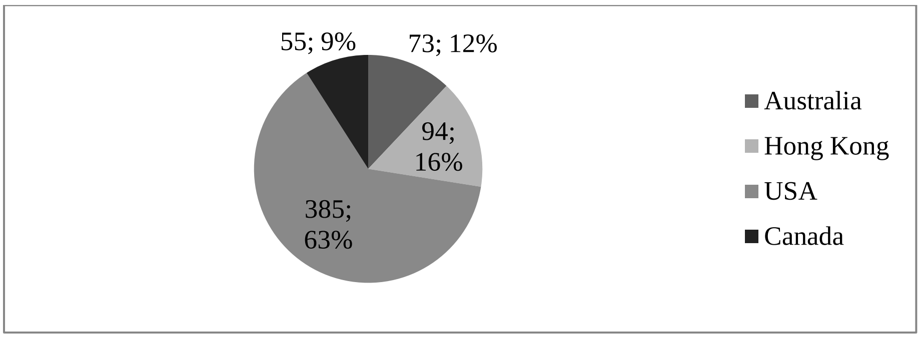

Fig. 1. Regional responses

Four hundred and fifty three respondents identified their managerial position. These positions were categorized into three management levels. Top tier level included responses from Presidents, CIOs, CFOs, COOs, vice presidents, and directors. Middle tier included responses from general managers, administrators, and managers from functional areas. Lower tier included responses from senior analysts, engineers, consultants, and other supervisory positions. Figure 2 shows the management level of the respondents. Thirty three percent of our respondents belonged to the top tier and 41 percent to the middle tier.

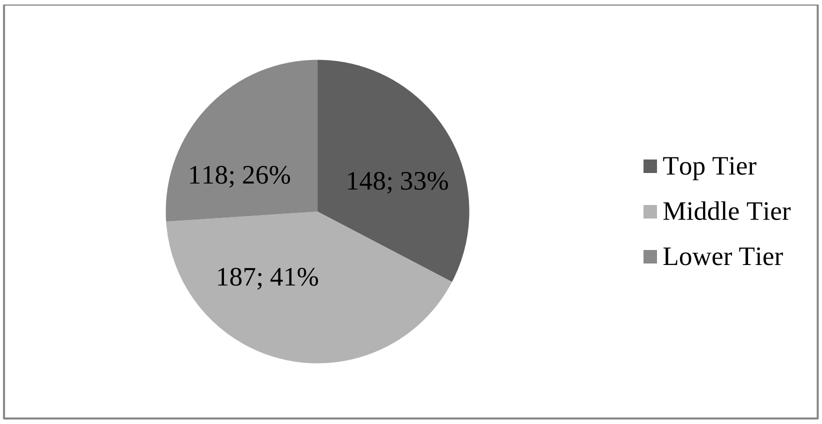

Fig. 2. Management levels of respondents

3 Organizational Assimilation of CITs

We collected data on the extent to which each of the four CIT clusters were accessible and used by end-users for collaboration in their respective organizations. We deployed a five point scale (1 = no one, 2, 3 = some people, 4, 5 = everyone) to measure access. Another 5-point scale (1= not used, 2, 3 = occasionally used, 4, 5 = always used) was deployed to measure the use of each of the four CIT clusters. The original 5-point scales were converted to 4-point scales to exclude those firms that provided no access and no use of any of the four CIT clusters. The means (ascending order) of responses from the global sample are shown in figure 3. The results indicate that conferencing technologies have the highest access and use while electronic meeting systems have the lowest access and use.

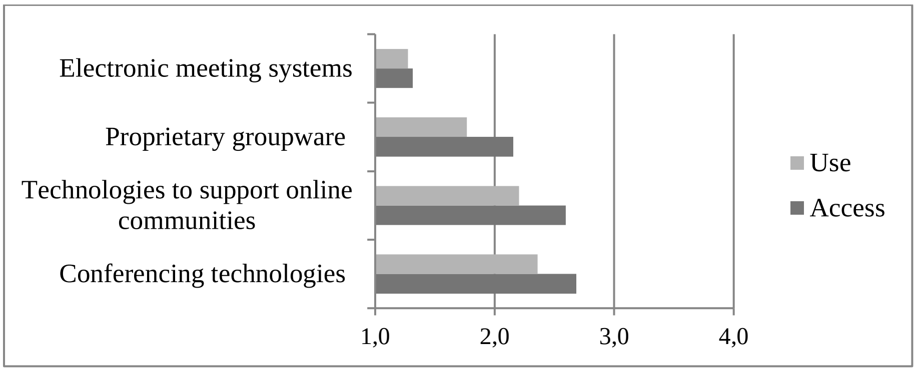

Fig. 3. Organizational access and use of CITs

Based on the level of access and use, an assimilation framework [1] was deployed to map the assimilation patterns of CITs. For simplicity, mid- points of the measurement scales were used as the cut-off points for low and high levels of access and use of CITs. Figure 4 shows the four assimilation states. According to innovation theory, once CITs are adopted, they can remain in the *limited* assimilation state or transition from *limited* to *lagging* (and finally) to *pervasive* states or they can transition from *limited* to *focused* (and finally) to *pervasive* states. Depending upon assimilation trends, it is plausible that each state may present itself as the end state in the assimilation of CITs. Therefore, transitioning from *limited* assimilation to other stages is not necessarily a natural phenomenon that is dictated by time. There can be several barriers to CIT assimilation. For example, cost, technical support, usefulness of CIT, negative impacts (increased information overload, increased fragmentation of work, decreased management control, decreased independence etc.) may impede assimilation in organizations who may choose to retain *limited* assimilation status rather than transition to other states.

Five hundred and forty-two firms in our sample were classified in the framework. The remaining 65 firms did not provide information on both access and use of CITs. *Limited* assimilation represents low CIT access and use. Two hundred and forty one (44.5%) of the firms were categorized in this state, indicating that the majority of the firms in our global sample provided access to only some end-users who used the CITs occasionally or less frequently to collaborate.

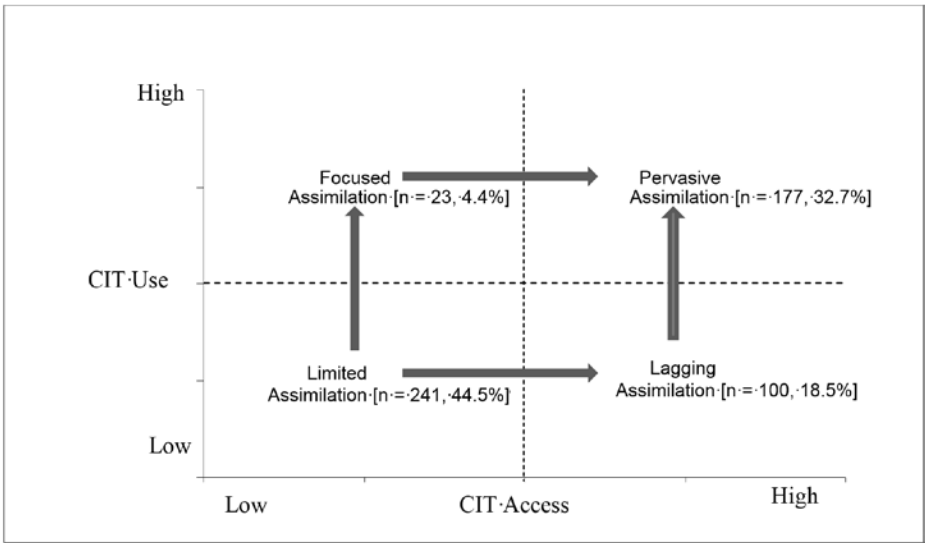

Fig. 4. CIT assimilation framework

Lagging assimilation represents a state where CITs are made accessible to more than some end-users who use them occasionally or less frequently to collaborate. One hundred of the firms (18.5%) in our sample were categorized in this state. *Focused* assimilation represents a state where CITs are accessible to some end-users who use them more than occasionally to collaborate. Only 23 (4.4%) of the firms were categorized in this state. *Pervasive* assimilation represents a state where CITs are accessible to more than some end-users who use them more than occasionally to collaborate. One hundred and seventy seven firms (32.7%) were categorized in this state, indicating that many firms in our global sample have the highest (perhaps desired) assimilation level of CITs.

4 Perceived Impacts of CITs

After reviewing the literature, we identified 14 potential impacts (internal and external) resulting from the use of CITs. These included: improvements in existing products/services, improved relationships with customers, suppliers, and business partners, improvements in existing business processes, structural changes, time savings, quick reaction to changes, increase peed of decision-making, increased productivity, appropriate responses to changes, facilitation of innovations, improved quality of decisions, and marketing the right products/services.

We deployed a five point Likert-type scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree) to measure the level of agreement with each of the impacts resulting from the use of CITs. There was higher agreement with time saving to accomplish tasks, improvements in existing products/services, improved relationships with customers, and improved business processes than with any of the other impacts. Figure 5 shows the impacts of CITs in *limited* and *pervasive* assimilation states.

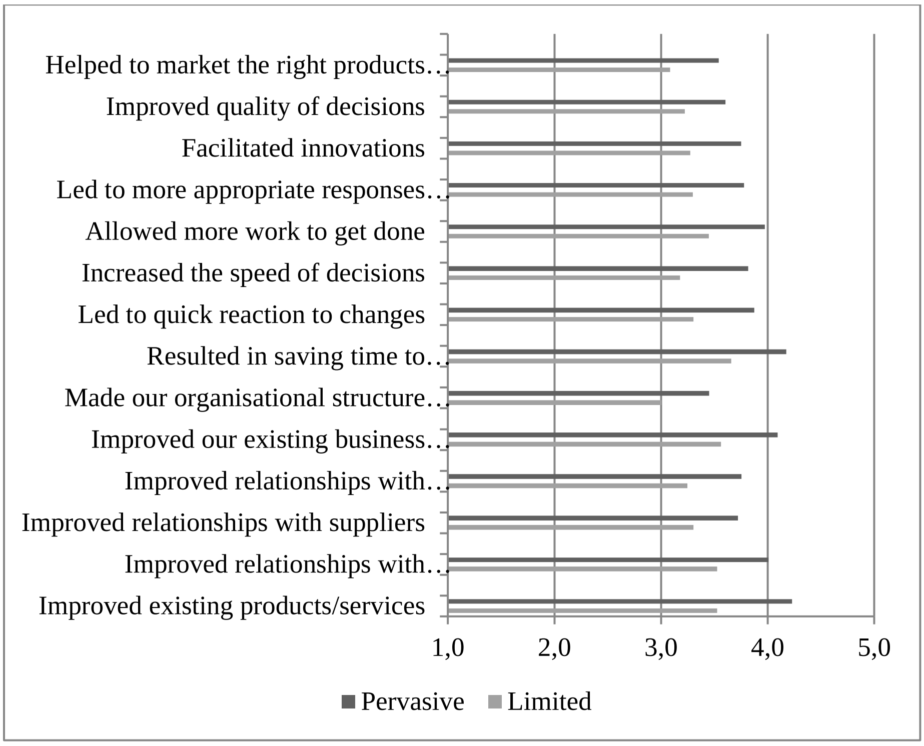

Fig. 5. Organization impacts of CITs in limited and pervasive assimilation

5 Discussion and Implications

From the standpoint of CIT assimilation, our findings provide a benchmark for the state of organization-level collaboration. Business and IT executives can benefit from assessing the current state of collaboration and the reach of CITs in their own organizations. We have deployed the IT assimilation framework [1] to identify four CIT assimilation states. In our sample, the majority of the organizations were classified in the *limited* assimilation state. Even though collaboration could be driven by users, business partners, in-house IT professionals, or vendors/consultants, business executives may have to take a leading role in providing an impetus to resolve CIT assimilation issues in this state. They need to assess the desired level of collaboration to accomplish organizational goals and objectives in order to sustain their competitiveness and then create the context that promotes collaboration.

Although *focused* and *lagging* states are expected to be transitional in nature (only 22.9% of the organizations were classified in these states), organizations may "freeze" in these states for an undesirably longer period of time. In the *lagging* state, organizations may be constrained by the inadequacy of cultivating a culture for CIT use. Simply providing access to CITs does not necessarily result in greater level of use. The role of business executives should be to nurture a collaborative culture while IT executives should promote greater awareness of CITs and end-user support for collaboration if these organizations desire to transition to the *pervasive* state. After all, the corporate culture is critical to either support or inhibit innovations in IT [6]. In the *focused* state, CITs are used more than occasionally but only by some employees. The CIT culture is prevalent in patches in these organizations. Organizations in the *pervasive* assimilation view collaboration as the key (a critical factor) to enhance organizational performance and improve competitive positioning. Collaboration is tightly inter-twined with their organization's capabilities and strategy. Executives must address the growing popularity of conferencing technologies and technologies supporting online communities as the proliferation of intelligent handheld devices increases world-wide. Use of traditional CITs like electronic meeting systems and proprietary groupware is likely to be less extensive as they are expensive, propriety in nature, hard to use, and therefore may not support a wide range of collaboration activities and expectations.

From CIT impacts standpoint, all of them are significant as there is more agreement than disagreement in our responses. Our findings at the organization-level are consistent with research that suggests a positive impact of CITs on collaboration quality and performance, including reduced time, better decision quality, improved relationship, and decreased cost [2]. As for the implications, business executives must recognize the potential of CITs from a strategic standpoint. Our research has identified fourteen impacts of CIT use. These impacts can be viewed as internal and external.

The internal impacts enhance the efficiency and effectiveness of the organization. Some of these impacts (time savings to accomplish tasks, accomplishing more work, increased speed of decision making etc.) can be realized in the short-term. Others (improvements in existing business processes and existing products/services, quality of decision-making, facilitating innovations, quick reaction to changes, and flatter organization structure etc.) are long-term impacts.

External impacts on the other hand, lead to better competitive positioning. For example, improvements in relations with suppliers, customers, and business partners can increase the transparency in the value chain. As a result, organizations can better leverage the competitive forces to maximize wealth for all the entities in the value chain. It must be pointed out that these external impacts can also have significant influences on some internal impacts. For example, improving relationships with customers by collaborating with them could lead to improvements in existing products and services. IT executives, on the other hand, must understand that the potential scope of organizational collaboration extends across organizational boundaries. Accordingly, they must appropriately address the scalability of their organization's IT infrastructure, security issues (as data and information is exchanged over the Internet), network management, end-user support, and vendor support for successful collaboration.

5 Conclusions

In this paper, we have extended our previous reach by investigating CIT assimilation and their impacts as a global phenomenon. We have intentionally not tried to make any regional comparisons as that research has been presented elsewhere. Our objective here was to present aggregate results from data collected in four global regions.

Collaboration is a complex phenomenon. However, CITs have the capabilities to support many collaboration activities and their use can have a wide range of impacts, both internally and externally. Our study provides evidence to support this notion. The CIT assimilation framework can be useful to understand diffusion patterns and to assess the current state of IT-enabled collaboration at the organizational level. Business and IT executives should critically address the potential of CITs in their respective organization, as these technologies can enhance organizational performance and improve relationships with other entities in the value chain. Our findings provide valuable insights for executives as they embark upon CIT assimilation efforts.

Despite the contributions, our research has some limitations. First, our research is exploratory in nature and we have not proposed any hypothesis to confirm causal relationships. Second, the data was collected over a long period of time and there could be some lag effects of CIT assimilation in the study regions. Third, a single respondent was used to collect data in each organization. While we made every effort to reach the respondent most knowledgeable about CIT assimilation in each organization, our survey could have been misdirected. Finally, the majority (63%) of our respondents belonged to organizations in the USA. Given the global focus of our research, it is plausible that our results could be biased. Nevertheless, our study furthers research on global CIT assimilation and their organization level impacts.

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A Decision Support System for Multiple Criteria Decision Making Problems

Morteza Yazdani[1,*], Soumana Fomba[1,2], Pascale Zarate[1]

[1] IRIT, Toulouse University, 2 rue du Doyen Gabriel Marty 31042 Toulouse Cedex 9 – France
[2] IRIT Université des Sciences, des Techniques et des Technologies de Bamako (USTTB) - Hamdallaye ACI 2000 - Rue 405 - Porte 359 -BP E423 - Mali
morteza.yazdani@irit.fr (corresponding author*), soumana.fomba@irit.fr, pascale.zarate@irit.fr

Abstract. Configuration of a system for decision making problem which facilitates decision process and enables users to get higher quality advantages is a deal always in academic communities. This paper deals with proposing and constructing decision making system performing online software. The system implements the algorithm of MOORA and COPRAS techniques with an example of robot selection to test the applicability and validate multi criteria decision problem results. Results shows COPRAS and MOORA ranking of robots are very close to each other especially the 1st and second top alternatives. The software can be extended to the other decision making problems as well.

Keywords: decision support system (DSS), multiple criteria decision making (MCDM), complex proportional assessment (COPRAS), multi objective optimization based on ratio analysis (MOORA), STROMa (SysTem of RecOmmendation Multi-criteria)

1 Short Introduction

Operation research is a discipline with wide range of concepts and logics from mathematical modelling and programming to efficiency and productivity measurement in order to aid us in complex and parametric decision problems. Multiple criteria decision making (Thery and Zarate, 2009; Yazdani et al. 2017) family as a major category of operation research has been discussed in order to facilitate evaluation and selection problems. Adopted algorithms, integrated formulas along to mathematical and logical approaches lead to the development of decision making methods. Multiple criteria decision making (MCDM) forms a perspective in decision theory which facilitates business processes in practice (Ghorabaee et al. 2017; Mardani et al. 2016) Zavadskas and Turskis (2011) believe developing economics, changing environment, sustainability of decisions are the reasons to develop new operation research techniques and specifically decision making approaches. A decision support system is defined a database, algorithm and user

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interface within a computer or operating system which can handle the whole decision making process in a visualized form. It can enhance quality and reliability of decision system.

In the real world issues, to overcome the complexity of the decision problem, we need to utilize the methods that are user-friendly and consider less computation to achieve the reliable solution. Mostly some decision support system comes up with simple methods like weighted product or simple additive tools. Rather than this the literature is saturated of using TOPSIS, VIKOR and other classical tools, so it is the moment to propose and validate to the more recent developed tools. This paper aims at finding solution for a typical decision making problem using two well-developed methods as complex proportional assessment (COPRAS) (Zavadskas et al. 1994) and multi objective optimization based on ratio analysis (MOORA) (Brauers and Zavadskas, 2006; Zavadskas et al. 2014). To get information and review of these methods, it is accessible (Brauers et al. 2008). The two methods have been employed in different decision making problems. Yazdani et al. (2017) studied on the affection of several normalization tools on COPRAS method. Moreover, in a supply chain, COPRAS has been applied with other methods to compare and release the performance of suppliers (Tavana et al. 2017). The application of the both MOORA and COPARS has been demonstrated in the evaluation of suppliers in a dairy company (Yazdani et al. 2017). The COPRAS method is a tool which originates from ratio and partial proportion of ideal parameters, while MOORA comes from a multi objective assessment which is able to distinguish negative and positive impact of criteria. As these two methods have been developed by same research group and are almost well-designed by MCDM configuration, they are chosen to be compared in a decision support framework. In addition, the difference of both methods algorithm can be realized in a common platform. Therefore, it is shown that the selected methods are validated and approved in a higher quality research. The application of integrated MCDM tool in a decision support framework is observed in advanced studies (Fallahpour et al. 2017; Ignatius et al. 206). The contribution of this article is the implementation of aforementioned methods in a decision support system in order to build a dashboard for easier data gathering and effective outcomes. This system is interpreted in the implementation part.

The paper is organized as this; section 2 presents main decision making tools as MOORA and COPRAS. Thereafter, implementation of DSS and a numerical example about robot selection problem is presented. Finally, a conclusion ends this paper and suggests short tips in section 4.

2 Methodologies

The paper intents to provide a group decision making system to show the performance of MCDM tools. The algorithms for two methods can be presented here;

2.1 Multi-objective optimization based on ratio analysis (MOORA)

MOORA, developed by, is a MCDM method consisting of two phases, namely, the reference point approach and the ratio system approach, and allows measuring both beneficial and non-beneficial criteria in a process of selecting an alternative from a set of alternatives.

An initial decision matrix whose *kj*-th element displays the performance rating of the *k*-th alternative ($k = 1, \ldots, t$) upon the *j*-th decision criterion ($j = 1, \ldots, n$) is formed. See the matrix of Eq. (3). Hence:

Step 1. Normalizing the decision matrix. To obtain dimensionless and comparable elements in the evaluation process, the *kj*-th element of the initial matrix are normalized using the following equations:

$$r_{kj} = \frac{x_{kj}}{\sqrt{\sum_{k=1}^{t} x_{kj}^2}} \tag{1}$$

Step 2. Determining the weighted normalized matrix. The *kj*-th element of the normalized matrix is replaced by the one calculated using the following:

$$v_{kj} = r_{kj} \cdot w_j \tag{2}$$

Step 3. Computing the overall rating of benefit and cost criteria for each alternative. The overall rating of the *k*-th alternative considering the beneficial and non-beneficial criteria are calculated implementing Eqs. (12) and (13), respectively:

$$S_k^+ = \sum_{j \in J^{Max}} v_{kj} \tag{3}$$

where J^{Max} is the index set of the set of beneficial criteria for which higher values are desirable;

$$S_k^- = \sum_{j \in J^{Min}} v_{kj} \tag{4}$$

where J^{Min} is the index set of the set of non-beneficial criteria for which lower values are preferable.

Step 4. Evaluating the overall performance of each alternative. The overall performance of the k -th alternative is calculated as the difference between the overall ratings for beneficial and cost criteria:

$$S_k = S_k^+ - S_k^- \tag{5}$$

Step 5. Ranking the alternatives. The S_k values form a cardinal scale that can be used to compare and rank the alternatives: the higher the value of S_k, the more preferred is the *k*-th alternative.

2.2 COPRAS

COPRAS is another MCDM method which selects the best alternative among a lot of feasible alternatives by determining a solution with direct and proportional ratio to the best solution to the ratio with the ideal-worst solution (Zavadskas et al., 2007).

To solve MCDM problem by COPRAS, after determining the alternatives and the related criteria, follow steps below;

Step 1 – Normalize the decision matrix: suppose x_{ij} is the decision matrix of alternative j under the evaluation criterion i, and then normalized decision matrix is here;

$$r_{ij} = \frac{x_{ij}}{\sum_{j=1}^{m} x_{ij}}, \; j = 1,2,.....,m \,, i = 1,2,...,n \tag{6}$$

Step 2 – Calculate the weighted normalized decision matrix where w_i includes the weights of criteria and given by $\sum_{i=1}^{n} w_i = 1$;

$$v_{ij} = w_i \times r_{ij} \,, j = 1,2,.....,m \,, i = 1,2,...,n \tag{7}$$

Step 3 - Identify the sums of weighted normalized criteria values (P_j) for each alternative whose higher values are more preferable using the following equation;

$$P_j = \sum_{i=1}^{k} v_{ij} \tag{8}$$

Where k is the number of criteria value, which must to be maximized

Step 4 - Obtain the sums of weighted normalized criteria values (R_j) for each alternative whose smaller values are more preferable using the following equation;

$$R_j = \sum_{i=1}^{n-k} v_{ij} \tag{9}$$

Where $(n-k)$ is the number of criteria values, which should be minimized

Step 5 – Identify the relative weight of each alternative Q_j

$$Q_j = P_j + \frac{\sum_{j=1}^{m} R_j}{R_j \sum_{j=1}^{m} \frac{1}{R_j}}, \tag{10}$$

Step 7 – Determine the priority of the alternatives based on the values of Q_j. The greater amount of Q_j declares the higher preference (ranking) of each alternative.

3 Implementation and a DSS

3.1 Implementation

We developed software to implement a decision support system which efficiently illustrates decision making process and it has the ability to be extended. The software is designed to receive information about decision problem including performance rating of the alternatives, weights of each criteria and optimization direction of the proposed criteria. As Figure 1 declares, firstly a detail of the decision problem must be defined as in "Description" section. The user is asked to specify the type of problem choosing whether it is a quantitative or qualitative problem. It is easy to label decision problem, define number of decision factors etc. The next step is to compose decision matrix which is appeared in "Performance" headline. This task is done entering information of the alternatives with respect to each criterion. The whole information is thus stored in a database while the algorithm of the proposed MCDM method is written by Java computer language. Implementation of these methods is carried out in the STROMa (SysTem Of RecOmmendation Multi-criteria) application (Fomba et al. 2017). STROMa is an integrated web application developed in JSF2 (JavaServer Faces). The objective is to find the best multi-criteria aggregation operator for a given decision problem.

Fig. 1. A decision support dashboard for multi criteria decision problem

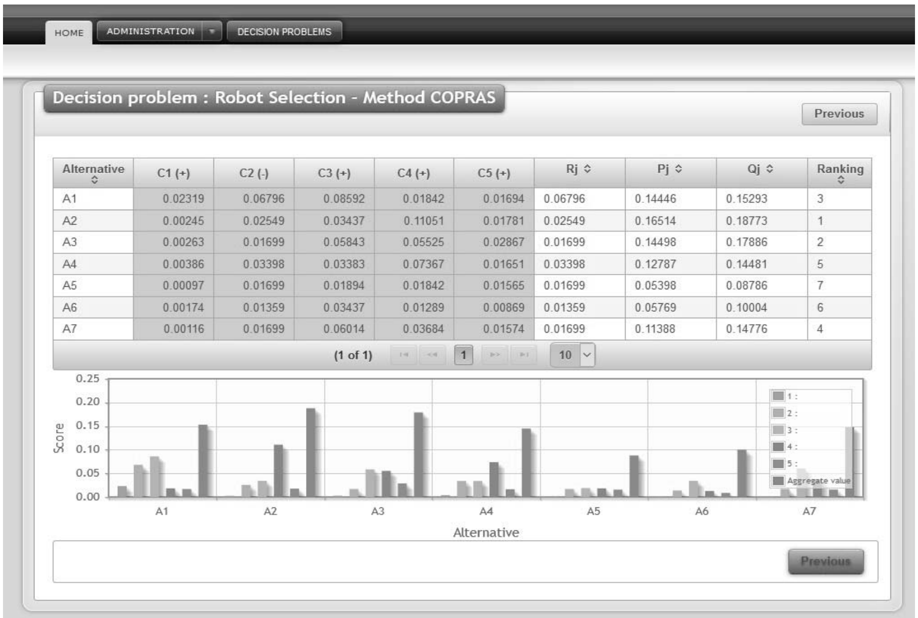
3.2 A numerical example

The paper examines a case example which is related to the selection of the most appropriate industrial robot (For more information see Chakraborty and Zavadskas, 2014). The weights of decision criteria are based on 0.036, 0.192, 0.326, 0.326 and 0.12, respectively for five criteria. Among five criteria, just C_2 is a cost criteria and rest of four factors are as benefit indicators. Table 1 shows the data and details for a robot selection decision problem including alternative information. The weights of decision criteria are shown in Figure 1. We object to solve the decision problem using COPRAS and MOORA methods which have been explained in the previous section.

Table 1. Example of robot selection problem by Chakraborty and Zavadskas (2014)

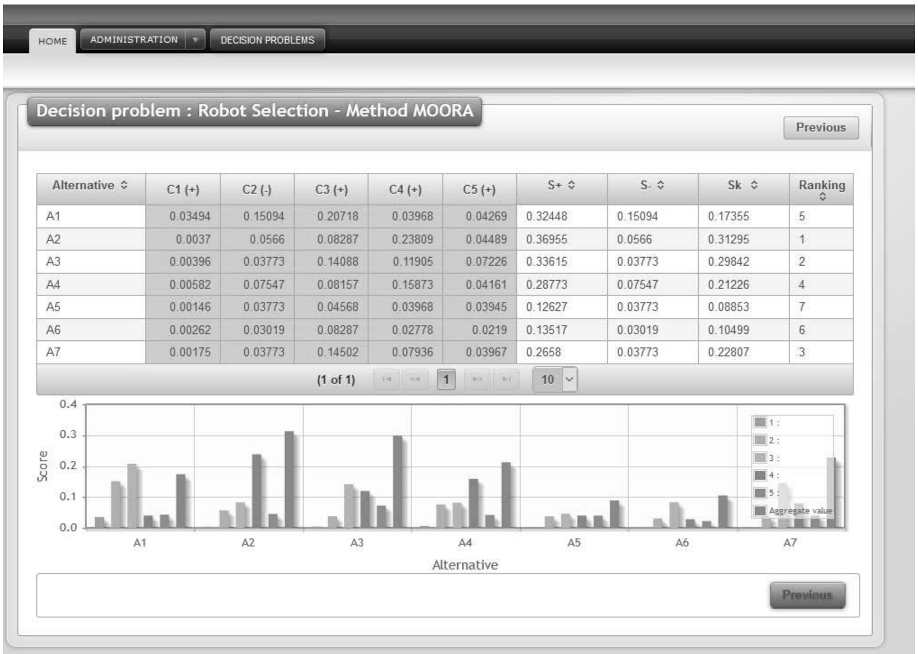
Alternative robots	C_1	C_2	C_3	C_4	C_5
A_1	60	0.4	2540	500	990
A_2	6.35	0.15	1016	3000	1041
A_3	6.8	0.1	1727.2	1500	1676
A_4	10	0.2	1000	2000	965
A_5	2.5	0.1	560	500	915
A_6	4.5	0.08	1016	350	508
A_7	3	0.1	1778	1000	920

As Figure 2 shows the detailed solution of COPRAS methodology is presented. The highlighted blue columns are weighted normalized matrix which is according formula 7. Then P_j and R_j values are measured using formulas 8 and 9, respectively. Finally Q_j values must be produced to release the ranking of robots. The last column shows the ranking of the robots as well. Outcomes validate the results with the study already done by Chakraborty and Zavadskas, 2014. The same rules are tracked for MOORA method as well. It is observed the ranking of MOORA and COPRAS is very close while the Spearman correlation coefficient between them is achieved the agreement of 0.89. The range is completely acceptable. The software is able to present a bar chart to compare alternatives ranking score schematically. This leads effective understanding for engineers and experts who desire deeper analysis.



Alternative	C1 (+)	C2 (-)	C3 (+)	C4 (+)	C5 (+)	Rj	Pj	Qj	Ranking
A1	0.02319	0.06796	0.08592	0.01842	0.01694	0.06796	0.14446	0.15293	3
A2	0.00245	0.02549	0.03437	0.11051	0.01781	0.02549	0.16514	0.18773	1
A3	0.00263	0.01699	0.05843	0.05525	0.02867	0.01699	0.14498	0.17886	2
A4	0.00386	0.03398	0.03383	0.07367	0.01651	0.03398	0.12787	0.14481	5
A5	0.00097	0.01699	0.01894	0.01842	0.01565	0.01699	0.05398	0.08786	7
A6	0.00174	0.01359	0.03437	0.01289	0.00869	0.01359	0.05769	0.10004	6
A7	0.00116	0.01699	0.06014	0.03684	0.01574	0.01699	0.11388	0.14776	4

Fig. 2. Illustration of COPRAS method



Alternative	C1 (+)	C2 (-)	C3 (+)	C4 (+)	C5 (+)	S+	S-	Sk	Ranking
A1	0.03494	0.15094	0.20718	0.03968	0.04269	0.32448	0.15094	0.17355	5
A2	0.0037	0.0566	0.08287	0.23809	0.04489	0.36955	0.0566	0.31295	1
A3	0.00396	0.03773	0.14088	0.11905	0.07226	0.33615	0.03773	0.29842	2
A4	0.00582	0.07547	0.08157	0.15873	0.04161	0.28773	0.07547	0.21226	4
A5	0.00146	0.03773	0.04568	0.03968	0.03945	0.12627	0.03773	0.08853	7
A6	0.00262	0.03019	0.08287	0.02778	0.0219	0.13517	0.03019	0.10499	6
A7	0.00175	0.03773	0.14502	0.07936	0.03967	0.2658	0.03773	0.22807	3

Fig. 3. Illustration of MOORA method

4 Conclusion

Employing technologies and innovative systems aids development a body of knowledge. In area of decision making theories and applications, evolution of decision support system allows experts and decision makers to get the chance of interfacing to a database and facilitating decision process. This short communication tries to present application of MCDM methods and their implementation in a decision support system. For this, a decision making problem is composed and the solution then is validated and visualized by a system called STORMa. Decision problem is basically tends to assess robots for a specific usage with respect to some criteria. We have solved decision problem with utilization of MOORA and COPRAS techniques and tried to enhance the accuracy of the results with implementation of the problem by decision-making software. This study suggests the development of other MCDM tools like TOPSIS or WASPAS in order to get such improvement in MCDM class.

In terms of group decision making approach, the decision making can be carried out by a team of decision makers to reflect different and integrated opinion of the participants. The proposed software and decision support system are enough flexible which enable a group of experts to decide efficiently. Therefore, it is possible to implement a group decision making structure in order to bring an optimized perspective for future research direction.

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Bargaining steps and preference types in Zeuthen-Hicks Bargaining

Rudolf Vetschera[1] and Luis Dias[2]

[1] University of Vienna, Department of Business Administration
Oskar Morgenstern Platz 1, 1090 Vienna, Austria,
[2] INESC Coimbra, CeBER and Faculty of Economics, University of Coimbra
Av Dias da Silva 165, 3004-512 Coimbra, Portugal

Abstract. The Zeuthen-Hicks bargaining model suggests how two parties may reach an agreement by making successive concessions. We analyze under which conditions bargaining steps are actually concessions (i.e., worsening the payoff to the conceding party) that will eventually lead to agreement on the Nash bargaining solution. We first show that if both parties have concave utility functions, then the process will converge. Then we show that considering Prospect Theory-like utility functions the Nash criterion can have multiple local optima. We present the first results of a simulation study to analyze the conditions under which this phenomenon is more frequent.

Keywords: Bargaining, Nash solution, simulation

1 Introduction

Zeuthen-Hicks bargaining [Bishop, 1964] is a simple dynamic bargaining model that explains how negotiating parties can reach the Nash bargaining solution [Nash, 1950]. Although the model shows how the ultimate outcome of a bargaining process can be equal to the Nash bargaining solution, it does not make clear predictions about the bargaining steps that the two parties make. Although these steps are referred to as "concessions", it is not clear whether they are really concessions in the usual sense so that the party making the concession reduces its utility, and whether the entire process will eventually converge. In particular, if the model would predict steps that actually take the two parties further apart, negotiations might eventually end in disagreement

In this work, we analyze under which conditions bargaining steps in Zeuthen-Hicks bargaining are actual concessions that will lead to agreement on the Nash bargaining solution. After a brief introduction to the model, we first analyze the case of standard preferences (concave utility functions of both parties) and show that in this setting the process will always converge. In the next section, we consider alternative types of utility functions similar to those proposed in Prospect Theory [Kahneman and Tversky, 1979] and analyze when such preferences might lead to disagreement.

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2 Zeuthen-Hicks bargaining

The Zeuthen-Hicks model is based on an analysis of individual bargaining steps. We consider a negotiation between two parties, whom we denote as Buyer (B) and Seller (S). Consider the problem from the Buyer's perspective. Within each bargaining step, the Buyer can decide whether to accept the Seller's offer x_S or make a counteroffer x_B. If the opponent's offer is accepted, the bargaining process ends with a compromise. If a counteroffer is made, there is the risk that the opponent terminates the bargaining process, leading to a disagreement outcome d. In Zeuthen-Hicks bargaining, this uncertainty about the opponent's reaction is expressed by a probability. Let $p_S(x_B)$ denote the Buyer's estimated probability that the Seller will reject an offer x_B. The Buyer will make a counter offer if the expected utility of this gamble is greater than the utility of the Seller's offer x_S:

$$p_S(x_B)u_B(d) + (1 - p_S(x_B))u_B(x_B) > u_B(x_S) \tag{1}$$

where u_B denotes the Buyer's utility function for outcomes. From (1), we can compute a critical rejection probability for the Buyer as

$$p_S^* = \frac{u_B(x_B) - u_B(x_S)}{u_B(x_B) - u_B(d)} \tag{2}$$

Similarly, a critical probability p_B^* can be computed from the Seller's perspective. The central assumption of Zeuthen-Hicks bargaining is that the party who has a lower critical rejection probability (who can tolerate a lower probability of rejection from the opponent) will adjust its offer so that its own critical probability exceeds that of the opponent. In other words, the Buyer will try to establish

$$p_S^* > p_B^* \tag{3}$$

which, after substituting (2) as well as the similar definition for the Seller's critical probability and some simplifications is equivalent to

$$(u_B(x_B) - u_B(d))(u_S(x_B) - u_S(d)) > (u_B(x_S) - u_B(d))(u_S(x_S) - u_S(d)) \tag{4}$$

Once the Buyer has the higher critical probability, the Seller will adjust its offer to gain the lead again, so obviously the actions of both parties will lead to maximization of

$$(u_B(x) - u_B(d))(u_S(x) - u_S(d)) \tag{5}$$

which is the function that is also maximized in the Nash bargaining solution.

Our main question is now whether these adjustments of offers always lead to regular concessions, in which one party reduces its own utility in favor of the other party's utility. To simplify the analysis, we consider only a single issue negotiation between a Buyer and a Seller over the price of an object. We furthermore assume that a trade is beneficial, i.e., the Buyer's valuation of the good being traded is higher than the Seller's. Without loss of generality, we set the Seller's valuation to zero and the Buyer's to one, so the two parties basically bargain about how to split the surplus of one that is created by the trade. We denote the price by x. Obviously, the Seller prefers a higher price and the Buyer a lower price, so

$$u_S(x+\delta) \geq u_S(x) \wedge u_B(x+\delta) \leq u_B(x), \forall \delta > 0 \tag{6}$$

If bargaining fails, no trade takes place and no value is created, so the disagreement outcome for both parties is zero ($u_B(d) = u_S(d) = 0$), which allows us to omit the disagreement outcome.

The bargaining process will converge, and both parties will in their respective steps make concessions if the function

$$n(x) = u_S(x) \cdot u_B(x) \tag{7}$$

has a unique maximum at some price x_N, and is monotonically increasing for $x < x_N$ and monotonically decreasing for $x > x_N$, i.e., if this function is quasiconcave. Under these conditions, when a party makes an offer that increases the product in (7), then this party is sure that it is moving in the direction of the global maximum. Otherwise, if $n(.)$ is not quasiconcave, situations like those depicted in Figure 1 might arise. In such situations, even if a party had perfect information about both utility functions in the neighborhood of its offer, moving towards a local maximum would not necessarily imply a concession.

3 Concave utilities

We first analyze the case where both u_B and u_S are concave. This is the case of well-known utility functions such as the logarithmic function or the negative exponential function (e.g., $u_S(x) = \frac{1-e^{-\alpha x}}{1-e^{-\alpha}}, \alpha > 0$).

It is easy to show that in these conditions the product of the utilities (7) is a quasiconcave function. First, note that $\log n(x) = \log u_S(x) + \log u_B(x)$ is a concave function in the domain where $u_S(x) > 0$ and $u_B(x) > 0$, since

a) both $\log u_S(x)$ and $\log u_B(x)$ are concave when u_B and u_S are concave (the logarithm being a concave function as well);
b) the sum of two concave functions is a concave function.

To show that $n(.)$ is quasiconcave amounts to demonstrate that:

$$n(x) > n(y) \Rightarrow n(\lambda x + (1-\lambda)y) \geq n(y), \forall \lambda \in [0,1] \tag{8}$$

As we are working with non-negative utilities, if either $u_S(y) = 0$ or $u_B(y) = 0$ then $n(y) = 0$ and (8) trivially holds. In the domain where both utilities are strictly positive, since the logarithm is a strictly increasing function, then having $n(\lambda x + (1-\lambda)y) < n(y)$ would mean that $\log n(\lambda x + (1-\lambda)y) < \log n(y) < \log n(x)$. However this cannot be the case because $\log n(.)$ is concave. Thus, $n(.)$ is quasiconcave.

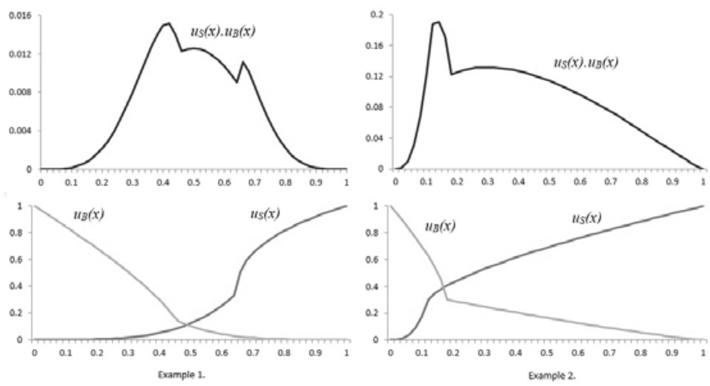

Fig. 1. Reference point levels and occurrence of multiple optima

4 Non concave utilities

We now consider the case that utilities are not concave. In particular, we consider a utility function that takes into account reference point effects as discussed in Prospect Theory [Kahneman and Tversky, 1979] and that is concave above some reference point and convex below. Such functions reflect the idea that decision makers consider outcomes above the reference point as gains, to which they react risk averse, and outcomes below the reference point as "losses", to which they react risk seeking. It should be noted that according to our assumptions, neither side will suffer an actual loss in case a trade is made. Still, parties might have expectations about the price they will achieve, and consider any outcome that is worse for them than this expectation as a "loss".

For the Seller, we therefore consider a utility function that is convex for $x < r_S$ and concave for $x > r_S$, where r_S is the Seller's reference level. Similarly, the Buyer's utility function is concave for $x < r_B$ and convex for $x > r_B$.

To study under which conditions such preferences are more likely to lead to multiple local maxima of $u_S(x)u_B(x)$ and consequently the possibility of negotiations ending in disagreement, we performed a simulation study. In the simulation, we used a simple power function specification for the utility function [Schoemaker, 1990,Bleichrodt et al., 2007]. The Seller's utility is specified as

$$u_S(x) = \begin{cases} x^{\alpha_S} \cdot v_S / r_S^{\alpha_S} & x < r_S \\ v_S & x = r_S \\ v_S + (x - r_s)^{\beta_S} \cdot (1 - v_S)/(1 - r_S)^{\beta_S} & x > r_S \end{cases} \tag{9}$$

where $\alpha_S > 1$ and $\beta_S < 1$ are two parameters determining the shape of the convex and concave parts. The entire utility function is scaled between zero and one, and obtains a value of v_S at the reference point r_S. The utility function for the Buyer is specified similarly.

The function u_S has four parameters: α_S, β_S, r_S and v_S, and the Buyer's utility function also has four parameters. For instance, Example 1 in Figure 1 corresponds to $\alpha_S = 4$, $\beta_S = 0.4$, $r_S = 0.65$ and $v_S = 0.35$, together with $\alpha_B = 4$, $\beta_B = 0.8$, $r_B = 0.45$ and $v_B = 0.15$, whereas Example 2 corresponds to $\alpha_S = 3$, $\beta_S = 0.7$, $r_S = 0.12$ and $v_S = 0.3$, together with $\alpha_B = 1.2$, $\beta_B = 0.7$, $r_B = 0.18$ and $v_B = 0.3$. Note that $r_S > r_B$ in Example 1, whereas $r_S < r_B$ in Example 2. These are just two arbitrary examples among many other ones, calling for a simulation study aiming at finding out whether these or other properties of the functions influence the probability of having multiple local maxima.

The simulation generated values of these four parameters for the two parties from uniform distributions within reasonable ranges, and then calculated the number of local maxima of the product of the two functions by considering suitably spaced discrete points. For the simulation, one million parameter vectors were generated and analyzed.

Note that the function (9) does not necessarily fulfill the usual assumption of Prospect Theory that losses are more important than gains and thus the function is steeper in the convex part. In fact, since the derivative of the concave part is infinite at the reference point, it is violated in some small neighborhood of the reference point. In the simulations it was operationalized by comparing the differences between the utility assigned to the reference point (v) and the utility values of the next discrete points above and below the reference point that were evaluated. We consider this fact a stylized property of the problem, which could have an impact on the number of local maxima.

As Table 1 shows, this property has indeed a strong effect on the occurrence of multiple maxima. No multiple maxima occurred when both utility functions fulfilled the assumptions of Prospect Theory and were steeper in the loss domain, while multiple maxima occurred in more than half of the problems in which both utility functions violated it.

A problem might be considered particularly difficult if the aspirations of the two parties are not compatible, i,.e., it the reference point for the seller is higher

Table 1. Number of maxima for functions fulfilling and violating assumption of Prospect Theory

	Assumption fulfilled		
Maxima	none	one	both
1	44.62%	75.71%	100.00%
2	38.37%	24.29%	0.00%
3	17.01%	0.00%	0.00%

than the reference point for the buyer, as in Example 1 in Figure 1. Table 2 shows that this factor also has an impact on the occurrence of multiple maxima. While multiple maxima still do exist, they are much less frequent in the case of compatible aspirations than when they are incompatible.

Table 2. Number of maxima for functions with different patterns of reference points

N. Maxima	All	$r_B < r_S$	$r_B > r_S$
1	67.03%	38.28%	95.78%
2	26.34%	48.63%	4.05%
3	6.63%	13.09%	0.17%

Figure 2 extends this analysis by also considering the values of the reference points. The two axes represent the locations of reference points for Buyer (y-axis) and Seller (x-axis), and the color of the dots represents the number of maxima in a situation with the corresponding reference point (r_S, r_B): green stands for one maximum, yellow for two and red for three. Multiple maxima mostly occur below the diagonal, where the buyer's reference point is lower than the seller's. However, there is also a small strip of three maxima (red dots) just above the diagonal.

For $x \leq \min(r_B, r_S)$, the utility function of the Seller is always convex and that of the Buyer is always concave, for $x > \max(r_B, r_S)$, they are the opposite. In between the reference point, two different situations might occur. If $r_B < r_S$, both functions are convex, and for $r_B > r_S$, both functions are concave. The intersection between the two utilities is not necessarily in between the two reference points. We therefore also analyzed whether it makes a difference whether the two utility functions intersect in the parts where the two utility functions have different curvature, or in the middle range where the curvature of both functions is the same.

Problems in which the two utility functions intersect in the middle region, where both functions have the same curvature, are significantly more likely to exhibit three maxima, and less likely to have just one maximum than problems in which the two utility functions intersect outside that region.

Finally, we also consider where the local maxima are located. As Table 4 shows, a considerable fraction of all maxima is actually located exactly at one of the reference points. In problems in which $r_B > r_S$ and thus both functions are

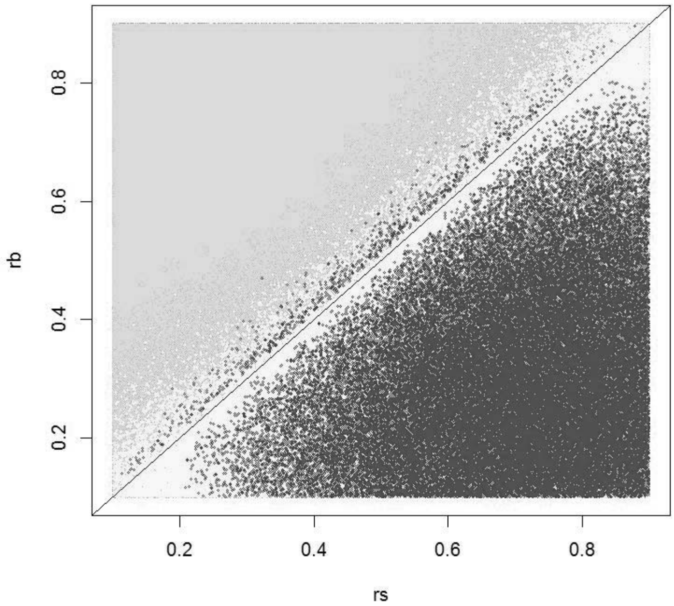

Fig. 2. Reference point levels and occurrence of multiple optima

concave in the middle part, it is also likely that a maximum exists in that part. In contrast, if the reference points are arranged in the opposite way, maxima are more likely to be located in the outer parts where one utility function is concave and the other one convex.

5 Conclusions

The Zeuthen-Hicks bargaining model offers a compelling rationale for two parties to make successive concessions towards the Nash solution. For risk neutral or risk averse parties, the concavity of their utility functions ensures that any

Table 3. Number of maxima and location of intersection between utility functions

	Intersection at		
N. Maxima	left	mid	right
1	72.09%	65.02%	71.99%
2	25.78%	26.56%	25.78%
3	2.13%	8.41%	2.23%

Table 4. Location of maxima

		Middle part both	
	All	concave	convex
Outer	43.98%	8.01%	65.49%
At ref.	12.91%	17.26%	10.32%
Middle	43.10%	74.73%	24.20%

local maximum of the product of utilities $n(.)$ will be *the* global maximum. A concession aiming at increasing $n(.)$ will surely lead the parties closer to the Nash bargaining solution. However, if utilities are not concave, $n(.)$ may no longer be quasiconcave, meaning that a party might move farther away from the Nash solution while increasing $n(.)$.

If each party has accurate information about the entire utility function of the other party, then they will be able to identify the global maximum of $n(.)$ even when $n(.)$ is not quasiconcave. Subsequently, according to the Zeuthen-Hicks model rationale they would converge to this agreement.

If each party has no information or has only local information (in the neighborhood of the current offers on the table) about the utility of the other party, then the Nash bargaining solution might be missed in some cases where the utilities are not concave. For instance, in Example 2 (Figure 1), if the Buyer has been overly generous offering 0.24 and the Seller's last offer was 0.60, they might take turns conceding utility to the other party reaching the local maximum at $x = 0.30$ (missing the global maximum at $x = 0.14$). Even if the Buyer now suddenly realized that he/she would be in a better position offering only 0.14, an offer that the Seller could not reject according to the Zeuthen-Hicks model, the negotiations might still collapse because the Buyer would be reneging a previous offer.

We have shown that if both parties have concave utility functions, then the process will converge to the global maximum. For the case of specific Prospect Theory-like utility functions, we have presented results of a simulation study. According to the simulations, multiple local maxima occur only if at least one utility function violates the assumption of Prospect Theory and is not steeper for losses than for gains. Another important characteristic of the problem is the relative position of r_S and r_B. Although multiple maxima can occur in both situations (Figure 1), they are more likely when the reference point for the seller is higher than the reference point for the buyer. In the former case, maxima are also more likely to occur in the region between the reference points, and thus aspirations of both parties are fulfilled.

Of course, these results only hold for the specific type of utility functions used in the simulation. We therefore intend to pursue this line of research by running more simulations and studying other types of utility functions.

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Getting to Yes at the Beach or in the Office? The Role of Location Formality and Negotiation Type on Negotiation Process and Outcomes

Alain P. C. I. Hong[1] and Per J. van der Wijst[1],

[1] Tilburg center for Cognition and Communication, Tilburg University, P.O. Box 90153, 5000 LE Tilburg, The Netherlands
{A.P.C.I.Hong, Per.vanderWijst}@tilburguniversity.edu

Abstract. The negotiation location plays an important role in negotiations. The present study examined to what extent the negotiation process and outcomes are influenced by the formality of the location and negotiation type. It was hypothesized that negotiations in a beach setting would yield better integrative results than negotiations in an office setting, whereas an office setting would yield better distributive outcomes than a beach setting. To examine this, an experiment was conducted in a virtual reality laboratory in which dyads had to perform a job contract negotiation at the beach or in the office, that was either integrative or distributive. We found that the beach setting, as expected, created a more informal atmosphere, a more positive mood, and slightly less stress, but this difference did not depend on the negotiation type. Also, integrative negotiations yielded higher joint gains than distributive negotiations, but this was the same for both location settings.

Keywords: negotiation, location, formality, virtual reality, distributive negotiation, integrative negotiation.

1 Introduction

We all feel probably more comfortable at the beach then in an office space. The beach is a better place for amusement, relaxation, and relational matters than the office, but how about negotiating at the beach? Can you be a tough bargainer when you are sitting in a deckchair? Does the beach setting improve your creative skills? Does it matter if negotiations on a beach or at the office are centered around distributive or integrative issues? Remarkably, so far not much is known about the impact the direct place or location can have where the negotiation takes place.

Negotiations form a communicative activity for which many factors have been studies that could influence the process or outcome. The role of emotions, gender differences, cultural differences, and personality traits have received ample attention [5]. However, the location where the negotiation takes place has yielded limited attention so far. Studies on this topic primarily focus on the strategical (dis)advantage of negotiating in a 'home' situation (e.g. own office, own country) versus traveling to the location the counterpart prefers [2] [4] [6]. The findings from these studies

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suggest that negotiating at the premises of your own organization often leads to a home advantage. However, in these studies on the role of location, the negotiation takes place and focuses on the (home) business setting, or on a simulated (home) business setting. In our daily life, we learn from the news that it is not unusual that informal negotiations, mostly pre-negotiation talks or diplomatic negotiations, also take place in more informal and less professional settings, such as a restaurant, café or even at the beach. More formal and decisive negotiations however seem to take place in more formal and professional settings, for example at the headquarters of an organization. It seems safe to assume that a professional environment, compared to less professional settings, adds to the formal character of the interaction, and this may have an impact on the negotiation process and, ultimately, the outcome. Yet, little is known about the possible role the negotiation location itself plays in a negotiation. Therefore, the main aim of the present study is to examine whether and how the formality of the negotiation location influences the negotiation strategies of the negotiators.

If a distinction is made between distributive (zero-sum) and integrative (win-win) negotiations, a higher formality of a location seems to be more appropriate for distributive bargaining strategies than for integrative strategies. The latter would benefit more from an informal location. On the one hand, a formal standpoint helps keeping a relational distance from the counterpart, which in turn makes it more easy to be competitive and to 'claim value'. Good integrative bargaining, on the other hand, presupposes exchanging information, being open to the needs of the counterpart, searching for joint solutions, and taking a problem-solving approach in order to 'create value'. Although the factor 'formality' as such has not been studied extensively in this context, we know that relational factors and the mood and emotions for instance impact the success of an integrative negotiation [1] [3]. Negotiators with more common ground share more information and are more willing to listen to their counterpart. Being in a good mood and experiencing positive emotions have shown to be beneficial for the integrative process [7].

The central question in this study is to what extent the characteristics of the location where the negotiation takes place influence the negotiation process and outcomes. We expect that an informal setting will be beneficial for integrative bargaining, whereas a formal setting facilitates distributive bargaining. More specifically, we expect that the higher formality of the office produces a greater 'fixed-pie' bias in the distributive negotiation and leads to more competitive outcomes in the distributive case, and to lower joint outcomes in the integrative case. We therefore hypothesize a higher joint gain in integrative negotiations taking place in an informal location than in a formal location, and that differences in outcome between negotiators will be more pronounced in distributive negotiations taking place in a formal location compared to an informal location.

1.1 Present Study

To examine whether and how the negotiation process and outcomes are affected by the location formality and type of the negotiation, we set up an experiment in which participants negotiated the terms of a working contract during a job interview in an office space or at the beach, in dyads, face-to-face. The location was manipulated in the DAF Technology Lab[1] of Tilburg University, in order to increase the validity of the study. The lab enables the creation of very realistic Virtual Reality environments. For the purpose of this study a realistic office and beach setting was programmed. The addition of office furniture versus deckchairs increased the validity. We used a 2D application in which the setting (office or beach) was projected by eight beamers from the ceiling on all four walls of the room. The realism of the setting was enhanced by accompanying sound and motion of the setting. In the office location, participants heard a moving ventilator and office sounds in the background, whereas in the beach setting, they heard sounds of moving waves reaching the beach.

2 Method

2.1 Participants and Design

One hundred sixty two undergraduate students (81 dyads) from Tilburg University participated in the experiment as part of a course requirement. Participants' average age was 23.40 years (*SD* = 3.02), and they were randomly assigned to one condition in a 2 (location: office or beach) × 2 (negotiation type: distributive or integrative) between-subjects design. The dependent variables consisted of the negotiation outcome (individual profit, joint profit), satisfaction about negotiation process and outcome, and relational variables (experienced formality, experienced trust, fairness, and mutual liking). Only experienced formality as a relational variable was used in this study.

2.2 Procedure

Upon arrival in the virtual reality beach or office, participants were introduced to each other and they were told that they would perform a negotiation with each other consisting of a job interview. The role of employer and employee was randomly assigned to the participants, and participants in the office setting were told that the negotiation took place at the office of the employer. After having been informed about the study, participants signed a consent form and completed a first questionnaire that contained demographic background variables, and items that assessed participants' mood and stress level. After completing this questionnaire, the participants were given written information about the negotiation case. The negotiation case entailed a job interview between an employer and a future employee, who had to agree on three items: the salary, the length of the contract and the number of vacation days. A pay-off matrix was created in which for each option of the three items a different pay-off in gains was indicated. This allowed to create a distributive

[1] For more information about the DAF Technology Lab see: https://www.tilburguniversity.edu/campus/experiencing-virtual-reality/.

and an integrative negotiation case. In the distributive setting the pay-off matrix for both parties was completely mirrored with the most beneficial item and option for a negotiator being the opposite for the counterpart. In the integrative setting however, the importance of the items was not the same for both parties. In this case the employee had a relatively higher pay-off for the salary options whereas it was more important for the employer to limit the contract length. This difference created an integrative potential by logrolling. Participants were given a maximum of 10 minutes to prepare for the negotiation. Before entering the lab, they had to do an exercise of calculating the total pay-off of several offers in order to check whether they understood the matrix. Furthermore, they had to write down their planned first offer. Finally, they were entered into the lab and the negotiation started.

Participants negotiated about the offers of each item. During the negotiation they used the pay-off matrix to negotiate their (counter) offers. After approximately 15 minutes participants had to decide if they came to an agreement, and if so, what the negotiated outcome was for each item. After the negotiation ended, they had to indicate on a special form whether or not they came to an agreement, and the final offer for each item. Then the participants were asked to fill out a questionnaire that assessed their stress level, mood, satisfaction about the process and outcome, and relational variables (experienced formality, trust, fairness, and mutual liking). Only experienced formality was used in the present study. After having completed this questionnaire, participants were thanked for their participation and were fully debriefed via email approximately two weeks after the end of the experiment.

2.3 Measures

Mood. Participants mood was measured before and after the negotiation and consisted of 12 items on a 5-point scale (1 = very slightly or not at all, 5 = extremely) that were adopted from the original Positive and Negative Affect Schedule PANAS [8]. Six items measured positive affect (PA: interested, strong, determined, happy, excited, and proud) and 6 items measured negative affect (NA: afraid, nervous, scared, irritable, weak, and ashamed). Cronbach's Alpha for the positive affect scale was .79 (*M* = 2.88, *SD* = 0.72) for the pre-measurement and .84 (*M* = 3.15, *SD* = 0.84) for the post-measurement. Cronbach's Alpha for the negative affect scale was .70 (*M* = 1.66, *SD* = 0.56) for the pre-measurement and .68 (*M* = 1.56, *SD* = 0.56) for the post-measurement.

Stress Level. Stress level was measured prior to and after the negotiation and consisted of one question on a 7-point Likert scale (1 = very relaxed, 7 = very tense). The mean score on this scale was 3.64 (*SD* = 1.52) for the pre-measurement and 4.65 (*SD* = 1.86) for the post-measurement.

Satisfaction. Participants satisfaction was measured with two items: one item assessed their satisfaction about the process of the negotiation and one item assessed how satisfied they were with the result of the negotiation. Both items were measured on a 5-point Likert scale (1 = Completely disagree, 5 = Completely agree). The average score for process satisfaction was 4.13 (*SD* = 0.91) and for outcome satisfaction 4.11 (*SD* = 0.94).

Experienced Formality. Experienced formality was measured with a single item on a 5-point Likert scale (1 = Completely disagree, 5 = Completely agree), and had a mean score of 3.83 (*SD* = 1.10).

3 Results

3.1 Joint Gain and Outcome Difference

In a first analysis, we tested whether an informal location (i.e. beach), compared to a formal location (i.e. office) would lead to a higher joint gain in integrative negotiations. To examine this, we performed a 2 (location: beach or office) × 2 (negotiation type: distributive or integrative) ANOVA, with joint gain as the dependent variable. The joint gain was computed by summing the pay-off gains for each party (i.e., employee and employer). The means can be found in Table 1.

Table 1. Means and standard deviations (between brackets) for joint gain as a function of negotiation location and type.

	Beach	Office
Integrative negotiation	5,258.02 (125.95)	5,254.17 (94.97)
Distributive negotiation	5,108.33 (64.78)	5,137.78 (30.52)

The analysis revealed that the negotiations with integrative potential yielded higher joint gains (M = 15,769.77, SD = 342.63) than the distributive negotiations (M = 15,362.86, SD = 162.85), $F(1, 74) = 37.84$, $p < .001$, $\eta_p^2 = .34$). No effect for negotiation space nor an interaction between negotiation type and space was found, $Fs < 0.59$, $ps > .444$. These findings do not support the hypothesis that an informal location would lead to a higher joint gain in integrative negotiations than a formal location.

In the second analysis, we examined whether differences in outcome between negotiators would be more pronounced in distributive negotiations taking place in a formal location than in an informal location. To examine this, we performed a 2 (location: beach or office) × 2 (negotiation type: distributive or integrative) ANOVA, with outcome difference as the dependent variable. The outcome difference was computed by subtracting the pay-off gains for each party[2]. The means can be found in Table 2.

Table 2. Means and standard deviations (between brackets) for outcome difference as a function of negotiation location and type.

	Beach	Office
Integrative negotiation	322.22 (290.45)	358.33 (405.79)
Distributive negotiation	505.00 (585.42)	408.89 (288.80)

The analysis shows that there were no main effects for office setting and negotiation type, nor was there an interaction between location and negotiation type, $Fs < 1.51$, $ps > .223$. Thus, contrary to our expectations, differences in outcome between negotiators were not more pronounced in distributive negotiations taking place in a formal location compared to an informal location.

3.1 Additional Analyses: Mood, Stress Level, Formality, and Satisfaction

Although not a prime focus of this study, we examined whether the beach or office setting would influence the negotiators mood, stress levels, formality, and satisfaction. To examine whether participants' mood was influenced by the location and negotiation type, we conducted two mixed ANOVA's on participants' mood, one on participants' positive affect (PA) and one on their negative affect (NA). In both analyses, location (beach or office) and negotiation type (distributive or integrative) were entered as the between-subjects variables, and timing of the measurement

[2] Since the outcome difference could be positive or negative, we first squared the differences and then square rooted the result to end up with an outcome difference that was positive.

(pretest-posttest mood) was entered as the within-subjects variable. The first analysis showed that participants' had a more positive mood after the negotiation (M = 3.15, SD = 0.84) than before it (M = 2.88, SD = 0.73), $F(1, 154) = 29.51$, $p < .001$, $\eta_p^2 = .16$. Furthermore, participants' generally had a higher positive mood in the beach negotiations (M = 3.13, SD = 0.71) than in the office negotiations (M = 2.84, SD = 0.73), $F(1, 154) = 6.03$, $p = 0.15$, $\eta_p^2 = .04$. Regarding participants' negative affect, the analysis revealed that they had a less negative mood after the negotiation (M = 1.56, SD = 0.56) than before it (M = 1.66, SD = 0.56), $F(1, 154) = 6.21$, $p = .014$, $\eta_p^2 = .04$. Thus, overall, the beach setting yielded a more positive mood than the office setting, and negotiations in general increased participants' positive moods and decreased their negative moods. However, location did not influence participants' positive and negative mood (i.e., increase or decrease), and this also did not depend on the type of negotiation.

The stress the negotiators experienced increased significantly after the negotiation, $F(1, 153) = 30.28$, $p < .001$, $\eta_p^2 = .17$. Furthermore, although not significant, the general stress experienced at the beach was slightly lower than in the office, $F(1, 153) = 3.06$, $p = .082$, $\eta_p^2 = .02$.

Moreover, with regard to the experienced formality, the negotiators found the beach setting more informal than the office setting, $F(1, 153) = 5.66$, $p = .019$, $\eta_p^2 = .04$.

With respect to satisfaction about the negotiation process and outcome, the negotiators in the integrative setting were more satisfied with the results than the ones in the distributive setting, $F(1, 154) = 5.16$, $p = .025$, $\eta_p^2 = .03$. No main effect for location nor interaction between negotiation type and location was found, $Fs < 0.53$, $ps > .468$. Also, with regard to the negotiators' satisfaction about the process, no main effects for negotiation type and location nor an interaction was found, $Fs < 1.84$, $ps > .177$.

4 Discussion

In the present study, we examined the possibility that the negotiation process and outcome are affected by the negotiation location and the type of negotiation. We hypothesized a higher joint gain in integrative negotiations taking place in an informal location than in a formal location, and that differences in outcome between negotiators would be more pronounced in distributive negotiations taking place in a formal location compared to an informal location. Our findings do not support our expectations. We found that the joint gain was higher in the integrative negotiation than in the distributive negotiation, but the joint gain was not higher in the informal integrative negotiation than in the formal integrative negotiation. Also, the outcome difference was the same for distributive negotiations in the formal and informal location.

Our findings suggest that the negotiation process and outcomes may not depend on whether the negotiation location is more (in)formal, but they do indicate that the location formality influences negotiators' perceptions and emotions. To our knowledge, this is the first study that has systematically examined how formality of the negotiation setting influences a negotiation. Its added value for the study of negotiations is primarily in the effect the location or surrounding can have on the atmosphere, stress, and on the mood of the negotiators. The use of the Virtual Reality Lab makes it possible to create different negotiation environments that influence how participants perceive the setting as well as the negotiations. We created a beach and an office setting and found that both locations yielded different experiences. The increased informality of the beach setting resulted in slightly less stress compared to the office setting, and also the mood of the participants was generally more positive at the beach than in the office. These findings suggest that the manipulation of the environment was quite successful. As this is a first step into building our understanding of the impact the formality of a location can have on negotiations, we encourage scholars to further explore this direction.

Our findings also suggest that negotiating at ‘home’, that is negotiating on the grounds of one of the negotiators, does not necessarily create an advantage for the home party in either a distributive or integrative negotiation. The negotiations that took place in the office had a home-advantage for the employee in the job contract negotiation whereas the negotiations in the beach environment were not at the premise of one of the parties. We found that negotiations with integrative potential yielded higher joint gains in general, but this effect was not stronger (or less strong) in in either location. Furthermore, the outcome differences in the distributive negotiations at the beach did not differ from the office negotiation outcomes. These findings nuance previous studies that indicate a strategical advantage of negotiating in a ‘home’ situation [2] [4] [6]. With regard to getting ‘better’ deals, it does not seem to matter whether parties negotiate in a neutral territory or in one of both parties’ location. However, since negotiations are often aimed at long-term relationships between parties, our findings do suggest that it could be beneficial to negotiate in neutral, ‘advantage-free’ locations. The negotiators generally had a more positive mood in the beach negotiations than in the office negotiations, and the former location was also slightly less stressful for the negotiators than the latter location. Thus, neutral settings seem to be better at fostering the negotiation process and relationship. However, examining the effect that these locations can have on relationship variables was out of the scope of this study. Therefore, future studies should more systematically examine whether formality of the location plays a role in negotiation relationships, and also whether this is different for home-advantage or advantage-free locations.

The finding that the location had no impact on the negotiation outcome variables (i.e. joint gains and outcome differences) could be an indication that the manipulation of the surrounding was not strong enough. Still, the effect that the location had on negotiators’ emotions (mood) and perceptions (stress) variables offers interesting new opportunities to further study the effects of mood on negotiations, and the fact that this is not induced by negotiation variables or by the interaction with the counterparts. This makes a Virtual Reality Lab an interesting tool to continue that line of negotiation research.

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Trust-free Systems in the Trust Age? A Review on Blockchain and Trust in the Sharing Economy

Florian Hawlitschek[1], Benedikt Notheisen[1], Christopher Mertens[1], Timm Teubner[1], and Christof Weinhardt [1],

[1] Karlsruhe Institute of Technology,
Institute of Information Systems and Marketing,
Fritz-Erler-Str. 23, 76133 Karlsruhe, Germany
{Florian.Hawlitschek, Benedikt.Notheisen, Timm.Teubner, Christof.Weinhardt}@kit.edu
chr.mertens.tu@gmail.com

Abstract. Trust-free systems based on blockchain technology promise to revolutionize interactions between peers that usually require a trusted third party. As a part of a global hype around the blockchain, the sharing economy is a promising field of application for such trust-free systems. However, trust plays a crucial and complex role in sharing economy interactions and therefore may not be easily substituted by a new technology. In order to shed light on the questions, if and how blockchain technology can be leveraged to solve the central issue of trust in the sharing economy through trust-free systems, we conducted a dual literature review on trust in both the blockchain and sharing economy context.

Keywords: Blockchain; Sharing economy; Trust; Trust-free system; Literature review

1 Extended Abstract

“Together, we are entering the trust age.” [1, p. 31]

The rise of peer-to-peer (P2P) markets has paved the way for commercial interactions among private individuals on large scales. In recent years, technology startups have leveraged the potential of higher resource utilization based on transactions between peers within the so-called ‘sharing economy’ [2]. The platforms therein enable short term peer-to-peer ‘sharing,’ renting of goods, and a variety of services [3]. A fundamental prerequisite for such interactions among private individuals is mutual trust [4]. According to Mazzella et al. [1, p.27], this “key building block of society” takes an essential role for the formation of interaction relationships in the context of P2P marketplaces and P2P services.

While the sharing economy started out as a decentralized market system that promised to sustainably distribute welfare among participants, critics nowadays often see the idea of sharing underutilized assets for charitable reasons lost in a capitalistic platform economy [5]. On the one hand, the providers channel of benefits created by the community of peers. On the other hand, the central entity provides not only the technical infrastructure, user interfaces, and process regulations for transactions but

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also takes a crucial role in establishing trust among users today by governing insurance mechanisms, controlling executive measures such as the punishment or banning of users, and maintaining reputation systems [6–9].

In recent years, the blockchain as a decentralized consensus system – sometimes denoted as “trust-free technology” [10] – is discussed as the basis for an alternative scenario to the platform economy by enabling transparent recording and value exchange mechanisms [11] without the need for a central authority or institution [12]. While players such as Airbnb and Uber profited from the role as an intermediary between peers, performing transactions based on their private resources, the blockchain is assumed to provide an infrastructure [13] with the potential to organize truly decentralized markets, defining the building blocks of the next generation of sharing economy business models [14]. Importantly, the blockchain technology is suggested to contribute to the resolution of one of the fundamental issues of P2P markets and sharing economy activities: trust [15]. Rachel Botsman, one of the early pioneers in the context of collaborative consumption [16] suggested that the concept of distributed trust, accelerated by the blockchain technology will fundamentally transform the way trust is built [17]. Moreover, IBM stated in a recent discussion paper, that blockchain technologies have the potential to form a “sharing economy 2.0” by decentralizing trust [18].

In fact, several platform cooperatives such as Lazooz have set out to establish decentralized sharing economy platforms with remarkable success in initial crowd funding initiatives [19]. After traditional technology transformed the traditional markets to large scale P2P sharing markets, the question arises whether or not blockchain as a ”trust machine” [20] will actually be able to disrupt the newly developed platform landscape by providing decentralized trust.

To shed light on the potential of the blockchain technology as a trust-free system in today's e-commerce landscape, an interdisciplinary approach is needed, integrating both the perspectives on blockchain technology as an IT-artifact as well as the corresponding interactions with related tasks, existing structures, and the broader sharing economy context [21, 22].

In order to pave the way for future research within this complex environment, we conduct a dual literature review on the topics of trust in the context of the sharing economy and blockchain within the Information Systems (IS) literature. Following the idea of analyzing the past to prepare for the future [23], we uncover the intersection of two highly relevant and upcoming topics in IS research. Our contribution is twofold. First, we provide a comprehensive overview and conceptualization of existing IS literature on trust in the contexts of the sharing economy and blockchain technology. Second, we integrate the two perspectives to estimate the potential of blockchain as a trust-free technology, to assess its disruptive impact on the formation of trust, and to suggest issues and paths for future research. Our findings suggest that the notion of trust-free systems is in fact only partly transferable to a sharing economy scenario thus far and requires further attention from IS researchers as well as practitioners.

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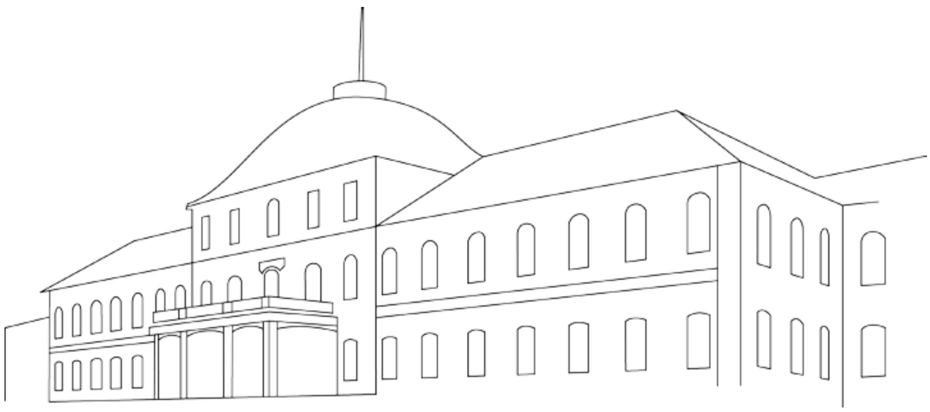
Conflict Resolution

Stream Organisers:
Liping Fang, Ryerson University, Canada
Keith W. Hipel, University of Waterloo, Canada
D. Marc Kilgour, Wilfried Laurier University, Canada



University of Hohenheim

An Information Fusion Approach to DEA Models with Non-homogeneous DMUs

Ye Chen , Liang-peng Wu, Bo Lu

College of Economics and Management, Nanjing University of Aeronautics and Astronautics, Nanjing, Jiangsu, China
{chenye,liangpengwu,bolu}@nuaa.edu.cn

Abstract. This study proposes a novel information fusion procedure to address the efficiency analysis of the Data Envelopment Analysis (DEA) with two non-homogeneous decision making unit (DMU) groups, where each group contains DMUs with different input and output (IO) criteria. Firstly, a novel framework of DEA models with diversified IO structures is established under two non-homogeneous groups, where each proposes distinct IO criteria. Next, a criteria fusion algorithm is designed to obtain different DEA modeling strategies. Then, a mixed value-weight optimization model is proposed to handle criteria with missing data, and an ordered weighted averaging (OWA) operator is applied to integrate different DEA analyses to reach final results. The new model relaxes the restriction of the classical DEA model, and provides more flexibility to address different decision analysis scenarios arising from practical applications.

Keywords: Data envelopment analysis; Inputs and outputs; Criteria fusion; Value estimation; OWA operator

1 Introduction

Owing to limited resources, efficiency evaluation is a common concern in human society, which can be observed in different kinds of organizations across various industries. The first DEA (Data Envelopment Analysis)model was proposed by Charnes, Cooper and Rhodes in 1978 [1], hereafter referred to as the CCR model, to tackle the efficiency analysis among a set of decision making units (DMUs)with multiple inputs and outputs. Subsequently, numerous research has been carried out to expand DEA from both theoretical development[2] and practical application perspectives [3].

In traditional DEA models, all DMUs are assumed to be evaluated with the same set of criteria setting. However, in many real life applications, different DMUs may argue for distinct evaluation criteria to better reflect their specific concerns. For example, a news magazine, Maclean's, ranks Canadian universities on an annual basis [4]. Given that programs offered in these institutions have a wild swing from primarily undergraduate to extensive graduate and medical, it is apparently unfair to compare these universities using the same set of criteria. As such, Maclean's first classifies different universities in Canada into three relatively homogeneous groups, 1) universities that focus on undergraduate studies with few or no graduate programs, 2)

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universities that have both extensive undergraduate studies and an extensive selection of graduate programs, and 3) universities that have a professional medical program and a selection of graduate programs, then evaluation ranking is carried out within each category where different criteria are applied to the three DMU groups.

Recently, research on the DEA with non-homogeneous DMUs catches many researchers' attentions. Imanirad *et al.* [5] extended the traditional DEA methodology to assess technical efficiency in situations with partial input-to-output impacts. In a recent article by Cook et al. [6], the efficiency analysis of non-homogeneous DMUs was formally conceptualized for the first time, where the overall efficiency of a DMU was determined as a weighted average of the efficiency scores for all subgroups that make up the DMU.

Inspired by this idea, this study proposes a novel DEA modeling framework to address the efficiency analysis with two non-homogenous DMU groups, where each DMU group has its own criteria set for DEA modeling. The unique features of this study include: 1) Easy to understand criteria fusion procedure: four kinds of criteria fusion procedures are designed to incorporate the two criteria sets proposed by two DMU groups; 2) A new estimation method for missing data: a mixed value-weight optimization model is designed to estimate missing values by modifying the conventional CCR model, which allows DMUs to assign the best value estimate to achieve the maximum efficiency; 3) Intuitive final result fusion procedure: an OWA (ordered weighted averaging) method is utilized to aggregate DMUs' efficiency values generated by different criteria fusion strategies.

The overall structure of the study is listed as follows: Section 2 provides the analysis framework under two non-homogenous DMU groups, and proposes four DEA model strategies based on different IO criteria fusion operations. Section 3 devises a mixed value-weight optimization model to estimate missing criteria values and applies an OWA operator to aggregate the derived different DEA results.

2 ADEA Framework for Two Non-homogeneous DMUs

2.1 Basic Definitions of the Model

To clarify relevant concepts, the following notations are introduced:

(1) The definition of two non-homogenous DMU groups

Two non-homogeneous DMU groups are denoted by G_1 and G_2, respectively. $G_1 = \{DMU_1^1, \ldots, DMU_1^j, \ldots, DMU_1^{|G_1|}\}$, where DMU_1^j stands for the j th DMU in G_1 and $|G_1|$ represents the cardinality of G_1. Similarly, $G_2 = \{DMU_2^1, \ldots, DMU_2^d, \ldots, DMU_2^{|G_2|}\}$, and DMU_2^d denotes the d th DMU in G_2. Generally, $|\cdot|$ gives the cardinality of a set in this study.

(2) Input criteria setting for two groups

It is assumed that each non-homogenous DMU group may propose a distinct input criteria set for DEA modeling. Let $I_1 = \{I_1^1, \ldots, I_1^i, \ldots, I_1^{|I_1|}\}$ and $I_2 = \{I_2^1, \ldots, I_2^i, \ldots, I_2^{|I_2|}\}$ represent the input criteria set for G_1 and G_2, respectively, where I_1^i and I_2^i, correspondingly, depict the ith input criterion for G_1 and G_2.

(3) Output criteria setting for two groups

It is assumed that each non-homogenous DMU group may put forward a different output criteria set for DEA modeling. Let $O_1 = \{O_1^1, \ldots, O_1^r, \ldots, O_1^{|O_1|}\}$ and $O_2 = \{O_2^1, \ldots, O_2^r, \ldots, O_2^{|O_2|}\}$,respectively, represent the output criteria set forG_1andG_2,where $O_1^i$and O_2^i represent the$i$th output criterion for$G_1$and G_2, separately.

2.2 Criteria Fusion for Non-homogeneous DMUs

Both input and output criteria have to be aggregated, so that the traditional DEA model can be applied to evaluate DMUs across two groups. Based on the concept of "or" and "and" operations in the set theory, the following criteria fusion operations are proposed to generate a set of unified input and output criteria.

(1) "or" operation for input criteria

Let $I_{or} = I_1 \cup I_2$, be the "or"-based input criteria set. Naturally, I_{or} keeps both criteria sets proposed by the two groups and reserves different opinions from both perspectives.

(2) "and" operation for input criteria

Let$I_{and} = I_1 \cap I_2$, be the "and"-based input criteria set. I_{and}identifies the common ground for both groups' opinions.

In a similar fashion, $O_{or}$and O_{and} can be defined as the "or" and "and"-based output criteria set, respectively.

2.3 DEA Modelling Strategies

Given the aforementioned two-input and two-output setting,I_1, I_2, O_1, O_2, and the four operations on the input and output criteria,I_{or}, I_{and}, O_{or}andO_{and}, the following DEA modelling strategies can be constructed to evaluate DMUs across the two groups:

(1) e_{and}^{or}-based DEA modeling: I_{and}andO_{or} are designated as the input and output criteria set for both groups' DEA modelling.
(2) e_{or}^{and}-based DEA modelling: $I_{or}$and $O_{and}$are designated as the input and output criteria set for both groups' DEA modelling.
(3) e_{and}^{and}-based DEA modelling: I_{and} andI_{and} are designated as the input and output criteria set for both groups' DEA modelling.
(4) e_{or}^{or}-based DEA modelling: I_{or} and $O_{or}$are designated as the input and output criteria set for both groups' DEA modelling.

Without loss of generality, this study assumes that the results of all criterion fusion operations are nonempty. In this case, the four aforesaid DEA modeling strategies (1)-(4) are referred to as$k = 1,2,3,4$, respectively.

3 A Mixed Value-Weight Optimization DEA Model

3.1Value Estimation for Criteria with Missing Data

Upon establishing the four DEA modeling strategies, the next step is to assess the DMUs according to different criteria settings. For any strategy, denote its input and output criteria sets by $I = \{I^1, ..., I^i, ..., I^{|I|}\}$ and $O = \{O^1, ..., O^r ..., O^{|O|}\}$, respectively. For convenience, the following notations are introduced:

- $\forall DMU_1^j \in G_1$, let $X_1^j = \left(x_1^{j1}, \dots, x_1^{ji}, \dots, x_1^{j|I|}\right)$ denote DMU *j*'s input value vector, where $x_1^{ji} \in \mathbb{R}^+$ refers to DMU *j*'s value on input criterionI^i.
- Similarly, let $Y_1^j = \left(y_1^{j1}, \dots, y_1^{jr}, \dots, y_1^{j|O|}\right)$denote DMU *j*'s output value vector, where $y_1^{jr} \in \mathbb{R}^+$ refers to DMU *j*'s value on output criterionO^rforDMU_1^j.
- Similarly, for any $DMU_2^d \in G_2$, X_2^d and Y_2^dcan bedefined accordingly as$X_2^d = \left(x_2^{d1}, \dots, x_2^{di}, \dots, x_2^{d|I|}\right)$ and $Y_2^d = \left(y_2^{d1}, \dots, y_2^{dr}, \dots, y_2^{d|O|}\right)$.

Based on this setting, the following four scenarios are discussed to address the issue of missing data in input and output criteria:

(1) Estimating missing data for input criteria in G_1

If $I_i^k \in I_1$, i.e. I_i^k is an original criterion proposed by G_1, then it is assumed that the relevant criteria value, x_{1i}^j, is always available, since the criterion is supported by G_1, and DMUs are ready to collect and apply the data for efficiency evaluation.

Definition 1: $\forall I_i^k \in I^k$, I_i^k is a *data-missing input-criterion* for G_1, if $I_i^k \notin I_1$.

When $I_i^k \notin I_1$, consequently$I_i^k$is a criterion proposed by G_2. Then DMUs in G_1 may not have relevant value data available for I_i^k, andI_i^k can be assumed as a data-missing criterion for G_1. How to estimate the value of data-missing criterion becomes a priority issue when applying different DEA modeling strategies.

To deal with such situation, the following methods can be employed to estimate the value of data-missing criteria:

It is assumed that with a *data-missing input-criterion* for G_1,I_i^k, all DMUs in G_2 have the criterion values, *i.e.* $\forall DMU_2^d \in G_2$,x_{2i}^d is available for DMU_2^d. Then, all DMUs in G_1 can utilize the value information in G_2 as reference points to estimate their values for a data-missing criterion I_i^k. Specifically,

1) Maximum principle approach: choose the maximum value of I_i^k in G_2 to be the data estimation of I_i^k for all DMUs in G_1, denoted as

$$x_{1i}^j = \max_{d=1}^{|G_2|}(x_{2i}^d) \tag{1}$$

Such assumption is an aggressive attitude to all DMUs in G_1 for efficiency analysis, since input value of I_i^k in G_1 may be overestimated.

2) Minimum principle approach: choose the maximum value of I_i^k in G_2 to be the data estimation of I_i^k for all DMUs in G_1, denoted as

$$x_{1i}^j = \min_{d=1}^{|G_2|}(x_{2i}^d) \tag{2}$$

Such assumption is a benevolent attitude to all DMUs in G_1 for efficiency analysis, since input value of I_i^k in G_1 may be underestimated.

3) Average principle approach: calculate the average value with all DMUs' data value of I_i^k in G_2 to be the data estimation of I_i^k for all DMUs in G_1, denoted as

$$x_{1i}^j = \text{average}_{d=1}^{|G_2|}(x_{2i}^d) = \frac{1}{|G_2|}(\sum_{d=1}^{|G_2|} x_{2i}^d) \quad (3)$$

(2) Value setting for Data-missing input-criteria in G_2

Similarly, the following definition is given for a data-missing input criterion for G_2.

Definition2: $\forall I_i^k \in I$, I_i^k is a *data-missing input-criterion* for G_2, if $I_i^k \notin I_2$.

Maximum, minimum and average principle approaches can be applied to obtain value estimation of x_{2i}^d for all DMUs in G_2.

(3) Value setting for Data-missing output-criteria in G_1

Correspondingly, the following definition is given for a data-missing output criterion for G_1.

Definition3: $\forall O_i^k \in O$, O_i is a *data-missing output-criterion* for G_1, if $O_i^k \notin O_1$.

Then, maximum, minimum and average principle approaches can be applied to obtain value estimation of y_{1r}^j for all DMUs in G_1.

(4) Value setting for Data-missing output-criteria in G_2

Likewise, the following definition is given for a data-missing output criterion for G_2.

Definition4: $\forall O_i^k \in O$, O_i is a *data-missing output-criterion* for G_2, if $O_i^k \notin O_2$.

Again, maximum, minimum and average principle approaches can be applied to obtain value estimation of y_{2r}^d for all DMUs in G_2.

3.2 Value Optimal Setting for DEA Model

As mentioned in Section 1, one of the advantages of DEA model for efficiency analysis is that DMUs are allowed to freely set criteria weights for their overall efficiency maximization. Inspired by this idea, in this section, a value optimal setting procedure is proposed for the value estimation of data-missing criteria [7].

Following the assumption that all DMUs in one group can use the other group's criterion value information as reference points to estimate their values of data-missing criterion, instead of the above mentioned maximum, minimum and average principle approaches, it is assumed that DMUs are allowed to freely set these values, as long as the following constraints are applied:

(1) The upper boundary of data estimation for a data-missing criterion

$\forall DMU_1^j \in G_1$, let $\overline{x_{1i}^j}$ be the upper boundary of DMU_1^j's data estimation for a data-missing criterion, I_i. Set$\overline{x_{1i}^j} = \max_{d=1}^{|G_2|}(x_{2i}^d)$, *i.e.* the maximum value of available criterion data in G_2 is used as the upper boundary of data estimation for G_1 due to limited information available.

(2) The lower boundary of data estimation for a data-missing criterion

$\forall DMU_1^j \in G_1$, let $\underline{x_{1i}^j}$ be the lower boundary of DMU_1^j's data estimation for a data-missing criterion, I_i. Similarly, set$\underline{x_{1i}^j} = \min_{d=1}^{|G_2|}(x_{2i}^d)$, *i.e.* the minimum value of available criterion data in G_2 is used as the lower boundary of data estimation for G_1.

Hence, with a data-missing input-criterion I_i for G_1, the value estimation of DMUs in G_1, x_{1i}^j, can be constrained by $\underline{x_{1i}^j} \leq x_{1i}^j \leq \overline{x_{1i}^j}$. Similarly, with a data-missing output-criterion O_i for G_1, the value estimation of DMUs in G_1, y_{1r}^j, is set as $\underline{y_{1r}^j} \leq y_{1r}^j \leq \overline{y_{1r}^j}$; with a data-missing input-criterion I_i for G_2, the value estimation of DMUs in G_2, x_{2i}^d, is set as $\underline{x_{2i}^d} \leq x_{2i}^d \leq \overline{x_{2i}^d}$; and with a data-missing output-criterion O_i for G_2, the value estimation of DMUs in G_2, y_{2r}^d, is set as $\underline{y_{2r}^d} \leq y_{2r}^d \leq \overline{y_{2r}^d}$. The following Eqs. (4) is summarized as constraints for DMU_1^j to estimate its values of data-missing input and output criteria:

$$\begin{cases} \underline{x_{1i}^j} \leq x_{1i}^j \leq \overline{x_{1i}^j}; \\ \underline{y_{1r}^j} \leq y_{1r}^j \leq \overline{y_{1r}^j}; \end{cases} \tag{4}$$

Eqs. (5) is summarized as constraints for DMU_2^j to estimate its values of data-missing input and output criteria:

$$\begin{cases} \underline{x_{2i}^d} \leq x_{2i}^d \leq \overline{x_{2i}^d}; \\ \underline{y_{2r}^d} \leq y_{2r}^d \leq \overline{y_{2r}^d}; \end{cases} \tag{5}$$

3.3 Mixed Value-weight Optimization DEA Model

The following revised CCR model, P1, is constructed to identify the maximum efficiency value for $DMU_1^{j_0}$ in G_1 under a specific strategy k.

Kindly notice that in P1, the decision variables include all input and output criterion weights, v_r and $u_i (r = 1,2,\ldots,|O|; i = 1,2,\ldots,|I|)$; all value estimations for data-missing criteria for all DMUs, x_{1i}^j and y_{1r}^j ($j = 1,2,\ldots,|G_1|$; $i = 1,2,\ldots,|I|; r = 1,2,\ldots,|O|$), and x_{2i}^d and $y_{2r}^d (d = 1,2,\ldots,|G_2|;\ i = 1,2,\ldots,|I|;\ r = 1,2,\ldots,|O|)$. With P1, the optimal efficiency value can be obtained for DMU_1^j in G_1 as well as all criterion weights and value estimations for all data-missing criteria. In a similar procedure, the optimal efficiency value can be identified for DMU_2^j in G_2. The details are omitted here.

It can be verified that there existed at least one optimal solution to P1, since P1defines a closed and bounded set. The objective function is a continuous function on this set. The extreme value theorem of advanced calculus [8],therefore implies that P1 attains a maximum value at least once.

$$
\text{P1}\begin{cases}
\max e_1^{j_0} = \sum_{r=1}^{|O|} v_r\, y_{1r}^{j_0} \\
S.t. \\
\sum_{r=1}^{|O|} v_r y_{1r}^{j} - \sum_{i=1}^{|I|} u_i x_{1i}^{j} \le 0, j = 1,2, \dots, |G_1|\,; \\
\sum_{r=1}^{|O|} v_r y_{2r}^{d} - \sum_{i=1}^{|I|} u_i x_{2i}^{d} \le 0, d = 1,2, \dots, |G_2|; \\
\sum_{i=1}^{|I|} u_i x_{1i}^{k} = 1; \\
v_r, u_i \ge 0, r = 1,2, \dots, |O|; i = 1,2, \dots, |I|; \\
\text{Eqs.}\,(4-5)\ for\ all\ data - missing\ crtieria\ with\ all\ DMUs;
\end{cases}
$$

3.4 OWA-based Result Aggregation

Upon the acquirements of efficiency values of DMUs under different DEA modeling strategies, a result aggregation procedure needs to be used to generate final results and facilitate decision analysis. Here, OWA (ordered weighted averaging) method is utilized to achieve such purpose. OWA provides a parameterized class of mean type aggregation operators. They were introduced by Ronald R. Yager [9]. Many notable mean operators such as the max, arithmetic average, median and min, are members of this class.

Assumed that $\forall j = 1, \dots, |G|$, the efficiency values of DMU_j under four strategies are available, then the following OWA aggregation procedure is designed:

(1) Efficiency value re-ordering: for each DMU, the order of its efficiency values is re-arranged discerningly. Let the descending order set of four DEA efficiency values for DMU_j is set as$E(DMU_j)$, where $E(DMU_j) = (e_j^1, e_j^2, e_j^3, e_j^4)$, and $\forall i = 1, \dots, 3$, it satisfies $0 \le e_j^{i+1} \le e_j^i \le 1$. Then, a position related weight vector, Q ($Q = (q_1, q_2, q_3, q_4)$, needs to be attached to$E(DMU_j)$, where $\sum_{i=1}^{4} q_i = 1$, and $0 \le q_i \le 1$. Some weight vector settings for Q discussed in [19] can be used and reproduced as follows: 1) Benevolent attitude-based result aggregation: Let $Q1 = (1,0,0,0)$, then $OWA_{Q1}^j = \max_{i=1,\dots,4}(e_j^i)$, where the best DEA result is selected as OWA_{Q1}^j. 2) Conservative attitude-based result aggregation: Let $Q2 = (0,0,0,1)$, then $OWA_{Q2}^j = \min_{i=1,\dots,4}(e_j^i)$, where the worst DEA result is selected as OWA_{Q2}^j. 3) Neutral attitude-based result aggregation: Let $Q3 = (\frac{1}{4}, \frac{1}{4}, \frac{1}{4}, \frac{1}{4})$, then $OWA_{Q3}^j = \frac{1}{4}\sum_{i=1,\dots,4}(e_j^i)$, where the arithmetic mean of all four DEA results is selected as OWA_{Q3}^j.

(2) Final result aggregation: a final DEA results for DMU_j can be achieved by through a selected aggregation from $Q1$ to $Q3$to aggregate different efficiency values, e_j^1-e_j^4:

$$OWA_{Q1-3}^{j}\left(e_j^1, e_j^2, e_j^3, e_j^4\right) = \sum_{i=1}^{4} q_i\, e_j^i \qquad (6)$$

Finally, Fig. 1 summarizes the overall DEA analysis procedure of two non-homogeneous DMU groups.

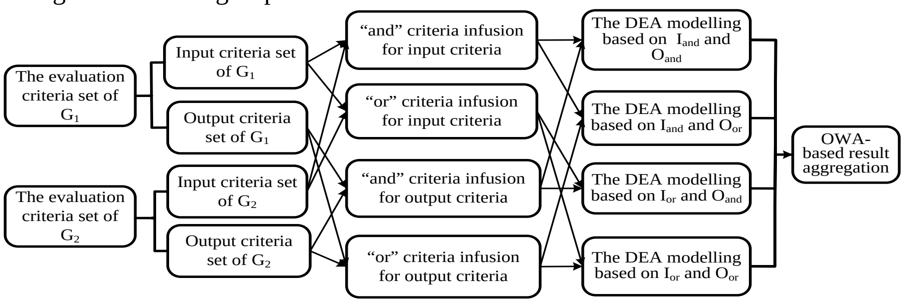

Fig. 1. The overall analysis procedure of this study

4 Illustration example

4.1 Background information

It is assumed that there exist 28 departments in a university in China. Two academic divisions, G_1 and G_2, have been set for these 28 departments, as shown in **Tab.** 1. G_1 stands for the group of Engineering-based departments containing 14 departments, as indicated by (A-N); G_2 stands for the group of humanities and social science-based departments containing 14 departments, as indicated by (*a*-*n*).

The input criteria set, I_1, proposed by G_1 include NFP (number of full-time personnel), and ESP (expense on scientific research project in RMB Yuan); the output criteria set, O_1, proposed by G_1 include JP (number of journal paper publication), AC (number of accreditation certificate for research performance) and NAW (number of national awards).

The input criteria set, I_2, proposed by G_2 include NFP and EHP (expense on humanities and social science research project in RMB Yuan); the output criteria set, O_2, proposed by G_2 include JP, NAW, and SCA (number of social community activities).

Next, based on the above criteria setting, the criteria value for each DMU is measured and listed in **Tab**. 1.

Tab. 1 The annual input and output data for 28 departments in a university

	Department	ESP	NFP	SHP	JP	AC	NAW	SCA
G_1	A	54284	1934	359	1794	91	5	3
	B	48879	454	1250	744	26	0	0
	C	96830	1269	285	800	49	5	2
	D	54595	790	765	470	22	2	2
	E	85779	1391	562	1281	21	2	1
	F	46512	1122	962	1481	39	0	5

	G	53834	1798	743	865	90	1	3
	H	70780	536	378	774	25	3	2
	I	72830	845	1252	1287	20	4	0
	J	53207	1501	686	1624	91	1	1
	K	90563	487	628	585	50	4	3
	L	53271	641	366	1475	85	3	2
	M	47361	1685	1287	1722	31	0	4
	N	70816	861	1056	1201	77	2	4
G_2	a	51629	872	4283	902	25	3	5
	b	23814	240	3514	349	28	2	3
	c	21179	609	2658	536	22	0	9
	d	32474	732	5904	567	27	1	6
	e	47789	974	5744	720	52	4	7
	f	53584	263	2045	651	28	0	8
	g	49254	223	5775	624	33	2	10
	h	30295	682	2140	885	46	5	9
	i	34424	259	2283	339	58	2	3
	j	59245	251	3816	854	32	5	8
	k	37524	463	3156	596	38	4	3
	l	55776	904	2794	698	49	1	7
	m	27032	282	4515	793	31	0	5
	n	30359	981	5413	368	47	1	4

4.2 Different efficiency values' calculation and results integration

According to **Fig.** 1, six kinds of DEA modelling results and three kinds of OWA aggregation final results are listed in **Tab.** 2.

Tab. 2 Calculated efficiency result for all DMUs

	e_{or}^{or}	e_{or}^{and}	e_{and}^{or}	e_{and}^{and}	e_1^1	e_2^2	Integration of OWA		
							OWA_Q^1	OWA_Q^2	OWA_Q^3
A	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
B	0.665	0.665	0.573	0.573	0.573	0.665	0.665	0.573	0.619
C	1.000	1.000	0.439	0.418	0.439	1.000	1.000	0.418	0.716
D	0.538	0.520	0.342	0.342	0.342	0.538	0.538	0.342	0.437
E	0.540	0.540	0.498	0.498	0.498	0.540	0.540	0.498	0.519
F	1.000	0.989	0.960	0.960	0.960	1.000	1.000	0.960	0.978
G	0.995	0.477	0.986	0.463	0.978	0.677	0.995	0.463	0.763
H	1.000	0.995	0.556	0.556	0.556	1.000	1.000	0.556	0.777
I	0.796	0.796	0.712	0.712	0.712	0.796	0.796	0.712	0.754
J	1.000	0.943	1.000	0.901	1.000	0.943	1.000	0.901	0.965
K	1.000	1.000	0.588	0.494	0.588	1.000	1.000	0.494	0.778
L	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
M	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
N	0.811	0.609	0.689	0.601	0.673	0.805	0.811	0.601	0.698
a	0.605	0.605	0.605	0.605	0.605	0.605	0.605	0.605	0.605
b	0.915	0.764	0.915	0.764	0.915	0.764	0.915	0.764	0.840
c	1.000	0.735	1.000	0.735	0.775	1.000	1.000	0.735	0.874
d	0.606	0.554	0.606	0.554	0.567	0.606	0.606	0.554	0.582
e	0.687	0.544	0.687	0.544	0.683	0.544	0.687	0.544	0.615
f	1.000	0.871	0.833	0.758	0.796	1.000	1.000	0.758	0.876
g	1.000	0.838	1.000	0.838	0.974	1.000	1.000	0.838	0.942
h	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
i	1.000	0.587	1.000	0.587	1.000	0.587	1.000	0.587	0.794
j	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
k	0.926	0.887	0.926	0.887	0.926	0.887	0.926	0.887	0.907
l	0.633	0.423	0.576	0.417	0.529	0.595	0.633	0.417	0.529

m	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
n	0.942	0.369	0.942	0.369	0.909	0.421	0.942	0.369	0.659

From the table 2, we can get the following results:

For OWA_Q^1, a benevolent attitude-based aggregation, there has the most number of DMUs achieving relatively efficiency;

For OWA_Q^2, a conservative attitude-based aggregation, there has the least DMUs achieving relatively efficiency;

For OWA_Q^3, a neutral attitude-based aggregation, the number of relatively efficient DMUs is in the middle between OWA_Q^1 and OWA_Q^2.

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Multi-Agent Modelling Using Netlogo on Carbon Emission Schemes in China: Taxes vs Trade

Qian Wu, Shawei He, and Ye Chen

College of Economics and Management, Nanjing University of Aeronautics and Astronautics
29 Jiangjun Avenue, Jiangning District, Nanjing, China, 211106
shaweihe@nuaa.edu.cn

Abstract. The preferences of emission enterprises in China over two carbon emission schemes, taxes and trade schemes, are investigated using Netlogo, a multi-agent modelling approach. As the Chinese government needs to compare the two schemes from the perspective of the emission enterprises, the circumstances under which each scheme is preferred by the enterprises are analyzed. In this short paper, the cost functions of emissions under the tax and trade schemes for each enterprise are defined. An enterprise would prefer the scheme with less emission costs. Meanwhile, the preference of one enterprise may be affected by others'. Steps for simulating the compliance of the carbon emission schemes for a number of enterprises using Netlogo language are provided. The simulation results indicate guidance of actions for the Chinese governments to design carbon emission policies more effectively by considering the interests of various emission enterprises.

Keywords: Multi-agent Modelling, Conflict analysis, Climate Change, Netlogo, Carbon Tax, Carbon Trade

1 Introduction

Global warming has posed a threat to the earth and wellbeing of mankind. In an effort to mitigate greenhouse gas emissions, multinational collaborations are carried out under the United Nations Framework Convention on Climate Change (UNFCCC). The governance over climate change is defined as the development of treaties, policies, and mechanisms towards reducing the risks and consequences of climate change (Jagers and Stripple, 2003). Within national borders, climate governance involves governments at multiple levels (Bulkeley and Newell, 2009). Traditionally, environmental laws and regulations are enforced by governments within the "top-down" framework. Besides, non-state organizations are playing an increasingly important role, such as the participation of business sectors and the self-governance of local communities (Power et al., 2002).

Market-based mechanisms have been developed as the complement of governmental laws and regulations. In particular, carbon taxes and carbon trade are two powerful tools to control carbon emissions. Carbon trading, or called cap and trade, is a market based approach to encourage the reduction of emissions for enterprises (Starvins, 2001).

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Compared with carbon taxes, carbon trade scheme allows emitters to customize the amount of emissions and profit from unused quota. The European Union Emission Trading Scheme (EU ETS) is the largest multinational trading scheme in the world. Major domestic trading markets can be found in Japan, the United States, and China. To ensure the effectiveness of trading policies, precise measurements are required to determine the inventories for trade (Tiwari et al., 2010). The implementation of carbon trading mechanism has many impacts apart from reducing carbon emissions, such as encouraging the development of clean technologies and an increase in low-carbon patents (Calel and Dechezlepretre, 2016). Several challenges and criticisms have been pointed out by researchers. The influence of carbon market on stock prices for enterprises cannot be ignored, although the environmental costs can be saved (Bushnell et al., 2013; Trotignon et al., 2015). Complexity of carbon trading markets will bring uncertainties to the implementation of trading policies (Lohmann, 2006).

As one of the countries with significant emission, China has taken efforts in continuously mitigating carbon emissions. National carbon trading scheme in China were announced by the national government in 2008 to allow the transaction of unused quota among enterprises (Philip, 2014). Seven cities in China were selected as trading centers, including Beijing, Shanghai, Shenzhen, Guangzhou, Wuhan, Chongqing, and Tianjin (Swartz, 2016). However, enterprises are homogenous at some trading centers, which means they may experience shortage or surplus at the same time. Thus, the fluctuating level of the quota for trade may result in low transaction rate (Tanpaifang, 2016). A more unified market incorporating all existing trading centers will be in use from 2017. Detailed policies at local levels need to be designed to support the running of the unified carbon market.

Carbon taxes have been adopted by a number of countries, such as European Union, Japan, Australia, and China. The amount of emission can be effectively controlled by determining the unit price of emission. The design of carbon tax policies has been thoroughly investigated from the perspective such as supply planning (Fahimnia et al., 2015), social costs (Yohe, 2007), and the impact on national economy (Lu et al., 2010).

Environmental laws have been initiated by governments including taxation on enterprises, especially on coal plants and cement factories. "Environmental Protection Tax" was passed nationwide in 2013, according to which CO_2 emissions were charged for the first time. Although a unified carbon market will be in effect in 2017, carbon tax is still a useful scheme, as it can cover a wide range of emission industries and also affect the use of energy (Parry and Wingender, 2016). However, the implementation of the tax scheme may impact the export and economic growth.

Whether to choose carbon tax or carbon trade by policymakers has been extensively discussed. When a tax scheme is applied, emission price has been determined to control the emission, while the amount of emission can be limited by adopting to carbon trade systems (David Suzuki Foundation, 2017). Under a tax scheme, the carbon prices are controlled by the governments. In comparison, the carbon prices are affected by many factors in carbon markets, such as economic growth (Pew Center on Climate Change, 2009). The selection of the two schemes depends on factors such as the economic incentives to reduce emissions and which sectors of emitting enterprises are from. As a unified carbon market in China will be established in 2017, policy makers need to investigate under what circumstances the respective schemes can work effectively. A carbon scheme cannot be successfully accepted and complied by emission enterprises unless it is beneficial for them. In this paper, the selection of the two aforementioned schemes is analyzed from the perspective of these enterprises. In reality, these enterprises cannot determine the governmental policies. However, they can be modelled as stakeholders who can decide which scheme is more preferred.

In particular, the behaviors of stakeholders impacting the climate change have been simulated using multi-agent approaches (Baghoussi et al., 2016; Filatova and Bin, 2014). Among them, Netlogo is a multi-agent programming language to model complex natural and societal systems. With its user-friendly platform, it can be applied to the complex interaction among large number of stakeholders when their patterns of behavior are hard to characterize, the dynamics of the interaction among the emitting enterprises in China need to be investigated to provide governments with guidance to design climate change policies. In this paper, Netlogo methodology is used to analyze which one of the two carbon schemes would be preferred by enterprises in China and under what circumstances. Although an enterprise cannot decide the schemes to adopt by itself, the preferences for these enterprises would be important for governments in China to design the structure and the detail of carbon mitigation policies. Assuming a number of enterprises as the agents in the Netlogo model, the preferences of one scheme over the other for these enterprises are considered as interactions among the enterprises. The preference for one enterprise can be affected by the preferences for others. This paper only covers the modelling of the multi-agent interactions using Netlogo, while detailed simulation will be discussed in the future research.

In the remainder of the paper, a brief introduction of Netlogo approach is given in Section 2. The cost functions for enterprises are defined in Section 3, followed by the selection of optimal emission costs for individual enterprises in Section 4. Generic steps for simulating the interaction among enterprises are introduced in Section 5. Conclusions and Further Study are provided in Section 6.

2 Netlogo Programming

NetLogo is designed to model complex systems using visual shapes and graphs. Agents are expressed in the form of turtles, patches, links, and the observer (Kornhauser, 2007). It can model the evolution of complex system over time. By inputting instructions to independent agents, the interactions among these agents can be simulated. Practitioners are provided with a large number of sample documents and codes to facilitate the modelling process.

Agents called "turtles" move over a grid of "patches," which are small rectangles in two dimensions or blocks in three dimensions. A patch is identified by its coordinate, (x, y) or (x, y, z). Several variables can be used to describe a path, such as color and time of being visited. A turtle can go from one patch to another based on specified rules and definitions on its motion. The simulation starts with a particular state and evolve over time. The behaviors for the agents can be monitored. Note that agents can learn from others. For example, an agent can switch to an option that has been taken by others, if it could benefit from the switch of the option.

Netlogo programming has been applied to various research area, such as decision making (Sirer et al., 2016; Jiang et al., 2015), resource management (Cascalho and Mabunda, 2015), computer science (Feciciani and Nishinari, 2016).

3 Modeling Carbon Emission Costs in China

In this paper, the interaction between one government and a number of emitting enterprises in China is investigated to test the effectiveness of two different climate governance policies, i.e. taxes and trade. Although these enterprises are passive receivers of any instructions from the governments in China, the preferences over one scheme to the other would be indicative for the policy makers. Each enterprise is assumed to prefer one scheme to the other according to its emission costs. Under each scheme, an enterprise will reach an optimal emission amount so that the corresponding costs are the lowest. It will prefer the scheme with smaller optimal costs.

Suppose the set of enterprises in China is denoted as *N*, the amount of emission for enterprise $i \in N$ is represented by q_i. As each enterprise can benefit from the emission, the reduction of the emission will result in some abatement costs (Fuentes-Albero and Rubio, 2010). As the cost of abatement can be denoted as a concave function indicating the decreasing returns of environment exploitation, the abatement cost function for *i* is written as $(\frac{c_i}{2})(\delta_i - q_i)^2$, where c_i is the parameter reflecting the abatement costs for *i* and, δ_i the emission for *i* under the condition of BAU (business as usual) (Botteon and Carraro, 2001; Fuentes-Albero and Rubio, 2010).

The overall emission for all enterprises is $Q = \sum q_i$. The carbon emissions will bring environmental damage and economic loss to the nation. For each enterprise, the loss is different. Hence, the loss caused by the overall emission for *i* is marked as $D_i(Q) = d_i Q$, where parameter d_i describes the loss per ton of CO_2 for *i*.

Two climate change policies are considered, carbon trade and carbon tax. Under the scheme of carbon trade, the unit price of emission is marked as *p*; $\hat{q}$ denotes the maximum emission allowed by the government for each enterprise. The cost function of emission for enterprise *i* is written as

$$C_{i1} = (\frac{c_i}{2})(\delta_i - q_i)^2 + d_i \sum q_i - p(\hat{q} - q_i) \quad (1)$$

The cost function for *i* under the scheme of carbon tax is denoted as

$$C_{i2} = \left(\frac{c_i}{2}\right)(\delta_i - q_i)^2 + d_i \sum q_i + e q_i \quad (2)$$

where *e* represents the parameter related to the tax.

Under the two schemes, each enterprise wishes to minimize the emission cost. The optimal emission for *i*, q_i^*, and its minimized emission costs can be obtained by calculating the derivatives of C_i shown as follows.

Under trade scheme: $q_i^* = \delta_i - \frac{d_i + p}{c_i}$ and

$$C_{i1}^* = \frac{(d_i + p)^2}{2c_i} + p(\delta_i - \hat{q}) - \frac{(d_i + p)p}{c_i} + d_i \sum(\delta_i - \frac{d_i + p}{c_i}) \quad (3)$$

when $\frac{dC_{i1}}{dq_i} = 0$.

Under tax scheme: $q_i^* = \delta_i - \frac{d_i + e}{c_i}$ and

$$C_{i2}^* = \frac{(d_i + e)^2}{2c_i} + e\delta_i - \frac{(d_i + e)e}{c_i} + d_i \sum(\delta_i - \frac{d_i + e}{c_i}) \qquad (4)$$

when $\frac{dC_{i2}}{dq_i} = 0$.

4 Selection of Carbon Emission Schemes

In this section, the emission costs under two schemes are compared. Suppose an enterprise should decide whether to pay emission tax or trade in the regional market.

The cost advantage of one option over the other for an enterprise depends on the parameters in the two cost functions. The comparison of the emission costs is explained in detail as follows.

By referring to Equations (3) and (4), the difference of C_{i1} and C_{i2} is expressed as

$$\Delta C_i^* = C_{i1}^* - C_{i2}^* = \frac{e^2 - p^2}{2c_i} + (p - e)\delta_i - p\hat{q} + d_i \sum \frac{e - p}{c_i} \qquad (5).$$

If $\Delta C_i^* > 0$, enterprise *i* prefers to trade;
if $\Delta C_i^* < 0$, enterprise *i* prefers to pay tax;
if $\Delta C_i^* = 0$, no difference in cost between the two schemes.

The abovementioned conditions indicate the when the selection of a given option is favorable for a focal enterprise. For example, if *i* pays the carbon tax, it will not change its option until $\Delta C_i^* > 0$.

In some carbon trading centers in China, the unit price of unused quota, *p*, fluctuates over time. Several conclusions are expected to be obtained by changing the values of the parameters in Equation (5).

In Equation (5), the value of ΔC_i^* is determined by $e - p$, if the values for other parameters are unchanged. With the increase of *e*, the focal enterprise is more likely to switch to the trading scheme. As *p* fluctuates, the tax levied on each amount of emission, *e*, should be adjusted accordingly to cope with the change of *p*.

With the increase of c_i, ΔC_i^* decreases correspondingly. The abatement costs increase under both carbon schemes. Given other parameters unchanged, the given enterprise is more likely to switch to carbon trade when c_i decreases. It can be concluded that the trading scheme is more suitable when abatement costs decreases by various means, for example, by developing new technologies.

It should be noted that the environmental loss to enterprise *i*, d_i, will affect the its preference over the two schemes. However, its relation with ΔC_i^* needs to be further analyzed during simulation.

5 Steps for Simulation using Netlogo

The process of selecting the two carbon emission schemes for enterprises are simulated using Netlogo. The variables in Equation (5) include the cost parameter c_i, the loss parameter d_i, the reference displacement δ_i, the allowable carbon emission for each enterprise $\hat{q}$, the unit price of emission *p*, and the tax-related parameter *e*. The dynamics of the actions of these enterprises are analyzed by changing one or more of these variables. The general steps for the simulation are provided.

Step 1: Model Initialization

A total of N emission enterprises are agents in the Netlogo model. To facilitate simulation, δ_i and $\hat{q}$ follow a normal distribution with a mean of 100 tons and the variance of 10 tons. The parameters c_i and d_i obey the uniform distribution as [l, 2] (10 thousand Chinese Yuan per ton). In a certain period of time, the value of parameters p and e *are* certain and determined by the national policy.

At the initial status, enterprises that prefers the trading scheme are denoted by stars, while enterprises in favor of the tax scheme are represented by squares, shown in Fig. 1. The proportion of the two types of enterprises can be set at the start of the simulation.

Step 2: Run

As the program runs, each enterprise takes the option in which the optimal emission cost can be achieved. As the parameters change, the trend of the optimal emission cost and the actions for these enterprises can be observed. As the interaction among agents evolves with time, the dynamics of the selection of the schemes can be observed.

Step 3: Learning

Learning process can be simulated by setting the parameters for enterprises according to those for some others. The parameters for a number of enterprises, $H \subset N$, are determined at the start of the simulation. As the interaction evolves, the parameters, such as q_j, for other enterprises $j \in N - H$, are determined by q_i for $i \in H$. In the real world, as the parameters in the cost function may not be obtained, an enterprise could actually determine its emission amount according to how much other enterprises emit.

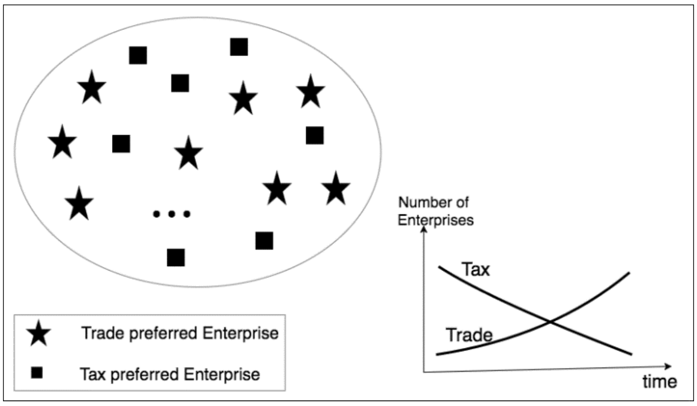

Fig.1. Illustration of simulating carbon scheme selections using Netlogo

6 Conclusions and Future Work

In this short paper, the selection of carbon tax and trade schemes carbon emission for enterprises China is modelled on the Netlogo programming platform. Considering the interaction of the enterprises as a conflict containing multiple decision makers, the emission costs of selecting two carbon schemes are compared for each enterprise. As an enterprise will reach an optimal emission amount so that the costs are the lowest under each scheme, it will prefer the scheme with smaller optimal costs. Simulation will be carried out in the further study to analyze the dynamics of selecting carbon schemes for a group of enterprises. Moreover, each enterprise could learn the selection of the carbon schemes from others. The results of the selection, as well as the value of the parameters, can provide guidance of actions for governments in China to design carbon emission policies.

The detailed simulation results need to be obtained at the next step of this research. Moreover, graph model for conflict resolution (GMCR) methodology can be applied to the carbon scheme selection for a large number of decision makers. GMCR is a formal approach to analyze strategic conflicts. As the parameters in the cost function are often hard to determine, each enterprise chooses the carbon schemes according to the ordinal comparison of the corresponding emission costs. The selection process under GMCR paradigm can be simulated using Netlogo language. The combination of GMCR and Netlogo can provide a flexible and powerful tool for policy makers to analyze the dynamics of interactions among stakeholders regarding carbon emission mitigation.

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Nuclear Accidents and Deterrence in a Bargaining Model

Daniela S. Scherer

ETH Zürich, Zürich, Switzerland
dscherer@ethz.ch

Abstract. We combine aspects of nuclear deterrence and nuclear accidents in one comprehensive game theoretic bargaining model. Based on the game equilibria, we determine the conditions under which actors prefer a conventional or a nuclear conflict environment. We find that aspects of nuclear deterrence and nuclear accidents are critical variables with competing character. We discuss the impact of our findings in the context of the Sagan-Waltz debate on the utility of nuclear weapons.

Keywords: nuclear weapons, game theory, bargaining model, international conflicts

1 Introduction

The debate on the role and utility of nuclear weapons is as old as the realization of the first nuclear weapon itself. Some nuclear weapons scholars focus on the causes and consequences of nuclear proliferation [1, 2], while others study the closely related topic of the general role of nuclear weapons, which has been discussed repeatedly over the last 70 years [3–9]. Although the studied topics related to nuclear weapons are diverse, there is a largely common, ultimate urge to understand certain, specific aspects of nuclear weapons in the hope to prevent a destructive nuclear war.

While most scholars agree on the importance of preventing such a war, they substantively disagree on how to ensure it. A prominent example, which we focus on in this work, was the debate between nuclear pessimist Scott Sagan and nuclear optimist Kenneth Waltz. In "The Spread of Nuclear Weapons: an Enduring Debate", which is in its third edition, the two scholars disagree as to whether the spread of nuclear weapons makes the world a more dangerous place, or whether these weapons provide peace and stability.

By analyzing their debate, it becomes evident that the authors approach the topic in two fundamentally different ways. Sagan, on the one hand, looks at it from an organizational theory standpoint. He assesses not only nuclear accidents but also terrorist attacks and preventive war, and emphasizes that the probability of a nuclear detonation is not negligibly low. Waltz on the other hand underlines the anarchic system the states find themselves in. He argues that the prospect of the devastation resulting from a nuclear escalation makes the states

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cautious. Therefore, he concludes that nuclear deterrence is a key pillar of peace and stability.

As we will point out later, Waltz' way of looking at this question is implicitly related to how many game theoretic studies approach the role of nuclear weapons. We will show that this strategy-focused approach leads to a line of argument, which is not a straightforward counterpart to Sagan's organizational viewpoint. In this work, we want to contribute to the understanding of the two theories' different levels, discuss their points of contact but also aspects where they are at cross purposes. Hence, we develop a bargaining game which focuses on the utility of nuclear weapons and incorporates two main aspects of Sagan's and Waltz' arguments: nuclear accidents and deterrence. We find that, if brought on the same level as in our model, the two aspects are critical variables with competing character, which determine the utility of nuclear weapons.

2 The Different Levels of the Nuclear Debate

2.1 Waltz' Reasoning and Game Theoretic Deterrence Theories

Based on two examples, we will point out parallels between Waltz' way of looking at the question of the utility of nuclear weapons and the approach game theoretic studies take.

Anarchic Environment Waltz states early on in the book, that "[s]tates coexist in a condition of anarchy" and that states must provide for their own security in the form of self-help [8]. This is an assumption that is also underlying most game theoretic models in international relations (cf. [10–12]). Usually, one goal of a game theoretic model is to understand which outcome(s) are most likely. The assumption that states coexist in an anarchic world justifies why the equilibrium strategies of all actors are determined by maximizing the player's expected utility.

Likeliness of War and the Cost of War Waltz builds a substantial part of his argument on the theory that "[w]ar becomes less likely as costs of war rise in relation to possible gains" [8]. This draws on the modeling of the war outcome in game theoretic models (cf. [12, 9]). The expected utility of going to war with another player is commonly modeled as a costly lottery, i.e. the probability to win the war times the concomitant benefit minus the costs of war. Since usually both players have to bear the cost of war, the payoff of this outcome decreases with increasing costs of war. Therefore, the likelihood that the game ends in this outcome decreases.

2.2 Sagan's Focus on Nuclear Accidents and Their Compatibility with Game-Theoretic Conflict Models

Sagan's argument about nuclear accidents, which is grounded in organizational theory, is often only partly or not at all incorporated in game theoretic models.

In the following, we will discuss how nuclear deterrence models usually only account for accidents in the war-related expected nuclear escalation costs, but not in a general way, i.e. in peace time (cf. [9, 13]).

Sagan's argument that military organizations may inadvertently use nuclear weapons "despite national interests to the contrary" [8], is incorporated in the expected costs of a nuclear escalation. Nuclear deterrence models usually account for these types of accidents in the war outcome. However, Sagan also discusses nuclear accidents based on Perrow's normal accidents theory [14]: in particular, he points out that "large-scale arsenals and command systems are highly complex, [...] and are tightly-coupled [...]" [8]. According to Perrow, organizations, which exhibit the two mentioned characteristics and are assumed to be boundedly rational, will not be able to eliminate the possibility of serious system accidents. These kinds of accidents could happen regardless of whether the states decide to go to war or not and they are not immediately compatible with common game theoretic conflict models.

In the following chapter, we use these insights to show how the role of nuclear weapons can be considered in a more comprehensive approach by proposing a bargaining model of conflict, which overcomes this difficulty.

3 Model

When thinking of the nuclear security dilemma as a *Prisoner's Dilemma* or *Chicken Game*, the strategic interactions between nuclear armed states is at the foreground. The possibility of accidents, which are independent of the players' action sets, is not incorporated at that point because the focus lies on the strategic interaction and the respective game equilibria. The question whether nuclear weapons are beneficial for the international community or a specific state is thereby not answered on a comprehensive level. Therefore, the conclusion that nuclear weapons provide peace and stability, which Waltz and others at least partly draw from nuclear deterrence theory is a conclusion, which is – in game theoretic terms – merely based on a subgame of a larger, and more comprehensive game.

Based on a conventional two-player bargaining model of conflict [12], we develop an extended model, which allows for the inclusion of the probability of accidents after Perrow. Depending on one player's choice, both players find themselves faced with a conflict either in a conventional or a nuclear scenario. The conventional and the corresponding nuclear game constitute two subgames of the overall model as shown in figure 1.

3.1 Subgame C: Conventional Single Round Bargaining

Subgame C is a common, conventional single round bargaining model based on the Rubinstein model [12, 15]. Player 1 and player 2 bargain over a dividable issue. First, player 1 offers an issue resolution $x \in X = [0, 1]$, where X denotes

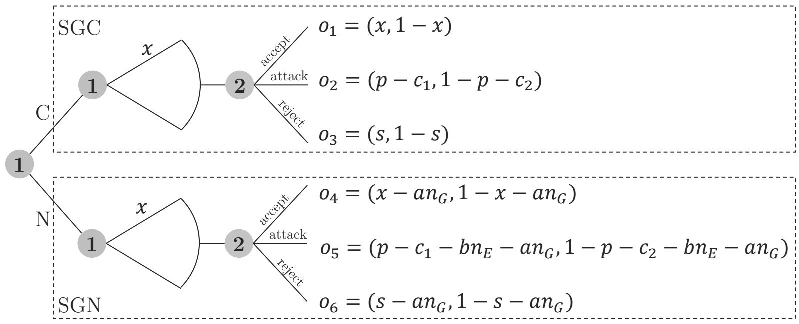

Fig. 1. Overall two-player model featuring two subgames: a conventional (SGC) and a nuclear scenario (SGN). Here, x is player 1's issue allocation offer, s is the status quo allocation, p the probability that player 1 wins the war, c_1 and c_2 the cost of conventional war for each player, an_{G} the general expected cost due to the existence of nuclear weapons, bn_{E} the expected cost of a nuclear escalation.

the normalized issue space. Second, player 2 decides whether to accept the offer (outcome 1), attack player 1 (outcome 2), or reject the offer (outcome 3).

In case that player 2 accepts player 1's offer x, both players are allocated a specific payoff, which is mapped by a utility function $u_i(x)$, $i \in \{1, 2\}$. We assume linear utilities, i.e. $u_1(x) = x$ and $u_2(x) = 1 - x$. If player 2 rejects the offer, the status quo allocation $(s, 1 - s)$ of the issue remains in place. In case of an attack, war is modeled as a costly lottery. Player 1 wins the war with a certain probability p. Correspondingly, player 2 wins the war with probability $1-p$. The player who wins the war is allocated the entire issue, while the defeated party gets nothing. Since war is costly, both players have to bear a cost of war c_i, $i \in \{1, 2\}$ regardless whether they win or lose. Therefore, player 1 receives the entire issue with probability p and nothing with probability $1 - p$ and he has to bear the cost of war c_1. Player 2 receives the entire issue with probability $1 - p$ and nothing with probability p, and he has to bear the cost of war c_2.

3.2 Subgame N: Bargaining in a Nuclear World

For the nuclear world scenario, each player's action set as well as the game structure remains the same. There are two differences, which are reflected in the payoff functions, and which are related to nuclear weapons possession. The first draws on nuclear deterrence theory in the sense that there exists a non-zero probability b that both players suffer the cost of a nuclear escalation n_{E}. Therefore, if player 2 chooses to go to war, both players have to bear an additional expected cost bn_{E}. The cost of a nuclear escalation does not necessarily have to be the same for both players, we will, however, in the following restrict our analysis to this special case.

The second difference is a general expected cost term an_{G} associated with possible costs due to the very existence of nuclear weapons. These costs are related to the risks that nuclear weapons pose and they can range from the costs from a full-scale nuclear war [16], a regional war [17], an attack involving a limited number of nuclear weapons [18], and general acquisition, maintenance and disposal costs [19].

In summary, both players bear an additional, general expected cost term an_{G} due to the existence of nuclear weapons in all three possible outcomes in the nuclear scenario, subgame SGN. Furthermore, the possibility of a nuclear escalation, once a conventional attack has been launched, is reflected in the expected cost term bn_{E} in the war outcome of SGN.

3.3 Introducing the Nuclear Option

In order to find the criteria that determine whether the players prefer to face a conflict in a conventional or in a nuclear scenario, we connected the two subgames SGC and SGN by a preceding decision node. The extensive form of the overall model is shown in figure 1. Player 1 first decides whether to face this bargaining conflict in a conventional world or in a world where both players are nuclear weapon states. Second, player 1 decides on a issue resolution $x \in X = [0, 1]$. Third, player 2 decides whether to accept the offer, attack player 1 or reject the offer. We analyzed this particular case here in greater detail, since we found that if player 2 had the choice between a nuclear and a conventional world, he would always choose the conventional world.

There are six possible outcomes o_i, $i \in \{1, \ldots, 6\}$ to this overall model. The first three outcomes o_1, o_2, o_3 are the outcomes of the conventional world, the other three outcomes o_4, o_5, o_6 are the outcomes in the nuclear world.

The payoffs for each player and outcome are formalized as follows:

$$
\begin{gathered}
u_1(o_1) = x \\
u_2(o_1) = 1 - x \\
u_1(o_2) = p - c_1 \\
u_2(o_2) = 1 - p - c_2 \\
u_1(o_3) = s \\
u_2(o_3) = 1 - s \\
u_1(o_4) = x - an_{\mathrm{G}} \\
u_2(o_4) = 1 - x - an_{\mathrm{G}} \\
u_1(o_5) = p - c_1 - bn_{\mathrm{E}} - an_{\mathrm{G}} \\
u_2(o_5) = 1 - p - c_2 - bn_{\mathrm{E}} - an_{\mathrm{G}} \\
u_1(o_6) = s - an_{\mathrm{G}} \\
u_2(o_6) = 1 - s - an_{\mathrm{G}}
\end{gathered}
$$

4 Results

We determine the equilibria of the game by backward induction. First, we find the subgame perfect Nash equilibria for each of the two subgames, SGC and SGN. Then, we determine the equilibria of the overall game. We know that the ordering of the reservation values is as follows:

$$r'_1 < r_1 < r_2 < r'_2 \tag{1}$$

Depending on the relative value of the status quo allocation of player 1, s, and each reservation values, we distinguish the following 3 cases:

Weak Starting Position If player 1 is in a weak starting position, i.e. if $s < r_2$, we know that $s < r'_2$ because of the relation in 1. Therefore, he compares payoffs $u_1(o_1(x = s)) = s$ with $u_1(o_4(x = s)) = s - an_{\mathrm{G}}$. He always chooses the conventional world 'C' because an_{G} is strictly positive.

Intermediate Starting Position If $r_2 < s < r'_2$ then player 2 compares the payoffs $u_1(o_1(x = r_2)) = p + c_2$ with $u_1(o_4(x = s)) = s - an_{\mathrm{G}}$. We know that $p + c_2 = r_2$. Even though s is larger than r_2 (by assumption), player 1's decision whether to choose 'C' or 'N' depends on the difference of s and r_2. Player 1 will choose 'C' if $s - r_2 < an_{\mathrm{G}}$.

Strong Starting Position If player 1 is in a strong starting position, i.e. if $s > r'_2$ then we know that $s > r_2$ because of the relation in 1. Player 1 compares the payoffs $u_1(o_1(x = r_2)) = p + c_2$ and $u_1(o_4(x = r'_2)) = p + c_2 + bn_{\mathrm{E}} - an_{\mathrm{G}}$. Therefore, player 1 chooses 'C' if $an_{\mathrm{G}} > bn_{\mathrm{E}}$.

We find that player 1 prefers to face a conflict in the nuclear world under two conditions, while player 2 never chooses to face a conflict in a nuclear world. One condition for a preference towards the nuclear scenario is that the difference between player 1's status quo s and player 2's reservation value in the conventional scenario r_2 has to be smaller than the general expected cost due to the existence of nuclear weapons an_{G}. The second condition relates the general expected cost due to the existence of nuclear weapons an_{G} and the expected cost of nuclear escalation bn_{E}. Specifically, bn_{E} has to be larger than an_{G}.

5 Discussion

We found that the relevant variables for the choice between a nuclear and a conventional scenario are the general expected cost due to the existence of nuclear weapons an_{G} and the expected cost of a nuclear escalation in war time bn_{E}. Hence, we brought together the aspects of nuclear deterrence and nuclear accidents in one comprehensive bargaining model in order to be able to discuss their relationship on the same level. In this ongoing research project, this will allow us to transfer our findings back into the debate on the utility of nuclear weapons and discuss their significance.

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When Negotiations Fail Before They Start - The Role of Preference Building Processes in Israeli-Palestinian Conflict Resolution

Johanna Sand[1]

[1]University of Hohenheim, Chair of Marketing and Business Development, Fruhwirthstr.32,
70599 Stuttgart, Germany

Abstract. This paper, based on research conducted in the field of international relations, discusses the persistence of the Israeli decision not to decide regarding the area of the West Bank of the Jordan river. Unlike the most common security arguments for this policy, the author focuses on the Israeli preference building process and its impact on the "decision not to decide" that is a major obstacle in the Israeli-Palestinian conflict resolution. This policy was the focus of interviews conducted with Israeli political elites that was supplemented by secondary sources, in order to give an inside view on the subjects at hand in future negotiations with the Palestinian people. With the help of George Tsebelis' "Veto Player Theory", the author addresses major obstacles rooted in the Israeli political system. The analysis of preference is a vital first step in a larger negotiation management process, as it sets the foundation to realizing each party's true interests, thus allowing for an examination of those interests' compatibility.

Keywords: negotiation management, preference building, veto players

1 Introduction

While a new generation of Palestinians rise up against the Israeli occupation of the West Bank, the Israeli military administration holds on to the territories west of the Jordan river. The uprising contains violent actions in East Jerusalem, in the West Bank and since the beginning of 2016 escalated to what is called "knife intifada" in major Israeli cities like Tel Aviv and Jerusalem [1][2]. The territories are under Israeli military law since the end of the Six Day War in 1967, and neither have they been fully annexed like it was done so in the Golan Heights in 1983, nor have the established Jewish settlements on Palestinian ground been evacuated like it was done so in the Gaza strip in 2005. "The [Israeli] government decided on 19 June [1967] that in return for peace Israel was ready to withdraw to the international borders with Egypt and Syria respectively, but the government could not reach such a conclusion on the Jordanian front" [3] [p.233]. The highly costly occupation of the West Bank and the deterioration of the situation on the ground, which are known as key elements in

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the Middle East conflict between Israelis and Palestinians, show what kind of impact the 1967 established non-decision-policy has nowadays and questions the special status of the West Bank. Why did the Israeli government in 1967 purposely avoided making a decision on the future of the West Bank – and all the more striking – hold on to the non-decision-policy until today? A closer look at the inner Israeli preference building process with the American political scientist Andrew Moravcsik and his “New Liberalism” [4][5][6] is only one piece in the mosaic of a comprehensive negotiation management process as used in other fields of research especially in business administration [7]. Nevertheless, as the very first step on the way to successful negotiations with the Palestinians in regard to the identification of integrative potential, it is worth to be in the focus of research on negotiations and group decisions.

2 Theoretical Frame

Findings from International Relations theory can help to identify preferences and their impact on decision making of political actors. Moravcsik underlines in his republican variant of “New Liberalism” that the state and its government functions as a transmission belt of domestic preferences into foreign policy [5]. Starting from this approach on foreign policy level, the operationalization of the inner Israeli domestic preference building process with George Tsebelis “Vetoplayer Theory”[8][9] concretizes the phenomenon of the non-decision-policy in a deductive way. “In order to change policies – or, as we will say henceforth, to change the (legislative) status quo – a certain number of individual or collective actors have to agree to the proposed change. I call such veto players” [9] [p.2]. In regard to the Israeli non-decision-policy that means: If the political status quo of the military administration without annexing the West Bank should be changed, a certain number of individual or collective actors (the so called veto players) need to agree to this change of policy.

Croissant gives a clear frame for analysis with Tsebelis’ theory by stating that “the chance to change to political status quo is the higher, (1) the smaller the number of players; (2) the bigger the congruence of the veto players and (3) the more cohesive or homogenous they are” [10] [p.133]. In the sequence it becomes clear that “generally, the more players it takes to change the status quo, the lesser the chance that something will be changed” [11] [p.180]. Consequently, the change of the political status quo in Israel becomes more likely, if only a few veto players can be identified within the political system of Israel, their programmatic distance is very small and their vision regarding the future of the West Bank is homogenous.

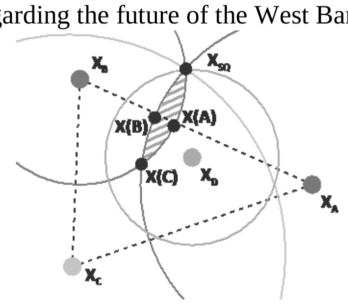


Illustration 1: graph based on Ganghof/Schulze 2015[12].

In a spatial model as designed in illustration 1, every actor (A-D) is able to define an ideal point ($X_{A\text{-}D}$) of his policy preference in a certain issue. The actors will then try to influence the policy to change the actual status quo of policy (X_{SQ}) in favor of their preference with knowledge of the preferences of the other players in the field. Since all players are indifferent towards solutions, that have the exact same ideological distance from the own ideal point as the current status quo, an indifference circle can be drawn around them. Due to acceptance of the status quo, the indifference circle usually intersects X_{SQ} in the spatial model. Policy stability – the retention of the status quo – is dependent on two variables: the size of the win set of the status quo W_{SQ} represented in the shaded area and the size of the unanimity core represented in the dashed line. The unanimity core is the connection between the ideal points of all actors and its size is an indicator for policy stability: "Indeed, a bigger unanimity core produces a larger set of points that cannot be changed" [9] [p.21]. If an additional veto player whose ideal point lies within the unanimity core is added, it will automatically be absorbed, since its position is already covered by the position of other actors (absorption rule). If an additional veto player whose ideal point lies outside the unanimity core is added, the unanimity core becomes bigger and policy stability increases.

In the synthesis of Moravcsik's "New Liberalism"[4][5][6] and Tsebelis' "Veto Player Theory"[8][9] the role of a preference building process is analyzed in a logical and comprehensive way. In the case of the West Bank it concludes, that each side of the future negotiations between Israel and Palestine needs to be clear about his own preferences regarding the contested core territory. In preparation to this larger negotiation process, the preference building process on both sides needs to be analyzed in detail in order to avoid negotiation failure. As a first step, this paper will give a detailed theoretical based insight on the Israeli side regarding the issue in the West Bank.

3 Methodology

Due to the expected negotiation expertise and their relevance as social actors, political parties are one of the subsequent objects of investigation when it comes to negotiation research. While the collection of data in negotiation research is highly problematic [13], the author choses a primary data frame by asking the political elite of the state of Israel themselves. Following the credo "Why not measure policy positions of politicians by asking the politicians themselves" [14] [p.213], the author collected data through guideline based interviews with representatives of Israeli parties. Even though gaining clear statements from Members of Knesset (MKs) or their direct representatives is challenging, the given statements in eight interviews with partners from six parties supplemented by party programs, public interview material and newspaper articles give an empirical based impression on the complexity of having a preference as an Israeli collective. Since party discipline in Israel plays a special role, the inherent reduction concerning the analysis of intern cohesion is less problematic than in comparable cases [16].

4 Empirical Findings

The empirical analysis contains data from the ruling coalition in Israel from March 2015 until May 2016 as well as the opposition parties in the Knesset. Even though it seems negligent to analyze the preference building process on the Israeli side by referring to parties only, this procedure can be justified by the central role that political parties in the Israeli society perceive [15][16]. Therefore, the focus of this paper will be on the partisan veto players as one specific group of veto players in contrast to institutional and other players in the field.

4.1 Veto potential of the Israeli parties and the role of the referendum policy

The established Israeli multi-party system, which results from a strictly proportional election system in a nationwide single-district, forces coalition governments [17]. In the analyzed period, the coalition contained five parties: The center-right “Likud” (30 of the 120 seats in the parliament), the central party “Kulanu” (10 seats), the settlers party “HaBayit HaYehudi” (8 seats), the ultraorthodox parties “Shas” (7 seats) and United Torah Judaism (6 seats). The opposition contained the center-left “Zionist Union” (24 seats), the Arab “Joint List” (13 seats), the 2012 newly founded liberal party “Yesh Atid” (11 seats), the Russian immigrants party “Yisrael Beitenu” (6 seats) and the leftist party “Meretz” (5 seats). The highly volatile party system, that is characterized by multiple changes of governments, show that the role of the opposition should not be underestimated. In a minimum winning coalition (61 seats out of 120), every single member of the governing parties is a potential veto player. The basic law “Referendum” strengthens the role of the opposition: “The referendum law […] requires a referendum on any treaty that entails giving up land to which Israeli law applies, including the Golan Heights and East Jerusalem but not the West Bank. However, if more than 80 MKs [Member of Knesset] support the treaty, it can be ratified without a referendum” [18]. Even if the West Bank de jure is not part of the referendum policy, de facto all the discussed scenarios for the future of the territory (two state solution, bi-nationalism, one state solution) contain either Jerusalem or the Israeli core territory (in the case of land swaps). Henceforth, every change of the current status quo in the West Bank de facto triggers the referendum policy. In order to reach the qualified majority of 80 MKs to avoid the referendum, the votes of opposition parties are necessary. In pursuance of a change of the legal basis of the referendum law itself, only a majority of 61 MKs is necessary. Nevertheless, the referendum law contains symbolic character. It passed the Knesset with a 68 MK-majority and not only therefore, its reversion is highly unlikely [18]. Once in place, referendum laws as elements of a direct democracy are hard to change. The electorate will always feel placed under disability if politicians topple a referendum policy. The opposition as well as the government contains veto potential regarding the future of the West Bank.

4.2 The dimensions of preferences

In order to find out, which kind of preferences are leading and relevant for the non-decision-policy, four key areas are in the focus of the interview guidelines:

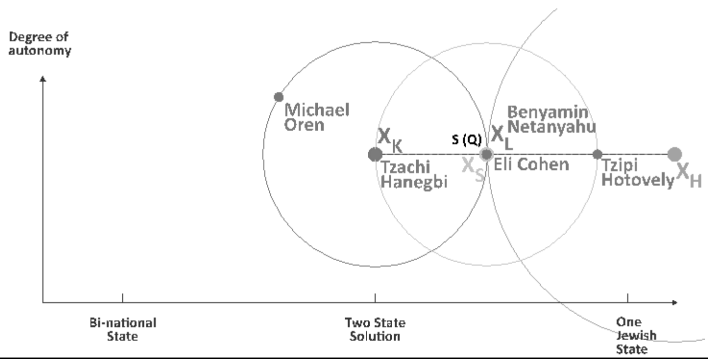
coexistence between Israel and an independent Palestinian state, Jewish character of the Israeli state, settlements in the West Bank and Israeli annexation or occupation of the West Bank. Those key areas are part of the Israeli-Palestinian peace process since the Oslo Accords of 1993.

During the interviews with Israeli party representatives two structuring dimensions become very clear and prevalent: The first dimension is the type of division of territory, namely if Israel should become a bi-national state, support a two state solution or become one Jewish state containing the West Bank as proper Israeli territory. The structuring element in this scale is designed from an Israeli perspective on the issue: The degree of Israeli sovereignty and its territorial expansion is increasing from left to right on a continuous scale that leaves room for options in between.

The second dimension is the degree of autonomy for the Palestinian population, namely the variation between a high degree of autonomy in a bi-national state to a low degree in a demilitarized variant of the two state solution. All statements of the politicians contain a clear position towards these two dimensions and help to structure the model usefully.

4.3 Party positions and their relations to the current Status quo

Within these two dimensions all parties, with the exception of United Torah Judaism, who does not have a position on the status of the West Bank, could be positioned by their preferences expressed in the interviews.



Key:
S(Q): Status quo
X_H: ideal point HaBayit HaYehudi X_S: ideal point Shas
X_K: ideal point Kulanu X_L: ideal point Likud party

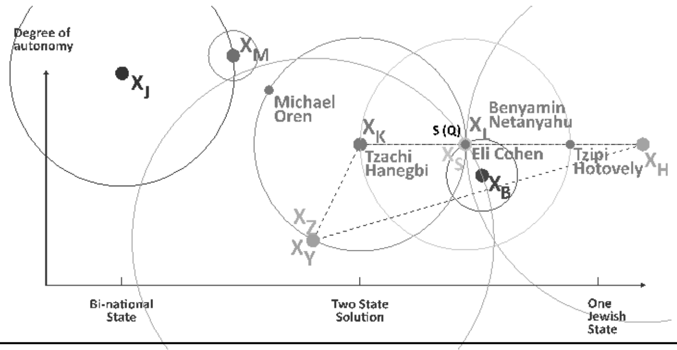
Illustration 2: Own graph based on Tsebelis 2002[9].

As presented in illustration 2, the parties do have varying ideal points keyed in the table below. In the “Likud” party as well as within “Kulanu” the intern cohesion is quite low. While Benyamin Netanyahu takes the middle position in the “Likud” that is congruent with the current status quo (S(Q)) of military occupation without annexation, his fellow MK Tzachi Hanegbi is a strong supporter of a two state solution. Hanegbi's counterpart within the "Likud" is Tzipi Hotovely. In an interview with Israel National News, she stated: "We expect as a model of principle that the international community recognizes Israel's right to build homes for Jews in their homeland. Everywhere." This statement gives a clear indication that settlements in the West Bank are included in an Israeli state and will be enlarged in the future. This means a clear violation of a possible sovereign Palestinian state in the West Bank. Also within "Kulanu" a congruent position is absent. While Michael Oren underlines the Israeli interest not to rule over another population [20], Eli Cohen opposes the principals included in the so called "Arab Peace Initiative" [18]. Within these principles, he strongly opposes the establishment of a Palestinian state and tends to be closer to the "One Jewish State"-dimension. Despite these variances in internal cohesion, there is as win set between "Kulanu" and "Likud". Their positions are overlapping. They open up a spot between their ideal points and give room for changing of the status quo – either in favor of Tzipi Hotovely, or in favor of Michael Oren. The next bigger member of the coalition in seats is the settlers' party "Habayit HaYehudi". "Habayit HaYehudi" is quite cohesive and openly opposes a two state solution: "On one hand we have the large vision of promised land to the Jewish people and at the end of the day that's striking strong and behind the Habayit HaYehudis' visions. A second reason is security: We see every place that was given over to our neighbors has turned into… that's the world that we're in." [21].

It shows, not only the cohesion of the first two players is low and policy stability therefore likely, but also that the congruence between the coalition parties is at a maximum level. The area of tension between "Kulanu" and "HaBayit HaYehudi" indicates policy stability as well. Both coalition partners accept the current status quo, their indifference circle intersects with S(Q). Besides the status quo, there is no win set between "Kulanu" and "Habayit HaYehudi". Their ideal points (X_K and X_H) are at a maximum distance touching the status quo: While "Kulanu" (X_K) is in favor of a two state solution, "HaBayit HaYehudi" (X_H) fights for a one state solution of a Jewish democratic state from the sea to the river and thereby including the entire West Bank. "It should be one Jewish state that is a democracy. Jewish state means sovereignty all over the place"[21]. The second theoretical conclusion of veto players theory is realized: The bigger the programmatic or ideological distance between the veto players, the more likely policies will remain as they are.

"Shas", the fourth government coalition party was not ready to participate in the guide line based interview. However, secondary sources indicate, that "Shas" does not have an outstanding position on the four key areas discussed. Its position and indifference circle is mainly congruent with the "Likuds'" position (X_L). Aryeh Deri, chair of the "Shas" party stated in public right before the elections in March 2015: "I do not agree to the partition of Jerusalem, and I do not agree to mass evacuations for no reason, but I do support the evacuation of isolated settlements, and I do support negotiations" [22]. Due to the congruence with the "Likud", "Shas'" position will be absorbed and will not be counted as another veto player following the absorption rule.

"United Torah Judaism" (UTJ), the fifth government coalition party stated in an interview with the Jerusalem Post in 2015, that is does not have an official position on Israeli-Palestinian conflict including the West Bank issue [23]. Hence, the position of UTJ is not localized in the chosen dimensions.



<u>Key:</u>

X_B: ideal point Yisrael Beitenu	X_M: ideal point Meretz
X_H: ideal point HaBayit HaYehudi	X_S: ideal point Shas
X_J: ideal point Joint List	X_Y: ideal point Yesh Atid
X_K: ideal point Kulanu	X_Z: ideal point Zionist Union
X_L : ideal point Likud party	S(Q): current status quo

Illustration 3: Own graph based on Tsebelis 2002[9].

When it comes to the opposition parties, policy stability becomes even more likely. As shown in illustration 3 the position of the “Zionist Union” and “Yesh Atid” are quiet homogenous which is proven by statements in favor of the two state solution with a low degree of Palestinian autonomy. In the interviews both stated: “I want to see a Palestinian State living side by side with the Israeli state” [25]. “We believe that we need to separate from the Palestinians, we believe in a two-state solution.[…] the security considerations have to be paramount. We believe that Israel has the right to act wherever there’s a threat to it, including in a future Palestinian state” [19]. They have the same ideal point (X_Y and X_Z) and since they both tolerate the current status quo their indifference circle becomes equalized by intersecting S(Q).

By adding those players, (following the absorption rule they are counted as one player) the size of the unanimity core becomes bigger. Following the third theoretical conclusion, the change of the current West Bank policy becomes even more unlikely due to the bigger unanimity core [9].

“Meretz” and the “Joint List” would make the story even more complicated since their current position does not even touch the status quo. Both parties are strong supporters of either a two state solution with a high degree of Palestinian autonomy or of a binational-state with an Israeli and a Palestinian entity according to the Bosnian prelude [26][27].

4.4 Limitations

Clearly the presented empirical data base is only a starting point in the analysis of the inner Israeli preference building process. Since the focus of this paper is on partisan veto players, institutional players as well as the population itself also need to be taken into account in order to draw a complete picture. Nevertheless, the central role of parties in the Israeli political sphere can justify the priority of parties in this article.

Moreover, due to their refuse, not all political parties or representatives took part in the interviews the analysis is based upon. This first analysis could be further strengthened by a second interview attempt in the field.
Usually it is difficult to look at parties as uniform players with coherent preferences. In the special case of the Israeli political system, they can be seen as uniform actors due to the special role of party discipline [16].

4 Conclusion

Within the analysis of the preference building process concerning the "decision not to decide" some logical, though underestimated findings have been revealed. The analysis of preferences within actors – and in this case within political actors – shows what in many negotiations is missing: A clear preference. Without having a clear preference in mind further negotiations with another entity not only seem negligent, but are sure to fail. Integrative subjects and compatible interests between actors can only be identified, if there is a preference in the first place. The exchange of negotiation subjects, the ability to make concessions and the final option to come to an agreement all depend on a clear preference as a starting point for negotiations. Therefore, not only a broad negotiation management process with all its elements is necessary, but also a vertical dimension that helps to identify key elements such as the preference building process before the leading part of negotiations start.
The Israeli decision not to decide demonstrates how a lack of preference for a certain issue can influence the situation on the ground in dramatic ways. However, through the analysis of the partisan veto players, their positions and their veto potential, some starting points for reforms could be uncovered. The political system as the context of the preference building process favors a lack of preference by making competition of interests more likely and more difficult. The Israeli multi-party system rooted in a strong proportional election system encourages the variety of preferences and their competing character. The necessity of coalition governments institutionalizes the partisan veto players' constellation. The absence of a win set between coalition parties is only one difficulty in the preference building process. The number of players in the field drive this difficulty on a further level and in this case leads to a nearly fifty years lasting non-decision policy on the Israeli side of the conflict resolution process.

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Micro-Level Perspective on Sanction Conflicts: An Agent-Based Simulation Approach

Tobias W. Langenegger

Chair of Negotiation and Conflict Management, ETH Zurich, Switzerland
e-mail: tlangenegger@ethz.ch

Abstract. The analysis of conflict requires an understanding of its dynamics and underlying structure. To study these underlying structures, we expand the existing theoretical work by introducing an agent-based model of a sanction conflict. This model describes rules on which the agents interact. Such rules are utility optimization, beliefs and expectations, subjective emotional actions, as well as learning and updating. In addition, the agents compare their actions to different negotiation solutions and agree on the negotiation solution if it is better for all involved agents. The simulation of this model allows studying conflict dynamics over many rounds as well as the emergence of negotiation solutions and helps for theory building in the area of conflict dynamics.

Keywords: Conflict, Agent-based model, Sanctions, Negotiation

1 Introduction

Conflicts are comprised of multiple interactions between diverse actors with a complex underlying structure. Studying such conflict structures and patterns is important for understanding the dynamics and development of a conflict. This is not only important for conflict analysis but also for studying the emergence of possibilities for a negotiated solution. However, comprehending such an underlying structure in an existing conflict is often complex and not easy to achieve. While most conflict models focus on a macro-level perspective, we introduce a generic model, which builds on the micro-level interaction of heterogeneous agents in a sanction conflict situation.

We expand the existing theoretical work on sanctions conflicts [e.g., 1–5] by introducing a sequential repeated agent-based model to study the interaction of a sanctioner and a sanctionee in a conflict situation. This allows us to study the dynamic of such a relation not only for one encounter but over many rounds. Instead of an analytical solution concept, which is not always suitable for repeated interacting models [6], we follow a simulation method based on an agent-based modelling approach. Agent-based models are based on autonomous agents, which are capable to interact with each other and their environment.

In our model, we introduce simple rules according to which the two parties of a sanction conflict act. The agents assess the state of the current situation and decide on their action according to utility optimization rules, beliefs about future reactions of the opponent, as well as subjective emotional factors and learn as they update their beliefs about the other side's behavior.

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2 Model

2.1 Conflict Structure

Our model builds on a sanction conflict structure [1], where one side can impose sanctions as a reaction to unwanted actions of the other side. The two interacting agents the sender S (sanctioner) and the target T (sanctionee) control one variable each. The sender controls the amount of sanctions s and the target controls the amount of the sanction-triggering topic t (this could be a nuclear program, pollution of the environment, human rights violation, or anything else that is unwanted by the sender).

The value of these two variables, that we assume to be between 0 and 1, affect the utility of the two players, which they want to maximize. An increase in s affects both the sender S and the target T negatively, whereas an increase in t affects S negatively but T positively. Sanctions are designed to harm the target but they are also negatively affecting the sender, whose economy can no longer freely interact with the target state. On the other hand, an increase in the disputed topic by definition negatively affects the sender and benefits the target. This can be explained through an increase in political power or the reduction of costs for the target, depending on the specific topic.

From a more formal consideration, the sender S has a utility function of s and t described as

$$u^S(s,t) \text{ with } \frac{\partial u^S}{\partial s} < 0 \text{ and } \frac{\partial u^S}{\partial t} < 0 \text{ .}$$

The target T on the other hand has a utility function of s and t described as

$$u^T(s,t) \text{ with } \frac{\partial u^T}{\partial s} < 0 \text{ and } \frac{\partial u^T}{\partial t} > 0 \text{ .}$$

The structure of interaction is sequential repeated, where sender S and target T alternately determine their controlled variable $s \in [0,1]$ respectively $t \in [0,1]$ or decide on a mutually agreed negotiation solution for the two variables. Even though we focus on sanction conflicts, the model can easily be modified to different conflict structures by changing the utility functions of the two players.

2.2 Agent-based Model

There is an ongoing transition from rational actor models to agent-based modelling, and from top-down macro decision-making to bottom-up microsimulation [7]. Different to an approach which wants to understand why specific rules are followed by the involved actors, the agent-based model defines micro-based rules of behavior and assesses whether they can explain macroscopic patterns. The main emphasis is on the explanation rather than on the prediction of behavior. In such a model, individual agents act according to rules, which can be simple or complex, fixed or adaptive, deterministic or stochastic and classical utility optimization is just one of many different [7]. We follow such an approach and present an agent-based model, which builds on five categories of rules: beliefs, emotions, optimization, learning, and negotiation.

Model Structure

The model follows a sequential repeated structure. The first player (the sanctionee) starts by observing the starting conditions. Following his rules, he decides on the new value for his variable and tries to optimize his utility based on how he perceives his action to affect the future reaction of the second player. Thereafter, the second player (the sanctioner) observes the circumstances and the changes made by player 1. She determines her new value for the controlled variable according to her rules (beliefs, optimizations, and emotions). In the subsequent rounds the players sequentially assess the new situation, update their beliefs, and decide on their actions. They always compare the current situation to a specific negotiation solution, which is only accepted, if its utility is higher than the current situation for both players. A schematic illustration of this procedure is shown in Figure 1.

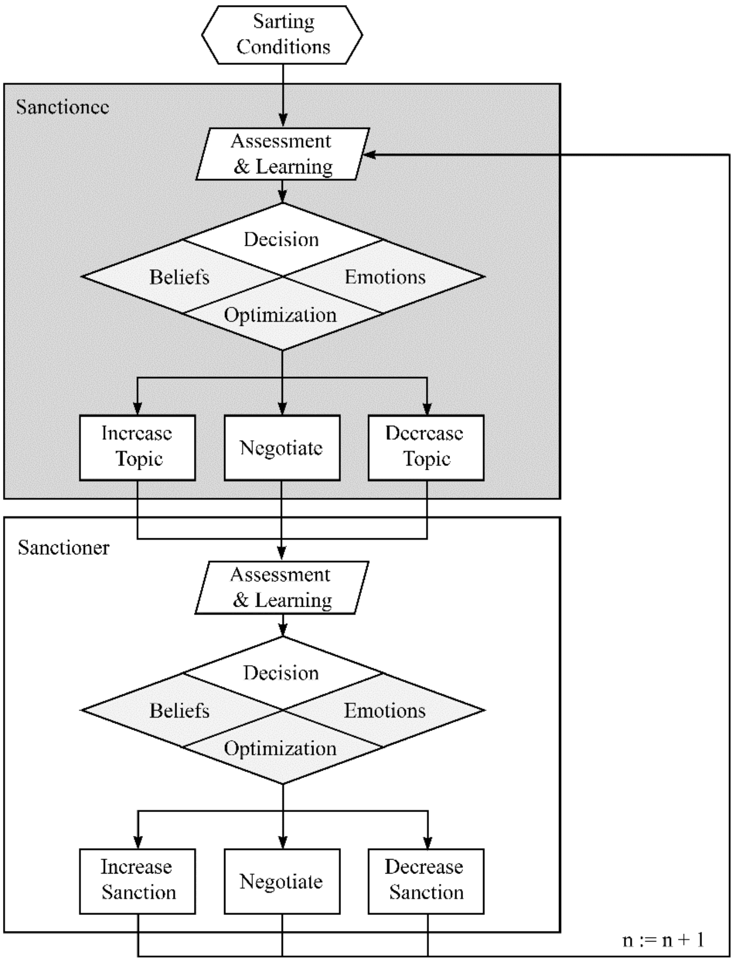

Figure 1: Illustration of the sequential repeated agent-based model

Beliefs

A set of rules, which represents the beliefs and expectations of the agent about future actions and reactions of the other party in response to the circumstances and own actions. This anticipation is an important element for the repeated action over many rounds, as the own actions are expected to have an influence on the other side in the subsequent round. We model this disposition through a simplified comprehension of the sanctioning mechanism, where the agent anticipate that a certain level of topic t / sanction s (above a threshold τ) will trigger a change in sanction / topic. An illustration of these algorithms is presented in Table 1.

Table 1: Illustration of the beliefs algorithms

Algorithm 1.1: Beliefs of T how a certain level of t will affect future level of s

```
input  : sanction s, topic t, threshold τ_S, security level σ_S
output : expected sanction s_x
initialization;
if topic is above the threshold then
    sanctions will be increased;
    if topic is between threshold and security level then
        sanctions will stay the same;
        if topic is below the threshold minus security level then
            sanctions will be decreased;
        end
    end
end
```

Algorithm 1.2: Beliefs of S how a certain level of s will affect future level of t

```
input  : sanction s, topic t, threshold τ_T, security level σ_S
output : expected topic t_x
initialization;
if sanction is below the threshold minus security level then
    topic will be increased;
    if sanction is between threshold and security level then
        topic will stay the same;
        if sanction is above the threshold then
            topic will be decreased;
        end
    end
end
```

Emotions

A set of rules, which represents a subjective emotional reaction, leading to stronger opposition and less willingness for concession if the other side increases his pressure. This opposing function describes an external reward for resisting pressure. In the context of state actors, this can be understood as an effect similar to the rally around the flag syndrome [8], where external pressure increases support for the government. Reasons for this additional support can for example be ideological in nature. Figure 2 illustrates possible opposing functions for sender and target as they can be implemented in the model, where the opposing of the target could be modeled as a square root function and the opposing of the sender could be modeled as a quadratic function to represent their different opposing behavior.

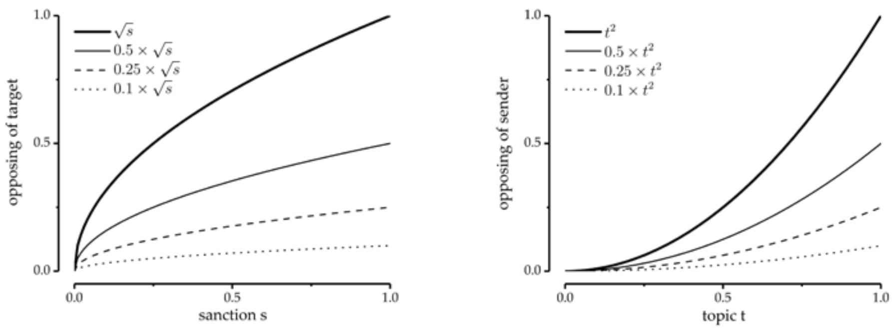

Figure 2: Illustration of possible opposing functions for target and sender

Optimization

A reaction function, which describes how the agent changes his controlled variable in response to the circumstances and the other party's action, building on utility optimization. One important element for the optimization are the beliefs, how the other side will react. An illustration of the optimization algorithms is presented in Table 2.

Table 2: Illustration of the optimization algorithms

Algorithm 2.1: Reaction function of sender S optimizing the new value for s	**Algorithm 2.2:** Reaction function of target T optimizing the new value for t
input : sanction s, topic t, expected topic t_x **output:** adjusted sanction s_n initialization; **if** *the utility of increasing sanction (including the expected reaction of the other side) is bigger than the utility of keeping it the same;* **then** sanction will be increased; **else if** *the utility of decreased sanction (including the expected reaction of the other side) is bigger than the utility of keeping it the same;* **then** sanction will be decreased; **else** sanction will stay the same; **end**	**input** : sanction s, topic t, expected sanction s_x **output:** adjusted topic t_n initialization; **if** *the utility of increasing topic (including the expected reaction of the other side) is bigger than the utility of keeping it the same;* **then** topic will be increased; **else if** *the utility of decreased topic (including the expected reaction of the other side) is bigger than the utility of keeping it the same;* **then** topic will be decreased; **else** topic will stay the same; **end**

Learning

A set of rules, which updates beliefs and expectations of the agent. This happens if the beliefs and expectations are proven wrong in the course of the interaction. The adjustment of the beliefs happens in a targeted way such that they should become more accurate over time. A simplified illustration of this learning algorithms is presented in Table 3.

Table 3: Illustration of the learning algorithms

Algorithm 3.1: Learning of target T: respective change of threshold τ_S after disproof of its accuracy	**Algorithm 3.2:** Learning of sender S: respective change of threshold τ_T after disproof of its accuracy

input : change in sanction $\omega_s = s_{n+1} - s_n$, topic t_n, threshold τ_S
output: changed threshold τ_S
initialization;
; `// underestimated threshold`
if *sanctions stayed the same and topic was below the threshold* **then**
threshold will be increased;
else if *sanctions decreased and topic was above the threshold minus security level* **then**
threshold will be increased;
; `// overestimated threshold`
else if *sanction increased and topic was below the threshold* **then**
threshold will be increased;
; `// else`
else
threshold will stay the same;
end
	input : change in topic $\omega_t = t_{n+1} - t_n$, sanction s_n, threshold τ_T
	output: changed threshold τ_T
	initialization;
	; `// underestimated threshold`
	else if *topic stayed the same and sanction was below the threshold* **then**
	threshold will be increased;
	else if *topic increased and sanction was above the threshold minus security level* **then**
	threshold will be increased;
	; `// overestimated threshold`
	else if *topic decreased and sanction was below the threshold* **then**
	threshold will be increased;
	; `// else`
	else
	threshold will stay the same;
	end

Negotiation

A set of functions, representing different types of negotiation solutions. The utilities for a specific function are compared to the current situation and the negotiation solution is only accepted if it is perceived to be better than the current situation by both agents. The types of negotiation solutions can be fixed (fixed value or fixed reduction), variable (continuing compromise over time or depending on the escalation), or stochastic as illustrated in Figure 3.

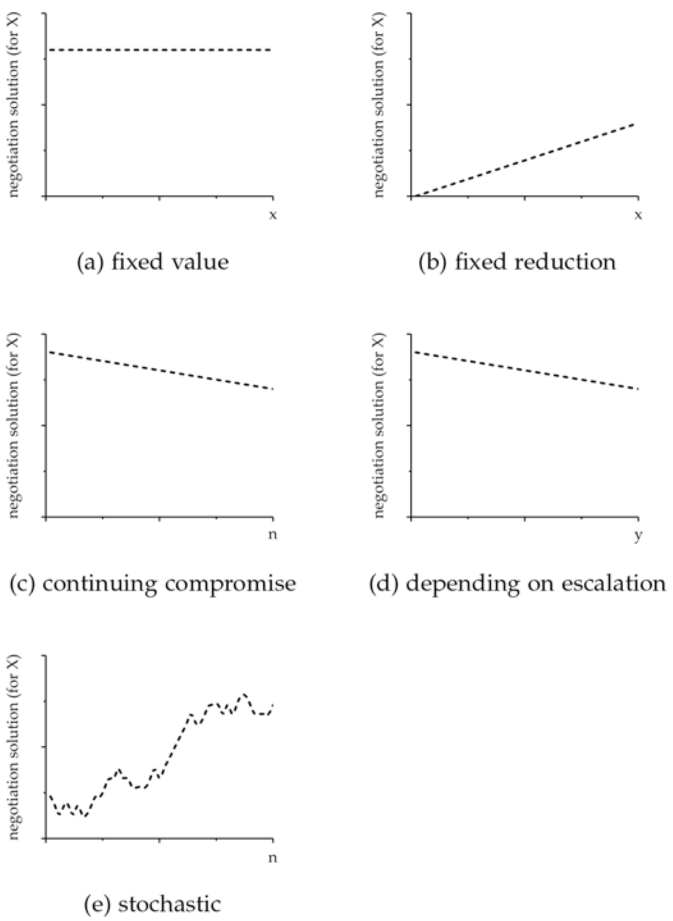

Fig 3: Illustration of possible negotiation solution

3 Conclusion

In this paper, we introduce an agent-based model for the analysis of a sanction conflict, its underlying structure, and the possibility for a negotiated solution. The analysis of the simulations shows how the two parties interact and how this affects the conflict dynamic and a negotiation agreement. One example, which this analysis allows to describe, is the transition of a conflict into a cooperative solution process. In this case, the preceding dynamics of coercion and concession occupies a central place, with escalation being one of the key concepts in the explanation of this transition.

As the use of models can be helpful for theory building [9], this study aims to develop a theoretical model to study conflict interactions, which can help to establish a set of testable hypothesis across different contexts. The model provides insights in underlying mechanisms and helps to assesses pathways under which conflict escalation can lead to one-sided concession as well as a cooperative negotiation.

The use of an agent-based model is particularly useful for this analysis for two reasons. First, agent-based models allow the analysis of complex systems. In our case, complexity emerges due to multiple interactions and different underlying rules for these actions. Second, agent-based models enable to study the underlying casual mechanism of a conflict. Such a systematic process tracing goes beyond models who estimate relationships within an input-output framework and allow for a further study of underlying reasons for conflict dynamics. A more general discussion of the advantages and disadvantages of ABMs in conflict analysis can be found in [10–12].

Further research should focus on the extension of the model with more than two interacting agents and other conflict structures. This would allow to study a broader set of conflicts and its relation to cooperative solution concepts.

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Conflict Analysis of Offshore Oil Exploration in the South China Sea

Ziming Zhu[a,b], D. Marc Kilgour[b,c], and Keith W. Hipel[b,d,e]
a. Research Centre for Contemporary Management, Tsinghua University, Beijing, China 100084
b. Department of Systems Design Engineering, University of Waterloo, Waterloo, Ontario, Canada N2L 3G1
c. Department of Mathematics, Wilfrid Laurier University, Waterloo, Ontario, Canada N2L 3C5
d. Centre for International Governance Innovation, Waterloo, Ontario, Canada N2L 3G1
e. Balsillie School for International Affairs, Ontario, Canada N2L 3G1

Abstract: Several offshore oil drilling disputes have recently occurred, or will likely occur, in the South China Sea. They are analyzed using the Graph Model for Conflict Resolution methodology. The goal is to acquire insight into the mechanisms and possible solutions of these conflicts, and to understand similar scenarios that may occur in the future. The analysis demonstrates the important role of an outside participant, the US, in the evolution of these conflicts.

Keywords: Graph Model; Conflict resolution; Strategic analysis; Oil exploration disputes; South China Sea

1 Introduction

Territorial disputes over the control of the South China Sea (SCS) are becoming more intense. China claims 90% of the SCS, a maritime region believed to hold untapped oil and gas wealth, and through which roughly $5 trillion of ship-borne trade passes every year. Vietnam, Malaysia and Brunei challenge China's claims to islands and reef systems closer to their territories than Beijing's (Guardian, 2016).

Offshore oil drilling in the SCS constitutes an important issue in recent disputes, and in the future. China's growing reliance on oil imports thus makes oil security a preeminent policy issue, particularly because, despite the sharply rising demand, China's domestic onshore production remains relatively flat, with decreases in recent years. Recognizing the economic and environmental costs of relying heavily on coal (about 2/3 of China's energy consumption, and the main reason for China's severe environmental pollution), and the limits of domestic oil resources, China's leadership has been developing diversification strategies to enhance future oil security. Offshore oil production represents a great opportunity, especially in the SCS. At the same time, the SCS is an important sea lane for China: in fact, more than 80% of China's imported oil is transported through the SCS (The Economist, 2016). Thus, there is a serious risk of conflict if China starts to drill oil in disputed waters.

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Two classes of offshore oil exploration conflict are possible in the SCS: conflicts between two countries, such as the conflict between China and Vietnam in the Paracel Islands, and conflicts among three or more states, such as among China, Vietnam and the Philippines in the Spratly Islands. Below, a strategic analysis of the two types of conflict will be carried out.

Offshore oil drilling conflicts have been investigated and modeled elsewhere. Oil and gas development in coastal areas from Delaware to central Florida was analyzed using the Graph Model for Conflict Resolution (GMCR) (Levy and Gopalakrishnan, 2010). Other modeling approaches employed for analyzing offshore oil field allocation include social choice theory, fallback bargaining and bankruptcy procedures (Sheikhmohammady et al., 2010).

Using GMCR theory, Xu (2013) interprets the oil exploration disputes between China and the Philippines, but does not consider the US as a Decision Maker (DM). While the US is not a claimant country, it has a national interest in the peaceful settlement of disputes in the SCS and in freedom of navigation in waters that it sees as critical for world trade. The need for allies may explain why several Southeast Asian countries have deepened their military ties with the US. Moreover, the situation is made more complex because the SCS is surrounded by a relatively large number of countries. For example, in sea surrounding the Spratly Islands, at least five countries are making claims.

The target of this research is to examine not only offshore oil drilling disputes that have already occurred in the SCS, but also those that will likely take place. The main tool is GMCR. In Section 2, offshore oil drilling disputes in the Paracel Islands are modeled and stability analyses are executed. Section 3 details the Graph Model analysis of the offshore oil drilling conflict in the Spratly Islands. Section 4 reviewed the strategic insights that result from the analysis, provides conclusions and suggests potential avenues for future research.

2 Graph model of the Paracel Islands conflict

The offshore oil drilling conflict in the Paracel Islands is modelled below at a point in time just after China sent oil platform No. 981 to operate near the Paracel islands, on May 2, 2014. To assess the impact of the US in the conflict resolution in the SCS, this dispute will be analyzed without and with US involvement. Because the US can decide to intervene in the Paracel conflict, or not, it is considered as a third party. If the US is included, it is regarded as a real DM with its own options and preferences.

2.1 Conflict analysis without the US intervention

If the US does not intervene in the dispute, the DMs' options and possible states are as shown in Tables 1 and 2. Notice that each DM has a single option. Each option combination is feasible, so it is labeled. In the states, a Y indicates that a DM has chosen to take an option, and an N means that the DM has chosen not to execute the option. For instance, option 2, Challenge, is the choice of Vietnam to use diplomatic or military action to try to force China to withdraw its oil. Undertaking this option means using force, while not selecting it means accepting the situation and allowing China to continue exploring for oil without disruption.

Table 1. Oil exploration conflict in the Paracel Islands: DMs and their options

DMs	Options	Descriptions
China	1. Withdraw	Withdraw the oil rig from the disputed territorial sea
Vietnam	2. Challenge	Challenge China in order to restrain its oil exploration

Table 2. DMs, options and states for the Paracel conflict (without the US)

DMs	Options	States			
China	1. Withdraw	N	Y	N	Y
Vietnam	2. Challenge	N	N	Y	Y
Label		1	2	3	4

Table 3. Ranking of states for the DMs in the Paracel conflict (without the US)

DMs	States			
China	1	3	4	2
Vietnam	2	4	1	3
	← More Preferred		Less preferred →	

The next step of the modeling process is to rank the states in Table 2 to show the preferences of each DM. A set of states ordered for a given DM contains a great deal of information about the DM’s viewpoint on the conflict. The preference rankings for China and Vietnam are shown in Table 3 where states are ordered, from most preferred on the left to the least preferred on the right, for each DM.

A key objective of the analysis is to identify the equilibrium states, from which no DM is motivated to move; therefore, the conflict will probably end at an equilibrium that is reached as the conflict evolves. To determine the equilibrium states, one uses solution concepts, which describe human behavior patterns based on moves and counter-moves. As mentioned before, equilibria are states that are stable for all DMs. Using the decision support system GMCR II, the equilibrium results for both China and Vietnam were obtained. The left column gives the different solution concepts, while the remaining columns present the stability results for each solution concept corresponding to the state. Nash and Sequential Stability (SEQ) are considered to be stronger stability definitions. GMR and SMR stabilities are weaker since the process of sanctioning may include moves that are not in the interest of the mover. See (Fang et al., 1989) for a discussion of the relationships among solution concepts. It is clear that when the US does not intervene in the Paracel conflict, the unique equilibrium is state 1, which means that China does not withdraw its oil rig, and Vietnam does not challenge. No state other than state 1 shows any form of stability, so state 1 is a very strong equilibrium.

2.2 Conflict analysis with US intervention

If the US decides to intervene, the DMs and options for the offshore oil exploration dispute in the Paracel Islands are as given in Table 4. Note that the US will not intervene in the Paracel conflict without Vietnamese support. Consequently, this leaves the feasible states shown in Table 5. Table 6 gives the preference rankings over the states for China, Vietnam and the US.

Table 4. Offshore oil exploration conflict in the Paracel: DMs and their options

DMs	Options	Descriptions
China	1. Withdraw	Withdraw the oil rig from the disputed territorial sea
Vietnam	2. Challenge	Challenge China in order to restrain its oil exploration
US	3. Intervene	Intervene on the side of Vietnam

Table 5. Options and states in the Paracel conflict

DMs	Options	States					
China	1. Withdraw	N	Y	N	Y	N	Y
Vietnam	2. Challenge	N	N	Y	Y	Y	Y
US	3. Intervene	N	N	N	N	Y	Y
Label		1	2	3	4	5	6

Table 6. Preference ranking of states for the DMs in the Paracel conflict

DMs	States					
China	1	3	6	4	5	2
Vietnam	2	6	4	5	3	1
US	2	4	6	3	5	1
	← More Preferred			Less preferred →		

After the DMs and their options and preferences are entered, GMCR II finds the equilibrium results shown in Table 7. It is clear that the strong equilibria are state 3 (China does not withdraw, Vietnam challenges China and the US does not intervene) and State 6 (China withdraws, Vietnam challenges and the US intervenes). State 4 (China withdraws, Vietnam challenges and US does not intervene) and state 5 (China refuses to withdraw, Vietnam challenges and the US intervenes) are very weak equilibria. From the status quo, state 1, China will move to state 3, in which it will not withdraw its oil rig. So state 3 becomes a strong equilibrium if the US does not intervene. But China will withdraw its oil rig if the US intervenes, which is another equilibrium, State 6.

Table 7. Equilibrium results for the Paracel Conflict

Solaution Concepts	States	3	4	5	6
Nash		√			
GMR		√	√	√	√
SEQ		√			√
SMR		√			√

The analysis of a conflict describes how each DM's preferences may have an impact on the overall conflict. Table 8 provides the actual evolution of the conflict, moving from the status quo on the left via several intermediate states to the final equilibrium on the right. At first, Vietnam alone challenged China, but China would not withdraw its oil rig. Then the US intervened, and China withdrew its oil rig from the disputed waters. This result is confirmed with actual events in the Paracel Islands in 2014, as was mentioned in Section 2.

In summary, if the US promises definite involvement in the Paracel conflict, then Vietnam would challenge China's oil rig in the Paracel waters. However, without US involvement, Vietnam would not challenge China, and China would not withdraw its oil rig.

Table 8. Offshore oil exploration dispute evolution in 2014

DMs	Options	Status quo	Intermediate states		Equilibrium
China	1. Withdraw	N	N	N →	Y
Vietnam	2. Challenge	N →	Y	Y	Y
US	3. Intervene	N	N →	Y	Y
Label		1	3	5	6

3 GMCR model for offshore oil exploration dispute in the Spratly Islands

If China explores for offshore oil in the Spratly Islands, more DMs will be involved than in the Paracel Islands. The DMs include China, Vietnam, the Philippines, Malaysia, and possibly others. In this paper, three countries are selected – China, Vietnam, the Philippines – as the DMs in addition to the US.

3.1 Offshore oil field conflict analysis in the Spratly Islands without US intervention

If the US promises not to intervene in the conflict in the Spratly Islands, then the DMs' options and states are as shown in Table 9. Table 10 gives the preference rankings over the states for China, Vietnam and the Philippines.

Table 9. DMs' Options and States for the Spratly Conflict (Without the US)

DMs	Options	States						
China	1. Withdraw	Y	N	Y	N	Y	N	Y
Vietnam	2. Challenge	N	Y	Y	N	N	Y	Y
Philippines	3. Challenge	Y	N	N	Y	Y	Y	Y
Label		2	3	4	5	6	7	8

Table 10. Preference ranking of states for the DMs of the Spratly conflict (Without the US)

DMs	States							
China	1	5	3	7	8	4	6	2
Vietnam	2	6	8	4	1	5	7	3
Philippines	2	4	8	6	1	3	7	5
	← More Preferred				Less preferred →			

The equilibrium results are given in Table 11. As can be seen, without US intervention, the unique equilibrium is state 1 (China does not withdraw its oil rig, and neither Vietnam nor the Philippines does not challenge China). There will be peace in the SCS if the US promises not to intervene. In particular, Vietnam and the Philippines have no incentive to cooperate with each other without the US intervention.

Table 11. Equilibrium results for the Spratly Conflict (Without the US)

Solution Concepts	State	1
Nash		√
GMR		√
SEQ		√
SMR		√

3.2 Conflict analysis in the Spratly Islands with US intervention

If the US decides to intervene in the Spratly Islands offshore drilling conflict among China, Vietnam and the Philippines, there exist four options in total. Because each option can be either selected or not, there are 2^4 (i.e. 16) states in total. All mathematically possible combinations are feasible; the set of feasible states is given in Table 12.

Table 12. DM's Options and States for the Spratly Conflict

DMs	Options	States															
China	Withdraw	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y
Vietnam	Challenge	N	N	Y	Y	N	N	Y	Y	N	N	Y	Y	N	N	Y	Y
Philippines	Challenge	N	N	N	N	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	Y
US	Intervene	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y
Label		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

In order to implement a stability analysis, GMCR II requires that feasible states be ordered from most to least preferred for each DM. Table 13 presents the rankings of states for all DMs in the conflict. Table 14 displays the equilibria after the foregoing information is input into GMCR II.

Table 13. Preference ranking of States for the DMs in the Spratly conflict

DMs	States															
China	1	3	5	7	10	14	12	16	9	11	13	15	6	4	8	2
Vietnam	2	10	14	16	12	6	8	4	5	7	3	15	11	13	9	1
Philippines	2	10	12	16	14	4	8	6	3	7	5	15	13	11	9	1
US	2	4	6	8	16	12	14	10	7	3	5	9	11	13	15	1
	← More Preferred												Less preferred →			

Table 14. Equilibrium results for the Spratly Conflict

Solution Concepts	States	3	5	7	10	12	14	15	16
Nash		√	√						
GMR		√	√	√	√	√	√	√	√
SEQ		√	√		√	√	√		√
SMR		√	√	√	√	√	√		√

It is obvious from the GMCR analysis that the strongest equilibria are states 3 and 5, which means that Vietnam and the Philippines select to challenge China, but China continues exploring the offshore oil field regardless of the opposition of Vietnam and the Philippines, while the US does not intervene. States 10, 12, 14 and 16 are SEQ equilibria, which suggest that when the US intervenes in the conflict with or without a challenge by Vietnam and/or the Philippines, a far-sighted China will withdraw its oil rig from the disputed waters, because of a credible sanction by the US.

4 Conclusions and future research

The US is clearly a key DM in offshore oil drilling conflicts in the SCS. If the US promises not to intervene in a conflict, there will be peace in the SCS: China does not withdraw its oil rig and none of the other countries around the SCS, Vietnam and the Philippines, challenges China's operations. However, tensions between China and its neighbors will not disappear.

It is possible to recommend policies for the countries involved in the disputes in the SCS. It may be in China's interest to develop a good relationship with the US, thereby discouraging the US from intervening in the conflict. The other countries surrounding the SCS could seek US help to restrain China's offshore oil exploration in the disputed waters of the SCS. Recently, the Philippines moved closer to China (GMA News Online, 2016) and cancelled two joint military exercises with the US (Rappler, 2016). The consequences will be assessed using coalition analysis to be carried out in a subsequent paper.

Conflict may occur among more than three countries in the Spratly Islands, as will also be considered in future research. For example, the offshore oil exploration conflict among China, Vietnam, the Philippines and Malaysia will be analyzed. Moreover, the preference rankings of national governments versus domestic groups may be different. For example, in Subsection 2.1, the Vietnamese government prefers state 1 (China does not withdraw and Vietnam does not challenge) to state 2 (China does not withdraw and Vietnam challenges). But the domestic nationalist groups in Vietnam prefer state 2 to state 1. Further research will also consider domestic groups' influence on government actions.

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Determining a Conservation Target for Water Demand Management

Yi Xiao[1], Liping Fang[2, 1], Keith W. Hipel[1, 3, 4]

[1]Department of Systems Design Engineering, University of Waterloo, Waterloo, Ontario, Canada N2L 3G1
[2]Department of Mechanical and Industrial Engineering, Ryerson University, Toronto, Ontario, Canada M5B 2K3
[3]Centre for International Governance Innovation, Waterloo, Ontario, Canada N2L 6C2
[4]Balsillie School of International Affairs, Waterloo, Ontario, Canada N2L 6C2

yi.xiao@uwaterloo.ca, lfang@ryerson.ca, kwhipel@uwaterloo.ca

Abstract. An optimization formulation is proposed to estimate how much water can be conserved from consumptive uses while maintaining at least the same level of economic output in a river basin. In this model, the productivity of various consumptive uses and the hydrological constraints are taken into consideration. The results can be used to facilitate a better understanding of present water consumption and guide policy makers to make more informed decisions for water demand management.

Keywords: demand management, conservation, consumptive uses, productivity

1 Introduction

Demand management receives particular attention when scarce resources, such as energy and water, are shared and utilized by various stakeholders to satisfy people's needs for products and services. The concept of demand management involves influencing demand by a series of socially beneficial measures such that a scarce resource can be utilized efficiently and sustainably [1]. Water resource especially, as one of the most valuable and scarce resources on this planet, requires attention on the demand side [2]. Unlike conventional supply-oriented management, which seeks to expand water supply to satisfy future needs by constructing various forms of infrastructure, demand management focuses on changing the water consumption levels of end uses such that future needs do not exceed the available water supply. The term "end uses" implies not only residential uses, but also industrial, commercial, agricultural, and other uses like water transfer to another basin. Improving the efficiency and productivity of these end uses and conserving water usage are the main objectives of water demand management (WDM).

Efficiency improvement and conservation normally imply two scenarios: either to provide more output with the current level of water usage or to consume less water to obtain at least the same level of economic output. However, conservation is common-

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ly not only a technical issue but also a perceptual problem, because how much water can be conserved is limited to not only technological factors but also the adoption level of existing water-saving technologies by people. The latter may even be more important since many advanced technologies already exist but have not been widely adopted. The successful implementation of WDM requires initiatives and cooperation from both individuals and policy makers.

To investigate an achievable conservation target for WDM when the productivity of various consumptive uses is taken into consideration, an optimization problem for minimizing consumptive uses of water is formulated. Moreover, the characteristics of different uses, which are discussed in Section 2, have to be taken into account in WDM.

2 Key Characteristics of Consumptive Uses

Consumptive uses, which typically refer to "water that is unavailable for reuse in the short term in the water sources from which it was extracted" [3], are the focus of WDM, and commonly consist of agricultural, industrial, and municipal uses. Municipal use generally includes residential, commercial and public infrastructure uses. The three types of consumptive uses possess distinguishable characteristics.

In terms of total demand, municipal and industrial (MI) uses are projected to significantly increase in the near future due to burgeoning urbanization and industrialization, while agricultural use will experience a slight decrease [4]. With respect to the consumption ratio, most water withdrawn by MI uses are returned to the water body, which means water consumed is much less than the water taken by them. In contrast, agricultural use consumes a majority of the water it abstracts, thereby making it the biggest water consumer in a region. For instance, agriculture in Canada accounts for only five percent of total water withdrawal in 2013, but is still the largest water consumer [5]. Moreover, water use efficiency in agriculture is generally lower than that in MI sectors.

As water is a scarce resource, a price is introduced for managing demand like an economic good. Many studies have been conducted on estimating the price elasticity of water demand for both MI [6][7] and agricultural uses [8]. However, empirical studies suggest that elasticity in the municipal sector is relatively low, mostly falls between -0.75 and 0, and normally varies from case to case [9]. Industrial use is generally inelastic as well and ranges from -0.79 to -0.1 [10]. Agricultural use is not normally very sensitive to price changes, either, with a mean value of price elasticity of -0.48 [8]. Another important feature of agricultural use is its seasonality. Specifically, agriculture normally requires a sizable amount of water during the crop growing season, and much less water during the other months of the year; while the MI demand is generally evenly distributed throughout the year.

3 Minimizing Consumptive Water Uses

As aforementioned, achieving a high conservation target requires the joint efforts of several sectors, especially consumptive uses. When considering the characteristics of these consumptive uses, agricultural use may become the greatest contributor since it is the largest water consumer and has the most significant potential decreasing its demand. As indicated by a study in southern Alberta, a 4.6% improvement in irrigation efficiency could conserve enough water to cover the annual usage of all municipalities in the basin [11]. To evaluate what type of effort, either conservation or consumption by each of the uses, and how much is required, an optimization problem is formulated.

In this formulation, the objective is to minimize the total water usage of all consumptive uses during all planning periods τ, as shown in the optimization structure in Equation (1), subject to various physical and policy constraints. For the purpose of fairness, an initial allocation step is carried out prior to executing this optimization. $Q_{ini}(i,t)$ and $NB_{ini}(i,t)$ in the formulation represent the initial water consumption of use i during period t and the corresponding initial net benefits produced from the water usage, respectively if the output of water is evaluated by economic returns. The symbol C means consumptive uses.

$$min \sum_{i \in C} \sum_{t \in \tau} Q(i,t) \tag{1.1}$$

$$\text{subject to} \begin{cases} \sum_{i \in C} \sum_{t \in \tau} NB(i,t) \geq \sum_{i \in C} \sum_{t \in \tau} NB_{ini}(i,t), \forall i \in C & (1.2) \\ Q(i,t) \geq (1-\rho(i,t)) * Q_{ini}(i,t), \forall i \in C & (1.3) \\ Q(i,t) \geq Q_{ini}(i,t), \forall i \notin C & (1.4) \\ Q_{in}(i,t) + Q_a(i,t) - Q_c(i,t) - Q_l(i,t) = Q_{out}(i,t) & (1.5) \\ Q_{min}(i,t) \leq Q(i,t) \leq Q_{max}(i,t) & (1.6) \end{cases}$$

where the inequality in Equation (1.2) implies that the economic output produced by consumptive uses of water would not become worse. Equation (1.3) represents the impact of conservation limit ($\rho(i, t) \in (0,1)$) in which water consumption $Q(i, t)$ should be no less than its initial consumption minus the amount of water one is able to conserve. Equation (1.4) is used to guarantee that non-consumptive uses will not be adversely affected by the changes of consumptive uses. Equation (1.5) shows a typical water balance constraint in which Q_{in} and Q_a refer to the inflow from upstream uses and adjustment flows from local tributaries, respectively; Q_c and Q_l indicate the amount of water consumed due to economic activities and the amount of water lost during transportation, respectively; and Q_{out} means the outflow to downstream uses. In fact, more complicated and realistic physical constraints can be built into this formulation as well. Equation (1.6) expresses the minimum and maximum demand for each consumptive use.

4 Insights

Determining an achievable conservation target allows one to better understand the current status of water consumption and provide guidance to policy design for WDM. Furthermore, if WDM is considered in a more comprehensive and long-term manner, it can also be an integrated part of a broader approach called “water soft path” [12][13] in which its ultimate objective is to search for new ways to produce the products and services currently provided by water so as to achieve water sustainability in the long-run. It should be mentioned that in addition to estimate the minimum water requirement to produce at least the same amount of benefits, another aspect for WDM is to evaluate the maximum benefits can be achieved given the current water availability in a river basin subject to a set of hydrological constraints, as examined by Xiao et al. [14].

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Hypergames in Graph Form

Yasir M. Aljefri[1,5], Keith W. Hipel[1,2,3], and Liping Fang[4,1]

[1]Dept. of Systems Design Eng., Univ. of Waterloo, Waterloo, Ontario, Canada N2L 3G1
[2]Centre for International Governance Innovation, Waterloo, Ontario, Canada, N2L 6C2
[3]Balsillie School of International Affairs, Waterloo, Ontario, Canada, N2L 6C2
[4]Dept. of Mech. and Indust. Eng., Ryerson Univ., Toronto, Ontario, Canada, M5B 2K3
[5]Dept. of Industrial Eng., Univ. of Jeddah, Saudi Arabia
yaljefri@uwaterloo.ca, kwhipel@uwaterloo.ca, lfang@ryerson.ca

Abstract. A novel design is presented for incorporating hypergame theory within the paradigm of the Graph Model for Conflict Resolution (GMCR). This new structure enables an analyst or expert to investigate real-life situations having misperceptions among the participating decision makers (DMs). Within this improved design, a DM can hold misperceptions about itself and/or its adversaries. In order to accomplish this, the sets of options, or courses of action available to the DMs, and the associated states within the standard GMCR are expanded to the universal set of options and states for a hypergame. Thereby, they include not only the real options and states for the dispute but also the misperceived ones. Also, to determine the equilibria for the hypergame, a range of GMCR solution concepts, depicting the way humans may interact in a real-life conflict, are formally incorporated into the hypergame analysis within graph form. With these developments, self-misperception can be modeled for the first time within the representation of hypergame in graph form and the reaction of DMs after they recognize the hypergame equilibria, which may not be what they expected, are investigated and highlighted.

Keywords: Hypergame, Conflict, Misperception, Graph Model for Conflict Resolution.

1 Introduction

Strategic decision making under conflict can be investigated using a flexible methodology called the Graph Model for Conflict Resolution (GMCR) [1], [2], [3]. GMCR is purposefully designed to model and analyze a broad range of real-life conflicts under the premise of complete knowledge and common perception among the players, also known as decision makers (DMs). This methodology predicts the possible equilibria that are accessible to DMs in conflict circumstances. Solution concepts, imitating the way humans interact in a conflict setting, are used to calculate the equilibria of the conflict.

Here, GMCR is extended to allow DMs to have incorrect perceptions about the conflict situation. It should be noted that many real-life disputes possess asymmetry of perception among the engaging DM, perhaps because of incomplete information or

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misperception in recognizing the actual conflict parameters, such as the DMs' options and preferences [4], [5], [6], [7]. Hypergame is a technique that investigates conflict with misperception among the participating DMs. Hence, the objective of this paper is to improve the modeling and analysis of a hypergame by embedding it with the GMCR setting. That is, the applicability and efficacy of GMCR are extended to account for not only conflict with complete information but also with misperception.

2 Background

A hypergame is a technique used to formally study conflict circumstances in which DMs have different perceptions about the dispute [4], [5], [6], [7]. Within this methodology, a DM may have misperception about the options and preferences available to its opponents or even may be unaware of all of DMs in the dispute. In some situation, a DM may assume the existence of one or more DMs when in fact they do not have any connection with the conflict situation. Within the classical hypergame theory [4], [5], [6], [7], a DM is assumed to correctly perceive its own parameters in the dispute. Also, a DM may have different levels of perception in a conflict setting [4], [5], [6], [7]. For example, if all DMs correctly capture the conflict situation and are cognizant of each other’s parameters, the dispute is a simple game or a zero-level hypergame. However, if each DM in the dispute perceives the conflict in a subjective fashion and no one is aware of the differences of understanding among the DMs, then the conflict is a first-level hypergame. Moreover, if at least one DM is aware of the other DMs' misperception, the conflict is a second-level hypergame. Keep in mind that the level of a hypergame can be extended up to any level of perceptions depending on the complexity of the conflict situation.

There are a number of recent articles that incorporate hypergames theory into GMCR. For example, Aljefri et. al. [8] model DMs' preference misperceptions within GMCR. Also, misperception of unknown options and preferences was incorporated to GMCR [9]. In addition, the concepts of the universal set of options and states for a first-level hypergame are developed in graph form [10]. Within these concepts, self-misperceptions are permitted. Lastly, the overall structure of a second-level hypergame in graph form is developed [11]. In this paper, a general structure of hypergame theory at any levels of perception is put forward within the paradigm of GMCR.

3 Hypergame Model and Analysis in Graph Form

The suggested graph model for a hypergame with any level "h" of perception, where $h \geq 0$, contains two modules: the design of the universal set of states for the h-level hypergame and the construction of each DM's subjective hypergame.

For an h-level hypergame in graph form, states are defined by using DMs' universal sets of options for an h-level hypergame. A particular DM's universal set of options includes all the options that are correctly considered by the DM itself and those options that are misperceived by itself and its competitors. The collection of all

DMs' universal sets of options constitutes the universal set of options for an *h*-level hypergame and creates the universal set of states. These states include all possible scenarios of the dispute, both real and misperceived. Because DMs may not be aware of each other's misperceptions, the construction of the universal set of options and states for an *h*-level hypergame is accomplished by an outside analyst who is cognitive of the asymmetry of understanding among the competing DMs.

After defining the universal set of options for an *h*-level hypergame, one can define each DM's individual hypergame. Note that the level of each DM's subjective hypergame depends on the overall level of the hypergame. For example, if the overall level of hypergame is zero, then the game is a simple game, and thereby one graph model is used to model and analyze the dispute. However, if the overall level of hypergame is one, then the conflict is a first-level hypergame, and each DM's subjective hypergame is of a zero-level. In this case, one can see that a first-level hypergame is a collection of individual zero-level hypergames, each of which depicts a particular DM perception of the dispute and no one is aware of any misperception happening. In summary, if the level of hypergame is *h* then the level of each DM's individual hypergame is (*h-1*). The universal set of states for an *h*-level hypergame is used to determine states in each DM's (*h-l)* subjective hypergame.

A hypergame analysis in graph form is accomplished in two steps: the analysis of (1) each DM's individual hypergame and (2) the overall hypergame analysis. In the first step each DM's subjective hypergame in graph form is analyzed using a range of stability concepts defined within the hypergame in graph form. The objective is to predict the equilibria in each DM's subjective hypergame. In the second step, one combines the solutions obtained from each DM's subjective hypergame to predict the equilibria for the overall hypergame. These overall resolutions are expected to take place in reality. Of course, a DM may or may not perceive these overall resolutions in its subjective hypergame. If he or she perceive the equilibria, then one can conclude that the misperception could be preserved for that particular DM. If he is shocked by the overall resolutions, then the misperceptions is exposed to him and information about the true situation may be revealed to him to take appropriate action if he can.

4 Conclusions

The overall layout of the *h*-level hypergame in graph form is introduced in this paper. This framework investigates any level of DMs' perceptions in a conflict situation and within the structure of GMCR. It also models self-misperception as well as a DM's misperceptions about its adversaries. Moreover, it can predict the equilibria of the overall hypergame and provides strategic insights.

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Design and Application of a Values-Focused Decision Support System to Facilitate Public Participation in Environmental Decision-Making

Simone L. Philpot[1], Keith W. Hipel[2,3,4], Peter A. Johnson[1]

[1] Department of Geography and Environmental Management, University of Waterloo. Waterloo, Ontario, Canada.
[2]Department of Systems Design Engineering. University of Waterloo, Waterloo, Ontario, Canada.
[3]Centre for International Governance Innovation. Waterloo, Ontario, Canada.
[4]Balsillie School of International Affairs

Abstract. An interactive values-focused software program, P2P-DSS, is designed and evaluated in relation to its impact on the collection and integration of public input for highly regulated environmental decision-making. The software program prompts the user to engage in values-focused thinking about the decision under deliberation while providing a platform for experts and citizens to interact with the decision model and to share their perspectives on proposed alternatives. The authors present the design of the software program and early results related to the impact of using this approach to join citizen and expert knowledge in a case study about a proposed amendment to an aggregate mining operation in Ontario, Canada.

Keywords: Decision Support System, Values-focused Thinking, Public Participation, Environmental Management

1 Introduction

Resources management decision-making typically requires shared decision-making between multiple stakeholders with differing perspectives, knowledge domains, and objectives. Moreover, between these groups, and even within one group or individual, multiple competing objectives are generally of interest and debate [1]. These qualities, along with uncertainty over the impacts of decisions, create contexts that are prone to conflict. In order to mitigate conflict and facilitate the implementation of decisions and policies, integrating pubic participation is increasingly recognized as an important foundation to effective decision-making [2]. While many relevant stakeholder groups have developed sophisticated and formal mechanisms to engage in the decision-making processes, enduring challenges remain when the goal is to involve public citizens who are impacted by complex decisions [3]. This is particularly true in highly

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technical issues that are constrained by regulatory structures. Nonetheless, decision-making in resources management increasingly demands the inclusion of citizen perspectives as part of integrating social and human dimensions that are relevant to planning and policy-making [4]. In response to these challenges, the development of systematic methods to structure and support the integration of public input in formal decision-making processes will provide valuable support in environmental governance and management. In this project, the authors examine the capacity for participatory modeling to advance values-focused approaches to decision-making. The objective of this approach is to assist local governments, regulators, and researchers to collect, integrate, and gain insights into public perspectives on complex environmental problems. Herein, the authors present the design and early results of an application of this program.

1.1 Foundations for Eliciting and Integrating Social Values in Decision-Making Contexts.

Methodologies to support multiple objective, multiple participant, decision making have been developed in the Decision Sciences [5], Operations Research [6], Conflict Analysis [7], and Participatory Modeling [8], [9]. Facilitating complex decision-making specifically by integrating social values into decision-making has been operationalized through a variety of approaches including Values-focused Thinking [5], Discourse-based Valuation, the Pebble Distribution method, Contingent Valuation [10], [11], and Values Mapping [12], [13], [14]. In spite of this momentum, values have not yet been operationalized in a software platform and examined as a public participation tool in the highly regulated sectors of resources management decision making and planning.

2 Development and Evaluation of a Participatory Modeling Software Program to Facilitate Values-focused Thinking

The authors develop and examine a novel participatory process for collecting and integrating citizen perspectives on management level decision-making. An interactive software platform is developed to assist local government decision-makers and regulators to collect, integrate, and gain insights into public perspectives on complex environmental problems. Specifically, the authors design and implement a software program that provides a shared interactive space for modelling decisions and ranking outcome proposals. This program is designed to both trigger and facilitate values-focused evaluations of the proposals. Through examination of revealed behavior tracked by the software program, and responses to user surveys, the authors explore perceptions that formal decision-makers and public participants have of the impact this process has on the quality of public participation in decision-making, and the understanding that the collected data contributes to each user group. This work re-examines the concept of ‘values’ as a research object in light of new modelling and communications technologies, examines public participants and formal decision-makers within one coherent research context, and applies values-focused decision-making to challenges facing civic representatives as their citizens seek new methods to engage in environmental decision-making.

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China, USA, Japan, and the Asian Infrastructure Investment Bank

Taha J. Alhindi[1,5], Keith W. Hipel[1,2,4,6], and D. Marc Kilgour[1,3]

[1]Dept. of Systems Design Eng., Univ. of Waterloo, Waterloo, Ontario, Canada N2L 3G1
[2]Centre for International Governance Innovation, Waterloo, Ontario, Canada, N2L 6C2
[3]Dept. of Mathematics, Wilfrid Laurier Univ., Waterloo, Ontario, Canada N2L 3C5
[4]Conflict Analysis Group, Univ. of Waterloo, Waterloo, Ontario, Canada N2L 3G1
[5]Dept. of Industrial Eng., King Abdulaziz Univ., Jeddah, Saudi Arabia 21589
[6]Balsillie School of International Affairs, Waterloo, Ontario, Canada N2L 6C2

talhindi@uwaterloo.ca, kwhipel@uwaterloo.ca, mkilgour@wlu.ca

Abstract. The crucial stage of the conflict among China, USA and Japan over the Asian Infrastructure Investment Bank (AIIB) is analyzed using the Graph Model for Conflict Resolution methodology. In October 2013, China proposed the establishment of the AIIB. Initially, USA and Japan opposed the idea, but eventually an agreement was reached. Several conclusions emerge from the analysis, including that the most likely outcome at the time of analysis was that the Trans-Pacific Partnership, a trade agreement involving 12 countries, would be rejected by the USA and Japan, and that China would proceed to establish the AIIB on terms acceptable to USA.

Keywords: Conflict Resolution, Graph Model, GMCR, AIIB

1 Introduction

The ever-growing economic and military strength of China is a major concern for the United States of America (USA) and their allies especially Japan. Over the past few decades, China has shown that it is well on its way to becoming the next global superpower, one important event was the establishment of the Asian Infrastructure Investment Bank (AIIB), which is considered to be a rival to the World Bank and the Asian Development Bank (ADB), which are led by the USA and Japan. The rising concerns of the USA and Japan over China's international policies have led to many political and military disputes. The present study investigates the conflict over the AIIB which among China, USA, and Japan. It develops a graph model of the conflict, which is analyzed utilizing the Graph Model for Conflict Resolution (GMCR) methodology, in order to obtain strategic insights regarding the possible outcomes of the conflict [1][2][3]. This conflict interesting in itself, and also appears to be a good illustration of the effects of adding new options to a graph model.

The study is organized as follows. The background of the conflict is outlined in Section 2, while Section 3 describes the method used to construct and analyze the

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model. Section 4 discusses the construction and the analysis of the GMCR model of the conflict. In Section 5, the study is summarized, and the insights into the outcome that it leads to are elaborated.

2 Conflict Background

In the past few decades, China has exhibited remarkable growth on many dimensions, including economic, military, and population. In 2008, China became the largest creditor to the USA [9]. In 2010, it became the world's second largest economy, not far behind the USA [9]. It has been estimated that China will overtake the USA as the world's largest economy by 2027 [10]. China is well along the path to superpower status.

China proposed the creation of the Asian Infrastructure Investment Bank (AIIB) in October 2013 [11][12]. The concept of this institution was broadly accepted around the world, and in particular by the majority of nations in Asia. However, the idea was challenged by USA and Japan, who attempted to convince their allies not to join the AIIB. The opponents, USA and Japan, were clearly concerned that China would utilize the bank to carry out its own agenda [11][12][13]. Nevertheless, many USA's allies, including the United Kingdom, Germany, Australia, and South Korea, ended up joining this Chinese-led banking institution [11][13]. Moreover, China's veto right in the AIIB could be revoked should the USA and Japan join the Chinese-led bank, which will reduce the voting shares of China [14].

Surprisingly, however, USA and China reached a truce over the AIIB in 2015 [15]. In exchange for the USA and Japanese agreement, China increased its support for the World Bank and assured it that the AIIB will operate under the highest environmental and governance principles [15].

The USA and Japan proposed a trade agreement that would include 12 countries bordering on the Pacific Ocean. Named the Trans-Pacific Partnership (TPP), it was led by the USA Obama Administration, and was perceived as a counterweight to the Chinese-led AIIB, aimed at reducing Chinese influence in the region [16]. However, some analysts had their doubts about the effectiveness of the TPP in reducing China's influence. According to these analysts, the TPP would encourage trade and economic growth in the region, which will ultimately be to the advantage of the whole region including China [17].

3 Methodology

Any graph model must represent the decision situation at a particular point of time. The model must identify the decision makers (DMs) and the options they control at that time point. Any combination of option is potentially a state, but care must be taken to remove infeasible combinations from the model to determine the feasible states. The next step is to identify which changes of a DM's options are reversible or irreversible, which determines each DM's allowable transitions [18]. Finally, each DM's preference ranking of the feasible states must be entered into the model, which can be done efficiently using option prioritization.

This study included an exhaustive stability analysis using several solution concepts for every state and every DM. These solution concepts are: Nash stability (Nash) [4][5], Sequential stability (SEQ) [6][7], General Metarational Stability (GMR) [8], and Symmetric Metarational Stability (SMR) [8]. If a state is stable for every DM under a specific solution concept, then it is an equilibrium under that solution concept too.

4 The Graph Model and its Analysis

Based on the discussion in Section 2, the time point selected was February 2016. By this date, most of the information about the conflict was available, especially regarding the TPP. The key DMs considered in this conflict are China, and the USA and Japan. The objective of the USA and Japan is to reduce the ever-growing influence of China, both globally and locally in the Asian-Pacific region. The USA and Japan have both shown their concerns over the AIIB and the increased influence it allowed China. They both have endeavored together to implement some strategic decisions like the TPP, opposing the AIIB, and joining the AIIB together to reduce the voting shares of China to revoke its veto in the organization. Because of the similarity of their options, objectives, and vision, the USA and Japan are considered here as one DM

The options for the DMs are explained below.

China**:**

- Establish the AIIB: This option includes lobbying other countries to join the bank, and committing to environmental and governance standards determined by China.
- Accept US terms: This option includes accepting the US proposal for an increased contribution by China to the World Bank.

USA and Japan:

- Join the AIIB: This option precludes a Chinese veto over AIIB decisions.
- Insist on US terms: This option refers to China increasing its contribution to the World Bank and requiring the highest governance and environmental standards in the operations of the AIIB.
- Oppose the AIIB: This option refers to lobbying other countries against joining the AIIB.
- Launch the TPP: This option sees the implementation of the TPP as a counterweight to the AIIB.

Table 1 summarizes the DMs and their options they control (on the left). States are defined on the right; an option exercised in the current state is denoted ‘Y’ and an option not exercised is denoted ‘N’. The DMs’ preference rankings are given at the bottom, from most to least preferred. In these rankings, states that are equally preferred are contained within brackets. Note that any option combination not included in the table was considered infeasible.

The preference ranking for each DM is constructed based on certain assumptions with respect to that DM. For China, the following statements are assumed:

- China's highest priority is to establish the AIIB to increase its influence globally and regionally.
- China will agree to USA terms over the AIIB if the terms are offered.
- China prefers that the USA and Japan do not implement the TPP, as there is a risk that the Chinese influence will be reduced.
- China prefers that the USA and Japan do not join the AIIB, which would reduce its voting share and eliminate its the veto.

As for the USA and Japan assumptions were also drawn based on exhaustive research conducted to understand the conflict. The following is assumed for the USA and Japan for constructing the preference ranking:

- The USA and Japan prefer that China remains at State 1 (status quo).
- The USA and Japan prefer to launch the TPP as it will increase their influence and reduces China's.
- The USA and Japan prefer that China agrees to the terms provided by the USA over the AIIB, since it will increase China's contribution to the US and Japan led World Bank.
- The USA and Japan prefer to oppose the AIIB if China is not willing to agree their terms over the AIIB.
- The USA and Japan least prefer the scenarios where they end up joining the AIIB, which they consider their last resort.

Table 1. Graph Model of AIIB Conflict

DM	States (Ordered)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
China	Establish the AIIB	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y
	Accept USA terms	N	N	N	N	Y	N	Y	N	N	N	N	N	N	Y	N	Y	N	N
USA and Japan	Join the AIIB	N	N	Y	N	N	Y	Y	N	N	N	N	Y	N	N	Y	Y	N	N
	Request China accept USA terms	N	N	N	Y	Y	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	N	Y
	Oppose the AIIB	N	N	N	N	N	N	N	Y	Y	N	N	N	N	N	N	N	Y	Y
	Launch the TPP	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
State Ranking	China	$[\overline{2},\overline{4}] > 11 > 13 > 5 > [\overline{8},\overline{9}] > [\overline{17},\overline{18}] > 14 > 1 > [\overline{3},\overline{6}] > [\overline{12},\overline{15}] > 7 > 16 > 10$																	
	USA and Japan	$10 > 1 > 14 > 5 > 16 > [\overline{17},\overline{18}] > 13 > [\overline{12},\overline{15}] > [\overline{8},\overline{9}] > 7 > 6 > 11 > 3 > [\overline{2},\overline{4}]$																	

4 Equilibria of the Graph Model

The stability analysis of the conflict as presented in Table 2 showed that the following seven states are equilibria: 1, 5, 12, 14, 15, 17, and 18. However, state 14 is considered a weak equilibrium and the equilibria at states 1 and 5 cannot arise unless the DMs exhibit a minimal level of foresight. Thus, states 12, 15, 17, and 18 are considered strong equilibria, any of which could be a resolution of the conflict.

The status quo of the model was considered to be state 1. A status quo analysis (see below) suggests that the most likely outcome of the conflict is state 5, which is SEQ, GMR and SMR stable for all DMs. Once state 5 is attained, it would be difficult for a decision maker to reach a more preferred state, because each DM has the chance to sanction its opponent's moves.

Table 2. Stability analysis of the AIIB conflict

DM	**States (Ordered)**	**1**	**5**	**12**	**14**	**15**	**17**	**18**
China	Establish the AIIB	N	Y	Y	Y	Y	Y	Y
	Accept USA terms over AIIB	N	Y	N	Y	N	N	N
USA and Japan	Join the AIIB	N	N	Y	N	Y	N	N
	Request China accept USA terms	N	Y	N	Y	Y	N	Y
	Oppose the AIIB	N	N	N	N	N	Y	Y
	Launch the TPP	N	N	Y	Y	Y	Y	Y
Equilibria	**Nash**	-	-	✓	-	✓	✓	✓
	SEQ	✓	✓	✓	-	✓	✓	✓
	GMR	✓	✓	✓	✓	✓	✓	✓
	SMR	✓	✓	✓	✓	✓	✓	✓

5 Evolution of the conflict

The status quo analysis reported in Table 3 reveals that the model will probably end up at state 5, where China establishes the AIIB and agrees to USA terms, while the USA withdraws its opposition and declare a truce over the AIIB.

In the real world, the resolution at state 5 was indeed reached, as predicted. Table 3 shows the evolution of the model over time. The model moved to state 2 from the status quo when China established the AIIB. Then it passed to state 8, where USA and Japanese opposition became clear. Subsequent insistence on the terms proposed by USA and Japan then took the model to state 9. Finally, the equilibrium at state 5 was reached when China agreed to the terms and the USA and Japan withdrew their opposition.

Further research can be done in order to develop the model further by including more options such as the implementation of Regional Comprehensive Economic Partnership (RCEP). RCEP is a trade agreement that involves 10 Association of Southeast Asian Nations (ASEAN) member countries and 6 ASEAN free trade agreement partners, in which China and Japan are present while the USA was not [19][20].

Table 3. Evolution of the AIIB conflict

		Status Quo	State 2	State 8	State 9	State 5 (Equilibrium)
China	Establish the AIIB	N →	Y	Y	Y	Y
	Accept the USA's terms over the AIIB	N	N	N	N →	Y
USA & Japan	Join the AIIB	N	N	N	N	N
	Request China to accept the USA's terms over the AIIB	N	N	N →	Y	Y
	Oppose the AIIB	N	N →	Y	Y →	N
	Launch the TPP	N	N	N	N	N

The conflict analyzed here can be categorized as a long-term conflict [21], as changes in the presidency of either China or the USA would change the preferences, which would ultimately lead to a shift in the equilibrium states of the conflict. The next stage of the project is to analyze the same conflict before the TPP, and after the USA withdrawal from it, in order to study how the inclusion of new options, or the deletion of existing options, changes the equilibria of a graph model.

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Evolution of the Keystone XL Pipeline Dispute

Yasser T. Matbouli

Department of Industrial Engineering, Faculty of Engineering,
King Abdulaziz University, Rabigh, Saudi Arabia
ymatbouli@kau.edu.sa

Abstract. The historically reached equilibria of the Keystone XL pipeline dispute is revisited using the characterization of long-term conflicts and robustness of equilibrium analysis. A discussion shows that the Keystone XL rounds can be treated as one conflict. As a result, a robustness of equilibrium analysis is suggested to gain strategic insights into possible future evolutions.

Keywords: Keystone XL, graph model, conflict resolution, long-term conflicts, robustness of equilibria.

1 Introduction

In 2008, TransCanada Corporation proposed a new Keystone KL Pipeline to carry Alberta's oil sand from Canada to refineries in the southern US states. The project needed a presidential approval from the US to be allowed to cross six state lines in the US, including Montana, South Dakota, Nebraska, Kansas, Oklahoma, and Texas. Due to environmental concerns, especially around the Ogallala Aquifer and the Athabasca River [4], the project faced some opposition. There were many decision makers (DMs) involved in influencing the presidential decision, including, the US Congress, the State Department, Nebraska Department of Environmental Quality (NDEQ) and some non-governmental organizations.

Using the Graph Model for Conflict Resolution, the Keystone XL dispute has been analyzed by [4]. The initial analysis predicted three possible equilibria. Over the course of the dispute, an equilibrium that was reached initially was not sustainable. The objective of this paper characterizes the Keystone XL dispute as a long-term using criteria appeared in [1]. Then, apply robustness of equilibrium analysis [2] to understand the evolution of this protracted conflict.

2 Background

The Graph Model for Conflict Resolution (GMCR) is used to model strategic decision-making situations between two or more interacting DMs. GMCR uses graph theory to represents game-like dynamics in which nodes represents states and arcs represent possible moves. Then, solution concepts of various stability conditions are applied to find equilibria points. When a dispute restarts

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after reaching an equilibrium, traditionally GMCR is used again considering the restart of an original conflict as a new one. However, characterization of a conflict parameters [1] can be used to determine if separate rounds of a conflict should be treated as one or not. Then, the robustness of equilibrium analysis [2] is applied to understand conflict evolution.

The Keystone XL is mainly a local energy conflict caused by environmental concerns over oil pipeline [4]. This dispute went through many stages and events that reflected predicted equilibria as suggested by [4] model. The three equilibria as analyzed by [4] are given in Table 1 below. State 12 represents a situation where the US President requests to modify the proposal to address environmental concerns, and the Canadian Coalition (consisting of TransCanada, the Canadian Federal Government, and the Government of Alberta) accepts the modifications. State 19 represents the situation where the US President disapprove the project, and the project is canceled. On the other hand, state 21 is the situation where the US President approves the project. Looking at historic events from 2008 to March 2017, two of the equilibria states have been reached. First, in November 2015 when President Obama rejected the proposed project citing that " the Keystone XL Pipeline would not serve the national interest of the United States" [3], which is the outcome of state 19 of the model. Then, in March 2017, President Trump approved the Keystone XL proposal saying that it was an overdue historic moment for North American energy independence and a job creation opportunity [5].

Table 1. Equilibria States in the Original Keystone XL Graph Model [4]

DMs	Options	States		
		12	19	21
US President	Approve	N	N	Y
	Modify	Y	N	N
Canadian Coalition	Build	N	N	Y
	Modify	Y	N	N
US. Congress	Pressure	Y	Y	Y
NDEQ	Pressure	N	Y	Y

3 Methodology

How would a conflict reach two different equilibria? Would this conflict be considered as one or two separate disputes? To answer these questions two steps are applied: characterization of a long-term conflict [1], then a robustness of equilibrium analysis [2]. Considering two rounds of the dispute, the first took place between 2008-2015, and the second 2015-2017, it is noteworthy to mention that options remained the same, DMs positions that represent the public interests remained the same (a change in representation is allowed according to conditions given in [1]). Also, the status quo of the second dispute is the same as the equilibrium of the first dispute. Therefore, according to criteria given in [1], the two rounds are part of the same conflict and should be treated as one.

Because the two rounds are treated as one, it is now important to understand the evolution of equilibria and understand whether it could be possible to identify the first one as temporary. It is now observed after the fact that the first equilibrium was not sustainable. The change in equilibrium came as a result of changing in US President preferences, which is one of the causes of equilibrium changes. Using robustness of equilibrium analysis, it is possible to investigate the level of freedom for each DM at all equilibrium states to rank the robustness of stable states.

4 Conclusion

The Keystone XL pipeline dispute is a real world example that can be used to show how strategic insights can be gained when long-term conflicts are treated as one. Conditions for connecting rounds must be examined, then a robustness of equilibrium can be applied. Future work to include a detailed analysis of equilibrium robustness and insights into the possibility of further evolutions.

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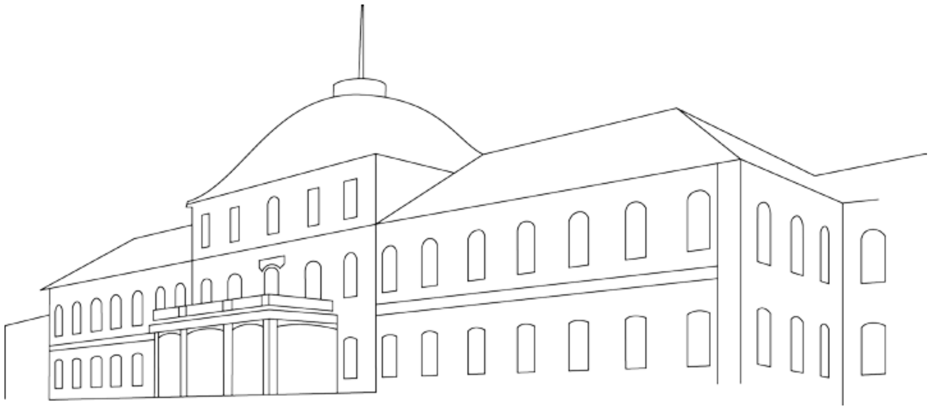
Emotions in Group Decision and Negotiation

Stream Organiser:
Bilyana Martinovski, Stockholm University, Sweden



University of Hohenheim

Intrapersonal Emotional Responses to Inquiry and Advocacy

Ilkka Leppänen [a,c,d], Raimo P. Hämäläinen [a], Esa Saarinen [b] , Mikko Viinikainen [a]

[a] Systems Analysis Laboratory, Aalto University, P.O. Box 11100, 00076 Aalto, Finland, E-mails: ilkka.j.leppanen@aalto.fi, raimo.hamalainen@aalto.fi, mikko.viinikainen@aalto.fi.
[b] Department of Industrial Engineering and Management, Aalto University, P.O. Box 15500, 00076 Aalto, Finland, E-mail: esa.saarinen@aalto.fi.
[c] Corresponding author, E-mail: ilkka.j.leppanen@aalto.fi, Tel: 358 50 432 3591, Fax: 358 9 863 2048.
[d] Present address: School of Business and Economics, Loughborough University, Loughborough LE11 3TU, United Kingdom.

Abstract. The role of two interaction modes, inquiry and advocacy, have been of interest in group decision and negotiation. Inquiry refers to an interested and explorative interaction mode, and advocacy to an assertive and narrow mode. However the intrapersonal emotional responses to the inquiry and advocacy modes remain yet unexplored. We studied the intrapersonal emotional responses to inquiry and advocacy by facial electromyography and skin conductance response. Subjects were prompted to adopt the different modes in hypothetical encounters with other persons. We found that Duchenne smiles were specific to the inquiry mode and furrowed brows were specific to the advocacy mode. The results emphasize the importance of interaction modes and the related possibilities of influencing one's internal emotional state by communicating with the inquiry or advocacy mode.

1 Introduction

This paper reports the results of an experimental study of intrapersonal emotional responses to two interaction modes, inquiry and advocacy. In group decision and negotiation the person's own emotional states and facial expressions triggered by the two interaction modes will have an impact on one's own and the other's negotiation behavior and subsequently on the success of the negotiation. Language and emotions have also been shown to play a role in on-line negotiations and negotiation support systems in which there is no direct facial contact (see e.g. Brett et al. 2007; Hine et al. 2009; Broekens et al. 2010). So it is also important to understand how the negotiator's communication mode affects her emotional state.

A person with an inquiry mode shows interest in the other's points of views and asks questions and explores different possibilities. A person with an advocacy mode approaches others with a narrow and assertive way and emphasizes her own points of view. Inquiry and advocacy have earlier received interest in the organizational learning literature (Argyris & Schön, 1978; Senge, 1990, Schein, 2013). This

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literature emphasizes the systems perspective in understanding and improving organizational behavior. More recently the concept of systems intelligence was introduced by Hämäläinen and Saarinen (2004). It reflects the way we interact with people in systemic settings such as in groups. The construct was shown to have eight factors some of which relate directly to how people are encountered and are thus directly related to group interaction (Törmänen et al., 2016).

2 Literature

Inquiry and advocacy have also received interest as ways to introduce cognitive conflict into an organizational decision making process (Schweiger, Sandberg, & Ragan, 1986). Evidence from laboratory experiments show that introducing and balancing inquiry and advocacy in the decision making process improves decisions over a simple process where only expert recommendations are followed and no conflict between the decision makers is present (Schwenk, 1990).

Emotions are particularly important in studying face-to-face interactions because factors such as nonverbal signs and speech intonation are so often used to express emotion (Martinovski, 2015a). Positive emotion expressions are known to increase cooperativeness and reduce conflict and lead to better outcomes than negative emotions (Barsade 2002; Kopelman et al. 2006; Hine et al., 2009) and carry informational value in decisions despite being seemingly irrelevant (Steffen et al. 2008). Negative emotion expressions such as anger cause more concessions (Sinaceur & Tiedens, 2006; Van Kleef et al. 2004) as well as an anger response in the opponent (Friedman et al., 2004), but experienced anger may be counterproductive (Allred et al., 1997). Positive and negative emotions affect differently on cognition: Whereas negative emotions narrow attention and bias it against threats (Frijda, 1994), positive emotions broaden attention and increase cognitive flexibility (Fredrickson, 2001), promote in-group identity (Johnson & Fredrickson, 2005), and may lead to different information processing strategies than negative emotions (Forgas & George, 2001).

Despite of the extensive interest in emotions in human interactions and in group decisions, previous research has not studied the intrapersonal emotional effects of language and communication modes such as inquiry and advocacy. At first thought one might assume that the advocacy mode only incorporates negative emotions and the inquiry mode positive emotions. However, this is a too simplistic view. For example, it is possible that a fraudulent person expresses non-genuine positive emotions in advocacy, or that a person in an inquiry mode gets frustrated at the interaction process and experiences negative emotions. It may also be that neither of the modes generates changes in the internal emotional state of the person.

3 Methods

To explore the emotional responses to inquiry and advocacy we carried out experiments where the subjects were facing an on-line type setting where they were not in direct face to face communication but they were shown a picture and a textual statement from another person. The subject was then instructed to take either an enquiry or an advocacy mode reaction towards this virtual counterpart. We then measured how the facial expressions of emotions and the activation of the autonomic nervous system (ANS) of the person related to the two modes. Subjects (N = 33) were prompted to adopt an inquiry mode, an advocacy mode, and a passive (neutral) viewing mode in simulated encounters with other persons who were represented by facial pictures accompanied by statements. We then measured emotions in the alternative modes in a within-subject design. To distinguish genuine positive emotional expressions from non-genuine ones, we measured both the Duchenne and the non-Duchenne smiles. These facial expressions were measured by facial electromyography (EMG). The 2048-Hz EMG data was band pass filtered between 90 Hz and 200 Hz, smoothed, rectified and logarithmized. The EMG scores were obtained with a similar procedure as used by Johnson et al. (2010). The signal during the 18-s stimuli was averaged into 3-s bins, the mean from the 60-s baseline signal was subtracted from each bin, and each bin was coded active for a positive remainder. A Duchenne smile was registered if both the zygomaticus major and the orbicularis oculi were active but the corrugator supercilii inactive. A non-Duchenne smile was registered if only the zygomaticus major was active. A furrowed brow was registered if only the corrugator supercilii was active. Each EMG score therefore has a count value 0 to 6. Activation of the sympathetic part of the ANS, emotional arousal, was measured by the skin conductance response (SCR). The 128-Hz SCR data was deconvoluted into an integrated SCR (ISCR) score (Benedek & Kaernbach, 2010) and logarithmized. The ISCR score has unit μSs. To include somatic responsivity as a control variable in the analysis we formed an empathy score for each subject with a 33-item self-report questionnaire.

4 Results

The results were analyzed using linear mixed models (LMMs) where the subjects were treated as random effects. This takes the between-subject heterogeneity in the psychophysiological measurements into account. The degrees of freedom were calculated by Satterthwaite approximations. We report the SD of random effects as $\sigma0$ (residual) and $\sigma1$ (slope).

Figure 1 shows the main results. There were more both Duchenne and non-Duchenne smiles in the inquiry treatment than in the passive treatment. Thus, the inquiry treatment generated both genuine and non-genuine positive emotional expressions. The number of Duchenne smiles was not different between the advocacy and passive treatments. However, the number of non-Duchenne smiles was higher in the advocacy treatment than in the passive treatment. Thus, the genuine positive emotional expressions were above the passive treatment numbers only in the inquiry treatment, whereas the non-genuine positive emotional expressions were above the passive treatment numbers in both the inquiry and the advocacy treatments. Furthermore, the mean bin count of the Duchenne smiles was significantly greater than the mean bin count of the non-Duchenne smiles in the inquiry treatment (one-sided paired t-test, $t = 8.79$, 831 df, $p < .001$).

The comparison of the mean numbers of non-Duchenne smile bin counts between treatments in Figure 1 raises an additional question: Did the advocacy treatment have a higher number of non-Duchenne smiles than the inquiry treatment? An LMM with a focused contrast between the advocacy and inquiry treatments indicated that this difference was not significant (LMM, slope coefficient −0.01, SEM = .03, t = −0.26, 1632 df, p = .79, σ0 = 0.56 and σ1 = 0.81).

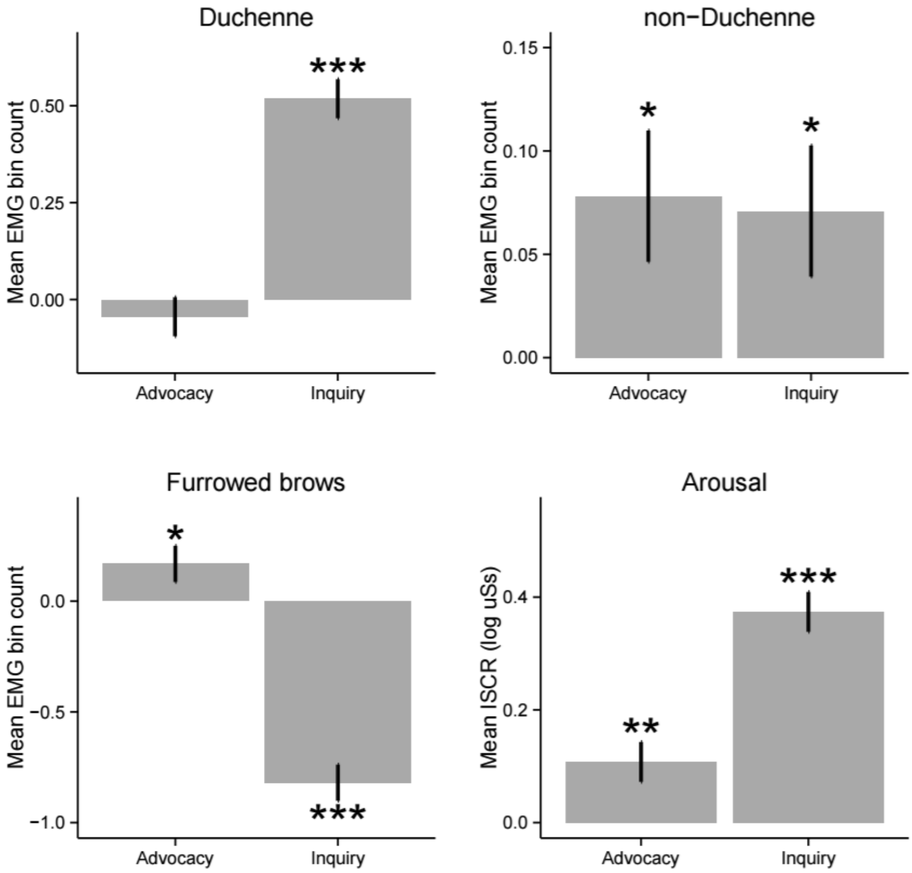

Figure 1. LMM estimates of mean bin counts of EMG for the three facial expressions and ISCR for arousal. Note: The reference treatment, passive, is moved to zero, i.e. the bar heights represent deviations from the passive treatment level. The error bars represent standard errors of the means. The random effect standard deviations are: σ0 = 1.03, σ1 = 0.62 (Duchenne), σ0 = 0.65, σ1 = 0.62 (non-Duchenne), σ0 = 1.67, σ1 = 1.62 (Furrowed brows), σ0 = 0.66, σ1 = 0.40 (Arousal). Asterisks represent significance levels: * p < .05, ** p < .01, *** p < .001.

There were a higher number of furrowed brows in the advocacy treatment than in the passive treatment and a lower number of furrowed brows in the inquiry treatment than in the passive treatment (Figure 1). In other words, the furrowed brows expression was activated in the advocacy treatment and inhibited in the inquiry treatment. This suggests that there was a treatment-specific inverse relationship between furrowed brows and the Duchenne smiles. We also studied the relationship between the bin counts of the furrowed brows expressions and the Duchenne and non-Duchenne smiles. This revealed that the furrowed brows bin count at each stimuli was indeed inversely related to the bin counts of the two smiles (LMM, Duchenne coefficient −0.27, $t = -8.53$, 2487.6 df, $p < .001$, non-Duchenne coefficient −0.31, $t = -5.97$, 2495.1 df, $p < .001$, $\sigma 0 = 1.69$ and $\sigma 1 = 1.52$).

Figure 1 shows that there was more emotional arousal in both the inquiry and advocacy treatments than in the passive treatment. Mean ISCR was 0.27 log μSs (SEM = 0.04) higher in the inquiry treatment than in the advocacy treatment (LMM with a focused contrast between the advocacy and inquiry treatments, $t = 6.9$, 1377 df, $p < .001$, $\sigma 0 = 0.72$ and $\sigma 1 = 0.5$).

How did the different emotional expressions moderate the treatment effect of emotional arousal? Table 1 shows results from an LMM where emotional arousal is the dependent variable and the emotional expressions are the independent variables and the treatments are included as interaction effects. Only the non-Duchenne smiles were differently related to emotional arousal in the inquiry and advocacy treatments. This treatment interaction effect was positive in the inquiry treatment and negative in the advocacy treatment. In other words, arousal increased in the bin count of non-Duchenne smiles in the inquiry treatment, but in the advocacy treatment arousal decreased in the bin count of non-Duchenne smiles. The relationship between emotional arousal and the Duchenne smile was constant and increasing across all the treatments. The relationship between emotional arousal and furrowed brows was constant and decreasing across all the treatments, albeit only at a marginal significance level ($p = .07$).

Table 1. *How the Emotional Expressions Are Related to Emotional Arousal, LMM Estimates*

Independent variable	Estimate (*SEM*) × 1000
(Intercept)	638.8 (102.1) ***
Duchenne	0.75 (0.3) *
Non-Duchenne	5.11 (0.37) ***
Furrowed brows	−0.26 (0.14)
Duchenne × Advocacy	0.00 (0.41)
Duchenne × Inquiry	−0.5 (0.38)
Non-Duchenne × Advocacy	−10.36 (0.62) ***
Non-Duchenne × Inquiry	−1.97 (0.54) ***
Furrowed brows × Advocacy	0.31 (0.21)
Furrowed brows × Inquiry	0.13 (0.22)

Note. The dependent variable is the ISCR score. The EMG bin counts are centered on subject means. The main treatment effects are omitted from the regression. The random effect standard deviations are: σ0 = 0.62, σ1 = 0.52. Asterisks represent significance levels: * p < .05, *** p < .001.

The mean empathy score was 43.4 (SD = 23.7). Table 2 shows results from LMMs where each emotional expression and emotional arousal were in turn the dependent variables and the empathy score was the independent variable and the treatments were included as interaction effects. Empathy correlated with all the EMG bin counts as well as with the arousal score in the inquiry treatment, but in the advocacy treatment empathy correlated only with the non-Duchenne smile. With the Duchenne and non-Duchenne smiles this treatment effect was increasing, i.e. in the inquiry treatment subjects with a higher empathy score expressed a higher number of positive emotional expressions than subjects with a lower empathy score. With the furrowed brows expression this treatment effect was decreasing, i.e. in the inquiry treatment subjects with a higher empathy score expressed a smaller number of negative emotional expressions than subjects with a lower empathy score. With arousal the treatment effect was increasing but again only in the inquiry treatment.

Table 2. *How Empathy Moderates the Treatment Effects of Each Emotional Measure, LMM Estimates*

Independent variable	Duchenne	Non-Duchenne	Furrowed brows	Arousal
Intercept	26.15 (10.56) *	13.9 (10.78)	215.9 (28.48) ***	46.0 (7.8) ***
Empathy	0.49 (0.44)	0.12 (0.45)	−0.86 (1.2)	0.14 (0.33)
Advocacy	−4.61 (4.88)	8.4 (3.14) **	16.82 (8.08) *	10.77 (3.48) **
Inquiry	53.18 (4.88) ***	7.5 (3.14) *	−83.39 (8.08) ***	38.03 (3.48) ***
Empathy × Advocacy	−0.26 (0.21)	0.92 (0.13) ***	−0.02 (0.34)	0.00 (0.15)
Empathy × Inquiry	2.14 (0.21) ***	0.64 (0.13) ***	−2.2 (0.34) ***	1.0 (0.15) ***
σ_0	1.0	0.64	1.65	0.65
σ_1	0.56	0.6	1.58	0.39

Note. Each psychophysiological score is in turn the dependent variable. Each cell shows the estimate (SEM) × 100. The empathy score is centered on its mean. Asterisks represent significance levels: * *p* < .05, ** *p* < .01, *** *p* < .001.

5 Discussion

We found that Duchenne smiles were specific to the inquiry mode and furrowed brows were specific to the advocacy mode. Subjects with a high empathy score expressed more Duchenne smiles than those with a low empathy score. The results highlight that genuine positive emotional expressions are related to the inquiry mode and negative emotional expressions to the advocacy mode. We provide experimental evidence on genuine positive emotional responses to the inquiry mode and negative emotional responses to the advocacy mode.

We were also interested to know how well the different emotional expressions in different treatments correlated with internal emotional states. Our hypothesis was that emotional arousal would activate alongside the emotional expressions such that it shows specificity to either positive or negative emotional expressions. This hypothesis is supported, as the Duchenne smile increased in arousal and the furrowed brows expression decreased in arousal across treatments. ANS activity as measured by SCR, or emotional arousal, is known to increase in facial expressivity (Adelmann & Zajonc, 1989) and be specific to many discrete emotions (Kreibig, 2010). Thus, one possible way to interpret our findings would be as follows. The furrowed brows and the Duchenne smiles corresponded to internal emotional states to which emotional arousal showed specificity across the treatments. In contrast, the non-Duchenne smile did not correspond to an internal emotional state as its linear relationship to emotional arousal was different between the different treatments. This interpretation is in line with the monotonicity hypothesis (McIntosh, 1996; Soussignan, 2002) that argues that autonomic arousal increases monotonously with the intensity of the facial expression. The monotonicity hypothesis would thus indicate that that the non-Duchenne smile did not correlate with an internal emotional state

Our results thus provide evidence that the communication mode also has an impact on the person herself. Thus one should not only consider the language of communication but also the intrinsically triggered emotions as factors that will influence group decisions both in face-to-face and on-line settings. This emphasizes the importance of interaction modes and the related possibilities of influencing one's internal emotional state by communicating with the inquiry or advocacy mode. When the person is aware of the resulting emotional responses in herself and the related facial expressions she can use the modes more effectively in group interactions and negotiations.

Research on group decisions making is increasingly interested in emotions (Martinovski, 2015b). These developments are reflected in our second methodological conclusion which is that because emotions do play a key role in negotiations the use of psychophysiological measurements as well as brain imaging methods is likely to increase in group research. For the first time we can also measure, neural correlates of two-person social interactions (see e.g. Hari & Kujala, 2009). We suggest that group decision researchers should increasingly use these new tools to help understand how people's emotional responses are related to group decisions. The resulting insights can then be used to find improved ways of supporting group decision processes.

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Emotion Feedback in Small Group Collaboration: A Research Agenda for Group Emotion Management Support Systems

Michael T. Knierim[1], Anuja Hariharan[1], Verena Dorner[1], Christof Weinhardt[1]

[1] Karlsruhe Institute of Technology (KIT),
Institute for Information Systems and Marketing (IISM),
Fritz-Erler-Str. 23, 76133 Karlsruhe, Germany

{michael.knierim, anuja.hariharan, verena.dorner, christof.weinhardt}@kit.edu

Abstract. With emotion management continuously emerging as a central factor for positive cognitive and affective small group collaboration outcomes, more investigations are appearing that utilize digital emotion information in group tasks like decision-making, idea generation and structured problem solving. However, no coherent and structured approach has been developed to address the variety of critical aspects of emotion management support. In this article, we outline central research gaps aligned with an established data quality framework. We argue that group emotion management support systems (GEMSS) research should be driven to investigate matters of how digital emotion information is measured, how information should be designed and transmitted, how emotion management can be supported in the context of collaboration scenarios, and how privacy and personal requirement concerns need to be integrated.

Keywords: Emotion Management, Emotional Intelligence, Group Support Systems, Small Group Collaboration, Emotion Data Quality

1 Introduction

Adequate processing of emotion is one of the hallmarks of positive social interactions and a crucial factor for the integrity and viability of social units [1]. Unsurprisingly, emotions have been found to play an important role in small group collaboration in general [2, 3] and group decision and negotiation in particular [4]. Emotions guide thought and influence intrapersonal dimensions such as feelings, attitudes, and motivation, as well as interpersonal dimensions such as conflict and cooperation [2–4]. Also, emergent group level phenomena such as group emotion, stress or flow experiences have been reported to influence collaboration outcomes [2, 5]. In the context of group decision-making and creativity especially, emotion has been found to influence elaboration on shared information, to influence exploration behavior, and to determine aggressiveness and success in negotiation [2, 6, 7]. Consequentially, abilities to manage emotion are increasingly found as important factors in cognitive

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(e.g. performance) and affective (e.g. satisfaction) collaboration outcomes [3, 7–9]. Perhaps most exemplary are the recent findings on the so called collective intelligence factor (the group equivalent to individual IQ) [8], that show abilities related to emotion recognition to be more strongly related to group performance than individual cognitive abilities or team quality aspects like team cohesion, motivation, and communication behavior [8, 10].

As individuals differ in their emotion management abilities [11], supporting technologies could strongly improve collaboration outcomes [12]. One promising approach is the amplification of cues on emotion phenomena (i.e. states and processes) to increase the emotion information base for individuals to act upon [12, 13]. These require detection and presentation of phenomena through suitable methods and formats. Diverse emotion measurement approaches are available and allow the detection of a variety of emotion experiences based on facial, vocal, or postural expressions, and from physiological changes [14, 15]. Emotion information has been used by previous investigators to for example reduce experiences of stress in instructor-worker scenarios [16], increase engagement in team task processing [17], or improve communication and cognitive performance in negotiation tasks [18, 19].

Clearly, the plethora of usable emotion information creates numerous possible designs for group emotion management support systems (GEMSS). The importance of appropriate system design as effectiveness determinant has demonstrably been outlined by DeSanctis and Gallupe’s [20] theoretical work on group decision support systems. Nevertheless, research on GEMSS has not received the same amount of investigation, as for example research on supporting communication behavior in groups (e.g. [21, 22]), information-sharing behavior and preference aggregation in group decision or negotiation (e.g. [23, 24]), or other task-specific outcome support systems. Central questions that remain to be answered are (i) how emotion information can be derived adequately, (ii) how presentation and transmission formats need be designed, (iii) what type of emotion information is useful for emotion management in different small group scenarios, and (iv) how aspects of privacy and individual preferences are taken into account to support the viability of GEMSS. Given these challenges, we turn our attention to the development of a research agenda for the integration of emotion management in group support systems.

2 A Research Agenda for Emotion Management Support Systems

2.1 Emotion Phenomena & Emotion Management Abilities

In order to understand the complexity of emotion phenomena, a few central concepts need to be outlined. Emotional experience has been described with a variety of facets that are captured predominantly by dimensional and discrete emotion models [25, 26]. Emotion takes on different forms in time, for example by the distinction of emotion (short-lived) from mood (longer experience) and forms part of preferences and attitudes [25, 26]. While an emotional experience is in essence perceived by an individual, other levels of analysis like the experience of vicarious affect (i.e. feeling something for someone else) have been described on the dyadic level. Also, group level emotion and emotion experienced on behalf of a group are additional facets of interpersonal emotion phenomena [1, 2]. Furthermore, emotion phenomena are being described in dynamic terms. On the individual level dynamics relate to links between different emotion experiences (e.g. relations of two emotions like anger or fear), or emotion facets (e.g. mood influencing the experience of emotion) [25, 26]. On the interpersonal level, the experience of empathy or the process of emotional contagion in group settings represent main dynamics [1, 2]. Knowledge of this variety is critical in the development of systems that are to support emotion management.

Two aspects of emotion management need to be distinguished that are (i) general emotion management abilities and (ii) their use in social interaction. General emotion abilities are described in ability models of emotional intelligence that classify such skills as recognition, understanding, utilization and regulation of emotions [11, 13]. Facets of these abilities have been found to strongly explain cognitive and affective collaboration outcomes [3, 7–9]. The potential to support emotion management abilities comes from findings on intra-personal emotion management support that show emotion feedback can improve self-recognition and self-regulation of emotional reactions [27, 28]. Additionally, explorative studies on digital emotion information in social interaction indicate a facilitation of emotion reflection and regulation in dyads [28, 29]. Aside from general ability levels, it has furthermore been found that the utilization of emotional abilities is prone to situational limitations such as induction of bias from own emotional states [30], or simply that in interaction, especially task collaboration, attentional resources are divided between task and emotion processing [31, 32]. Therefore, GEMSS and the amplification of emotion cues might not only be beneficial, but potentially even necessary to ensure good and stable use of emotion management abilities in collaborative interactions.

2.2 A Data Quality Perspective for Emotion Information Systems

The approach of amplification of emotion cues is in essence built on data collected from each group member to be processed and fed back. This relates GEMSS in a central manner to digital data processing, which is why the data quality framework (DQF) by Wang & Strong [33] is adopted to structure this research agenda. Main benefit of the DQF is its generic description of data quality requirements. Previous research has for example capitalized on this property for the case of recommendation systems [34]. Main argument in the DQF is, that high quality data is represented by the degree of fit for data consumption [33]. Furthermore, four central dimensions of data quality are outlined that are intrinsic, contextual, representational and accessibility data quality. We adopt these dimensions for GEMSS and order them in descending manner, along the criterion of how critical they are for the feasibility and effectiveness of GEMSS.

2.2.1 Intrinsic Quality – Emotion Data Sourcing

Intrinsic quality describes the “extent to which data values are in conformance with the actual or true values” [33 p. 18]. Included dimensions are believability, accuracy, objectivity and reputation of data [33]. In the case of GEMSS, this dimension represents the critical foundation of every system, a necessity condition to be fulfilled in order to derive value from it. Consider for example a system that reports ungrounded information on emotional arousal (e.g. heart rate changes without baseline comparison or normalization to account for inter-individual dynamic differences). This unprecise data will inhibit accurate interpretation and will probably cause confusion or dismissal of data as alternative, more accurate sources will be taken to infer emotional states (e.g. one’s own perception of other’s faces). Objectivity is critical to provide a ground truth that can be acted upon, which is especially important when data is shared between individuals. Accuracy is important to further facilitate data interpretation. Believability represents an interesting aspect to emotion data, in that it has previously been found to influence perceptions of objectivity and accuracy [35]. This observation is representative for the present difficulty to capture this personal experience validly and reliably [25, 26]. Furthermore, this relation shows that regardless of theoretical accuracy, individual understanding and perception of emotion information have to be taken into account to ensure high intrinsic emotion data quality. Reputation of emotion data factors into GEMSS usability in a similar manner, but the novelty of this type of date makes it difficult to draw conclusions yet. Different emotion data sources might come with their own reputation, to how accurate, objective and believable they are. For example, with physiological data it has often been proposed, that this data is objective and more difficult to manipulate voluntarily as for example self-reports [14, 15], which might represent a distinct reputational characteristic.

We propose GEMSS researchers put emphasis on comparison of how different measurement modalities perform in terms of the four sub-dimension. This relates to three granularity levels: Comparison of approaches that use (i) different source classes like bodily expressions (e.g. face, posture, gestures), verbal expressions (i.e. speech or text), or psychophysiological signals (e.g. heart rate, electrodermal activity, skin temperature) on a macro level, (ii) different features within such a class (e.g. comparing how heart rate (ECG) or sweating (EDA) perform as arousal indicators) on a meso level, or (iii) different algorithms within a feature (e.g. comparing how HR-arousal algorithms perform) on a micro level. The latter is of special importance as research in this direction often relies on manual calibration (e.g. [16, 28]) and that comparison knowledge is missing.

2.2.2 Representational Quality – Emotion Data Feedback

Representational data emphasizes format and meaning of data and refers to the “extent to which data are presented in an intelligible and clear manner” [33 p. 18]. This dimension includes the sub-dimensions of interpretability, ease of understanding, representational consistency, and concision of representation [33]. In the case of GEMSS this dimension represents the second critical step towards usability of systems. No data, no matter how valuable can be utilized if it cannot be processed well by group members. Consider the case of a visual dashboard, integrating a small, symbolic display of arousal levels (e.g. a trend plot for multiple people alongside a mouse cursor) superimposed on complex and dynamic stock market data. Such a representation of data might run the risk of going unnoticed or mistaken by the system user. This pertains not only to the visual representation itself, but also to the question whether visual information allows adequate information transmission itself.

Therefore, two research avenues are proposed that touch on all the sub-dimensions of representational data quality: Comparison of (i) emotion data transmission channel, and (ii) emotion data design. Whereas a larger amount of research on GEMSS has focused on visual data representation as an intuitive way to transmit data (e.g. [16, 28, 36]), this modality is simultaneously limited in transmission effectiveness when the same sensory channel is occupied by reception of other task-relevant data. Therefore, other modalities like audible or tactile feedback have been proposed as alternatives [37, 38]. Especially the use of tactile feedback seems to be a promising avenue for GEMSS, as the haptic channel is not as occupied and more wearable devices with usable actuators are now available (e.g. smartwatches). However, as this modality is relatively novel to GEMSS, design of haptic emotion data representations still poses a research challenge. Similarly, while there have been several reports on how visual data ought to be designed to support collaborative interaction (e.g. [39]), there have not been comparisons as to how representations (e.g. symbols, values, placements) influence conscious and subconscious emotion data reception and how they differ in terms of interpretability, ease of understanding, representational consistency, and concision of representation. Whilst knowledge on general requirements to emotion data representation are a main concern in its own right, representation is closely tied to contextual variables, that are discussed next.

2.2.3 Contextual Quality – Emotion Data in Collaboration Scenarios

Contextual data quality describes the “extent to which data are applicable (pertinent) to the task of the data user” [33 p. 18]. This includes the sub-dimensions of added value, relevance, timeliness, completeness and appropriate amounts of data [33]. The main argument in this category is, that information needs differ across situations. Therefore, effective GEMSS should take these influences into account in order to enable and improve system utility. Relevance and added-value of emotion data play an important role in GEMSS as perception thereof is another necessity condition that determines system use. With contextual data quality, it needs to be pointed out that a major point of concern is to delineate which emotion phenomena (for an overview see [1, 2]) add value and are relevant in collaborative scenarios. Consider for example crisis management teams that are more strongly required to receive information on emotional arousal to reduce bad decisions in critical situations (as has been investigated for groups of stock traders [36]), e-sport teams or product innovation teams requiring the elicitation and maintenance of positive emotion tones to be more creative or achieve group flow states [5, 40]. In each instance, different types of emotion management systems could have different requirements to ensure relevance and added value of emotion data. Specification of required emotion phenomena included in GEMSS should be a major concern in future research.

Furthermore, we propose to structurally compare how different emotion data influences perceptions of the aforementioned five sub-dimensions across different types of (i) teams and (ii) tasks. Structural team conditions (life span, physical distribution, communication, leadership and role structure, as well as task interdependence) [41], and member compositions (distributions of abilities, functional and cognitive diversity) [42, 43], impose different requirements on GEMSS. Considering for example the difference in physical distribution (i.e. co-located or distributed collaboration), requirements for digital collaboration might differ as contextual emotion information is comparatively scarce to face-to-face interaction [12] and relevance of emotion data might intuitively be perceived as higher. Team compositions refer to the aspects of what individual members bring to the group in terms of emotional, cognitive and functional abilities, modes of thinking and personality [42, 43]. Consider for example that groups with people bringing lower levels of emotional abilities might require more frequent emotion data to support their interaction. Also, teams with increased diversity (e.g. cognitive, personality or organizational function), could require more timely emotion management support due to higher conflict potentials [43]. Different task types (managing or advising others, human service, negotiation, problem-solving, psychomotor action) have been the center of attention in a lot of team research [8, 41], demonstrating that different tasks types require different GEMSS. However, abstracting slightly from the cognitive processes involved in different task types, properties that span across task types and moderate any type of emotion information feedback should more strongly be taken into focus. These conditions refer to aspects like task complexity or time pressure that invoke more general complications like competition for attentional resources [32, 31]. Consider for example, that a task requires constant attention to minute detail in comparison to a task with a more open setting, supplying time for reflection, where the former intuitively evokes more complications when highly frequent emotion information is supposed to be processed.

2.2.4 Accessibility Quality – Emotion Data Protection and Personalization

Accessibility data quality emphasizes the role of data access as an important component to data quality and refers to the "extent to which data are available or obtainable" [33 p. 18]. This includes the sub-dimensions of accessibility and access security [33]. Accessibility data quality posits a final optimization challenge to effective GEMSS. Consider for example a system that collects emotion information through video cameras [44]. Such a system might provoke reservation by users that feel out of control on which data is collected on them, as well as uncertainty about who else might be able to access it. Therefore, the provision of emotion data through GEMSS needs to include research on how highly personal emotion data access can be managed well. The guiding question here is, how access to emotion information for the individual, group and external actors can be supported. This pertains the aspects of (i) how emotion data is collected, (ii) distributed, and (iii) stored. This is especially important as explorative studies have highlighted, that user preferences and acceptance of digital emotion support technologies vary strongly [28, 29].

Data collection and the obtrusiveness of measurement, pertains emotion data access with a trade-off in awareness and user control. On the one hand, the application of sensors on subjects represents an obvious way of keeping the user in control of what data is collected from himself, whilst potentially making him overly aware and distracting him from other relevant tasks. On the other hand, non-contact measurement presents unobtrusive collection, but alleviates the user from controlling data access. Investigations need to take into account how different approaches influence user perceptions of data access for different parties in GEMSS. Also, distribution of emotion data in and beyond the group represents a major area of concern. Naturally, not everyone might want to expose one's own emotional state, as to avoid malicious manipulation, embarrassment, or simply because it might cause others to experience unwanted emotions [45, 46]. Questions such as how these experiences relate to control and access to distributed data within the group form additional research avenues for GEMSS. Furthermore, the question how acceptable access to different emotion data is for external actors (e.g. managers or institutions) will need to be taken into consideration. A final concern is how emotion information is stored, and how access is provided for retrospective utilization (e.g. for individual or team analysis purposes). While it has for example been found beneficial for intrapersonal emotion management, to log and review records of emotion experiences [47], the storage and treatment of historical data on emotion in the interpersonal and group context represents a considerably more tenuous question. Even though the promise of higher quality emotion management for cognitive and affective interaction outcomes is tempting and justifies this avenue of research, it needs to be ensured, that advances do not come at the cost of individual rights, values, and preferences.

3 Concluding Remarks

As the quality of management of emotion in small group interaction is a central factor in cognitive (e.g. performance) and affective (e.g. satisfaction) collaboration outcomes [3, 7–9], the advancement of GEMSS promises to be a highly valuable contribution. Building on Wang & Strong's DQF [33], we outlined propositions for salient aspects to be taken under more scrutiny in group emotion management support research. These comprise (i) how emotion information can be derived adequately, (ii) how presentation and transmission formats need be designed, (iii) what type of emotion information is useful for emotion management in different small group scenarios, and (iv) how aspects of privacy and individual preferences are taken into account to support the viability of these systems. Each dimension represents a central limiting factor to the effectiveness of GEMSS, yet we discussed them in the order of our perceived criticality to outline research priorities.

As all GEMSS build essentially on the quality of data that is collected, we conceive intrinsic data quality as the first dimension that needs to be addressed by future research. Within the intrinsic data quality dimension a major concern is the lack of comparison of how data on emotion phenomena are measured and how different approaches perform in terms of objective criteria (objectivity and accuracy), but also subjective criteria (believability and reputation of data). Therefore, comparison research should be advanced across data sources (e.g. behavioral vs. physiological) and within data sources (e.g. comparing different algorithms). Given sufficient intrinsic data quality, representational data quality was discussed as the next step in limitations to GEMSS effectiveness, with the argument that no data, no matter how valuable can be utilized if it cannot be processed well. Therefore, we outline two main areas for investigations that compare how different transmission channels (e.g. visual vs. haptic) and different information designs (e.g. visualization complexity) fulfill sub-dimension requirements like ease of understanding and interpretability. Given adequate emotion data representation, contextual data quality was discussed as a step to enable and optimize GEMSS for specific usage scenarios. The main argument is, that emotion data needs differ across team types and task requirements. Therefore, comparison of the adequacy of considered emotion phenomena (e.g. individual vs. group emotion metrics) in specific team structures (e.g. distributed vs. co-located) and specific tasks (e.g. high vs. low attentional requirements) should be put forward to improve on data quality sub-dimensions like added value and relevance of represented data. Lastly, given sufficient data quality from all the previous dimension, in a last step of optimization, accessibility data quality posits a challenge to effective GEMSS. This refers to the problem that individual user acceptance and control of such systems needs to be integrated. Therefore, we outline that comparison of designs that integrate user preferences and control would further be beneficial to increase the feasibility of GEMSS.

In summary, while in this discussion we mainly argue for comparison of how systems differ across situations, we want to outline that findings from comparisons might also highlight, which factors are stable across situations and therefore would allow to support collaborative action in a more generalizable manner. This links back to the observation of the collective intelligence factor and its relationship to emotion recognition abilities [8, 10]. A final limitation to be outlined at this point, is that even though we argue for the central importance of emotion management in small group interaction, an extension to a more general level of mental state management is conceivable. This conception is similarly derived from collective intelligence findings [8, 10]. Even though these authors find the relationship between a test that is argued to primarily address abilities of emotion recognition [48], the test extends to the concept of mentalizing, i.e. to more general abilities of processing interpersonal mental state information [49]. Future extension to encompass more holistic mental state management, would thus provide an even more valuable point of orientation for research endeavors in small group collaboration support.

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Perceived Anger Intensity in Electronic Negotiation

Sriram Venkiteswaran[1*], RP Sundarraj[2]

[1] Research Scholar, Department of Management Studies, IIT Madras
[2] Professor, Department of Management Studies, IIT Madras
[*]Sriram Venkiteswaran, email: sriramve2000@gmail.com

Abstract. Anger plays an important role in negotiation. In this paper, we study how anger intensity is perceived in an electronic negotiation. Participants are asked to judge the emotion and emotion intensity of a series of statements that were shown to elicit anger in previous experiments. We test whether there is significant difference in overall anger intensity perception among the statements that were perceived as angry. Statements that evoked the most and least anger intensity are reported.

Keywords: perceived anger intensity, electronic negotiation, emotion.

1 Introduction

Large number of studies have documented the impact of emotion on negotiation. Effectiveness of sadness expression in negotiation [1], impact of power and emotion in negotiation [2], negotiation outcome when interacting with a worried, guilty or regretful counterpart [3], concession behavior under angry and happy counterparts [4], positive and negative effect of anger expression on dispute resolution [5], interpersonal effect of emotion [6] attest to the growing importance of emotion research in negotiation. Among all the emotions, anger is the most studied. In addition to studying the raw effect of anger on negotiation outcomes, researches have gone deeper and investigated the role of power [7], effect of person-directed vs behavior-directed anger displays [8] and impact of culture [9], thereby deepening our understanding of negotiation under the influence of anger.

Although the study of emotions in negotiation is relatively new, they have been the focus of study for a long time in social sciences. Theoretical models in psychology [10], economics [11] and philosophy [12] routinely have emotional constructs at its core. Effect of anger on health [13], workplace [14], sports [15] and conflict [16] have been explored in depth.

One of the dimensions of anger studied in the psychology literature is anger intensity. Anger intensity has proven to be a useful measure in studying the impact of anger on pain [17] [18], in examining the relationship between cognition and anger [19] and in other behavioral contexts. However, in early '90s, Sonnemans et. al. remarked that, in the psychology field, "…this aspect of emotion has been almost completely ignored as a specific object of research." [20]. Electronic negotiation literature has dealt with anger at an emotional level and anger scores were mainly used to judge whether participants were more or less angry compared to other

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emotions and in manipulation checks in assessing the overall participants perception of the opponent's emotion [21][4][8]. Opponent's anger intensity perception at the participant's level is not explored further. Hence this paper addresses the gap by first asking the question, given a set of angry statements, how is an opponent's anger intensity perceived by the participants? In [4], a set of angry and happy statements were analyzed and those statements that were perceived to be most angry and most happy were reported. We use a similar approach but report statements that were most angry and least angry. We also differ by asking the participants to choose only one emotion and rate it instead of asking to rate how each statement reflected anger and happiness. The pilot study in [4] was done on 28 participants while we significantly expand our sample size to 88. Finally, in addition to including the top angry statements reported in [4], statements from a more recent study [26] were taken up and the dynamics of anger intensity perception is studied. Our study contributes by presenting two sets of statements that differ significantly in anger perception, which can be further used in future experiments to explore the effect of anger intensity on demand and concessions. This study is part of a broader research of anger intensity perception in electronic negotiation that is in progress. The rest of the paper is organized as follows: Section 2 has definition of anger intensity and hypothesis, section 3 has a survey of existing literature, section 4 describes the methodology, section 5 has the discussion of the results, section 6 concludes the paper and section 7 highlights the limitations.

2 Definition and hypothesis

2.1 Definition

We define perceived anger intensity in the context of an electronic negotiation as follows. "Perceived anger intensity is the degree of anger that a negotiator thinks his or her counterpart is feeling, judged only by text message(s) exchanged by the counterpart during the course of electronic negotiation. The text message(s) are devoid of special characters, emoticons and other cues and written in plain English language." Thus perceived anger intensity is viewed as an abstract construct that is configured or assessed only by viewing the counterpart's messages. Emoticons and other paralinguistic cues are known to affect the meaning of the messages in electronic negotiations [38]. Since this is a first attempt to look at perceived anger intensity, we wanted to study the effect of only the text messages without the confounding effect of the cues.

2.2 Hypothesis

Intensity perception is subjective. A subject may easily answer the question 'How intense was your emotion?' but the underlying motivations for their answer may vary widely. In this respect, five dimensions of intensity were identified, comprising of recollection and re-experience of emotion, duration of the emotion and delay, action tendency, belief changes and long term behavior and perceived bodily changes and strength passivity[22]. The overall felt intensity is thought of as a function of these five factors and the joint function appeared to vary with emotions or occasions. A similar view that an emotional component is composed of multiple cognitive components is shared by [23], where these components were identified as behavioral, experiential and psychological. In addition, cultural norms and appropriateness of anger expression also impact behavior. Expressing anger induced larger concessions from European American negotiators but smaller concession from Asian and Asian American negotiators but Asian American negotiators made large concessions when the anger expression is adjusted for cultural appropriateness [24]. Appropriateness of anger expression, along with power, was also found to influence the counterpart's intention to compete or cooperate [25]. Interplay of several such complex and subjective factors in anger expression and intensity perception leads us to the hypothesis:

H: Given a set of angry statements, some of them will be perceived as significantly more angry than the other.

3 Literature survey

The main motivation of this paper is to understand how anger intensity is perceived by one's partner in a negotiation setting. Perception of anger and its impact on negotiation was studied by Van Kleef as early as 2004 [4]. A comparison of demand levels of participants who were paired with an angry opponent placed lower demands and gave larger concessions as compared to participants who were paired with happy opponent. Subsequent studies have established the role of anger in negotiation [26][27][28]. In [4], participants were shown statements representing anger and happiness and asked to score how well each statement represented anger and happiness on a 7-point scale. The statements that had the highest score on the emotion they were supposed to reflect and the lowest score on the emotion they were not supposed to reflect were selected and used in negotiation experiments. The intensity of emotion is compared on a scale and the intensity values were used for statement selection. Further the adequacy of anger manipulations were tested with a post-experiment questionnaire by asking how angry, irritated, happy and satisfied they thought their opponent had been on a 7-point scale. In addition, the participants own emotion were tested by asking to what extent they felt they experience anger (or happiness) during their negotiation on a 5-point scale. In [26] questions such as to what extent the confederate display anger was measured in a 7-point Likert scale. Similar scale based measurements were used in [28] where the participants were asked to rate to what extent they thought their counterpart expressed anger on a 6-point scale. Multiple item questionnaire could be used to record perceived anger expressions as in [29] where a three item questionnaire with 9-point scale was used.

Electronic negotiation literature mainly employs self-report measures, items and scale to measure anger, but there are other alternatives. Psychological studies measure anger states and intensities at various periods of time using scales such as State Trait Anger Expression Inventory (STAXI-2) [32]. STAXI-2 assess the momentary experience of anger that occurs in response to some event or person (State-Anger), how frequently, easily and intensely the person feels angry (Trait-Anger) and what the person does when feeling angry (Anger Expression-In, Anger Expression-out, Anger-Control). Other scales such as Positive and Negative Affect Schedule (PANAS) [33] is used to measure mood or emotion comprises of a scale of 20 items, 10 measuring positive effect and 10 measuring negative effect. Each item is rated on a 5 point Likert Scale with 1 being "Very Slightly" and 5 being "Extremely". Item composition of the PANAS-X [39] scale, an extended form of the PANAS scale, lists additional three scales, Basic Negative Emotion Scales, Basic Positive Emotion Scales and Other Affective States. Among these scales, there are subscales for different emotions. And among the subscales, hostile, disgusted, irritable, loathing and scornful emotions are all treated the same as anger. Due to its simplicity and ease of use, we considered an adapted form of PANAS-X scale for our study.

4 Methodology

4.1 Survey

A survey was conducted to collect data on anger intensity perception of a group of statements. The survey details out a negotiation setting, similar to the one used by Van Kleef [4]. Participants were told that they are negotiating for buying a used cell phone. Past research has found that negotiation behavior changes while negotiating with a stranger as opposed to a known person [34]. Hence it was mentioned in the scenario that the negotiation is happening with a stranger. It is a multi-round negotiation with exchange of offer and counter offers. Participants were told that in each round of the negotiation, they get a counter offer from the seller along with a message. They were asked to judge how well they understood the message and the emotion and emotion intensity of the counterpart from the message. The message that were selected were shown by prior research to elicit anger [4][26]. A more recent study by Chesin [26] categorized statements as angry resolute, angry flexible, happy flexible and happy resolute. They also found that verbal and text-based communication of emotion played a significant part in the attribution of anger. Hence we included the statements used in his study. In all, a total of 25 statements were presented to the participant out of which 15 statements were angry as per literature. The statements were randomized for each participant. A 5-point scale was used to measure comprehension and emotion intensity. List of emotions were selected from PANAS-X scale [39]. It lists 11 different emotional states under Basic Negative Emotion Scales, Basic Positive Emotion Scales and Other Affective States along with their corresponding sub-scales. During pilot runs, we found that listing all of them results in confusing the participant and made it harder to complete the survey. Hence to decrease the cognitive load, the user was asked to select only a subset of three emotions, Happy, Sad and Angry. An additional 'Other' option was used to capture any other emotion. Since our focus is only on understanding how text messages are interpreted, any emoticon and other special characters such as capital letters, exclamation marks and other paralinguistic cues were removed. Details such as gender, age-group, country of birth, country of residence and job level were also collected.

4.2 Results

A total of 88 participants responded to the survey. There were 63 male respondents and 25 female respondents. We started our analysis by analyzing the 15 statements that were listed as angry from literature. Participant's perception of the opponent's emotion for each statement was arrived at by calculating the percentage agreement among the participants for each of the emotion. For instance, emotion for a statement was tagged as angry if more participants rated them as angry compared to sad, happy and other. Considered this way, 12 out of the 15 statements were found to reflect opponent's anger and were carried over for further analysis. An single factor ANOVA test for anger intensity with the statements as the factor found significant difference in intensity ratings between the statements at $p<0.05$ level $F(11,1032)=11.3185$, $p=0$. The statements were sorted based on anger intensity and the average anger intensity of the top three statements were compared with the bottom three using a paired-t test. For the paired t-test and ANOVA, the intensities of those statements for which the participants responded with 'not comprehensible' were coded as 0. Intensities of non-angry statements were similarly coded as 0. The test found a significant difference between the top 3 ($M=2.9693$, $SD=1.2755$) and bottom 3 statements ($M=1.8582$, $SD=1.1743$); $t(86)=8.9869$, $p=0$. Thus Hypothesis 1 was supported. The top three and bottom three statements with the most and least anger intensity are given in Table 1 and Table 2 respectively.

Table 1. Top three statements with the most anger intensity

Sl.No.	Statement
1	This negotiation pisses me off.
2	This offer really makes me mad. There is no way I am selling for this price.
3	How long does it take you to respond. I agreed to your awful request.

Table 2. Bottom three statements with the least anger intensity.

Sl.No.	Statement
1	Well, ok. I will give in this time. But this is really making me mad.
2	Whatever. But send your offer fast. I am tired of waiting.
3	Ok. But you are starting to get on my nerves.

5 Discussion

Anger is a negative emotion that may occur due to interruptions in planned activities, loss of pride or self-esteem and the violation of personal wishes and social norm [35]. Previous studies investigated anger and focused on comparing negotiation behavior with other emotions. Our study looked deeper into anger intensity perception from a participant's point of view. The results highlight that that even though participants predominantly agree that a group of statements signify angry emotion, there are significant differences in the anger intensity perception of those statements. Another contribution of the study is the identification of high intensity and low intensity angry statements that may be used to study concession behavior under varying intensities.

The fact that anger intensity perception differs among the participants may have implications in electronic negotiations. For instance, Flaming is an antinormative hostile behavior characterized by the use of profanity and insults [27][30]. It can, by definition, be considered as a more intense form of anger and has been documented to occur more in electronic communications compared to face to face communication. Such intense form of anger expression has an impact on negotiation outcome and concession behavior. Flames directed at the negotiation opponent slightly decrease the likelihood of reaching an agreement, while, flames directed at the negotiation context significantly increase the likelihood of agreement. It also produces unexpected outcomes such as the negotiation result favoring the flame recipient when an agreement is reached [31]. Van Kleef proposed Emotion as Social Information model (EASI) to explain the effect of emotion on the communication process [36][37]. According to the EASI model observers draw inferences from others' emotional expressions, which in turn guide their own behavior and/or response. Hence, correctly interpreting a counter-part's emotion intensity and having the ability to convey statements with the right intended anger intensity may add strategic depth to a negotiation and can be helpful in fostering better negotiation outcomes and improved inter-negotiator relationship. Wrongly concluding that a negotiator is very angry might result in giving too much concession while under estimating the anger intensity may result in impasse or failed negotiation. The top three and bottom three statements of varying intensities, reported in this paper, may help in the conduct of future experiments to test this behavior.

6 Conclusion

Impact of emotion on electronic negotiation is an active field of study. The paper discusses anger intensity and its perception during an electronic negotiation. This study is part of a larger study on the impact of anger intensity in electronic negotiation and it presents two findings. One, even though participants rate a group of statements as angry there are variations in the anger intensity perception of those statements. Second, a set of statements having high perceived anger intensity and another having low perceived anger intensity is presented, which has the potential to be used in future negotiation experiments to further validate anger perception hypothesis.

7 Limitation

The result of the study was based on a survey. Survey lack experimental realism compared to experiments. Thus, the results of the study need to be interpreted accordingly. A sample size of 88 respondents may not be enough to come to a valid conclusion. Of all the respondents, 71.6% were male, skewing the study towards a predominantly male response. The study asks the respondents to choose only one emotion along with the intensity of emotion, thereby subscribing to Discrete Emotion Theory [40][41]. However, it is possible that participants may be experiencing a range of emotions, as proposed by the Dimensional model of emotion [42][43][44]. The survey did not control for the personality profiles of the participants, which could have a critical role to play in anger intensity perception. Culture could also have an impact in emotion intensity perceptions. The present study does not study its effect.

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Communication Influences Culture and Emotion in Decision Taking and Negotiation

Bilyana Martinovski[1]

[1] Department of Computer and Systems Sciences, Stockholm University, Stockholm, Sweden

Abstract. This paper proposes a dynamic modular model of emotion- and culture-based communication in decision taking and negotiation, which reflects intercultural communication processes and can be used in the design of life-like negotiation-training scenarios. Communication is defined as an opportunity for meeting of Otherness. Culture is defined as a semiotic process and a system, which builds upon Self and Other identities and which is sustained and modified through communication and cognitive-emotive mechanisms, such as reciprocal adaptation, interactive alignment and appraisal. Since culture covers many different aspects of social life i.e. people practice intercultural-communication on daily basis, Human-Virtual Agent interaction is modeled as a form of intercultural communication.

Keywords: emotion, culture, communication, simulation, decision, negotiation

1 Introduction

Emotion and culture influence how we communicate, how we take decisions and how we negotiate. The opposite is also valid yet less obvious, namely, that communication influences culture, emotion, and decision taking processes. In effect, simulation of emotion and culture-based communication is a challenge in design of intelligent systems such as Virtual Agents. There is diversity of behaviors and cognitive frameworks in different cultural environments. Yet, the relation between emotion states and culture-based communication is unclear. Both humans and Virtual Agents need to behave appropriately according to environment, for instance, when involved in life-like training scenarios. This explains why there has been increasing interest in emotionally and culturally adaptive agents. The agents are built to relate to particular cultures by exchanges of modules related to behaviors and functions. In most cases, the agent's designer decides what set of culture-based features are to be used in order to generate culturally appropriate behavior [1].

This paper proposes and motivates a model of emotion and culture-based communication for humans and Virtual Agents, which aim is to to capture the dynamic relation between emotion, communication and culture in decision taking and negotiation. It starts with theoretical foundations and definition of the modeling concepts. Section 2 defines culture. Section 3 defines communication in culture relevant terms. Section 4 offers a description of culture-as-a-process mechanisms such

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as reciprocal adaptation and interactive alignment. Section 5 defines emotion as used in the model of culture-based communication presented in Section 6.

2 Culture as a process and a system of interpretation

There are various definitions of culture some emphasizing competence, others – performance, cognitive aspects vs. communicative and activity aspects. Its history of conceptualization is long, starting with cultivation of crops, moving through a dilemma - ‘culture vs nature’, followed by a view of culture as high and low expressions of human talent and insight, and later as ‘a historically transmitted pattern of meaning embodied in symbols’ [2]. The currently dominant conceptualization of the term defines culture as ‘programming of the mind…interactive aggregate of common characteristics that influence a human group’s response to environment’ [3]. Although the dominant usage of culture concept is based on nationality, cultures vary also with respect to ethnicity, age, gender, profession, activity, language, and even species. For instance, Shuter’s [4] study of proxemics behavior among Latin American pairs in conversation shows regulations not only according to national culture but in dependence of gender, where women stand closer to each other than to men independent of nationality and Costa Ricans stand closer to each other than Columbians independent of gender. In other words, we participate in different forms of intercultural communication on daily basis and there are measurable behavioral changes depending on cultural context. Therefore, a model of cultural awareness is better grounded on the fundamental relation between Self and Other informed by modular variation of cultural and communicative features.

As cultural values, perception, judgment, emotions and communication are acquired at very early age, cultural awareness becomes a process, which develops from low to high awareness. A child acquires cultural values and habits actively and non-critically, which define his/her sense of Self. Realization of Self is thus contingent on realization of Otherness: if one has no understanding of Self as different from the Other, one has no realization of Self [5, 6]. Without the neural ability to distinguish Self and Other [7] culture-awareness would not be formed. From a neurocognitive point of view, the brain and the body assemble inner and outer information depending on the capacities of the specific species [8]. Except for the sense of smell, which initially does not go through interpretative circuits, the human brain interprets information coming through the outer senses. For instance, when a sound wave reaches the ear receptors there is no interpretation of what that sound is but we cognize that we perceived a sound of a train because we immediately created an interpretation, based on possible already experienced or learned sounds. Thus, what we ordinarily regard as perception is rather the act of interpreting sensory data [8, 9].

This applies also to culture-sensitive phenomena such as proxemics. Through the process of upbringing we learn to ‘perceive’ certain distance between speakers as right and wrong, comfortable and uncomfortable. During this rather unconscious process, we built our culture-specific model or system of proxemics. From the moment of birth, our environment supplies us with a range of possible interpretations. With time, the possibilities turn into a full system by means of which we conduct all our perceptual transactions. In that sense, culture is not only a full system of preferred interpretations of sensory data but also the very process of acquiring and building that system. It is the process aspect of culture that expresses its dynamics, its ability to change. Both as a system and as a process, Pierce's three basic semiotic signs - icon, index and symbol - are realized in human culture and communication as various modalities [10]. Therefore, the definition of culture adopted in the proposed model is formulated as follows:

Definition 1. Culture is a dynamic semiotic process and a semiotic system of interpretation of Self and Otherness by means of which we conduct our perceptual transactions in interaction with environment.

Contemporary research on the functions of mirror-neurons [11] examines the neural mechanisms, which support our understanding of others' and own intentions and states, which, in turn, are used for development of cultural and social cognition [12, 7]. Beliefs about age, gender, language, environment, and so on contribute to cognitive 'models' that individuals form and keep of each other's characteristics and intentions. Baron-Cohen [13] went as far as to claim that the human brain has a particular "mindreading" mechanism, specialized module dedicated to prediction and interpretation of others' intentions. He characterized this as a natural and innate capability, which enables socio-cultural contact to take place.

3 Culture-relevant definition of communication

Culture is tightly related to the concepts of language and communication. This section provides an overview of conceptualization of communication in order to reach a culture-relevant definition operative in the proposed model (see Section 6 below).

There are two major views on the relation between language and communication. The more dominant view concludes that language originated as a tool for communication and that communication is exchange of information. Within this view, miscommunication is treated as a problem, which can be solved by more communication. Culture-specific concepts are explained with differences in objective reality. However, there are languages that lack specific words for e.g. color, but does that mean that there are no colors in their regions or that the speakers don't perceive color? Universalist studies [14] on perception of color show that the speakers perceive colors although they don't have specific words for color and that their concepts have different semantic fields i.e. they use the word 'blood' to denote even the color of red. These findings suggest another view on the relation between language and communication, namely, that language originated as an inborn tool for thinking and that communication is not the primary function of language. The cognitivist view [15] underlines universal linguistic structures and concepts. Surface lexicalizations and expressions could be culture-specific but not the underlying inborn syntactic and conceptual structures, which define us as species. Miscommunication is not necessarily resolved by more communication because language is not a tool for communication but rather a tool supporting thought processes.

These two views are competitive with respect to origin and function of language but they also express a dichotomy in the modern concept of communication, which Peters [16] sees as a product of 'a dream for instantaneous connection or a nightmare of being locked in a labyrinth of solitude'. In other words, we prefer to define communication and language as means for immediate connection between Self and Other because we are terrified by the idea of being locked in a solitary world of solipsistic thought. In this context, we need to examine the history of the dominant definition of communication as exchange of information.

For the past 60 years the humanities have been dominated by a metaphor of communication borrowed from telephony (ibid.). In his view, this definition locks us in a dichotomy - instantaneous connection vs. nightmare of solitude – and dislocates our attention from the cultural and ethical nature of communication. Communication becomes either destructive or therapeutic, its main function is to eliminate differences or cure us from our differences. This tendency towards sameness, caused by and resulting in irrational fear of otherness builds on the temptation to reduplicate the Self, to mirror signal/meaning/ideas. Therefore, Peters (ibid.) revises the definition of inter-human communication as a transmission of information and develops the idea of communication as a manifestation of the ethical. Ethics emerges through and in language: beyond the contents delivered and the linguistic structure it enforces, language inspires the fundamental response-ability between Self and Other. Responsibility implies both being response-able to the Other's call and being responsible for the Other, reaching out to Alterity, beyond the Self. Communication transpiring between Self and Other is not only exchange of information, or participation in a discursive sphere; it is also a manifestation of the fundamental responsibility to and for the Other. This, according to Martin Buber [5, 6] and Emmanuel Levinas [17] is the origin of language and communication: openness, exposure, proximity, and responsibility. Response-ability as a priori agreement is not always representable linguistically, it is the fundamental relation and the condition for any understanding and representation. Locked within a dichotomy in conceptualization of communication "at once a bridge and a chasm" [16: 5], telepathy and solipsism, telephony and poesis, missiles and swan lakes, we miss the opportunity to meet the Other and the Self. Instead of viewing human communication as a battle against noise for a clear message or as a therapeutic technique, we can view communication as an ethical process, as an opportunity to meet otherness, outside or inside the Self. As Peters' [16: 21] puts it: "Communication as reduplication of the self or its thoughts in the Other needs to crash for the resulting discovery of the Other (besides knowing and the check on the hubris of the ego) is in essence the way to the distinctness of human beings. " Inspired by Ralph Waldo Emerson, William James, Adorno, and Buber, Peters [16: 31] offers a new idea of communication as reconciliation with Alterity: "The most wonderful thing about our contact with each other is its free dissemination, not its anguished communion….acknowledging the splendid otherness of all creatures that share our world without bemoaning our impotence to tap their interiority.' Based on this analysis of communication, the definition adopted in the proposed model is as follows:

Definition 2: Communication is an opportunity for a meeting between Self and Other.

This calls for re-evaluation of "miscommunication". It is precisely the failure in communication that opens up the very possibility for ethics to manifest. It is in the unsettling moment of incomprehensibility that one is exposed to the Other's otherness with no guidance as to how to respond. Intercultural communication confronts with otherness on daily basis, which is often seen as a challenge therefore the next section explores the definition of intercultural communication.

The dominant view on language and communication as sender's signal to a receiver dominates the field of intercultural communication yet there is diversity in the evaluation of the effect of intercultural communication. Iles [18] finds that it aggravates relational conflict. "Culture is more often a source of conflict than of synergy. Cultural differences are a nuisance at best and often a disaster." (Hofstede http://www.geert-hofstede.com/). Few emphasize its potential for enhanced performance and creativity [19].

There are not so many studies of intercultural communication. Cross-cultural studies predominate the field. The cross-cultural perspective studies behaviors, values, norms, and perceptions of one culture in mono-cultural conditions and in comparison to those in another culture [20]. Intercultural studies examine behaviors, values, norms, and perceptions of participants representing different cultures in intercultural settings. However, most 'findings' in this field are based on cross-cultural studies and oriented towards description of similarities and differences [21], e.g., collective cultures prefer charismatic leaders, Individual cultures prefer task-oriented leaders, High Power Distance prefer directive leadership; In Japan turn-taking is characterized by pauses, in USA by latching and in Brazil – by overlap, etc.

There are only a few pure intercultural negotiation behavior studies. Reeh et al. [22] finds nonverbal reciprocal adaptation [23] in intercultural conditions, which is not observed in mono-cultural conditions. Qui & Wang [24] find verbal reciprocal adaptation in negotiation role-play between Chinese and Swedish women manifested by bargaining - gravitating towards each others' value, mirroring, and drop of learned own cultural behaviors.

Whereas cross-cultural studies compare cultures in their intra-cultural functionality and find or predict an established system of similarities and differences, in intercultural conditions we observe a process of mutual adaptation, of reciprocal reaching towards each other, which along with exposure to otherness produces hybrid cultures. Intercultural communication brings adaptation as a reaction to the exposure to Otherness, which manifests the tension between a desire for fusion, for reduplication of Self and a possibility for reconciliation with Otherness, for openness to the unknown. Exposure to Otherness opens a possibility for communication as manifestation of the ethical. It is therefore important to understand how this adaptation occurs and how it relates to culture-based behavior.

4 Reciprocal adaption and alignment

There are interactive mechanisms, which build culture-based frames of reference. Two, relevant for our inquiry, concepts have been introduced, namely reciprocal adaptation and interactive alignment. Gumperz [23: 13] definition of reciprocal adaptation is in short the following: "the procedure...where each participant gradually learns to adapt and to enter into the other's frame of reference." In his view, reciprocal adaptation is involved in interactive reframing of situations, knowledge and arguments and it does not presuppose conscious or less conscious processing of information. This communicative, cultural and learning mechanism is not only cognitive but also linguistic, emotive and behavioral i.e. speakers adapt to each other on different levels:

lexical and semantic choice, syntax, posture, gaze, proxemics, orientation, tone of voice, etc. It is a mechanism behind linguistic phenomena such as creole-like varieties of languages and interactive emotions such as empathy and rapport [25]. Similarly, human users adapt to the speech and behavior of the Virtual Agent [26, 27].

According to Pickering and Garrod [28] communication in discourse is accomplished through an interactive process they call alignment and successful communication is accomplished through good alignment: 'the development of similar representations in the interlocutors … interlocutors align situation models during dialogue.' [ibid.: 1]. The main claim of their theory is that 'automatic processes play a central role and explicit modeling of one’s interlocutor is secondary' in communication [ibid.]. The alignment involves situation models and non-situational knowledge such as language knowledge. Interlocutors align their situational knowledge but they also align knowledge of situation and language (for instance, what they think 'right' means with the word 'right'). The situation models include notions such as 'space, time, causality, intentionality, and reference to main individuals under discussion' [ibid.: 2]. Alignment is based on willingness for cooperation and on mechanistic automatic imitation (of lexical choices, syntax, tone of voice, etc.): 'Our underlying conceptualization of conversation is collaborative, in that we treat it as a “game of pure cooperation” … in which it is in both interlocutors’ interest for it to succeed for both interlocutors' [ibid.: 22] and 'the interactive-alignment account proposes that alignment is primitive. It is a form of imitation and drops out of the functional architecture of the system… In these accounts, imitation is an automatic, non-inferential process and is in some sense the default response. Generally, imitation does not appear to require any decision to act' [ibid.: 18].

Thus, alignment does not involve building of entire theory of the other as in Theory of Theory of Mind but a primitive turn-to-turn alignment on different linguistic levels of the message: phonetic, syntactic, semantic, etc. Each level is processed and aligned for itself and misalignment on one level enhances alignment on another level. Pickering and Garrod point out that children can't inhibit alignment, which speaks for the forcefulness of this interactive mechanism. They base their view on situated interaction where participants have to find interactively each other's position in a maze without being able to see it and assume that the same mechanism works on everyday conversation: 'Such models are assumed to capture what people are “thinking about” while they understand a text, and therefore are in some sense within working memory (they can be contrasted with linguistic representations on the one hand and general knowledge on the other). Successful dialogue occurs when interlocutors construct similar situation models to each other.' [ibid.: 1-2].

They point out 'that this account differs from Clark [29] who assumes that speakers carefully track their addressees’ mental states throughout conversations' [ibid.: 10] and that 'the important point is that effects of partner specificity do not imply that interlocutors need employ complex reasoning whenever they produce an expression. Instead, they have a strong tendency to employ the form that they have just encountered' [ibid.: 20].

Interactive alignment is similar to the concept of reciprocal adaptation in that they refer to framing in terms of similar discourse processes and do not demand conscious processing during interaction, although the connection has not been made nor explored yet:

Reciprocal adaptation: “the procedure...where each participant gradually learns to adapt and to enter into the other's frame of reference".
Interactive alignment: "the development of similar representations in the interlocutors … interlocutors align situation models during dialogue”.

However, since alignment is by definition a primitive process, i.e. it does not involve complex reasoning or active long-term memory based monitoring, it is hardly the case that interactants rely only on this process in order make sense of a situation. Rather, it is more likely to see it as a way of preliminary or first layer framing. In Gumperz' terms, interactants gradually learn to frame their activities through reciprocal adaptation in order to make sense of a situation. It is a more general term than alignment because it does not pose a condition of automaticity and short-term memory basis, but does not exclude it either.

Even more complex cognitive-emotive processes such as some forms of Theory-of-Mind-building produce culture-based behaviors. Martinovski, Traum and Marsella’s [30] analysis indicates that complex emotions such as empathy involve Theory-of-Mind models. Martinovski [31] found that emotions function as engines in conflict management and involve opposite reciprocal adaptation and that they realize in different manner depending on culture-specific settings. Thus a model on culture-based behavior and awareness needs to involve emotions.

5 Emotion and Culture

According to the social and anthropological constructivist theory [32] socio-cultural interpretations determine emotions and body behaviors. Cornelius [33] gives as an example of emotion attitudes to language variations such a dialects. However, although attitudes may trigger regularly the same emotions as a result of culture-specific appraisals this does not mean that attitudes are the same as emotions. Test on capacity for interpreting body language, the so called, PONS-tests, Profile of Non-Verbal Sensitivity [34] show that women are generally better then men at recognizing expressions of emotions but worse in interpreting anger. The socio-cultural perspective explains these results by pointing out that in patriarchal, i.e. in most, societies women are prohibited in various ways to express anger, which is part of the subjugation of women [35]. Yet, prosodic comparisons of intended and recognized emotions and attitudes in different unrelated languages found “remarkable similarities” [35: 2], which indicates that the relation between content and expression of emotion is not arbitrary i.e. the results supported that universalist perspective on emotion.

In the framework of Darwinism, emotion has a role in adaptation in the course of evolution and therefore universal because expression of emotion is found in other species [33]. In Descartes’ era, emotions intertwined with cognition of stimuli. William James [36] introduced the role of the body in the cause and effect chain: the mind perceives the reaction of the body to stimuli, e.g. increased heartbeat; the sensation of the physiological response is a feeling which mental representation is an emotion, e.g. fear.

Contemporary neuroscientists report evidence for the involvement of emotion in so called rational cognitive processing. Neuroscientists such as Von Uexkull [37] Fuster

[38] and Arnold Scheibel (personal communication) observe that evolution gave privilege to the limbic system: emotional feedback is present in lower species, but other cortical cognitive feedback is present only in higher species. In that sense, emotion functions in evolution as a coordinator of other cognitive and non-cognitive functions. Damasio [39] suggests that the state of the mind is identical to the state of feeling, which is a reflection of the state of the body. He explores the unusual case of Phineas Gage, a man whose ability to feel emotion was impaired after an accident in which part of his brain was damaged. Damasio finds that, while Gage's intelligence remained intact after the accident, his ability to take rational decisions became severely handicapped because his emotions could no longer be engaged in the process. Based on this case, the neurologist comes to the conclusions that rationality stems from our emotions and that our emotions stem from our bodily senses. Certain body states and postures, e.g. locking of the jaw, would bring about certain feelings, e.g. anger, which in turn will trigger certain thought and interpretations of reality, a thought traced back to William James. Appraisal theory sees emotion as something automatic, non-reflective and immediate and at the same time, cognition leads emotion, i.e. the way we cognize events influences our emotions related to them, not the opposite. In that sense, emotions become and involve coping strategies [40].

Three mutually exclusive theories have been suggested to explain how we understand others i.e. what are the cognitive-emotive mechanisms that facilitate communication and learning: by imitation [7] - ex. we understand what it means to have stomach ache by imitating that state; by simulation [41, 42] - ex. we understand what it means to have stomach pain by associating it with our state when we ourselves have stomach ache; by symbolic representation which does not rely on neither imitation nor simulation [43] – we understand when it means to have stomach ache by having a fixed set of features describing how one feels when one has stomach ache and a fixed set of features on how one should react to that state in different contexts. Given the short overview above, the definition adopted here for emotion is as follows:

Definition 3: Emotion is sensory feedback recognition and a coping strategy, which coordinate decision-making on individual level and in interaction.

Martinovski [44] finds indications that all three cognitive-emotive processes are employed in human interaction. Reciprocal adaptation and interactive alignment are directly supported by imitation and simulation. Yet, symbolic representations of states are dependent on simulation. There is correspondence between these cognitive processes and Pierce’s semiotic signs: icon (similarity-based relation between signifier and signified), index (indexical associative relation between signifier and signified) and symbol (convention/representation-based relation between signifier and signified). Design of Virtual Agent systems is based on representation-based and simulation-based cognitive-communicative processing which is similar to appraisal theory’s view on emotion but even imitation, which is productive in human learning, has proven possible and productive method, especially in culture-based communication training systems [45].

6 Model of culture-based communication

The model of culture-based communication proposed here relies on definitions motivated by the theoretical overview in the previous sections, namely:

- Culture is a dynamic semiotic process and system of interpretation of Self and Otherness by means of which we conduct our perceptual transactions in interaction with environment.
- Communication is an opportunity for a meeting between Self and Other.
- Emotion is a sensory-feedback recognition and a coping strategy.
- Interactive alignment is a primitive cognitive-emotive process based on imitation during which interlocutors develop and align similar representations in dialogue.
- Reciprocal adaptation includes interactive alignment and complex long-term memory cognition where each participant gradually learns to adapt and to enter into the other's frame of reference.

It suggests a process-like representation of culture-based communication, which builds on connection between different modules, such as modules of culture awareness, culture behavior, communication processing, alignment, appraisal, and revision. Each module has a separate set of features and under modules. For instance, the module of culture behaviors includes modules on turn-taking, gaze, proxemics, gestures, semantic fields, etc. Culture awareness consists of values related to awareness to each of the behavioral modules as well as other culture related features such as values, beliefs, and goals. For the purpose of Virtual Agent simulation, they can be represented as in XML format as in Jan et al. [1].

Culture and emotion form and are formed by communication assisted by both primitive and complex cognitive interactive procedures, such as interactive alignment and reciprocal adaptation, as illustrated by Fig.1 below.

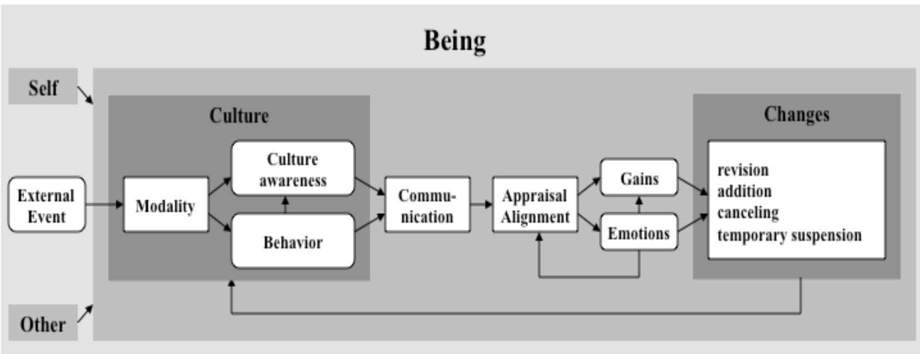

Fig. 1. Model of Culture-based Communication

Studies suggest [46, 47] that awareness of and reference to co-existence in a larger context facilitate communication and decision-making. Therefore, in this model, each interaction is embedded in a larger existential context, which wraps in all human and other activity. Each interactive situation starts with a basic level of awareness of Self and Other, which is imbedded in a general sense of existence, of being and which can vary from person to person. This existential sense of Self and Other is then processed by degrees of awareness of own and Other culture and expressed in situated behavior in different modalities. Communication is the process through which both non-culture-based and culture-based awareness are realized and have a chance to change. Communication may include activities, such as talking between interlocutors, silent co-presence, reading, singing together, teaching, training, etc.

During communication, beliefs and emotions related to Self and Other are aligned and appraised which brings about coping strategies. These trigger re-evaluation of initial conscious or unconscious models of Self and Other, including goals and beliefs, which may result in need to change cultural models, awareness and behavior. Alignment and appraisal based states may change without changing culture-based awareness and behavior. Emotions are not static. They are processes on a neurological, biological and expressive level. One and same stimuli can cause a chain of different physiological reactions, emotional sensations and cognitive appraisals, each of which can influence the other in time. That is, a physiological reaction may bring about an emotion, which can influence cognitive appraisal but this appraisal can in turn bring about coping strategies, which generate other emotions.

Reasoning in intercultural situations is based on abduction rather than deduction of induction because the premises of beliefs and goals in the 'awareness' and 'behavior' modules may be incomplete or incorrect. In order to illustrate how the model works we can observe the following scenario: a woman from a culture in which women stand physically far from male acquaintances, especially in public, meets physically and converses on a public street with a male acquaintance who comes from a culture with similar proxemics between women and men. Proxemics is usually a low consciousness feature in non-verbal communication, therefore we can define the initial culture-based awareness of Self and Other on both parties i.e. awareness of the exact comfort distance between women and men in own and Other culture to be low. The behavior is defined as expected according to respective proxemics culture. Given their cultural settings of proxemics, the woman may move slightly away from the man as he tries to shorten that distance to fit his cultural habits. Both may experience initial cooperative alignment but may appraise the changes in proxemics as uncomfortable. For example, the woman may feel invaded or in danger and the man may feel unappreciated or avoided. These dynamics will occur in the small loop between appraisal and the module of changes. The reciprocal adaptation mechanism may push both parties towards final acceptance of a distance which is least uncomfortable for both parties but in short term, it may not result in changes of culture-based awareness of own and Other proxemics, nor in changes of culture-based behavior. Only after repeated exposure may culture-based awareness and behavior change and thus yield less emotionally and cognitively loaded interactions. If however, both parties start with high level of culture-awareness regarding the Other but not Self, the process may get stuck in the smaller loop until there is one-sided adaptation or until there is increase in Self culture–awareness. If both parties are highly aware of cultural regulations of proxemics in own and Other culture, the cognitive-emotive load for conscious processing of reciprocal adaptation may be higher i.e. the smaller loop will be shorter, given that there is no special agenda which blocks their will to reciprocal adaptation, but may take more conscious cognitive effort.

7 Summary

Based on concept analysis and empirical findings within the research fields of emotion, culture and communication, this study concludes that cultural awareness is acquired through communication and filtered through emotion. The proposed dynamic modular model of emotion- and culture-based communication reflects this process-oriented view of culture and includes emotion as an engine for cultural learning and expression. Culture is defined as a semiotic process and a system, which builds upon Self and Other identities and which is sustained and modified through communication and cognitive-emotive mechanisms, such as reciprocal adaptation, interactive alignment and appraisal. Communication is defined as an opportunity for meeting of Otherness. In that sense, Human-Virtual Agent interaction can be seen as a meeting with otherness. Since intercultural communication involves interactive alignment and reciprocal adaptation, these mechanisms can be applied also to simulation of culture-based communication where the adaptation occurs with respect to culturally varied and measurable features and behaviors i.e. the model can be utilized and operationalized in the design of life-like training scenarios.

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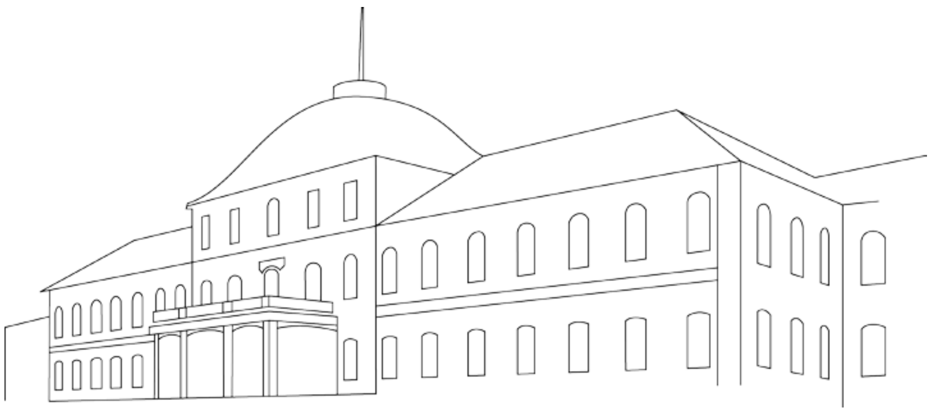
Negotiation Support Systems and Studies

Stream Organisers:
Gregory E. Kersten, Concordia University, Canada
Sabine T. Köszegi, Vienna University of Technology, Austria



University of Hohenheim

A Multi-Agent Negotiation Support System for Supply Chain Formation

Florina Livia Covaci

Business Informations Systems Department
Babeş-Bolyai University, Cluj-Napoca, Romania

Abstract. During the supply chain formation process, agents must agree on different combinations of values for shared issues that are part of the contracts between involved parties and each of them is trying to maximize their utility. This paper focuses on contract negotiation during the decentralized supply chain formation process by mapping the problem in terms of a directed acyclic graph where the nodes are represented by the suppliers/consumers acted by agents. Communication between agents along the supply chain is done by message exchange and provides support for negotiation of contract constraints along the network. By encoding the values of negotiated issues in messages that are sent between each pair of agents in the supply chain the overall system stability will be achieved and the specific contract requirements will be propagated autonomously across all participants within the supply chain.

Keywords: Agent-based negotiation, Contract Negotiation, Supply Chain Formation, Decision Support

1 Introduction

Negotiating contracts between providers and consumers is the core of supply chain formation (SCF) because a consumer and its provider can balance their interest conflicts. The Supply Chain Formation (SCF) problem has been widely studied by the multi-agent systems community. Numerous contributions can be found in the literature where participants are represented by computational agents [2],[6],[3],[7]. These computational agents act in behalf of the participants during the SCF process. By employing computational agents it is possible to form SCs in a fraction of the time required by the manual approach [8].
The existing literature on SCF uses two approaches: the first one is modeling the supply chain as a network of auctions, with first and second-price sealed bid auctions, double auctions and combinatorial auctions among the most frequently-used methods [1],[2]. In the past years another type of approaches were proposed. These approaches make use of graphical models and inference algorithms to tackle SCF and related problems [4],[6],[7],[8].

Although the second types of approaches have a lot of advantages over previous approaches, they have the limitation of using only cost for pairwise agents. Also the optimization problem is treated only as a profit maximization function and it doesn't

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consider the propagation of constraints from the underlying suppliers. In real world scenarios the SCF problem is more complex because:

1. The contracts between partners in the supply chain involve multiple issues (cost, time of delivery, quality constraints, penalties etc.), that the involved entities are negotiating on. These give raise to different utility values for a contract of the participating agents, according to their preferences.

2. In a SCF process, an entity can be both a supplier and a consumer in different negotiation contexts at the same time (Figure. 1). The dual role of a participant in the SCF complicates the negotiation scenarios. In particular, a participant has to confirm that its own suppliers can support the issues it negotiates with its consumer, before it commits to his own contract as a supplier.

Having the above stated problems for real world scenarios, the present paper explores the following research challenge: providing support for negotiation and for linking end-consumer requirements to underlying suppliers to conjointly guarantee end-to-end agreed contract parameters.

The participants in the supply chain are modeled by self-interested agents that own utility functions and communicate directly with the other participant agents representing their potential buyer or seller and take actions in order to maximize their utility functions.

Our results indicate that the proposed formalism provides means to perform decentralized supply chain formation that optimize participants' utility and propagate negotiated constraints from the underling to the upper level participants. The present paper is structured as follows: section 2 describes the proposed SCF formalization and encoding for agent messages for the shared negotiated issues, section 3 provides background and related work for SCF, section 4 provides an experimental evaluation of the proposed approach and finally section 5 provides conclusions and future work.

2 Negotiation in Supply Chain Formation by Message Passing

Multi-agent systems enable the modelling of supply chain formation (SCF) using self-interested agents for decentralized decision making and the process of information propagation across the whole network.

The current paper uses the max-sum algorithm mechanism of passing messages for the values of the issues that the agents are negotiating on, the agents having an exact way to estimate the utility they get, by making use of utility functions. The agreed values of the negotiated issues are reflected in a contract which has a certain utility value for every agent. By using utility functions, they can assess the benefits they would gain from a given contract, and compare them with their own expectations in order to make decisions.

During the SCF process the messages are passed between a consumer and its suppliers. Agents send messages regarding multiple contract issues: cost, time of delivery, quality indicators, delay penalties etc.

The following paragraph provides a formal description of the supply chain formation problem in terms of a directed, acyclic graph (X, E) where $X = \{X_1, X_2, ..., X_n\}$ denote set of participants in the supply chain represented by agents and a set of edges E connecting agents that might buy or sell from another.

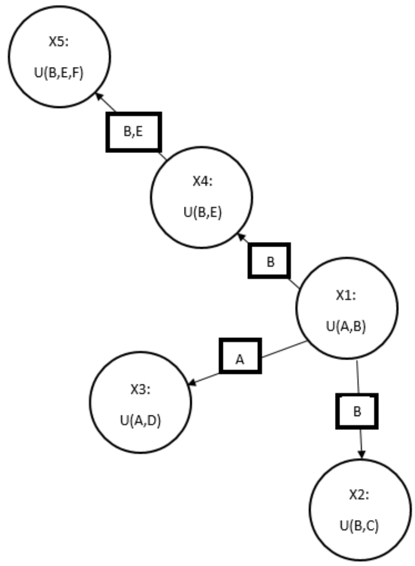

Fig. 1 Example of supply chain with agents sharing state variables

The agents negotiate on multiple contract parameters and negotiation finishes with a contract that is composed of the actual values of the issues that they have agreed on. Notation v_i represents the expectation of a participant in the supply chain on issue *i* of the contract and U(v) the utility that a participant obtains by receiving the actual value v =(v_{i1} ,v_{i2} , ..., v_{ik}). When a supplier (seller) negotiates with a consumer (buyer), both parties are interested in obtaining those contract values v =(v_{i1} ,v_{i2} , ..., v_{ik}) that maximize their utility functions U(v) . This means that during the negotiation, the agent sends a messages to its neighbors regarding the states of his variables that is maximizing its utility function.

The utility functions U(v) will be calculated by means of weighted sum as follows:

$$U(v) = \sum_{i=1}^{k} w_i * v_i \text{ , } with \sum_{i=1}^{k} w_i = 1 \quad \textbf{(1)}$$

where 0 <= w_i<= 1 represent the weights measuring the importance of a given issue *i* for a certain agent in the chain.

The agents don’t know each other utility functions, they are aware only of the values of the discrete states variables they share. Each agent interacts with its neighbors agents such that the utility of an individual agent U(v), is dependent on its own state and the states of these other agents.

Solving the problem stated above provides means for finding an allocation that maximize each agent utility in the supply chain within the underlying partners' constraints.

An allocation is a sub-graph (X',E') ⊆ (X, E). For Xi, Xj ∈ V ', an edge between X_i, X_j means that agent X_j provides goods to agent X_i. An agent is in an allocation graph if it acquires or provides goods.

In the graph in Figure 1 each node represents a participant in the supply chain. Each two nodes share at least one issue that they must agree on, and the value that they have agreed on, must be propagated from the underlying suppliers to the upper level of the supply chain. Figure 2 shows how the message is send between node X_1 and X_2 and back, when the agents have to agree on the issue B of a potential contract.

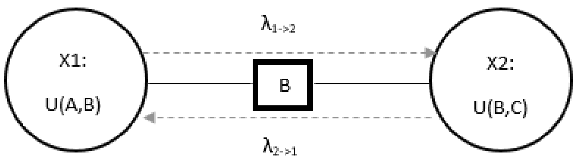

Fig. 2 Messages sent from X_1 to X_2 and back when they negotiate on issue B

By sending the message in equation (2), X_1 says to X_2 which is his preferred value from the set of values for issue B. Table 3 shows an example of computed values for message $\lambda_{1\to2}(B)$.

$$\lambda_{1\to2}(B) = max_B(U(b_j, c_k) + max_A\left(U(a_i, b_j)\right)) \qquad \textbf{(2)}$$

X_1 sends the max-marginalization of B over A ($max_A(U(a_i,b_j))$) and then adds the computed utility of agent X_2 and then computes the max marginalization of B over the above terms. Table 3 shows an example of computed values for message $\lambda_{1\to2}(B)$.

Table 1 Utility obtained by agent X_1

A	B	$U(a_i,b_j)$
a_1	b_1	4
a_1	b_2	1
a_2	b_1	0
a_2	b_2	2

$max_A(U(a_i,b_j))$	
b_1	4
b_2	2

$max_C(U(b_j,c_k))$	
b_1	5
b_2	3

Table 2 Utility obtained by agent X_2

B	C	$U(b_j,c_k)$
b_1	c_1	5
b_1	c_2	2.5
b_2	c_1	1.2
b_2	c_2	3

Agent at node X_2 evaluates using his utility function, the utility that he gets for each combination of values from the set of values for issues B and C. X_2 send to X_1 the message in equation (3), which is his preferred value from the set of values for issue B. Table 4 shows an example of computed values for message $\lambda_{2\to1}(B)$.

Table 3 Computing values for $\lambda_{1->2}$(B)

A	B	$U(b_j,c_k)+max_A(U(a_i,b_j))$
a_1	b_1	5+4=9
a_1	b_2	2.5+2=4.5
a_2	b_1	1.2+4=5.2
a_2	b_2	3+2=5

Table 4 Computing values for $\lambda_{2->1}$(B)

A	B	$U(a_i,b_j)+max_C(U(b_j,c_k))$
a_1	b_1	4+5=9
a_1	b_2	1+3=4
a_2	b_1	0+5=5
a_2	b_2	2+3=5

$$\lambda_{2\to 1}(B) = max_B(U(a_i, b_j) + max_C\left(U(b_j, c_k)\right)) \qquad \textbf{(3)}$$

X_2 sends the max-marginalization of B over C (max_C $(U(b_j, c_k))$) and then adds the computed value for utility of agent X_1 and then computes the max marginalization of B over the above terms.

The messages are scheduled starting from leaves and then are propagated upward towards the root.

3 Background and related work for SCF

3.1 Max-sum

Max-sum [9] is a message passing algorithm that provides approximate solutions for the problem of maximizing a function that decomposes additively in three steps. First, it maps the problem into a structure called local term graph. Then it iteratively changes messages between vertexes of that graph. Each vertex of the local term graph is in charge of receiving messages from its neighbors, composing new messages and sending them to its neighbors. Finally, it determines the states of the variables.

3.2 Loopy Belief Propagation (LBP)

LBP is the first peer to peer approach that has been used to solve the SCF problem in a decentralized manner [4],[5],[7],[10]. In [5], an LBP-based approach was applied to the SCF problem, noting that the passing of messages in LBP is comparable to the placing of bids in standard auction-based approaches.

The work in [4] shows that the SCF problem can be cast as an optimization problem that can be efficiently approximated using max-sum algorithm [9] presented in the section above. Thus, the authors offer the means of converting a SCF problem into a local term graph, on which max-sum can operate.

3.3 Reduced Binarized Loopy Belief Propagation (RB-LBP)

As LBP suffers from scalability issues in [6] the authors introduce the Reduced Binarized Loopy Belief Propagation algorithm (RB-LBP). RB-LBP is based on the max-sum algorithm and simplifies the calculation of max-sum messages through careful analysis of its local terms. The variables are binary which simplifies the supply chain formation process and each buy and sell decision is decoupled, encoded in a different variable, from the rest of buy and sell decisions. By decoupling these decisions the algorithm is able to reduce the number of combinations to take into account.

4 Experimental Evaluation

In order to validate the proposed model in section 2, PeerSim simulator was selected. The reasons for making this choice are the PeerSim performance regarding scalability and because it is based on components that allows prototyping a new protocol, combining different pluggable building blocks. [11].

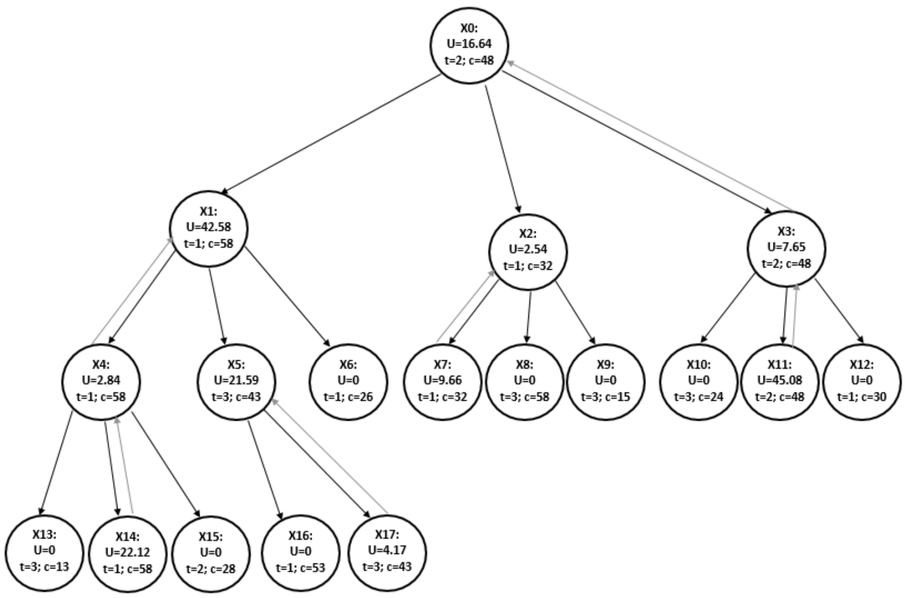

Fig. 3 Solution 1 -possible allocation sub-graph

The network used for the current simulation has 18 nodes and each node has three possible partners that he can trade with. Each node *v* has a vector of numeric values that are the preferred states of the negotiated issues. The considered issues for negotiation over the supply chain are: delivery time and cost. The delivery time is measured in months and the cost is measured in the amount of money spent and it has been divided by 100 for the simplicity of the illustration of the values obtained. Also each node owns a utility function which is computed as a weighted sum from each of the issues that the agents in the supply chain are discussing on. At the beginning of the simulation all the agents in the network are being initialized with random preferred values for the states variables and also for the weights used at computing every agent utility.

Each node that is not a leaf is receiving messages from its neighbors, composing new messages and sending them upward to its neighbors. Each node will assess messages received from the corresponding neighbor according to his own utility function and will chose among all the possible partners the one that maximizes his utility function.

The first solution that the implemented protocol finds is the allocation sub-graph presented in Figure 3 being formed of the following nodes $\{X_{11},X_3,X_0\}$and the utility that the end-consumer gets is 16.64 with the states of the variables being propagated to the root (t=2;c=48)

Fig. 4 Solution 2 -possible allocation sub-graph

The second solution that the implemented protocol finds is the allocation sub-graph presented in Figure 4 being formed of the following nodes $\{X_6,X_1,X_0\}$and the utility that the end-consumer gets is 19.14 with the states of the variables being propagated to the root (t=1;c=58).

The propagation of the states of the variables for agent X_2 has two phases: in phase 1 the agent X_2 chooses X_9 as a partner as it finds that the utility that he gets is higher than the previous one but in phase 2 the agent chooses agent X_8 as he gets an even higher utility that the one provided be agent X_9. The delivery time is shorter and the cost is higher than the ones at the allocation in solution 1 and according to the utility function of the agent at node X_0 it provides a higher utility. The agent gets a higher utility if the required component is provided in shorter time event it costs more.

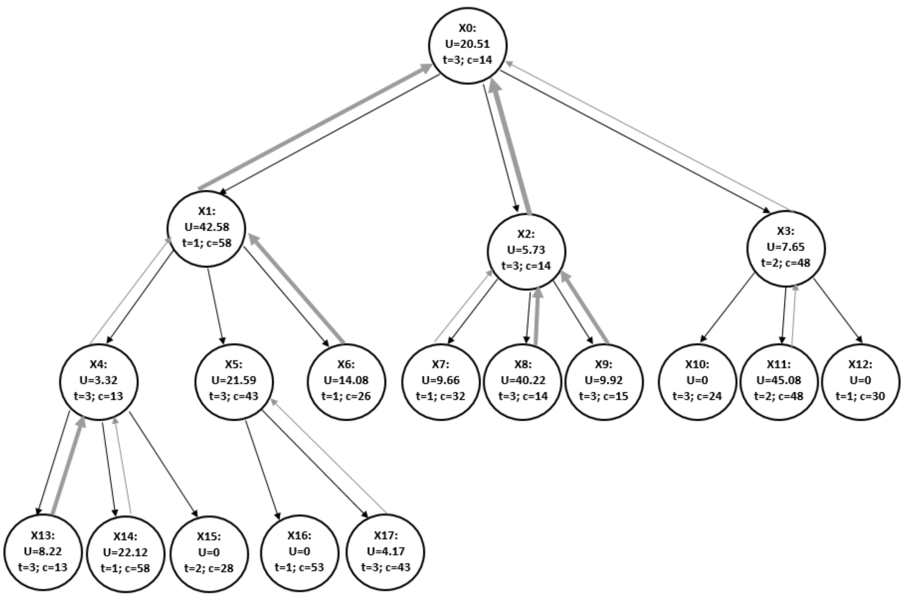

Fig. 5 Solution 3 -possible allocation sub-graph

The third solution that the implemented protocol finds is the allocation sub-graph presented in Figure 5 being formed of the following nodes $\{X_8, X_2, X_0\}$ using the propagation at the previous solution it propagates further the states of agent X_2 to the root and the utility that the end-consumer gets is 20.15 with the values states of the variables (t=3; c=14). The delivery time is longer but the cost is much lower that the allocation at solution 2 and according to the utility function of the agent at node X_0 it provides the maximum utility.

5 Conclusions and future work

In this paper we have proposed a negotiation support system for SCF. As opposed to the previous decentralized approaches, the current approach translates the SCF optimization problem not as a profit maximization problem but as a means for maximizing a utility function. Hence, it incorporates multiple negotiated issues and enforces the propagation of the negotiated values from the underlying suppliers to the upper levels in the supply chain. As a future work we consider investigating the impact on the SCF process when agents make decisions under risk situation.

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Human-Software Agent Negotiation: Impact of Agents' Tactics and Task Complexity on Human Behavior

Rustam Vahidov[1], Gregory Kersten[1], Bo Yu[1]

[1]Concordia University Montréal
rVahidov@jmsb.concordia.ca, gregory.kersten@concordia.ca, bo.yu@concordia.ca

Abstract. The results of experiments involving software agents negotiating with humans are discussed. The purpose of the experiments was to study humans' behavioral differences caused by the agents' different concession-making tactics. In the experiments, human subjects acted as buyers of a mobile phone service. Software agents represented a telecom company. The negotiation task complexity was manipulated to determine the effects of interaction between tactics and complexity level. Results show that interaction between negotiation task complexity and negotiation tactic has significant impact on negotiation outcomes and on subjective assessments by the human participants.

Keywords: Electronic negotiations, software agents, multi-issue negotiations, concession-making, experimental studies.

1 Introduction

Software agents have been proliferating in various aspects of e-commerce (Yu et al., 2015) as they can enable automating active offer-exchange processes in negotiations. An automated negotiating agents competition (ANAC) held recently (Baarslag et al., 2012) attests their growing popularity. Nonetheless, because of the inherent uncertainty in agent-managed negotiations, especially when negotiating with human counterparts, it is important to be able to assess their performance while utilizing various negotiation tactics.

Effective and efficient use of agents in negotiations can be influenced by a number of factors, including the economic outcomes achieved by the agents, and the subjective assessments by human counterparts of the outcome and of the process of negotiation. In this work, we evaluate the performance of negotiating agents paired with human counterparts in experimental settings. The effects of agent negotiation style and negotiation task complexity as manipulated by introducing a different number of negotiation issues were studied in experimental treatments. In addition to measuring objective outcomes, including agreement rate and agreement utility we also measured the effects on subjective variables, e.g. satisfaction with the outcome and perceived ease of use.

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2 Background

Faratin et al. (1998) proposed three categories of tactics: behavior-dependent, resource-dependent and time-dependent. Tit-for-tat is an example of behavior-based tactics. In resource-dependent tactics concession levels are adjusted depending on the scarcity of the resources. If concession-making is a function of time elapsed between the beginning and the end of negotiation period, then such tactic is time-dependent. Curves showing small concessions in the beginning correspond to tougher competitive behavior, while those making large concessions relate to conceding behavior.

An early experimental study matching humans with agent counterparts was reported in (Byde et al., 2003). A salesperson agent that employed persuasion and other negotiation techniques while negotiating product price with a customer is described in (Huang and Lin, 2007). Persuasion took place through customer – agent dialogue with the use of pre-defined arguments organized into a tree. Price was the single negotiated issue. The findings suggested that persuasion increased buyers' product valuation and willingness to pay, increasing the seller's surplus.

Using various agent negotiation tactics in experiments with human subjects has been reported in (Vahidov et al., 2014). The experiments involved purchasing a computer. The participants used five different concession-making styles, including: competitive, linear, conceding, competitive-then-conceding, and tit-for-tat. The agents played the role of a seller. A control group on the seller side included human subjects. The results showed that most agent types outperformed humans in terms of utility of the achieved agreement, and the agreement rate.

The current study looks at the evaluation of the impact of agent negotiation tactics, and of task complexity on the negotiation outcomes and assessments. On one hand, increasing the number of issues leads to more room for maneuver, and, potentially to higher propensity towards agreement. On the other hand, higher task complexity implies higher cognitive effort, and, thus lower agreement rate.

3 Experiments

The case featured a sale of a mobile phone plan. Two versions of the case were included: a simple and a complex one. The simple case involved the following issues: price, regular air time, extra air time, text messaging, and data. The buyers and sellers were given different weights for these issues according to their importance levels. The complex case, additionally, included call display, voicemail, call waiting, conference call, and call forwarding as extra issues (Figure 1).

Tradeoffs were considered to be one of the key integrative negotiation characteristics. Therefore to facilitate tradeoffs, weights were set differently for the sellers and for the buyers. Although the system allows users to specify their own preference structures, these were fixed to be the same for all human users so that variation in the experiments could be controlled. Four time-dependent tactics were used: competitive, conceding, competitive-then-conceding, and conceding-then-competitive. The concession schedule for the competitive tactic is shown in Figure 2. The conceding agent has a convex profile, while in the other two types these profiles are switched over midway through the time scale.

Issue	Type	Weight S↓ B↓	Initially Activated
Price	Numeric	35 % 0 %	Yes
Regular air time (7am to 7pm)	Categorical (single choice)	20 % 0 %	Yes
Extra air time (outside 7am to 7pm)	Categorical (single choice)	10 % 0 %	Yes
Text messaging	Categorical (single choice)	7 % 0 %	Yes
Data	Categorical (single choice)	12 % 0 %	Yes
Call display	Boolean	4 % 0 %	Yes
Voicemail	Boolean	4 % 0 %	Yes
Call waiting	Boolean	3 % 0 %	Yes
Conference call	Boolean	2 % 0 %	Yes
Call forwarding	Boolean	3 % 0 %	Yes

Fig. 1. Setup of the simple case

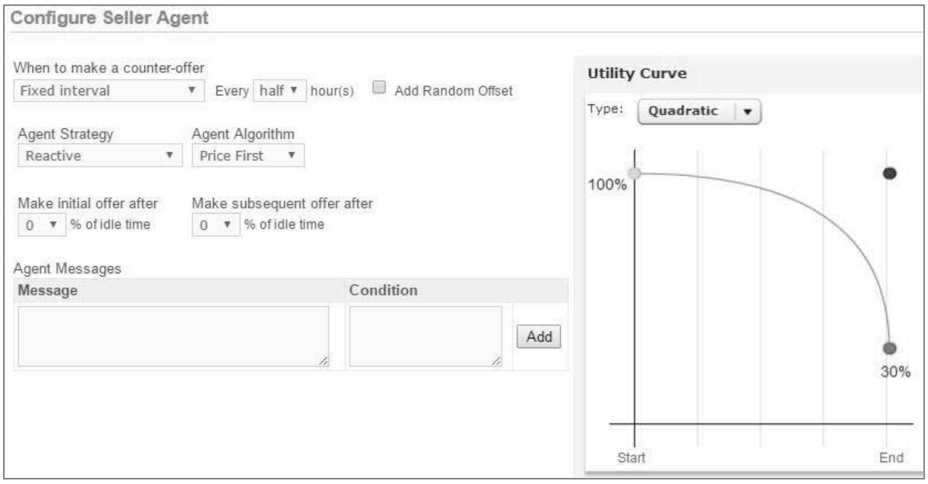

Fig. 2. Competitive agent

The subjects were recruited among university students. We randomly paired the subjects with different types of agents in a simple or complex case. The experiment was conducted on the web, whereby subjects could perform their tasks from any location in an asynchronous mode during a two-day period. The subjects were invited to join the negotiations via email containing the link to the system.

4 Results

A total of 754 subjects were registered for the experiment and completed the experimental task. We only used data where subjects made more than one offer, which reduced the number to 368. From these 262 negotiations (71%) ended with an agreement, and 106 (29%) without.

The agreement rate for the simple case setting was 75.5%, while for the complex case it was 65.4%. On the one hand, a larger number of issues should have given negotiators more space for "maneuvering" in negotiations, thus facilitating higher likelihood of making an agreement. On the other hand, the complexity of the case demanded higher cognitive effort. The chi-square test conducted for the agreement rates was significant at a o.o5 level (p-value = 0.021). The agreement rates are shown in Table 1.

Table 1. Agreement rates for different tactics of the agents.

Case		**Simple**			**Complex**		
Agreement		No	Yes	Rate	No	Yes	Rate
Tactic	Competitive	27	36	57.1%	24	23	48.9%
	Competitive-Conceding	9	22	71.0%	10	15	60.0%
	Conceding-Competitive	6	31	83.8%	15	35	70.0%
	Conceding	10	71	87.7%	5	29	85.3%
Total		52	160	75.5%	54	102	65.4%

As expected, the highest agreement rates were achieved by the conceding agents; the lowest rates were achieved by the competitive agents. Conceding-competitive agents made more agreements than the competitive-conceding ones. The case's complexity did not seem to have a large effect on the agreement rate for the conceding agents. This is because the agents conceded irrespectively of their human counterparts' concessions. In effect, the agents using this tactic reached agreements early regardless of the complexity of the case. However, for competitive agents the situation is different. Competitive agents made more deals in the simple case.

Table 2 shows the average utilities achieved by sellers. In the simple case, the average utility per one seller is the highest for the competitive tactic followed by conceding-competitive tactic. Interestingly, in the complex case conceding and conceding-competitive agents achieved highest utility values. Overall, these three strategies yielded much higher utility, compared to the competitive-conceding tactic.

Table 2. Average seller's utilities.

Average Utility			**Seller**	
	Case	Simple	Complex	Total
Tactic	Competitive	27	36	57.1%
	Competitive-Conceding	9	22	71.0%
	Conceding-Competitive	6	31	83.8%
	Conceding	10	71	87.7%
Total		52	160	75.5%

We further analyzed only the instances where the agreement was achieved (Table 3). As one can see, agents achieved higher utility (58.93) in simple case settings than in complex settings (50.93). Further, competitive agents achieved highest utility agreements, followed by the conceding-competitive, competitive-conceding, and lastly, conceding agents. The complexity of the case has the largest impact for competitive agents. We developed a general linear model incorporating agent types and the complexity level for predicting the obtained utilities of seller agents and human buyers. The number of offers was included as a co-variate as it represented human buyers' effort in the negotiation instances. The test results show that the case complexity, agent type, and the number of offers, were all significant. Furthermore, the interaction between the case complexity and agent tactic, as expected, was also significant.

Table 3. Average utilities for sellers who achieved agreements.

Average Utility			**Seller**	
	Case	Simple	Complex	Total
Tactic	Competitive	81.42	61.55	71.49
	Competitive-Conceding	53.26	46.33	49.80
	Conceding-Competitive	54.16	49.86	52.01
	Conceding	47.05	45.96	46.51
Total		52	58.97	50.93

We have also conducted a survey among the participants to obtain insights into the user assessments that could serve as a basis for future research. A survey questions asked about five aspects of user experiences, including perceived ease of use (PEU), perceived usefulness (PU), satisfaction with outcome (SO), perceived procedural fairness (PPF), and overall experience (OE).

Three tests using general linear model were conducted. The first test was conducted on the dataset including all instances. Test 2 was conducted using only the instances that featured an agreement. Test 3 was conducted using the instances that had an agreement, however, it used achieved utility as a covariate to replace the number of offers.

The decomposed effects of the independent variables on each of the subjective assessment variables are reported in Table 4. The results show that case complexity has a significant direct effect on PPF in all of the three tests (p = 0.037, 0.021, and 0.012). Case complexity and agent tactics have a significant interaction effect on PEU in the three tests (p = 0.003, 0.001, 0.002). They have a significant interactive effect on SO only in Test 1. The number of offers has significant direct effect on PU (p=0.002 and 0.027) and SO (p =0.011 and 0.042) in its relevant tests (Test 1 and 2). Agent tactic has a significant direct effect on PPF only in Test 1. Achieved utility has a significant direct effect on PEU in Test 3.

Table 4. Average utilities for sellers who achieved agreements.

Decomposed effect		Agent tactic	Case complexity	Number of offers	Achieved utility	Case complexity * Agent tactic
PEU	Test 1	0.840	0.182	0.918		0.003
	Test 2	0.775	0.484	0.525		0.001
	Test 3	0.315	0.552		0.019	0.002
PU	Test 1	0.188	0.441	0.002		0.453
	Test 2	0.298	0.186	0.027		0.415
	Test 3	0.609	0.097		0.220	0.412
SO	Test 1	0.538	0.371	0.011		0.040
	Test 2	0.748	0.918	0.042		0.145
	Test 3	0.807	0.672		0.325	0.262
PPF	Test 1	0.098	0.037	0.348		0.775
	Test 2	0.309	0.021	0.271		0.747
	Test 3	0.335	0.012		0.629	0.675
OE	Test 1	0.601	0.653	0.223		0.148
	Test 2	0.436	0.739	0.164		0.129
	Test 3	0.540	0.577		0.510	0.150

The above results suggest that agent tactic by itself does not have a significant effect on any of the dependent variables. Case complexity had a significant effect only on the perceived procedural fairness. Here, when faced with a high number of issues subjects reported lower perceived fairness. The interaction effect on PEU is significant in all three tests. The means of the score of PEU (sum of the item scores) are reported in Table 5. These results look surprising at first glance. When negotiating with a conceding agent, users perceived the system to be easier to use in the simple case as compared with the complex one. However, paired with competitive agents, subjects felt the system was *easier to use* in the *complex* negotiation setting. We believe, that this is due to the fact that concessions made by competitive agents on ten issues are less visible than those made by the same type of agents in the simpler case. Therefore, subjects may be perceiving competitive/complex setting more as a fixed-offer (take it or leave it) mechanism, rather than negotiation. The former is perceived as easier to use than the latter, since negotiations involve more effort.

Table 5. Effects on perceived ease of use

Agent tactic	Test1		Test2		Test 3	
	Simple	Complex	Simple	Complex	Simple	Complex
Competitive	9.57	10.87	9.07	11.85	8.92	11.36
Competitive-Conceding	10.22	10.36	10.06	11.80	9.65	11.06
Conceding-Competitive	11.42	9.88	11.41	10.36	10.69	9.93
Conceding	11.22	9.15	11.16	9.42	10.18	8.27

5 Conclusions

The experiments revealed that the interaction between the agent negotiation tactic and the negotiation task complexity has significant impact on objective, and some subjective variables. The results show that competitive agents made fewer agreements and had considerably lower agreement utilities in complex cases compared to their performance in simple cases. For the conceding agents, there was not much difference between the complex and simple cases. Agent tactic by itself did not have much impact on the subjective variables. However, its interaction with the case complexity did prove to be significant for perceived ease of use, and, partially for satisfaction with the outcome. Future research could focus on the study effects of on varying levels of complexity.

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Classifying Electronic Negotiations Based on Their Communicational Content

Michael Körner[1], Mareike Schoop[1]

[1] University of Hohenheim, Chair of Information Systems I, Schloss Hohenheim 1, 70593 Stuttgart, Germany
{koerneml, schoop}@uni-hohenheim.de

Abstract. In this paper, we describe an approach to build an automatic classification model that analyzes the communicational content of electronic negotiations and determines whether negotiations ended in impasse or success. In order to do so, we constructed a category scheme that simplifies the exchanged messages based on word lists. Based on semantic lexica, a machine learning model was trained that achieves comparable classification performances compared to recent research on this topic. These models could now be employed in order to proactively evaluate communication in ongoing electronic negotiations and lay a foundation for advisor technologies for e-negotiators.

Keywords: electronic negotiations, machine learning, sentiment analysis, negotiation support systems

1 Motivation

Communication has always been a crucial factor for negotiation success, especially in electronically mediated scenarios, for example when state-of-the-art Negotiation Support Systems are used. Most of these systems offer different approaches to structure the communication task such as regulating the communication protocol or explicating communicational actions via message types [1]. Whilst this form of support mainly structures the communication flow between the negotiators, there is still further potential for supporting the communicated content itself. Advances in Sentiment Analysis and Text Classification provide us with apt toolkits that are able to automatically analyse negotiation transcripts during negotiations and provide advice for the negotiators.

The notion of automatic conversation analysis and support has also recently spread into practice, with important examples being the IBM Watson™ Tone Analyzer that analyses emotional tone expressed in emails and is accessible programmatically [2], the personality analysis service based on communication style offered by Crystal [3], or the "emotion spellchecking" services by ToneCheck [4].

Systems that analyse communication behaviour at runtime of the negotiation can improve negotiation results and agreement rate in that they may provide early detection of potential negotiation failures such as negotiation partners expressing their wishes to end the negotiation. Further analysis of the communication may even provide

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diagnostic means to investigate what went wrong in a negotiation. These systems may then enter into dialogue with the negotiators and provide advice to steer the negotiation back onto the path towards agreement. However, in order to achieve this, important foundations have to be provided.

First of all, we need to identify critical communication behaviour in negotiation that are indicative of failure or success. We specifically focus on an explicit distinction between agreement, where a final contract was accepted by both parties and impasse, where at some point a party actively ended the negotiation. Whilst there exists a lot of variety between these extremes, treating the distinction as binomial is a necessary reduction in order to simplify the classification problem in further steps (see [5] and [6] for similar simplifications)

Secondly, this knowledge has to be employed in the form of a machine learning classifier that automatically analyses negotiation transcripts and provides judgement about the outcome of the negotiation. This does *not* mean to improve on human judgement of negotiation outcomes based on transcripts – which is naturally far more accurate in such a complex classification task – but rather to enable Negotiation Support Systems to detect critical "entry points" at which means of support can be offered.

Lastly, advice for the negotiators has to be extracted from this classifier judgement, either in the form of general communication advice or in a more concrete fashion relating to the communication problem detected by the classifier.

The present paper presents a multi-step approach to take on the first two challenges described above. We derived semantic lexica from a large corpus of negotiation data that was coded into meaningful linguistic and semantic categories available for automatic analysis. This was partially done by incorporation of ideas from Sentiment Analysis. Afterwards, several machine learning models were trained on the preprocessed data that seek to classify negotiations into the categories "successful" and "failing". This will be presented before discussing inferences that can be made for giving advice to negotiators based on the classification data.

2 Theoretical Background

Whilst the importance of communication in negotiations is undisputed, there exists a plethora of theorisation on its exact role and contribution to electronic negotiation success.

Different influential factors that are manifest in communication have been established both in negotiation and communication theories. In general, communication is seen as playing an essential role to structure the interaction flow between the negotiators, to convey information and achieve mutual understanding, and to form an impression of the counterpart, contributing to relationship-building and the generation of mutual trust [7], [8], [9]. If these functions of communication are fulfilled adequately by the negotiating parties, the likelihood of reaching an agreement increases.

Classical cues-filtered-out approaches from the theoretical realm of interpersonal computer-mediated communication such as Media Richness Theory [10] or the Social Identity Model of Deindividuation Effects (SIDE, [11]) suggest that the usage of an electronic medium should have detrimental effects on relationship-oriented communication because of the narrowed possibilities to exchange social cues. Furthermore, the usage of electronic media may facilitate misunderstandings and result in overly aversive behaviour of negotiators, because they feel less accountable for their utterances, lacking visual or aural access to their negotiation partner.

Social Information Processing Theory (SIP, [12]) employs a different viewpoint on this matter. It argues that whilst there *are* fewer channels available to convey social context cues, this does not impede impression formation or relationship-building since the remaining cues will attain greater importance and compensate for the lacking channels. Furthermore, new forms of cues are encoded into the language content, either explicitly via lexical choice or implicitly via stylistic elements of the message [13].

Following this line of thought, we argue that indicators of successful relationship-building and, furthermore, of negotiation success are externalised in the content of the messages exchanged between the negotiators and can be used to detect negotiation failure or success. Hence, when we assess the communicational content of the negotiation, we are specifically interested in linguistic indicators that provide information about the final result of the negotiation.

Seminal research on this topic shows that the language actually does differ between negotiations ending in impasse or agreement. Early work by Simons [14] already indicated that linguistic patterns are capable predictors of negotiator agreement. Hine et al. [15] analysed communication of INSPIRE [16] data and found that words of positive emotion and expressions of assent are common in successful negotiations, whilst negation expressions and negative emotions displayed in the last half of the negotiation indicate that the negotiation fails. Sokolova and colleagues used different approaches to classify negotiation data and showed that degrees, scalars, and comparative words yield a high classification accuracy [17] They also discussed possible category representations of negotiation data [18]. Lastly, Twitchell et al. [5] employed a speech-act based coding scheme on divorce negotiations and found that scoring models of integrativeness of these speech acts can serve as predictors for negotiation outcome.

A commonality in all of these findings is the important role that emotions play for deciding the result of the outcome. This is consistent with the notion that communication serves as the main vehicle to express emotional state, whether unwillingly (or unknowingly) or not, which has been addressed in seminal research on the influence of emotions on negotiation outcome ([19], [20], [21]).

Sentiment Analysis is a research stream that specifically analyzes the role of emotional expressions in written texts. It gained interest with the increased amount of user-generated content during what was called Web 2.0. The original aim of sentiment analysis was to provide a means to distinguish positive evaluations (of products, politicians, brands, etc. etc.) from negative ones in an automated fashion. Since then, the notion of Sentiment Analysis has spread into a multitude of other fields, where these techniques have been applied, as for example medical texts [22] or online discussions [24]. Usually, singular expressions in texts would be tested for their valence (“positive” or “negative”), either by using sentiment dictionaries that provide a mapping of words to valence or by using a machine learning classifier [23]. These evaluations are subsequently aggregated to an overall evaluation of the valence of the document.

We argue that a classification approach that draws on these ideas can – in combination with feature categorization schemes as in [17] or [18] can increase classification accuracy for automatic evaluation of negotiation texts.

3 Classifying Electronic Negotiations

Channeling previous research as well as communication-theoretic influences, we used a multi-step process to train a machine learning classifier on a corpus of negotiation data. The initial corpus consisted of 173 negotiations in the B2B-domain conducted by trained students in various experiments at the University of Hohenheim. Different experimental cases were used over those experiments, all of which consisted of a multi-attribute negotiation scenario containing both integrative and distributive issues. Using existing sentiment lexica ([25] and [26]), we created a domain-specific sentiment dictionary in the context of negotiations. Therefore, we extracted adjectives and verbs that occurred in the context of common nouns (and nouns paired with possessive pronouns, such as “your offer”) in our corpus and assessed their valence via the existing sentiment lexica. Overall, we extracted 762 sentiment expressions which we split into adjectives and verbs of positive or negative valence respectively (see [27] for the exact steps which were undergone to create the sentiment dictionary).

Since context is often an important aspect for the occurrence of these polar adjectives and verbs (which is suggested by the findings of Hine et al. [15]), we used our existing list of top nouns occurring in the corpus and tried to separate them into a set of domain-specific categories, similar to open-coding processes in Grounded Theory and also similar to the approach used in [18]. This approach is also similar to what is usually done when performing content analysis on negotiation data. However, existing category schemes for negotiations seem to be too complex to be used as input for machine learning processes [28], hence we decided to develop a rather simple scheme, which can be obtained from table 1.

Table 1 Semantic categories for nouns in negotiations.

Semantic category	Content
Discussion	Nouns related to the offer exchange and argumentation / persuasion
Issues	Nouns related to the negotiation agenda and its issues
Demands	Nouns related to individual goals and demands
Integrative	Nouns related to joint goals and compromises
Problems	Nouns related to potential problems and errors during the negotiation process
Internal	Nouns related to expressions of internal feelings of the negotiators
Relationship	Nouns related to the relationship and partnership between the negotiators

The category sets we extracted this way make up our group of semantic level categories. Additionally, we introduced context through rather syntactically defined categories which are not dependent on content-specific knowledge but can be obtained via the application of linguistic rules. We included categories for different personal pronouns, negation expressions, and intensification expressions.

In the end, we used these semantic categories to create coded representations of electronic negotiation texts, i.e. we performed automatic, dictionary-based coding for each expression belonging to one of our categories, resulting in a Term-Document-Matrix that can be used as an input for Text Classification. These recoded messages were then used to train machine learning classifiers to separate failing from successful negotiations. The preliminary classification results of the different classifiers can be obtained from table 2. The data set used here consisted of a balanced set of 234 complete student negotiation transcripts, half of which ended in explicit agreement and the other half resulting in explicitly stated impasse i.e. an “accept” or “reject” message was sent at the end of the interaction. Category sequences were treated as bigrams in the term-document-matrix, with term frequency scores being used as cell values.

Table 2. Classification quality for electronic negotiations (10-folded CV, baseline 50%. β=1 for F-Score) .

	Naïve Bayes	kNN	Logistic Regression	Neural Network	SVM	Decision Tree
Accuracy	68.62	64.04	69.08	65.29	69.91	63.93
Precision	69.03	64.85	70.39	65.35	71.79	64.47
Recall	68.68	64.20	69.25	65.24	70.05	63.92
F-Score	68.85	64.39	69.81	65.29	70.91	64.19
Kappa	0.373	0.283	0.384	0.305	0.400	0.279

All in all, a significant improvement in classification quality compared to the baseline has been achieved, which shows that the representation of negotiations in semantic categories retains important information about the result of the negotiation process. The overall classification performance seems to be on a similar level to the levels reached by previous research, although no exact comparison is possible due to differing baselines.

4 Conclusion

In this paper, we outlined steps towards using automated negotiation classification in order to detect success or failure of negotiations. The research presented builds up on the work of Sokolova and colleagues and offers a differentiated category scheme in order to provide further diagnostic information of potential sources of negotiation failure. Furthermore, approaches of sentiment analysis are employed in order to obtain enriched information about the negotiators’ communication that can be used as an input for classifying negotiations according to their outcome.

The information obtained this way could be used by a negotiation support system in order to evaluate the negotiators’ communication during the ongoing negotiation process. It would thus be possible to give concrete communication advice either on an individual or a joint level – and, furthermore, the system could detect potential negotiation breakdowns and use further user interaction to investigate the exact nature of the problem during the negotiation and then inform the negotiators about potential paths of resolution. In order to do so, the classification models have to be enabled to classify partial negotiation transcripts, to allow for a detection of potential failure as early in the process as possible. This step is subject to our current research, training using similar classification methods on half and three quarters of negotiation transcripts.

Automatic classification of negotiations opens up a multitude of future research tasks and possible variations on the topic. First of all, the classifier itself could be refined in different ways; for example in that it considers both negotiators separately in order to include information about the actual interaction between them and to detect asynchronous conflicts (i.e. where only one party perceives conflict or frustration).

Secondly, micro-level classification could be refined – either by providing a more differentiated category scheme or by replacing dictionary-based methods with machine learning classification models, that account for differences between factual and evaluative statements, a task known to sentiment analysis as subjectivity detection [23].

The next step that was also introduced as part of the motivation for this research is deducing options of advice that a system can give based on the information obtained by the classifier. Technically, it would be possible to determine which kind of utterances occur in an ongoing negotiation and subsequently identify whether they are indicative of success or failure according to the classification models established over the course of our research. Based on this information, general communication advice such as that given in [9] could be adapted to the specific situation, e.g. avoidance of unnecessary aggression, explication of emotions to avoid misunderstandings, asking questions to check the assumptions made about the partner etc.

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What Is the Right Tone? Language Sentiment in E-negotiations

Simon Alfano[1], Bo Yu[2], Gregory Kersten[2], Dirk Neumann[1]

[1] University of Freiburg, [2] Concordia University Montréal
simon.alfano@is.uni-freiburg.de, bo.yu@concordia.ca, gregory.kersten@concordia.ca, dirk.neumann@is.uni-freiburg.de

Abstract. As negotiations become increasingly embedded in electronic systems, the role of written language has assumed a greater relevance than ever before. However, insights into the importance of language dynamics are scarce. We evaluate the role of language tone (also known as sentiment) on the outcomes of bilateral e-negotiations. Our study draws from 1,304 bilateral e-negotiations with 10,929 negotiation messages from the Inspire e-negotiation database. Our results suggest that a more positive language tone increases the chances of reaching an agreement. At the same time, the avoidance of negative words is a stronger driver of higher payoffs than increased levels of positive words. Intriguingly, successful e-negotiations exhibit a more positive sentiment during the opening stage, and a reduced utilization of both positive and negative words during the core negotiation phase. Our findings suggest that careful language choice remains crucial in e-negotiations.

Keywords: negotiations; e-negotiation; negotiator language; negotiation process; sentiment analysis.

1 Introduction

Negotiations are a critical process in economic systems: they serve the purpose of facilitating a market agreement among two or more parties seeking to exchange goods and services. The negotiators aim to secure a better deal through a potentially opportunistic interaction than they would without negotiating (Lax, Sebenius 1986).

The use of the Internet and other digital services in economic transactions leads to negotiations being conducted online. Exchanges, often impersonal, rely on electronically submitted textual content. Negotiators may purposefully choose the language with which they encode such qualitative information. They select the words that they feel will best express their opinions and emotions. The assessment of the positivity and negativity embedded in such communication is the concern of sentiment analysis (Tetlock et al. 2008; Loughran, McDonald 2016).

Emotions in negotiations have been studied in the context of face-to-face interactions and, more recently, in e-negotiations (e.g., Griessmair, Koeszegi 2009, Griessmair et al. 2015; Hine et al. 2009; Kurtzberg et al. 2005; Parlamis, Geiger 2015; Sheehy, Palanovics 2006). Hine et al. (2009) find that more positive emotions and less negative

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language have a favorable effect on the success rate of e-negotiations.

Earlier language-focused negotiation research relied on machine learning to predict negotiation outcomes on the basis of certain linguistic elements. Sokolova et al. (2008) and Sokolova, Szpakowicz (2007) used machine learning approaches to show that in e-negotiations, the later part of the communication is a better predictor of the negotiation outcome than the opening part in a negotiation conversation.

Sentiment analysis is a dictionary-based approach, in which dictionaries are used to classify words as either positive or negative. Positive and negative words are counted and a formula is used to obtain a sentiment score. Dictionary-based approaches are used in various fields of business; for example, Tetlock (2007b) shows that sentiment in financial media is positively related to stock returns and Antweiler et al. (2004) find that stock price volatility can be more accurately predicted when accounting for online stock message boards.

This paper employs sentiment analysis to assess the effect of language sentiment on e-negotiation outcomes. Messages exchanged by participants of the Inspire negotiations (Kersten, Noronha, 1999) are analyzed using the psychological Harvard-IV dictionary (Stone 2002). The results show that negotiators who employ less negative language sentiment are more likely to achieve an agreement with a higher payoff. The negative language sentiment component exerts a stronger effect on negotiation outcomes than positive language. Using less negatively connoted words increases the probability of achieving an agreement and a better outcome, while using more positively connoted words has no statistically significant effect on outcomes.

Following this introduction, Section 2 introduces related work on the role of sentiment in negotiations and the methodological approach to sentiment analysis. We set forth our research hypotheses in Section 3. Section 4 presents the experiment design and data. Section 5 reviews our results as well as the implications for our hypotheses. Section 6 concludes the paper.

2 Language sentiment analysis

Information Systems (IS) research is well-equipped to study how agents process information conveyed by the language used in textual messages (Chen et al. 2012). Textual content provides relevant insights into the position of the message originator through the tone of the language. The subjective tone of documents can be assessed using sentiment analysis, which includes methods used to measure the positive or negative language that comprises textual information (Loughran, McDonald 2016).

Sentiment measures enable the evaluation of the role of language in the context in which it is used. Among other applications, sentiment analysis has been used to study the function of language in financial markets (e.g. Antweiler et al. 2004, Tetlock et al. 2008, Karapandza 2016, Loughran, McDonald 2016). Thereby, sentiment analysis can be deployed for datasets of varying sizes. For instance, while Tetlock (2007a) studies the role of sentiment in a newspaper column on financial markets with a few thousand observations, other papers analyze several hundred thousand media articles (e.g. Ahern, Sosyura 2014).

IS research has developed various approaches to measuring sentiment, since sentiment analysis is deployed across various domains and applied to a range of different textual sources (Pang, Lee 2008). Overall, sentiment analysis approaches fall into two categories: dictionary-based approaches and machine learning methods. Dictionary-based approaches produce reliable results by counting the frequency of words pre-defined as either negative or positive by a given dictionary (Loughran, McDonald 2016).

Domain-independent dictionaries that perform this function, Harvard-IV being one of them, are developed by psychologists. Their aim is to gauge and then to reflect the likely cognitive reaction to a specific word. The Harvard-IV dictionary contains different categories, which reflect the polarity (a binary classification as either positive or negative), emotions, or arousal, to name just a few. We rely on the polarity of words. Many dictionaries are domain-specific and classify words differently for different domains. For example, words such as ‘tax’ or ‘cost’ are assigned a negative sentiment in the Harvard-IV dictionary but may convey a positive meaning in a financial context (Loughran, McDonald 2011; Stone 2002).

Language sentiment analysis requires a pre-processing stage during which the text messages corpus is prepared. In this stage tokenization splits a running text into single words, called tokens. Negations are then adjusted using a rule-based approach to detect negation scopes and invert the meaning accordingly (Dadvar et al. 2011). In a next step, the so-called ‘stop words’ are removed; these are words without relevance, such as articles (e.g. the, a, an) and pronouns (Lewis et al. 2004). Finally, stemming is performed via the Porter stemming algorithm in order to truncate all inflected words to their stem (e.g. stemming truncates ‘announces’ and ‘announced’ to ‘announc’).

The results of the pre-processed corpus allow for the computation of the sentiment variable. We select the psychological Harvard-IV dictionary to label the stemmed word tokens as either positive or negative (Stone 2002). Different from dictionaries utilized in financial market research, the Harvard-IV dictionary is not specifically tailored to textual content in financial markets. In contrast, this dictionary reflects to most common perception of a given word on the basis of psychological experiments. The Harvard-IV dictionary has been deployed in business research (e.g. Tetlock 2007a) and non-business research (e.g. Sureja, Sherasiya 2017). Therefore, we deem this dictionary most suitable for our case study, which reflects a business negotiation setting, however, among students and thus non-professionals.

The Net-Optimism metric of Demers and Vega (2010), combined with the Harvard-IV dictionary, is one such variable that yields a robust relationship. The Net-Optimism metric $S(m)$ of message m processes all words contained in message m, where $S(m)$ is the difference between the count of positive W_{pos} and negative W_{neg} words divided by the total count of words W_{tot} in message m; that is:

$$S(m) = \frac{W_{pos} - W_{neg}}{W_{tot}} \in [-1, +1]. \qquad (1)$$

Note that the sentiment variable is standardized to mean 0 and standard deviation 1. Below, $S(m)$ is referred to as *sentiment*.

3 Hypotheses

Van Kleef, Gerben A et al. (2004) and Kopelman et al. (2006) find negotiators to be more cooperative and willing to make concessions when they show positive affect. Griessmair, Koeszegi (2009) also show that friendlier language leads to a higher likelihood of reaching an agreement. Therefore, we hypothesize that positive sentiment has a favorable effect on the process of seeking a mutually agreeable resolution.

Hypothesis 1a (H1a): Language sentiment has a positive effect on the likelihood of achieving an agreement.

Hypothesis 1b (H1b): Language sentiment has a positive effect on the payoff achieved in a negotiation.

The influence of negative information was found to outweigh that of positive information in human decision-making (Kanouse 1984). The affective negativity effect assumes a stronger impact of negative versus positive affect, e.g. emotions or feelings, in human decision-making. The informational negativity effect suggests a higher cognitive relevance of negative than positive information, e.g. a more pronounced response to negative than for positive information (Fiske 1980).

We pursue two alternative approaches in order to study whether negotiators treat language sentiment asymmetrically. First, we decompose language sentiment into its negative and positive components, respectively, by only considering negatively or positively connoted words within a given text. Consequently, we expect negative sentiment (as measured by negative language only) to play a more important role than positive sentiment (as measured by positive language only). Second, we perform quantile regressions on different payoff quantiles to understand whether the language reception intensity differs depending on whether the outcomes are poor or favorable.

Hypothesis 2a (H2a): Negative sentiment is a stronger driver of negotiation outcomes than positive sentiment.

Hypothesis 2b (H2b): Sentiment is a stronger driver of poor negotiation outcomes than of favorable negotiation outcomes.

The negotiation process is sequential and has several phases. Holmes (1992) formalizes such negotiation stage models according to three phases: (1) the initiation phase, in which the negotiators introduce themselves, establish a relationship, and clarify any preliminary questions; (2) the problem-solving phase, in which the negotiators lay out their positions, explore mutual opportunities, and make concessions; and (3) the resolution phase, in which the settlement is finalized and the negotiations are concluded. Prior research also suggests that the importance of sentiment varies across the different phases in a negotiation. Twitchell et al. (2013) and Sokolova et al. (2008) report an increase in the importance of language towards the end of negotiations. On the other hand, Simons (1993) emphasizes that negotiators focus on relationship-building at the beginning of a negotiation as trust must be established at this early stage (Elkins, Derrick 2013).

Hypothesis 3 (H3): Language sentiment is more positive during the initiation phase and the resolution phase and more negative in the problem-solving phase.

4 Negotiation Experiment

The data used here is the corpus of textual messages obtained from bi-lateral, multi-issue negotiations conducted via the Inspire system (Kersten, Noronha, 1999). The participants in the Inspire negotiations are students tasked with negotiating a contract between a music artist and an entertainment company.

The data was collected between 2009 and 2016. During this time 10 experiments were conducted in which 2,608 students participated, i.e. there were 1,304 bilateral negotiations, from which we obtained a total of 10,929 messages. The reported ages of the majority sample of participants (i.e. 93%) is between 20 and 30 years. We collected the data from eleven online experiments conducted between 2009 and 2016.

We test our hypotheses against two outcome measures. The first outcome measure is whether an agreement was made. This measure is binary. The second outcome measure then takes into consideration the payoff of each negotiator, which is 0 in the case of not achieving an agreement, and a full-integer value with a median of 75 and a maximum of 236 on a negotiator level otherwise.

5 Results

5.1 Language sentiment and negotiation outcomes

We assess the impact of language sentiment in terms of the probability of achieving an agreement and taking into account the negotiation's eventual payoff. The results suggest that the aggregated language sentiment is not a significant driver with respect to achieving an agreement, but that only negative language sentiment is. Thus, Hypothesis *H1a* only holds true for negative language, but cannot be generalized to aggregated language sentiment. In support of Hypothesis *H1b*, a one-standard deviation increase in language sentiment is linked to a 2.248 units (*P*-value smaller than 0.05) higher payoff for a negotiator, which is a 3.64 percent payoff increase over the mean payoff. We do not find a significant effect in support of *H1b* on the dyad-level.

5.2 The dominating role of negative tone

We also split up our sentiment variable into its positive and negative language components. As suggested by Hypothesis *H2a*, the negative language sentiment component exerts a stronger effect on negotiation outcomes than positive language. Using fewer negatively connoted words increases the probability of achieving an agreement. In fact, a one-standard deviation reduction in the use of negatively connoted words increases the likelihood of achieving an agreement at a statistically significant level (coefficient of 0.303; *z*-statistic of 3.220; *P*-value smaller than 0.01).

The negative language sentiment component also exerts a stronger influence on negotiation payoffs than positive language; both on a negotiator- and a dyad-level. Using fewer negatively connoted words increases the probability of achieving an agreement and a higher payoff, while using more positively connoted words has no statistically significant effect on the payoff. For instance, a one-standard deviation reduction in negative sentiment in a negotiation leads to a 7.677 units higher payoff. This is about 12.44 percent of the mean payoff per player across all negotiations and thus of high economic relevance.

In addition, we run quantile regressions on the 25th, 50th and 75th quantiles of the dyadic payoffs. In confirmation of Hypothesis *H2b*, language sentiment is a stronger driver of poor negotiation outcomes than of favorable negotiation outcomes. Again, this relationship is only statistically significant for negative language sentiment, but not for aggregated language sentiment or positive sentiment. In fact, the coefficient of negative language sentiment in a quantile regression is 20.798 (*t*-statistic of 2.365; *P*-value smaller than 0.05) at a quantile regression on the 25 percent payoff quantile. The coefficient decreases thereafter to 2.314 at the median payoff (50 percent quantile; *t*-statistic of 2.340; *P*-value smaller than 0.05) and to 1.297 at the 75 percent payoff quantile, which is statistically not significant.

5.3 Sentiment evolution

Next, we want to understand whether the message sentiment differs across successful and failed negotiations. We thus evaluate how our sentiment measure develops throughout the negotiation process. In order to examine this sentiment evolution throughout the communication process, we decompose our negotiations into three phases following Holmes (1992): an initiation (relationship building) phase, a problem-solving (negotiation) phase, and a resolution phase.

We assign the first two and last two messages, respectively, to the first and third phases. We assume that in a standard negotiation protocol, one of the two parties initiates the negotiation with a first (welcoming or introductory) message, while the other negotiator replies in kind with a similar (welcoming or introductory) message. Then the negotiation takes place. Finally, the last two messages serve to close the negotiation, whereby one party summarizes the (possibly) settled terms of the agreement and the negotiating party confirms the mutual understanding of the resolution.

As our results reveal, sentiment is more positive at the beginning (coefficient of 0.187; *t*-statistic of 6.817; *P*-value smaller than 0.001) and end of the negotiation (coefficient of 0.095; *t*-statistic of 4.707; *P*-value smaller than 0.001) than during the negotiation period (coefficient of -0.276; *t*-statistic of -11.486; *P*-value smaller than 0.001). Thus, we cannot reject Hypothesis *H3*. Whereas the initiation phase serves to establish a relationship based on positive sentiment, the sentiment in the middle, problem-solving stage is more negative, driven by a decreased use of positively connoted words and an increased use of negatively connoted words. Towards the end, once an agreement has been reached (or abandoned), the outcome becomes clear and the tone of messages rebounds and becomes more positive again.

A closer look at the comparative sentiment dynamics, subject to whether an agreement is made or not, reveals intriguing insights into how successful and abortive negotiations differ. While the differences in sentiment across the phases are all significant, the sentiment in negotiations leading to an agreement is more positive in both the relationship-building and closing phases, and lower during the core stage, as compared to futile negotiations. While this interaction effect is only statistically significant for the building phase, the directional effect size reveals that successful negotiations are characterized by a more diligent (social) opening and closing phase, but also a more intense negotiation period.

Interestingly, successful negotiations differ from abortive negotiations in the way negotiators manage their use of both positive and negative language. In negotiations that conclude with an agreement, negotiators' language is more positive in the opening phase (*t*-statistic is 2.053; *P*-value smaller than 0.05), but less positive in the central negotiation period (*t*-statistic is -2.424; *P*-value smaller than 0.05), as compared to abortive negotiations. Meanwhile, the degree of positivity in the final period of negotiation does not matter at statistically relevant levels. At the same time, successful negotiators (in terms of coming to an agreement) also reduce their amount of negatively connoted words during the negotiation phase as compared to abortive negotiators (*t*-statistic is 2.674; *P*-value smaller than 0.01).

6 Conclusion

The results show that the negotiators are more likely to succeed if they use more positive language during the opening phase and reduce the overall amount of positively or negatively charged words during the middle phase, when the actual negotiation occurs. This suggests that investing in initial trust- and relationship-building pays off and at the same time allows the negotiators to focus during the core negotiation phase on the negotiation itself in a matter-of-fact communication style.

The language of negotiations matters in electronic exchanges just as it matters in face-to-face exchanges. It is advantageous if negotiators avoid a high level of negatively connoted words in their language, since a reduced usage of negative language tend to increase the likelihood of an agreement and lead to better payoffs. We need to point out, however, that the language of negotiations that ultimately result in an agreement is more positive in the opening phase but it is more negative in the second, negotiation phase as compared to failed negotiations.

Finally, future research might apply dictionary generation approaches from machine learning to the textual content of negotiations. Such approaches allow to identify words, which have a positive of negative effect on negotiation outcomes. The resulting word lists may then also benchmarked against static dictionaries, such as the Harvard-IV dictionary used in our research, to validate their reliability.

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Sharewood-Forest – A Peer-to-Peer Sharing Economy Platform for Wild Camping Sites in Germany

Florian Hawlitschek[1,3], Tobias T. Kranz[3], Daniel Elsner[2,3], Felix Fritz[3], Constantin Mense[2,3], Marius B. Müller[3], and Tim Straub[1,3],

[1] Karlsruhe Institute of Technology, Karlsruhe, Germany
{Florian.Hawlitschek, Tim.Straub}@kit.edu
[2] Technische Universität München, München, Germany
{Daniel.Elsner, Constantin.Mense}@tum.de
[3] Sharewood-Forest e.V., Germany
{Hawlitschek, Kranz, Elsner, Fritz, Mense, Mueller, Straub}@sharewood-forest.de

Abstract. Sharing economy platforms aim at an increased utilization of un- or underutilized assets and posit enormous potential as a growing domain for online mediation and electronic negotiation. Within this paper we present the context, design, implementation and evaluation of a sharing economy platform for peer-to-peer sharing of wild camping sites in Germany – *www.sharewood-forest.de*. The platform is used productively by Sharewood-Forest e.V. – a German association for community-based wild and nature friendly camping – to facilitate the grant of permission for camping on private forest plots in accordance with the German forest laws.

Keywords: sharing economy, trust, wild camping

1 Introduction

Spending a night in a tent – out in the wilderness – is an untamed desire of many modern "urban" adventurers. The longing for experiences with the lonely beauty of nature fanned by popular writers such as Jack London or Thomas Hiram Holding has led to the pilgrimage of many German adventurers to European countries with the right of *freedom to roam*. This desire may be best expressed within the renowned verbalization by Hetfield and Ulrich [1]: "Anywhere I roam, where I lay my head is home / And the earth becomes my throne".

The main reason for many German adventurers to make the effort of a long journey, to countries such as Norway, Scotland, or Sweden is grounded in the German forest legislation, which prohibits the act of "wild camping" in public forests. The only option for German adventurers to camp "wild" is to elaborately identify private land owners of desired wild camping spots and ask for a special permission. Since the process of identifying the corresponding land owner and negotiating the terms for a special permission requires an unreasonable high amount of effort and time, the less (environmentally) sustainable and more expensive journey to foreign countries is frequently preferred.

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This inefficiency in both the search and negotiation process may be well addressed by Information Systems (IS). The implementation of an IS artifact such as an online platform for sharing privately owned forests in terms of wild camping permits, could help to address this problem. In today's internet based society, IS – and peer-to-peer (P2P) platforms in particular – leverage transactions among peers in large scales.

The so called 'Sharing Economy' as an umbrella term subsumes a variety of P2P transactions with both online and offline components [2]. Within a broad platform landscape (e.g., *gartenpaten.org* for garden sharing, *hipcamp.com* or *youcamp.com* for renting wild camping sites in the US and Australia), a variety of goods and services is provided and consumed by private individuals. While renowned platforms such as *Couchsurfing* stress the communal aspects of a transaction, others such as *Airbnb* increasingly focus on the provision of professional quality standards within a professionalized interaction, blurring the lines between *true* and *pseudo-sharing* [3].

For both providers and consumers trust – among other potential drivers and impediments [4] – is a crucial factor within the decision process for partaking in sharing economy activities [5, 6]. It is thus a major issue among sharing economy platform providers to design a platform that serves the need of a specialized community in guiding transactions and supporting the formation of trust [6].

Within the scope of this work we will present a design science approach for implementing a P2P sharing economy platform for wild camping sites in Germany.

The novelty of our platform design is grounded in the special domain it is addressing. Compared to other established sharing economy platforms, *www.sharewood-forest.de* possesses a set of unique and exciting characteristics. These inter alia include:

i) The character of the shared resources (wild camping sites) requires specialized means of communication and negotiation support (e.g., for determining where to build camp, where to find water or a toilet, how to arrange with animals, trees, dangers or other environmental factors).

ii) The platform exclusively enables nonmonetary exchange, i.e., the permission for a guest-night is granted on a voluntary and altruistic basis, which may require nonmonetary means of reciprocity (e.g., through permanent communication channels). Furthermore, in contrast to platforms like *Couchsurfing* the shared resources is typically not within a directly controllable range for the land owner.

iii) The platform addresses a small, nature enthusiastic, altruistic and responsible user community – which needs to be especially protected from improper or abusive platform usage.

In order to develop a basic and prototypical design for an adequate mediating platform, we follow the design science research approach as suggested by Peffers et al. [7], covering the phases of problem identification and motivation (Section 1), definition of the objectives for a solution, design and development (Section 2), as well as demonstration and evaluation (Section 3). The design artifact is the German platform *www.sharewood-forest.de* that facilitates sharing of privately owned camping sites in the forest by supporting and guiding the trust- and reciprocity-based request and permission process.

2 Basic Platform Design of Sharewood-Forest

The central problems to be addressed by a platform for P2P sharing of tangible resources (i.e., wild camping sites) inter alia comprise i) the provision of a trustworthy platform environment that encourages the registration of resource providers (i.e., land owners with their property) – particularly, if no prospect of monetary compensation is provided – ii) an online matching process with registered consumers (i.e., adventurers), and iii) the facilitation of offline interaction and subsequent evaluation of interaction. Since Sharewood-Forest is a *true sharing* platform in the sense of Belk [3], transactions are mainly based on social and altruistic motives (c.f. [4]), as no means of (monetary) compensation is provided. A key issue to be solved is therefore the formation of trust between adventurers and land owners (with higher stakes on the altruistically motivated land owner side).

Building on the work of Hawlitschek et al. [2], we break these problems down to six basic requirements: *R1*) Providers shall be able to *list* resources. *R2*) Consumers shall be able to *search and request* resources. *R3*) Providers shall be able to *respond* to (confirm/reject) requests. *R4*) Consumers shall be able to *book* a resource. *R5), R6)* Providers (consumers) shall be able to perform *trusting (reciprocating) behavior*.

The Sharewood-Forest booking process follows a unique and context-specific communication and cancellation policy in order to appropriately support and guide communication, negotiation and interaction between users (see Fig. 1.).

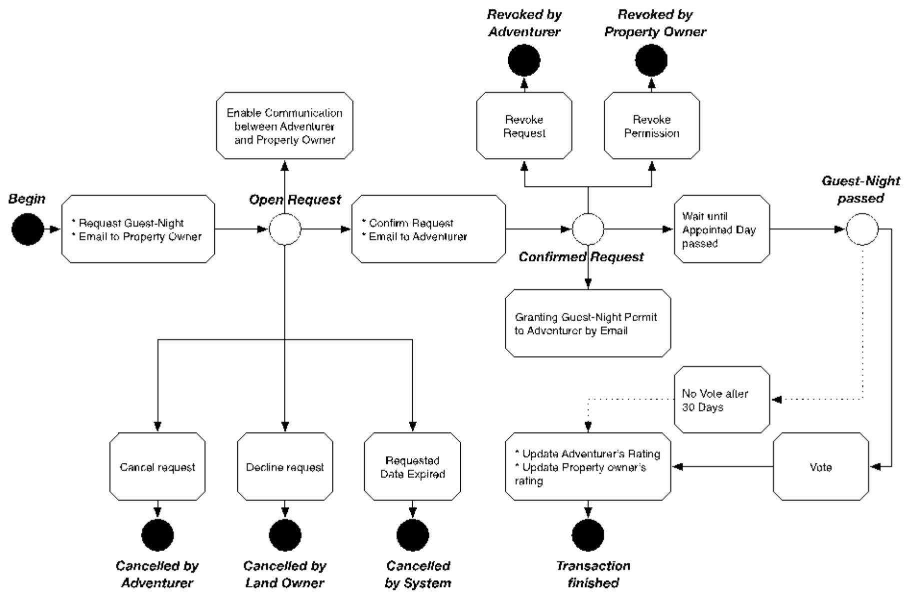

Fig. 1. Flow Chart of the Sharewood-Forest Booking Process

The design and implementation of the Sharewood-Forest platform that fulfills *R1)-R6)* will be described in the following:

Subject to a prior registration, land owners can offer a well-defined spot on their ground to adventures (*R1*). While presenting their land to all registered adventures on the platform (*R2*), they remain in full control of their right to permit or prohibit adventures to spend a guest-night (*R3*). Adventurers are given the possibility to browse all land owners' adverts, inspect their details and eventually bindingly book a spot for a guest-night (*R2*, *R4*).

Offering and booking are facilitated by the unique booking process of Sharewood-Forest, which is depicted in Fig. 1. By requesting a spot on a specified day for a guest-night, an email is sent to the respective land owner informing about that particular request (*R2*). The request contains profile information, a profile photo and a reputation score to increase perceived social presence and trust [5, 8, 9]]. Synchronously, a bilateral chat is provided on the platform for the participants in a transaction to exchange further details of the stay and provide a socially rich means of communication [10].

This *open request* can either change its state into a *confirmed request* through the land owner by granting the adventurer a guest-night permission, or into a *cancelled request* by one of the following actions: i) the adventurer cancels his former request, ii) the land owner declines the request, or iii) by the platform itself, if the requested date of the guest-night is expired (*R3*).

By trustfully granting the guest-night permission, an email containing an auto-generated legally binding permission is sent to the requesting adventurer (*R5*). This allows him to substantiate his right towards any person or authority he might get into contact with on the land owner's spot. But even in case of a *confirmed request*, both adventurer and land owner can cancel it at any time, leading to one of the respective *revoked* states. In case of the occurrence of a guest-night, it is the adventurer's responsibility to behave in a nature-friendly and trustworthy manner following outdoor ethics such as the leave-no-trace principle (*R6*).

In order to strengthen mutual trust amongst platform participants, access to a bilateral reputation and rating system [11] is granted to both parties on the day after the guest-night was "booked". Here, the adventurer may rate the visited spot, whereas the land owner may rate the adventurer's behavior; both using a wide-spread five-star rating. By publishing the results no earlier than after both parties cast their votes, or 30 days after the guest-night took place – whichever comes latest – the otherwise obvious conflict of interest is averted and reciprocity in ratings is mitigated [12]. In case none party casts a vote, the rating is closed 30 days after the guest-night took place.

3 Evaluation and Contribution

Our platform www.sharewood-forest.de (i) brings together nature enthusiasts; on the one hand land owners willing to share their land, on the other hand adventurers loving to explore wilderness, (ii) empowers nature enthusiast with the freedom to roam, (iii) provides legal certainty, hence supporting risk-averse land owners to securely act as land benefactors, and (iv) unites demand and supply in a non-profit sharing economy way (true sharing).

The platform is evaluated in live operation since September 2016 and used productively by the Sharewood-Forest e.V. – a German association for community-based wild and nature friendly camping (see Fig. 2 in the Appendix). A community of ~200 nature enthusiasts has created user profiles (see Fig. 3) on the platform and first registered camping sites (see Fig. 4) speak in favor of the long term success of the concept. The platform is accessed about 10 times per day, which provides the potential for future survey- and interview-based evaluation of the platform.

Following the call of Matzner et al. [13], this prototype paper provides a case for the design of a P2P sharing economy platform that may serve as a basis for cross-case replications. We therefore contribute to a growing body of literature that investigates the design of use-case specific P2P sharing economy platforms (e.g. [13, 14]). Specifically, we describe a use-case for the evaluation of designing trust building mechanisms between altruistically motivated peers. Our work is of particular practical relevance for platform providers who aim at designing P2P sharing economy platforms, but most importantly for nature enthusiasts and adventurers in Germany. We set the stage for a growing community of both altruistic land owners and wild campers who may now – facilitated through our platform – share their passion for outdoor experiences on private forest property in Germany.

4 Conclusion and Outlook

Within this paper we present the context, design, implementation and evaluation of a sharing economy platform for P2P sharing of wild camping sites in Germany, which addresses an existing demand. The platform is used to facilitate the communication and negotiation between users, in order to grant permission to camp on private forest plots in accordance with the German forest laws. The unique characteristics of the described platform design make our work particularly interesting for charitable non-profit organizations, especially with a certain closeness to nature. The concept is based on a user community, which is characterized by two main drivers: closeness to nature and individualization. In other words: By user self-commitment, forests are handled responsibly, enabling renaturation. Zeitgeists idealism enables highly diverse individual experiences (joyriding adventures) – commonly known as utilitarian striving. We contribute to existing work by describing a unique and novel use-case for the design of a P2P sharing economy platform for true sharing.

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Appendix

Fig. 2. Sharewood-Forest Homepage (*www.sharewood-forest.de*)

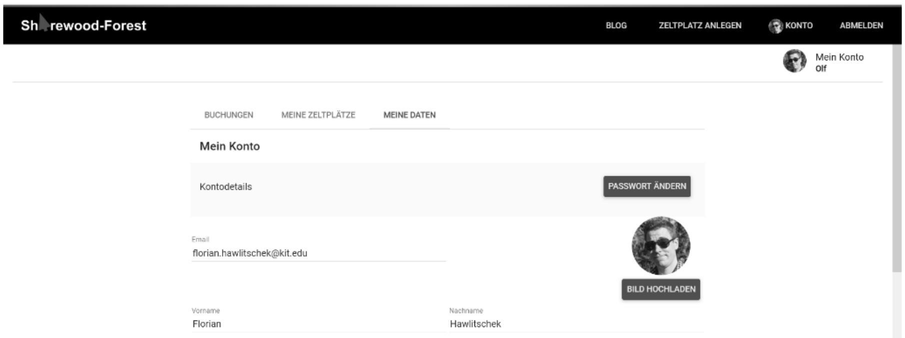

Fig. 3. User Profile on Sharewood-Forest

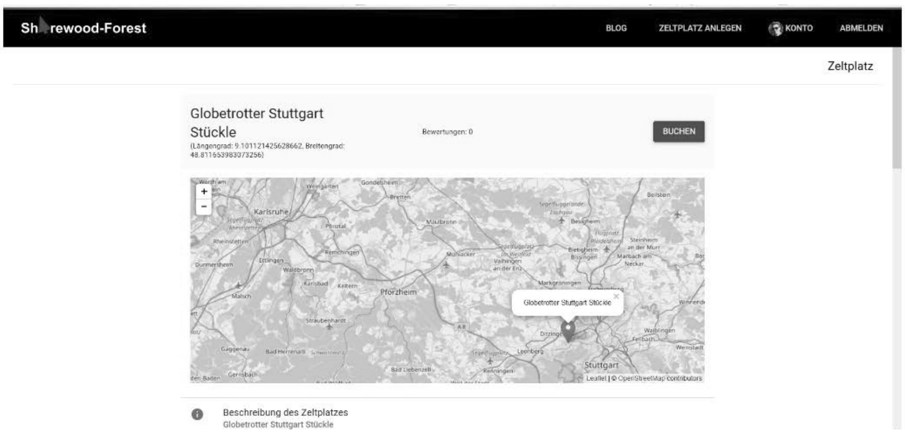

Fig. 4. Registered Camping Site on Sharewood-Forest

User Interface Artifacts in the Trust Game

Christian Peukert[1], Florian Hawlitschek[1], Marc T. P. Adam[2], Christof Weinhardt[1],

[1] Karlsruhe Institute of Technology, Institute of Information Systems and Marketing, 76133 Karlsruhe, Germany
{Christian.Peukert, Florian.Hawlitschek, Weinhardt}@kit.edu
[2] The University of Newcastle, Australia, School of Electrical Engineering and Computing, 2308 Newcastle, Australia
Marc.Adam@newcastle.edu.au

Abstract. Trust is a crucial factor in a variety of computer-facilitated interactions, for example in the context of electronic commerce or negotiation. Since most transactions on the Internet are carried out by interacting with a User Interface (UI), a variety of UI artifacts were developed particularly for the purpose of building trust between users. In order to investigate the effects of UI artifacts on trusting behavior, numerous researchers conducted trust game experiments focusing on the manipulation of the UI. Within the scope of this extended abstract, we introduce a structured literature review approach that aims at gathering the findings of these studies in order to streamline research and provide insights as well as future research directions for trust-related UI design.

Keywords: experiments; literature review; trust game; user interface

1 Introduction

Over the past decade, a wide range of activities in everyday life have become facilitated by a broad range of Internet-enabled services. Within this modern platform landscape, users engage in peer-to-peer interactions to, for instance, book accommodation and mobility services (sharing economy), outsource (micro) tasks to strangers (crowdsourcing), or communicate and socialize with people around the globe (social networks). In such peer-to-peer interactions, users often need to interact with persons they only get to know via the UI of the mediating platform, which may lead to a perception of risk or uncertainty [1]. Such burdens of uncertainty may, however, impede the usage of e-Services [2], as decisions become increasingly complex when considering all potentially occurring incidents originating from other actors [3]. According to Gefen [3], interactions will not take place in the long run without applying some kind of complexity reduction methods—*trust* is a highly effective means for enhancing interactions under uncertainty [3]. In general, trust is defined as “the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party” [4, p.712]. The *trust game*, also known as *investment game* or *shipping game*, is the most

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common experimental method to investigate economic trust scenarios and trust-related behavior [5]. It was first introduced by Berg, Dickhaut and McCabe [6] and has since then been widely adopted to investigate trusting relationships in a variety of settings. The rules proposed by [6] are as follows: Two anonymous players interact with each other in a two-stage sequential transaction. Before the game starts, both players receive an initial endowment of 10 monetary units (MU) and are assigned to play either the role of the trustor or the trustee. In the first stage, the trustor, acting in the role of an investor, decides how much ($x_t = (0,1, \dots ,10)$) of the initial MU 10 he or she wants to transfer to the other player (trustee). The amount sent is multiplied by a factor $\delta = 3$. In the second stage, the trustee in turn decides how much, if anything, of the received tripled amount he or she wants to return to the trustor ($y_r = (0, \dots ,\delta x_t)$). Applying backward induction, the subgame-perfect Nash equilibrium turns out to be a zero-investment by the trustor and a zero-return by the trustee, although both players would be—due to the multiplication factor's effect—better off if the trustor placed trust in the trustee and the trustee reciprocated [6]. As seen, the decision is characterized by a problem of trust in the first stage followed by a subsequent problem of reciprocity. However, it has been shown that people commonly deviate from the above described theoretical equilibrium.[1]

2 Literature Review

Numerous researchers have conducted trust game experiments addressing a wide range of questions in the domain of Cultural Studies, Economics, Psychology, and Sociology, to name just a few (for a meta-analysis of trust game experiments see [7]). However, the trust game has also been used in a variety of studies to investigate the role and impact of UI artifacts on the formation of trust (e.g., profile photos [8–11], avatars [10, 12], communication elements [12, 13], reputation systems [8], virtual world environments [12, 14], or design elements [15]. A large body of IS literature has acknowledged the important role of trust on IT-mediated interactions [16–18]. However, to the best of our knowledge, no prior study has set out to provide a systematic literature review (1) of the results of existing studies employing the trust game to investigate the role of UI artifacts in building trusting relationships online and (2) of how the trust game can be used to investigate these relationships from a methodological perspective. Common approaches to investigate trust in IS are, for instance, (experiential) surveys [19], field interviews, case studies, and experiments [1, 16] that are increasingly supplemented by neuro-physiological measures [10]. The trust game has the particular characteristic that the actual behavior within the game is used to capture trust [20]. Thereby, the major advantage lies in the fact that trust is observable in a real transaction environment.

In order to establish the current state of research on the usage of UI elements in trust games, we conducted a structured literature review of experimental studies. To identify UI artifacts which could potentially influence trusting behavior, we followed the structured literature review approach of Webster and Watson [21]. The review

[1] In the trust game experiment by [6], 30 out of 32 participants have sent on average $ 5.16 of their initial endowment to their counterpart.

covers full-paper studies that have conducted a computerized trust game experiment focusing on the manipulation of UI artifacts. We scanned the top ranked IS literature covering the "Basket of 8," all A* and A ranked IS journals, as well as the seven recommended generic IS conferences as recognized by ACPHIS [22]. Furthermore, we included relevant outlets from the field of Economics such as "Experimental Economics" or the "Journal of Economic Behavior & Organization." A full-text search was applied based on the following key words: either "trust game," or "investment game," or "shipping game," in combination with "experiment." Only trust games following the rules of Berg, Dickhaut and McCabe [6] or Bolton, Katok and Ockenfels [23] were included in order to ensure the comparability of the studies. As the focus especially lies on UI elements, experiments which solely use reputation information but do not consider the role of the actual UI artifact were also excluded from our search.

3 Summary

Overall, 44 studies were considered relevant for this review after conducting a backward search as well as a forward search using the "Web of Science[2]" as proposed by [21]. These 44 studies were published in journals originating from subject areas—besides IS—such as Economics, Neurosciences, Political Science, Psychiatry, or Psychology. Remarkably, 29 out of the 44 studies were published in the last six years, demonstrating the increasing relevance of experimental studies employing the trust game for understanding the formation of trust in online interactions. The majority of studies focus on UI artifacts aiming at an adequate user representation (35), whereof 30 apply a photo and 7 use an avatar for that purpose (2 studies implemented both). Another set of studies allows direct communication between participants (6), whereas 4 studies conduct experiments under virtual world conditions or manipulate other design elements. In addition, 5 studies provide their subjects with reputation information besides other UI artifact manipulations.

Overall, the influence of respective UI artifacts on trust varies widely between the artifacts, whereby the specific design of the UI artifact, also for UI artifacts originating from the same category, strongly influences behavior. In addition to the insights concerning trusting behavior, we give a comprehensive overview on the applied experiment design. This includes information on design parameters such as the multiplication factor, the initial endowment, the number of played rounds, the matching of players, whether or not roles are changed, the sample size, as well as the general framing of the study. Taken as a whole, we contribute to existing literature by aggregating and analyzing the most relevant articles on the influences of UI artifacts on trust related behavior in the trust game. Our findings may support practitioners in developing effective UI artifacts for applications that are based on trust between users, such as negotiation support and group decision support systems. For experimenters, this review may provide a comprehensive overview of established

[2] http://www.webofscience.com/

experimental guidelines for future trust game experiments and, hence, support their experimental design.

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On Experts' Intuition as a Supportive Mechanism in Negotiations

Matylda Gerber[1], Tomasz Szapiro[1]

[1]SGH Warsaw School of Economics, Warsaw, Poland

Abstract. The problem of negotiations with players grouped accordingly to their specific approach to negotiation process is considered. Then the concept of a profile of a player introduced by Mastenbroek [1] becomes a part of toolbox for strategy construction. Mastenbroek styles' classification is expanded with intuition-based attitude of player. The relevant literature shows that intuition occurs in ill structured problems with gaps in information on the problem. We introduce a framework embedding in classical negotiation style a description which treats intuition as insight-oriented process.

Keywords: negotiation style, experts, intuition, leap of faith, insight

1. The problem and discussion

Negotiation is seen here as a strategic dialogue between two or more parties intended to reach a possibly beneficial outcome over one or more conflicting at least one or more issues. Negotiation[1] depends on information assets. Parties do not possess complete information on themselves, therefore they are forced to make immense efforts to learn on circumstances important for other parties. There exists information gathered during negotiation process.

Parties frequently use consciously a pattern in their actions influencing both an outcome and context, called here a *strategy*. However rising body of research confirms also acting in accordance to unconscious patterns – developed due to implicit learning[2]. Intuition that is perceived to be mainly developed through implicit learning [2] is found to be a source of providing implicit strategy into decision-making [3].

In business or politics negotiation involves mutual discussion and arrangement of the terms of a transaction or agreement. These discussions aim at reaching an agreement, usually a formal one in this context. Thus negotiations can be considered as formal debate between people with different aims or intentions. Parties in negotiations remain

[1] For illustration in legal sphere who considers pretrial negotiation case with a plaintiff with private information see [4].

[2] Implicit learning is considered here as the process by which people acquire knowledge about rule-governed complexities of a stimulus environment independently of conscious attempts to do so [5].

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in conflicts but they may also internally disagree. Consequently, negotiations can be spilt in external and internal negotiations among own side of negotiations.

Research on negotiation tackles important issues related to *teamwork*, *information assets*, *complexity*, *role of intuition and negotiation styles*. Negotiating styles model of Mastenbroek is based on the *space of negotiation* and the *set of influence controls* concepts. The space of negotiation consists of mixtures of *cooperation and competing* behaviors called a *coopetition level* and interpreted as willingness to cooperate. The level of proactivity consists of *avoidance* and *exploring* proportions revealed in negotiation behavior. The set of instrument controls has five dimensions which will be labelled *persuasion, power, climate, constituency* and *procedures*. Each dimension - accordingly to the dimension level - collects players' actions which aim at control of negotiation dynamics. Each dimension describes thus sources of control of dynamics of negotiating. Hence negotiation problem can be located in space of negotiation with coordinates defined – *competition* and *proactiveness levels*. Different levels of these coordinates correspond to four negotiating styles: *ethical*, *analytical-aggressive*, *jovial*, *flexible-aggressive*. The control set can be constructed based on specificity of current negotiation problem and negotiation toolbox (assets and skills at disposition) [1].

Intuition in negotiation raised interest in various fields and was investigated from different perspectives from psychology and decision science to management. The research on role of negotiation shows importance of intuition and encourages to consider some findings in proposing negotiation supporting procedures. The research proves intuition to affect progress in understanding organizations and propose relevant research program [6]. Dane and Pratt [7] explain influence of domain knowledge and learning effectiveness of intuition rooted perceptions. Again, they emphasize on including intuition and its applications to managerial decision making.

Druckman [8] review of seminal negotiation research focuses on methodological approaches to conceptualization and studies of negotiation as a vehicle to discover appropriate research direction. Consideration of results achieved "at *the negotiating table, around the table, and away from the table*" leads to question for further research accordingly to this distinction. Intuition clearly fits this program.

Tsay and Bazerman [9] taking general methodological perspective advocate on importance of improvement the "*dialog between the descriptive and the prescriptive*" and participation both of academics and practitioners in this interaction. Achievements in behavioral decision theory merged with conclusions from practical experience can explain deviations from rationality in negotiation.

Intuition occurs in ill structured problems and lack of measurable information related to the problem. Above mentioned surveys show that intuition is promising direction of expansion of classical models. In the framework given below we provide a description treating intuition as insight oriented process. This insightful process can be attributed not only to personality of player, but also to professional role (culture).

On a theoretical level, intuition is typically perceived as one of two processing modes in a variety of dual-process theories i.e. [10], [11]. The models assume a deliberate mode of thinking as a counterpart to the intuitive mode.

The definition of intuition as *„affectively charged judgments that arise through rapid non-conscious and holistic associations"* [7] encompasses conscious result of unconscious processes that occurs in a form of affectively charged judgments (positive or negative feeling). The input data of intuition consists of implicit and explicit knowledge stored in long-term memory which was acquired through experience. Contrary to deliberate thinking, the input data of intuition are processed without conscious attention. That makes intuitive judgment to be a fast process [12] which allows holistic associations to occur [11]. Finally let us note that it is not gifted - *intuition is a result of - explicit and implicit – learning*, e.g. [10], [13].

An issue of identification of experts who equipped with intuition raises. Contrary to novices, experts direct a problem-solving process following their intuition. Even unsupported intuition leads to insight which becomes explicit support. The Figure 1 below represents how experts use unsupported intuition to gain explicitly supported insight they can implement to solve a problem. The moment experts approach a problem they have intuition which manifests in a form of a feeling about recognizing a familiar pattern experienced before. As intuition is highly-based on implicit knowledge, it is hard to define why the piece of information recognized by intuition is important. That is why, there appear a next unconscious process, called *leap of faith*[3], which interprets intuition in terms of explicit knowledge.

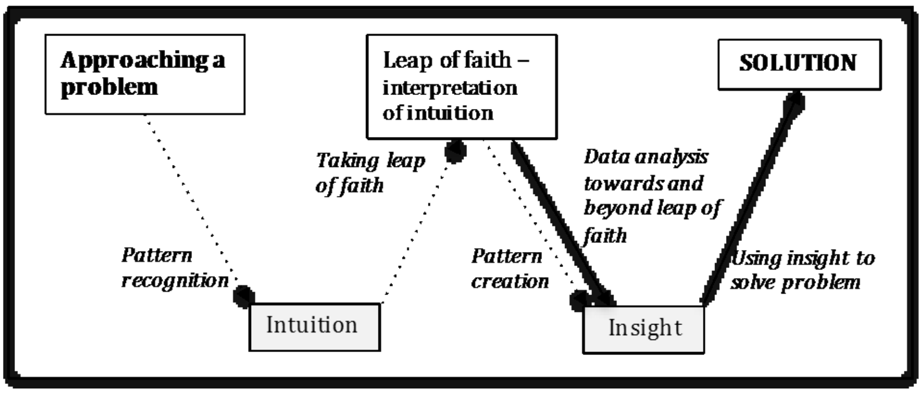

Figure 1 A mix of conscious and unconscious processes in situations of missing data employs expert intuition to find an anchoring point and a leap of faith to direct the search for solution to a problem [14].

Leap of faith [14] doesn't provide solution but rather indicate where to search for solution. The simultaneous conscious and unconscious processes allow to collect information towards and beyond leap of faith and to merge them with one's experience.

[3] Leap of faith is perceived as an *interpretation of intuitive judgments that arise from experience consistent with perceptions of a current situation* [14].

That results in insight which provides solution to a problem that could be supported with collected evidence**.** Insight allows to find solution when there is not enough data to do this by conscious analysis. Experts also are able verify when intuitive path is misleading using available information. The necessary condition to be an expert is experience and learning ability (needed to study the role of unconscious processes in decision-making). Each solved problem enriches collective artificial intuition which supports decision-making process not only by experts but also novices.

2. Intuition and negotiation styles

We modify the concept of the *space of negotiation* [1] by enriching the *set of influence controls*. We supply the *coopetition* and *proactivity* axes with intuition. Then we consider analyses mixtures of *intuitive* and *analytically organized* behaviors. More precisely we consider as equivalent direction of analyses mixtures of *intuitive* and *analytically organized* behaviors. It will be convenient to call *intuitive fathom level* such a mixture of behaviors and interpret this as measure of intuition driven component of negotiation strategy.

This expansion leads to possibility of enriching the set of influence controls. It doesn't raise resistance to note, that actions aimed at influence dimensions - persuasion, power, constituency and procedures - can be intuitively supported. The question is related with the problem of control of intuitive fathom level. Let us recall here that intuition is inseparably linked with unconscious thinking process, see e.g. [7]. The problem raises how to use assets that we are unaware if it exists and how it determines result. We address this issue in the next Section.

At conceptual level expansion adds to two coordinates – coopetition and proactiveness levels – in the negotiations space, the third one - *intuitive fathom level*. This expands a gallery of negotiation styles. Taking bipolar levels of intuitive and analytically organized behaviors, we can transform chart of styles presented in [1] to the cube presented in Figure 2. Of course, the cube as well as the chart can be split in more parts – the Figure 2 illustrates split into two polar positions for each axis.

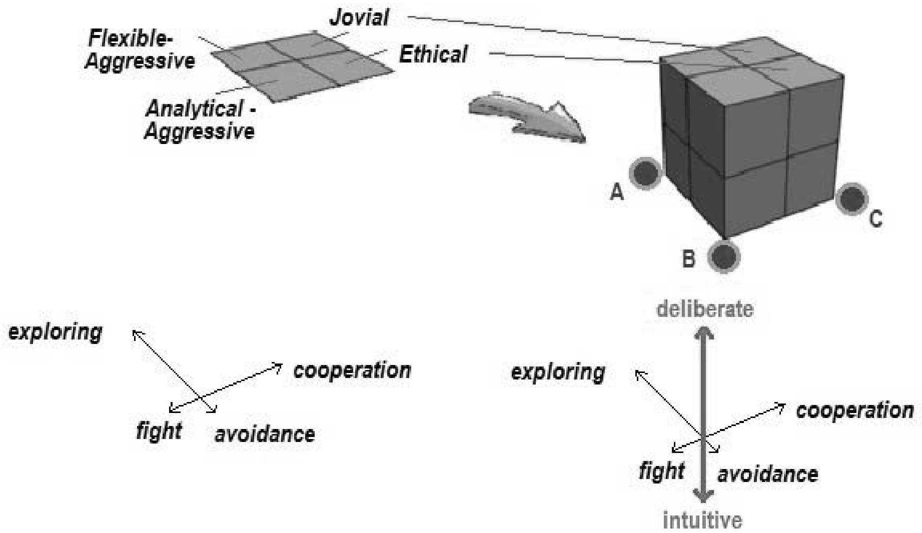

Figure 2. The classical model expands with the third coordinate. This leads to four new styles of which three are visualized as vertices A, B, and C of cube. Here A stands for Jovial with intuitive interventions style, B represents Analytical-aggressive with intuitive interventions style and C - Flexible-aggressive with intuitive interventions style.

Introduction of intuition enriches description of the process of negotiation, and consequently – introduces new possibilities to intervene positively in the process of negotiation. New styles are reflected again in attitudes revealed in this process, however the issue how to operate with unconscious thinking – raised earlier – requires deeper pondering. We discuss this issue to the next section.

3. Artificial intuition in negotiation support

Let us consider strategic thinking in analysis of negotiation problem and strategy. To clarify the argument, we consider two concepts. The first one is preference with respect to intuitive attitude in analysis versus procedural approach. The second one is intuitive potential – the capability to perform intuitive information processing analogously to general intelligence introduced by Charles Spearman, see [15]. It can be evaluated indirectly through comparison of insights revealed in testing problems demanding either intuitive or procedural action.

The problem of abovementioned preference was investigated by [16]. White collar employees (n=30) and entrepreneurs (n=30) were surveyed. Both groups operated over a year in Health Care, IT or Banking sector. The surveyed white-collar employees had no intention to set up their own business what allowed for a clear distinction between studied entrepreneurs and employees. There were used 27 statements from KSP Questionnaire [17] to measure the preference for intuitive over procedural approach in decision-making. The survey proved that there is neither intuition nor procedures significantly preferred one from another. Moreover, among entrepreneurs who revealed the preference there is no correlation between this preference and success in business. This result is compatible with a view that intuition is not opposite of deliberation [10]. Thus, intuition and deliberation are two independent dimensions to be considered jointly and not excluding one each other [18].

Another interesting finding in this paper is identification of intuitive potential as determinant of business success. It appears that potential of entrepreneurs is higher than white collar employees. Results show that entrepreneurs provide more solutions in series of problems requiring insight (an explicit form of initial intuition). Thus, potential of intuition was measurable or at least comparable for different parties.

Evaluation Decision making	Advantages	Disadvantages
intuitive	utilizing unique experience and creativity	lack of support of decision making process
procedural	ability to support decisions with data and knowledge on relations and connections among structure elements	Lack of creativity results in relaying only on information previously introduced by human

Table 1. Characteristics of pure intuitive and procedural modes in decision-making. The most functional decision-making model should arise form mixed modes in the way to maximize their advantages and minimize their drawbacks.

We claim that intuitive and procedural decision making should be present simultaneously in negotiation. To recommend search for appropriate mix of these two modes let us characterize advantages and disadvantages of (intuitive) human and (procedural) machine decision-making. They are presented in the Table 1.

This analysis suggests finding strengths of mix of intuitive and procedural modes of decision making in creation of ideas and their verification. The process of creation of ideas includes problem descriptions, structures and strategy elements and is based on players experience and intuition. The process of verification of creative ideas requires analyses of all available data and consequences. The appropriate mix negotiation support in creation of ideas and their verification is deeply dependent on learning.

All these postulates - capacity for logic, understanding, self-awareness, learning, emotional knowledge, planning, creativity and problem solving – are compatible with the definition of *intelligence* [19]. We aim at presenting a procedure to increase initial intelligence through organized process. The result of this process will be named artificial negotiating intuition to distinguish from natural skills. More precisely, artificial negotiation intuition is more generally described as the ability to perceive information, and to retain it as knowledge to be applied towards adaptive negotiation behaviors within an environment or context.

In negotiation support three modes of assistance of parties are considered, see e.g. [20]. The first one – *arbitrage* – assumes moving group decision problem to the external party provided with collected knowledge on the problem under condition of confidentiality. Then parties subordinate to decision resulting from the arbitrage. The second one – *advice* – assumes individual expert advice for a party. The third one – *mediation* – differs from arbitrage in treatment of mediator's verdict as recommendation only.

This classification can be supplied with so called *artificial intuition*. Here the adjective *artificial* emphasizes the fact that parties use in the process not only their own intuition but also intuition of a system which is raised from intuitions of all decision-makers. Even though we propose a procedure for increase of intuition usage (named extended advice in the sequel), we keep the term intuition since propositions from a learned system result from unsupported intuitions of players. The system allows constant development as result of all decisions made by its users. Each recommendation or decision enriches the system. It remains intuition driven as the results from artificial intuition are not supported by any evidence.

The following procedure leads to creation of artificial intuition in negotiation with assistance of experts in the expanded advice mode.

Step 1. Build relevant knowledge repository - acquire available knowledge on the problem i.e. structure, details, goals, criteria, constraints etc.

Step 2. Identify experts.[4]

Step 3. Provide experts with relevant knowledge repository[5] and analytical tools.

Step 4. Experts intuitively identify anchoring point for analyses.

Step 5. Experts take leap of faith which interpret the intuitive judgment and provide a general direction where to search for a solution.

Step 6. Experts form repository of solutions[6].

Step 7. Experts go beyond leap of faith and gain insight with a solution which is supported with collected information[7].

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[4] Usual criteria for expert identification include: reputation in the domain based on experience and achievements, number of years of experience. Expert supplies experience with record of excellent results and individual abilities that facilitated him/her to become expert (i.e. high intelligence, creativity, ambition, empathy, positive attitude, strength). On the contrary, novice is a person who is new for a given domain and didn't have time to collect sufficient experience to rely on it in their decision-making. There could be novices with a potential to become experts and novices who will never become experts.

[5] The most complicated decision-making occurs when we have not enough data to provide structured analysis. In such situations, experts use their experience e.g. to fill the missing data.

[6] Each solved problem is accumulated by a system with information about the role of intuition.

[7] To support such decision-making done by experts the system should allow experts to follow their analysis with accordance to their intuition and leap of faith but also to verify if the given intuition is not misleading.

Step 8. Experts (or artificial intuition supporting system coordinator) interact with parties treating them as novices to communicate and to explain their findings (cumulated correct experts' intuitions and proposals of possible solutions).

If a player - unexperienced novice at starting point - approaches a problem with missing data, then she can use cumulated by the system intuitions of experts. Their intuition indicates an anchoring point and leap of faith provides direction for further information collection and analysis so as to gain insight with a suitable solution. Within this approach not only intuition but also analysis is important.

The introduction of intuition into negotiation analyses allows to consider enriched mode of advice. More precisely, we assume that intuition of expert may be used by novice players to increase artificial intuition in negotiation.

4. Concluding remarks

Embedding intuition in the coopetition-proactiveness frame, leads to enrichment of variety of negotiating styles. New styles can allow to consider mixes of analytical and intuitive attitudes in preparation of negotiation strategies. The question rises whether new styles can be used in similar way as styles from the initial, classical set. In classical models, styles were treated in two ways. As far the other parties were considered, an attempt to identify styles of these parties was undertaken to decrease the level of uncertainty in forecasting their behaviors. This helped in building negotiation strategy. However, own style can be treated as a controllable variable – one can intentionally switch e.g. from flexibly aggressive to jovial style.

Identification and controllability of intuitive component of style was investigated in this perspective and remains challenging direction of future research. The first step in this direction was made in recalled study where a set of suitable tasks allows to distinguish and valuate between impact component of intuitive data processing. This approach could be recommended in real life problems to identify own party intuition profiles. The easiest way to control proportion of intuition in problem solving would be exchange of players in negotiation team. Under assumption that team profile is identifiable exchange of players with different intuition components will result in change of team intuition profile and thus will facilitate change of switching negotiation strategy. This can be illustratively compared with situation when defensive tactics of football team is switched to attack oriented one in result of replacement of player in defense with another one in attack. Switch of negotiating style may increase likelihood of leap of faith. The switch should be considered in two different situations, either when an anchoring point is identified or when it cannot be identified for very long time. Experts who recommend direction of negotiation process (see Figure 1) using concept of styles may assist in definition of a toolbox of actions in negotiations in the same way as in a traditional approach [1].

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Does Trusting Behaviour Pay in Electronic Negotiations?

Muhammed Kaya[1] , Michael Körner[1], Annika Lenz[1], Philipp Melzer[1], Serkan Sepin[1], Andreas Schmid[1], Mareike Schoop[1], Per van der Wijst[2],

[1] Department of Information Systems 1, University of Hohenheim, Stuttgart, Germany
[2] Department of Communication and Information Sciences, Tilburg University, Netherlands

{muhammed-fatih.kaya, m_koerner, annika.lenz, philipp.melzer, serkan_sepin, a_schmid, schoop}@uni-hohenheim.de, Per.vanderWijst@uvt.nl

Abstract. The question whether and how initial trust of the negotiators develops during negotiations leading to spill-over effects eventually influencing negotiation outcomes is important for negotiation research and practice. Therefore, we present initial results of a negotiation experiment involving students from 3 European universities showing effects of initial trust regarding ex post trust, outcome effectiveness, efficiency, and satisfaction of the negotiators. The trusting beliefs of the negotiator making the first offer exert a strong influence on the evolving negotiation.

Keywords: trust, negotiation, Negoisst, efficiency, effectiveness, satisfaction

1 Introduction

Trust is an important aspect in negotiations whatever the domain. When negotiators trust each other, they negotiate more cooperatively and information sharing is more apparent leading to more effective and efficient agreements [1]. However, business negotiation partners often change and are not always motivated to engage in expensive processes of relationship-building [2]. The question remains how to create and maintain a trustful relationship with the negotiation partner(s) effectively.

Numerous approaches have modelled initial trust formation and investigated the effect of trust on negotiation outcomes [1, 3]. How trust exactly develops during the negotiation process, however, is largely unknown. The current paper analyses trust in negotiations following an ex ante and ex post perspective and expecting a spill-over effect during the negotiation process. Initial trust is formed before the negotiation and then reassessed in continuous trust-related interactions with the negotiation partner eventually shaping the negotiation outcome. Based on this, our research question is: *Can high initial trust be beneficial leading to a positive reassessment increasing trust of the negotiation partner?* To this end, we present a negotiation experiment, manipulating initial trust formation of the participants and evaluating the aforementioned reassessment as trust spill-over between the negotiators.

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2 Theoretical Background

In the following, we will present a brief state-of-the art of research on initial trust formation and trust development. Furthermore, we will apply the concept of trust to negotiations and derive our hypotheses, which will be investigated in the remainder of this paper.

2.1 State-of-the-Art of Trust Research

Trust is defined as “the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party” [4]. We assess trust as an interpersonal construct emitted by the trustor to a trustee and vice versa. Following the model of initial trust formation (cf. Figure 1) by McKnight et al. [3, 5] a person’s general disposition to trust is influenced by personality traits such as trusting stance defining whether a person is to be treated as being trustworthy to maximise gains or to improve the relationship when no further information is available. Moreover, cognitive processes assessing the trustee such as categorisation processes (i.e. unit grouping, reputation, stereotyping) and illusion of control processes (i.e. confirmation of one’s beliefs about trustworthiness) influence trust formation. Institution-based trust plays an important role relying on promises, regularities, contracts, or guarantees, which create a belief of structural assurance. Additionally, an assessment whether the current situation is normal and can thus be managed leads to institution-based trust. The described factors act as antecedents of trust being defined as a combination of trusting beliefs (i.e. beliefs about benevolence, competence and honesty of the trustee) and trusting intention, which eventually influence trust-related behaviour.

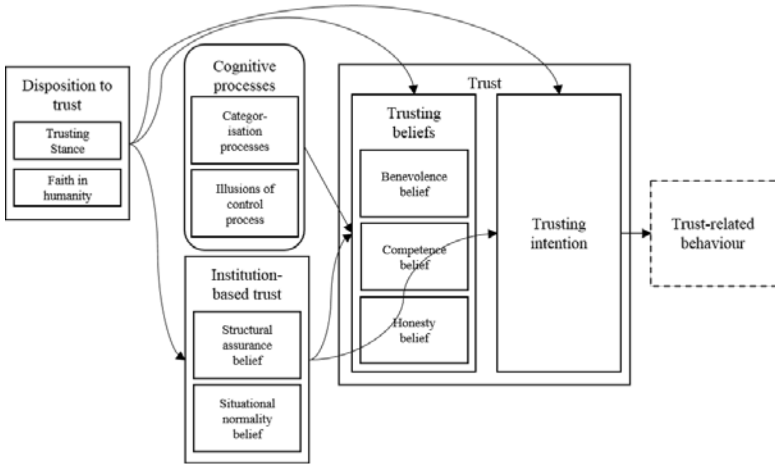

Figure 1 Initial trust formation model adapted from [3, p.476; 5, p.341]

Investigating possible spill-over effects of trust within groups, it is furthermore necessary to model trust development. Trust influences behaviour, which in turn leads to reactions of the trustee eventually providing a reassessment of trusting beliefs and intentions [6]. Negotiations enable researchers to analyse the process of trust development in a scenario where mutual gains as well as losses are possible coming to an agreement or rejection.

2.2 Hypotheses

Trust has been found to affect both decision making and communication in negotiations, leading to cooperative negotiation behaviour in cases of high trust or competitive negotiation behaviour in cases of low trust [1, 4, 7, 8]. Similarly communication behaviour is described to be more cooperative in cases of high trusting beliefs. In turn cooperative communication itself increases trusting beliefs.

While repeated interaction between trustor and trustee has been found to lead to the development of trust on both sides [9, 10], we will focus on the differences of trust development between dyadic negotiations with both, only one, or none of the negotiators with high trust assessing possible spill-over effects. Trust development is measured analysing the difference between ex ante trusting beliefs towards the negotiation partner and ex post trusting beliefs towards the negotiation partner (called ex ante trust and ex post trust respectively for the remainder of the paper). Regarding spill-over, people with high trust are described as having a greater tendency to ignore low trust-related behaviour of their partner, whilst people with low trust adapt to high trust-related behaviour of their partners [5]. Therefore, we assume negotiations with two negotiators exhibiting high ex ante trust to maintain their high trust. In contrast, negotiations involving negotiators exhibiting mixed ex ante trust show a spill-over resulting in a high trust development for the negotiator exhibiting low trust. This spill-over is assumed to lead to trust levels comparable to those in negotiations where both negotiators exhibit high ex ante trust. Negotiation where both negotiators exhibit low ex ante trust are assumed to achieve low trust development since spill-over is impossible leading to significantly lower ex post trust.

Relating trust development to negotiation outcomes, we hypothesise a positive relationship between trust development and individual outcomes [11] as well as joint negotiation outcomes [6, 12]. Previous studies report a positive relationship between trusting beliefs and outcomes regarding effectiveness [13] and efficiency [14]. Effectiveness in negotiations is measured analysing agreement rates, while efficiency is measured using individual or joint utilities representing achievement of preferences.

As negotiation outcomes are positively related to negotiators' satisfaction [15], we consequently hypothesise, that high ex post trust leads to increased satisfaction with the negotiation. To summarise:

H1: Negotiations involving one or two negotiators with high ex ante trust achieve higher ex post trust compared to negotiations involving two negotiators with low ex ante trust.

H2a: Negotiations involving one or two negotiators with high ex ante trust achieve higher individual utility compared to negotiations involving two negotiators with low ex ante trust.

H2b: Negotiation dyads involving one or two negotiators with high ex ante trust achieve higher agreement rates compared to negotiation dyads involving two negotiators with low ex ante trust.

H2c: Negotiation dyads involving one or two negotiators with high ex ante trust achieve higher joint utility compared to negotiation dyads involving two negotiators with low ex ante trust.

H3: Negotiations involving one or two negotiators with high ex ante trust achieve higher satisfaction compared to negotiations involving two negotiators with low ex ante trust.

Figure 2 summarises the described constructs and relationships. Initial trust is based on the model by McKnight et al. and is manipulated regarding institution-based trust and cognitive processes (dashed lines). Initial trust shapes trust development during negotiations as well as negotiation outcomes and satisfaction. Solid lines represent our proposed hypotheses.

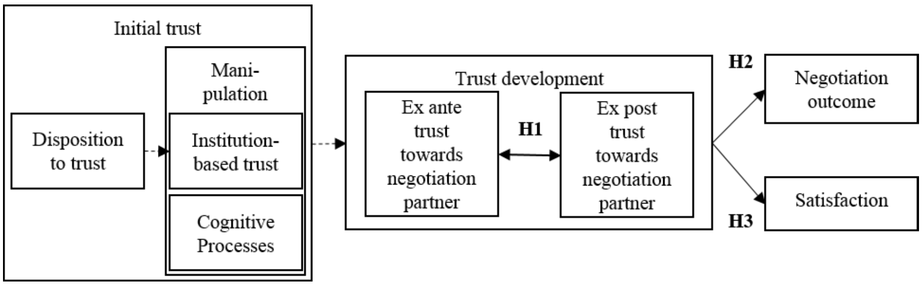

Figure 2 Constructs and Hypotheses

3 Experimental Design

We conducted an international electronic bilateral multi-issue negotiation via the negotiation support system Negoisst [16, 17].

The simulation case used is about student members of an international student association (ISA). The participants needed to negotiate five issues concerning the organisation of ISA's 50th anniversary event. They were provided with a general case description, private information (which varied according to the trust manipulation), and private preference information. The case was designed to enable the participants to follow a cooperative strategy (i.e. to maximise joint utility and minimise contract imbalance) or a competitive strategy (i.e. to maximise individual utility). The best negotiator will be awarded a job offer at ISA.

The negotiation was conducted via Negoisst which follows a holistic support paradigm providing decision support, communication support, and document management. Decision support plays an important role in this simulation because it provides individual utilities for each offer and counteroffer. To get to know individual utilities of the counterpart ,joint utility, and contract imbalance, participants could either try to estimate the negotiation partner's individual utility or ask for it in case of high trust.

The pre-questionnaire assessed the participants' disposition to trust [5] performing a confirmatory factor analysis. Using a median-split, participants were grouped into two treatments reflecting 92 participants with high disposition to trust (H), and 91 participants with low disposition to trust (L) (N = 183, Mdn. = 3.3675, SD = 0.62, Min. = 1.64, Max. = 4.52).

After the assignment to a treatment, trust disposition was amplified by manipulation providing second hand information about the reputation of the negotiation partner (e.g. H: The negotiation partner's previous projects have been successful; negotiation partner is a team player and very cooperative; L: The negotiation partner is stubborn, has a competitive attitude and strong self-focus) and by focusing on unit-grouping (e.g. H: Both negotiators are ISA members; negotiator has positive experiences with ISA members; they are very reliable, competent, and professional; L: Negotiation partner is student at another university; negative experiences with ISA members at a different university; they behave like self-exposers, try to achieve their optimal outcome, neglect the overall project goals, are idiots and fools). Moreover, we manipulated the structural assurance belief as part of the institution-based trust (H: e.g. Participant is pleased with the selection criteria; transparent, rigorous and performance-based application process; the application process is controlled by a neutral committee; L: Application process is non-transparent; rumours about unqualified applicants entered the simulation; students might have intensively used their contacts to leading ISA members; participant worries that winner will not be picked based on the evaluation criteria). After the manipulation, participants were assigned to the treatment groups following a two-by-two-design shown in table 1.

Table 1 Treatment groups

Treatments	High Trust	Low Trust
High Trust	HH dyads	HL dyads
Low Trust	LH dyads	LL dyads

The HL and LH dyads were further distinguished according to the person wiring the first message: (1) L in LL: low ex ante trust for both negotiators; (2) L in LH: negotiator with low ex ante trust writes first message; (3) H in LH: negotiator with high ex ante trust writes the first message; (4) L in HL: negotiator with low trusting beliefs writes the first message; (5) H in HL: negotiator with high trusting beliefs writes the first message; and (6) H in HH: high trusting beliefs for both negotiators. After the negotiations ended, substantial outcomes are investigated including individual utility and joint utility [18]. Also the post-questionnaire assesses ex post trust [18] and satisfaction of the negotiators [19].

4 Results

In the following we present descriptive results providing external validity to our dataset eventually evaluating the proposed hypotheses. All psychometric measures are assessed on a 7-point-Likert-scale using means to reflect constructs based on several items.

4.1 Descriptive Results

A total of 215 students – 125 of them graduate students - from three European universities in Austria, Germany, and the Netherlands studying Management, Information Systems, Communication and Information Sciences, and Engineering participated in the study. Participants were matched into negotiation dyads including two negotiators from different universities leading to a dataset of 142 individuals (36 L in LL, 14 L in LH, 13 H in LH, 18 L in HL, 19 H in HL, 35 H in HH, 71 female, M_{Age} = 24.29 years, SD_{Age} = 3.12) respectively 54 negotiation dyads after data cleaning (14 LL, 10 LH, 16 HL, 14 HH).

45 out of 54 negotiations concluded with an agreement leading to an agreement rate of 83.3%. Further investigations on negotiation agreements show an average individual utility of 54.15% (SD = 7.06%, Min = 31%, Max. = 82.26%), an average joint utility of 107.67% (SD = 6.61%, Min. 90%, Max. 113%), and an average contract imbalance of 7.76% (SD = 8.12%) ranging from a completely fair negotiation agreement with 0% to 34%. Cronbach's alpha of all constructs under investigation remains between 0.884 and 0.943 showing good construct validity [20].

The experimental manipulation worked as planned amplifying general trust disposition with regards to institution-based trust and cognitive processes. On average negotiators with low trust disposition had significantly lower institution-based trust (M = 4.30, SD = 0.80) compared to negotiators with high trust disposition (M = 5.08, SD = 0.58, $t(121.15) = -6.569$, $p < 0.001$). The same effect is prevalent for negotiators with low trust disposition having significantly lower ex ante trust (M = 4.02, SD = 0.13) compared to negotiators with high trust disposition (M = 4.65, SD = 0.88, $t(137) = -3.37$, $p < 0.001$).

4.2 Hypotheses

Regarding hypothesis 1, we expected a difference in ex post trust between negotiation dyads where high trusting negotiators are involved (HH, HL, and LH) compared to dyads involving solely low trusting negotiators (LL).

ANOVA shows a significant effect of the treatment groups on ex post trust ($F(5, 129) = 3.212$, $p = 0.009$, $r = 0.111$). To investigate hypothesis 1, planned contrasts were used comparing the treatment groups in detail revealing that negotiators with low ex ante trust differ neither in the LH group (M. = 3.95, $t(129) = -1.940$, $p = 0.055$, $r = 0.168$) nor in the HL group (M. = 5.01, $t(129) = 1.390$, $p = 0.167$ $r = 0.122$) regarding ex post trust compared to negotiations with low ex ante trust only (LL, M = 4.59). Therefore, hypothesis 1 cannot be supported. However, post-hoc analysis reveals an effect of who makes the first offer showing a difference regarding ex post trust between L in LH and L in HL negotiators. If the high trusting negotiator writes the first message there is a significantly higher ex post trust ($M = 5.01$, $SD = 1.04$) compared to if the low trusting negotiator writes the first message ($M = 3.95$, $SD = 1.05$, $t(30) = -2.840$, $p = 0.008$, $r = 0.460$).

Regarding hypothesis 2a, analyses performed using ANOVA show no significant effect of the treatment groups on individual utility ($F(5, 106) = 1.978$, $p < 0.088$, $r = 0.085$). Again planned contrasts were used to compare treatment groups with mixed ex ante trust to treatment group with equally high ex ante trust revealing no significant difference ($t(106) = 1.962$, $p = 0.052$, $r = 0.187$). However, analysing each treatment separately, the treatment group HL including negotiators with high trust making the first offer to low trusting negotiators achieved significantly lower individual utilities compared to HH negotiations (H in HH: M. = 56.93%, H in HL: M. = 52.05%, $t(106) = 2.348$, $p = 0.021$, $r = 0.222$ respectively L in HL M. = 52.72%, $t(106) = 1.993$, $p = 0.049$, $r = 0.190$). Comparing the LL treatment to all others showed no significant differences regarding individual utility ($t(106) = 1.457$, $p = 0.148$, $r = 0.140$). Only direct comparison of negotiations with two low trusting negotiators to negotiations with two high trusting negotiators revealed a significant difference in resulting individual outcomes (M_{LL}. = 52%, M_{HH}. = 56.93%, $t(106) = 2.507$, $p = 0.014$, $r = 0.237$). Therefore, hypothesis 2a cannot be confirmed. However, the data shows tendencies, that negotiators with low trusting beliefs achieve higher individual utility in mixed negotiations than negotiators with high trusting beliefs. Regarding hypothesis 2b, there is a significant medium association between the treatment groups and reaching a negotiation agreement ($\chi^2(3) = 7.406$, $p = 0.050$, Cramer's $V = 0.370$). LL negotiations exhibit the lowest agreement rate of 63.3%, followed by HH negotiations (78.6%). Mixed treatments achieved the highest agreement rates (LH: 90%, HL: 100%). Therefore, we can confirm hypothesis 2b showing that negotiations involving two negotiators with low ex ante trust achieve less agreements than negotiations with one or two high trusting negotiators. Regarding hypothesis 2c, a Kruskal-Wallis test is conducted showing a significant effect of our treatments on joint utility ($H(3) = 9.180$, $p = 0.027$). Visual inspection confirms our initial considerations showing that LL negotiations achieve worse results compared to negotiations involving negotiators with high ex ante trust (LH, HH), while HL negotiators perceive even worse than LL negotiators. Follow-up Mann-Whitney tests indicate, that HH negotiations achieved significantly higher joint utility compared to LL negotiations (M_{HH}. = 111.73%, M_{LL}. = 106.11%, $U = 20.50$, $p = 0.022$, $r = -0.511$). However, HL negotiations violate our assumptions achieving the lowest joint utilities of all treatments showing a significant difference to HH negotiations (M_{HH}. = 111.73%, M_{HL}. = 104.44%, $U = 35.50$, $p = 0.007$, $r = -0.510$). Therefore, hypothesis 2c cannot be confirmed.

Hypothesis 3 assumes a relationship between ex ante trust reflected in our treatments and satisfaction with the negotiation [15]. ANOVA reveals a significant effect of the treatments on negotiators' satisfaction ($F(5, 129) = 3.515$, $p = 0.005$, $r = 0.120$) representing our initial considerations that negotiations involving two low trusting negotiators (LL) achieve lowest satisfaction, while negotiations involving two (HH) or at least one high trusting negotiator (LH and HL) exhibit increased satisfaction levels. Further comparisons displayed no significant differences between

HH, HL, and LH treatments. Instead the LL treatment was significantly different to the remaining groups ($t(129) = 3.478$, $p = 0.01$, $r = 0.293$). Therefore, we can confirm hypothesis 3.

5 Discussion and Outlook

The present study describes a negotiation experiment investigating the research question, whether highly trusting behaviour leads to a positive reassessment and spill-over of trust during the negotiation process by comparing ex ante and ex post variables such outcome effectiveness and satisfaction of the negotiators. While negotiations involving two negotiators with high ex ante trust consistently perform better than negotiations involving two negotiators with low ex ante trust regarding all variables of interest, we cannot confirm spill-over effects in our mixed treatment groups. Trust spill-over can be observed increasing outcome effectiveness (H2b) as well as satisfaction (H3). Furthermore, tendencies show that the negotiator who makes the first offer influences trust reassessment of the negotiation partner increasing ex post trust (H1), albeit decreasing outcome efficiency (H2a, H2c). In contrast, low trusting negotiators are observed to achieve more efficient negotiation outcomes. One possible interpretation is that a negotiator with high ex ante trust making the first offer causes a spill-over and the negotiators focus on achieving an agreement. If a negotiator with low ex ante trust makes the first offer, no spill-over occurs leading to less effective but more efficient bargaining.

The present study also poses several challenges such as continuous interaction, which has been found to increase trust [9, 10]. This effect was also observed in our data ($M_{ex\_ante\_trust} = 4.41$, $SD_{ex\_ante\_trust} = 1.08$, $M_{ex\_post\_trust} = 4.71$, $SD_{ex\_post\_trust} = 1.13$). This might diminish the effects of the manipulation over the course of the negotiations.

These limitations directly lead us to the next steps of research. To further investigate the link between ex ante trust, trusting behaviour in negotiations, and ex post trust, the processual character of trust development needs to be brought into focus. Therefore, negotiation behaviour will be analysed w.r.t. concessions (using standardised interpolated path analysis [21]) as well as communication behaviour (performing qualitative content analysis). Through those additional consideration of procedural trust development in future research and taking into account the measured ex ante investigation presented above, the research circle can be closed so that a holistic approach can be achieved. This will further disentangle the complex relationship surrounding trust spill-over investigating the behavioural link between trust and negotiation outcomes.

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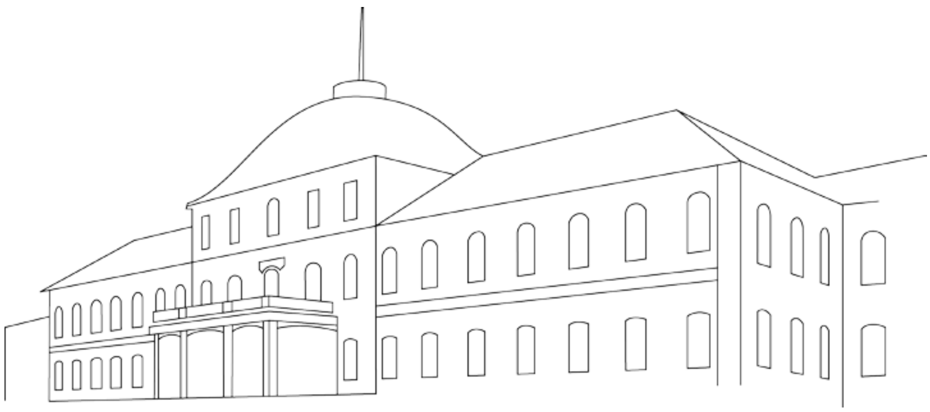
Preference Modelling for Group Decision and Negotiation

Stream Organisers:
Adiel Teixeira de Almeida, Universidade Federal de Pernambuco, Brazil
Tomasz Wachowicz, University of Economics in Katowice, Poland



University of Hohenheim

Simplifying Cardinal Ranking in MCDM Methods

Mats Danielson[1,2] and Love Ekenberg[2,1]

[1]Dept. of Computer and Systems Sciences, Stockholm University,
Postbox 7003, SE-164 07 Kista, Sweden, mats.danielson@su.se
[2]International Institute for Applied Systems Analysis, IIASA,
Schlossplatz 1, A-2361 Laxenburg, Austria, ekenberg@iiasa.ac.at

Abstract. There are several MCDM methods attempting to elicit criteria weights ranging from direct rating and point allocation methods to more elaborated ones. To facilitate the weight elicitation, some of the approaches utilise elicitation methods whereby prospects are ranked using ordinal importance information while others use cardinal information. In this paper, we explore simplified models mixing cardinal and ordinal statements and demonstrate which of them are more efficient than established methods. It turns out that weights are much more insensitive to cardinality than values, which has implications for all ranking methods.

Keywords: Multi-criteria decision analysis; Surrogate criteria weights; The CAR method; Simplifying rank order.

1 Introduction

One of the problems with the additive model as well as other MCDA models is that numerically precise information is seldom available, and most decision-makers experience difficulties with entering realistic information when analysing decision problems. For instance, Barron and Barrett [1] argue that the elicitation of exact weights demands an exactness which does not exist. There are other problems, such as that ratio weight procedures are difficult to accurately employ due to response errors [2].

The utilisation of ordinal or imprecise importance information to determine criteria weights is a way of handling this problem, and some authors have suggested surrogate weights as representative numbers assumed to represent the most likely interpretation of the preferences expressed by a decision-maker or a group of decision-makers. One such type is derived from ordinal importance information [1,3,4], where decision-makers supply ordinal information on importance and the information is then subsequently converted into surrogate weights corresponding to the extracted ordinal information. Often used methods are rank sum weights (RS) [5], rank reciprocal weights (RR) [5], and centroid weights (ROC) [6]. For instance, [1] introduced a process utilising systematic simulations for validating the selection of criteria weights, when generating surrogate weights as well as "true" reference weights. It also investigated how well the result of using surrogate numbers matches the result of using

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the “true” numbers. This is however heavily dependent on the distribution used for generating the weight vectors.

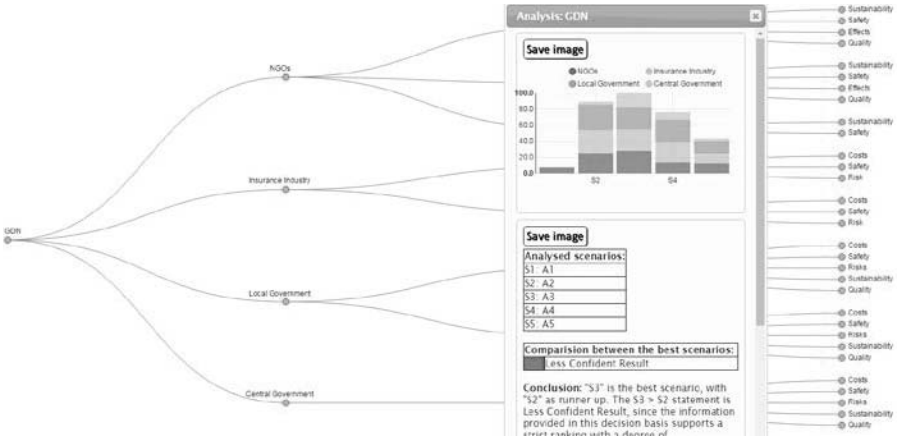

Fig. 1. The group decision tool Decision Wizard

We have earlier investigated various aspects of this in a couple of articles and compared state-of-the-art weight methods, both ordinal (ranking only) [7,8] and cardinal (with the possibilities to express strength) [9-11] in order to devise methods requiring as little cognitive load as possible. We also used these together with ranked values (utilities) and suggested a multi-stakeholder decision method that has been applied in, e.g., [10]. This method fulfils several desired robustness properties and is comparatively stable under reasonable assumptions. Figure 1 shows of a multi-criteria multi-stakeholder tool (POLA) developed for group decisions regarding infrastructure policy making in Swedish municipalities, using the CAR method of [11]. The values (utilities) of each alternative under each criterion is assessed by experts in the respective fields. Each stakeholder group will then order the criteria in terms of importance using cardinal ranking possibilities. The final evaluation then sees a combination of the stakeholders’ assessments, either directly or via a set of stakeholder weights for the purpose of sensitivity analyses. The underlying method in all stages is the CAR method. An observation during the use of POLA has been the inability of the stakeholder groups to express cardinality (similar to white cards in the Simos method), which spurred the investigation into even simpler means of expressing importance for stakeholders.

In this article, we take steps towards decreasing the cognitive load even further while still maintaining decision power and measure the effects of decreasing the load in different ways. Not least in multi-stakeholder decision situations, where different groups express different assessments (i.e. rank criteria and/or alternatives differently), there is a need to express these assessments with simple yet powerful expressions. In that sense, this is a follow-up study to [11] and other results presented at GDN conferences and we will for lack of space refer to those studies rather than repeating the methods and results in the earlier studies.

2 Surrogate Weight Methods

The crucial issue in all these methods is how to assign surrogate weights while losing as little information as possible. Providing ordinal rankings of criteria seems to avoid some of the difficulties associated with the elicitation of exact numbers. It puts fewer demands on decision-makers and is thus, in a sense, effort-saving. Furthermore, there are techniques for handling ordinal rankings with various success. A limitation of this is naturally that decision-makers usually have more knowledge of the decision situation than a pure criteria ordering, often in the sense that they have an idea regarding importance relation information containing strengths. In such cases, the surrogate weights may be an unnecessarily weak representation. Thus, we have also investigated whether the methods can be extended to accommodate information regarding relational strengths as well. This while still preserving the property of being less demanding and hence more practically useful than other types of methods. One well-known class of methods is the SMART family. The criteria are ranked and then 10 points are assigned to the weight of the least important criterion (w_N). Then, the remaining weights (w_{N-1} through w_1) are given points according to the decision-maker's preferences. The overall value E(a_j) of alternative a_j is then a weighted average of the values v_{ij} associated with a_j (Eq. 1):

$$E(a_j) = \frac{\sum_{i=1}^{N} w_i v_{ij}}{\sum_{i=1}^{N} w_i} \qquad (1)$$

The most utilised processes for converting ordinal input to cardinal use automated procedures and yield exact numeric weights. For instance, [12] proposed the SMARTER method for eliciting ordinal information on importance before converting it to numbers, thus relaxing information input demands on the decision-maker. An initial analysis is carried out where the weights are ordered such as $w_1 > w_2 > ... > w_N$ and then subsequently transformed to numerical weights using ROC weights and then SMARTER continues in the same manner as the ordinary SMART method.

The probably most well-known ratio scoring method is the Analytic Hierarchy Process (AHP). The basic idea of the AHP-process requires the same pairwise comparisons regardless of scale type. For each criterion, the decision-maker should first find the ordering of the alternatives from the best to the worst. Next, he or she should find the strength of the ordering by considering pairwise ratios (pairwise relations) between the alternatives using the integers 1, 3, 5, 7, and 9 to express their relative strengths, indicating that one alternative is equally good as another (strength = 1) or three, five, seven, or nine times as good. It is also allowed to use the even integers 2, 4, 6, and 8 as intermediate values, but using only odd integers is more common. As an alternative, we have in [11] suggested the CAR method and shown that this is a more efficient method than methods from the SMART family and AHP.

2.1 Strength of Weights

In order to make an ordinal ranking of N criteria into a stronger ranking, we add information about how much more or less important the criteria are compared to each other. Following [11], we use the following notation for the strength of the rankings between criteria as well as a suggestion for an intuitive verbal interpretation of these[1]:

$>_0$	equally important
$>_1$	slightly more important
$>_2$	more important (clearly more important)
$>_3$	much more important

While being more cognitively demanding than ordinal weights, these are still less demanding than, for example, AHP weight ratios or point scores like. In an analogous manner as for ordinal rankings, the decision-maker statements can be converted into weights.

2.2 Preference Strength Methods

Analogous to the ordinal weight functions above, counterparts using the concept of preference strength can straightforwardly be derived.

1. Assign an ordinal number to each importance scale position, starting with the most important position as number 1.
2. Let the total number of importance scale positions be Q. Each criterion i has the position $p(i) \in \{1,\ldots,Q\}$ on this importance scale, such that for every two adjacent criteria c_i and c_{i+1}, whenever $c_i >_{s_i} c_{i+1}$, $s_i = | p(i+1) - p(i) |$. The position $p(i)$ then denotes the importance as stated by the decision-maker. Thus, Q is equal to $\Sigma s_i + 1$, where $i = 1,\ldots,N-1$ for N criteria.

Then the cardinal counterparts to the ordinal ranking methods above can be found by using the results from [10], where the ordinal SR weights were given by Eq. 2

$$w_i^{\mathrm{SR}} = \frac{1/_i + \frac{N+1-i}{N}}{\sum_{j=1}^{N} w_j^{\mathrm{SR}}} \qquad (2)$$

and using steps 1–3 above, the corresponding preference strength SR weights (CSR, Eq. 3) are obtained as

$$w_i^{\mathrm{CSR}} = \frac{1/_{p(i)} + \frac{Q+1-p(i)}{Q}}{\sum_{j=1}^{N}\left(1/_{p(j)} + \frac{Q+1-p(j)}{Q}\right)} \qquad (3)$$

Using the idea of importance steps, ordinal weight methods in general are easily generalised to their respective counterparts. In the same manner, values (or utilities) can be assessed, either ordinally (ranking only) or cardinally (additionally expressing strength).

[1] Of course, this is not intended to be totally normative. Any interpretation is possible and can be formally handled in the same way.

Already in [11], we combined cardinal weights with cardinal values into the CAR method and assessed the method by simulations as well as a large number of user cases. The CAR method was found to outperform SMART and AHP in terms of performance and the ease of use (the cognitive load), but some of the users still wanted a method with even less cognitive load so we tried to satisfy this while still preserving reasonable requirements of correctness.

The CAR method follows the three-step procedure presented below [from 11]. First, the values of the alternatives under each criterion are elicited in a way similar to the weights described above:

1A. For each criterion in turn, rank the alternatives from the worst to the best outcome.
1B. Enter the strength of the ordering. The strength indicates how strong the separation is between two ordered alternatives. Similar to weights, the strength is expressed in the notation with '$>_i$' symbols.

Second, the weights are elicited with a swing-like procedure in accordance with the discussion above.

2A. For each criterion in turn, rank the importance of the criteria from the least to the most important.
2B. Enter the strength of the ordering. The strength indicates how strong the separation is between two ordered criteria. The strength is expressed in the notation with '$>_i$' symbols.

Third, the usual weighted overall value is calculated by multiplying the centroids of the weight simplex with the centroid of the alternative value simplex.

The same description can be used to introduce the three candidate methods called C+O, O+C, and O+O depending on whether a cardinal or ordinal procedure is used for the representation of weights and values respectively. In the original CAR method all the steps 1A, 1B, 2A, 2B, and 3 were performed in that order. The steps in the three candidate methods that we suggest are performed as follows: In O+C, step 1B is omitted, resulting in the sequence 1A, 2A, 2B, and 3 in order. In C+O, step 2B is omitted instead, resulting in the sequence 1A, 1B, 2A, and 3 in order. Finally, in O+O, both steps 1B and 2B are omitted, resulting in the sequence 1A, 2A, and 3 in order.

We will, in the next section, compare these CAR derivatives in search for a method with less cognitive load but still performing better than SMART and AHP. This is, to our knowledge, the first time ordinal and cardinal ranking methods (and combinations thereof) have been compared systematically in this way.

3 Assessment of Models for Weights

We will utilize similar techniques as in the simulation studies [8-11] and others for determining the adequacy of the methods suggested above. The assumption in all these is that all elicitation is made relative to a weight distribution held by the decision-maker. The basic idea is that decision-makers' mind-sets should be reflected by the random generator for generating test vectors, but all such machinery is then depending on the underlying distribution of the random generator, which must be taken into account.

Thus, the evaluation of MCDM methods in this paper will follow the procedure described in [8-11] in order to find the most efficient method.

3.1 Comparing Six MCDA Methods

We will compare the three methods SMART, AHP, and CAR, which were compared in [11], together with three new candidate methods (O+C, C+O, and O+O), i.e., the scaled-down versions of CAR as described above, in order to look for methods that are cognitively less demanding while still yielding powerful results. Remember that the CAR method consists of cardinally ranking weights and also cardinally ranking values.[2] The three candidate methods are composed as follows: O+C and O+O use ordinal SR weights while C+O and CAR use cardinal CSR weights. Further, CAR and O+C use cardinally ranked values while C+O and O+O use a pure ordinal ranking of the values (such as $v_{12} > v_{14} > v_{11} > \ldots$).

3.2 Simulations

The simulations were carried out with a varying number of criteria and alternatives. There were four numbers of criteria $N = \{3, 6, 9, 12\}$ and four numbers of alternatives $M = \{3, 6, 9, 12\}$ in the simulation study, creating a total of 16 simulation scenarios. Each scenario was run 10 times, each time with 10,000 trials, yielding a total of 1,600,000 decision situations generated. An *N*-variate joint Dirichlet distribution was employed to generate the random weight vectors for the simulations as well as a standard normalised random weight generator, see [11] for details. Unscaled value vectors were generated uniformly since no significant differences were observed with other value distributions. The value vectors were then used for multiplying with the obtained weights in order to form weighted values to be compared.

The results of the simulations are shown in Tables 1 below, which shows a subset of the results with a selection of pairs (*N*,*M*). The measure of success is the hit ratio, i.e. the number of times the highest evaluated alternative using a particular method coincides with the true highest alternative. The tables thus show the hit frequency for the three MCDA methods SMART[3], AHP[4], and CAR together with the three candidates.

It is clear from Table 1 that among the established methods, the CAR method outperforms the other methods. While CAR averages 87%, the other two well-known methods perform at around 80-81%. For example, in Table 2, CAR displays better overall ranking compared to the other methods. We know from [11] that the other two well-known methods fare about equal, with SMART being somewhat stronger when fewer alternatives are involved and AHP being somewhat stronger when more

[2] In the terminology in this paper, it could have been called C+C but we retain the name it is more widely known under.

[3] SMART is represented by the improved SMARTER version by [12].

[4] AHP weights were derived by forming quotients w_i/w_j and rounding to the nearest odd integer. Also allowing even integers in between yielded no significantly better results.

alternatives are involved. This is not surprising since a very large amount of information is requested for AHP's pairwise comparisons when the number of criteria and alternatives increases. The gap up to CAR for both of the other methods is substantial considering the relatively high hit rate level that the methods operate at. In Table 1, using an *N*–1-generator, this can be seen while the candidate methods fare both better and worse than the established ones.

In Table 1, the established methods yield results as expected and in accordance with [11]. An interesting pattern emerges between the candidate methods. The method O+C that kept cardinality in the values perform rather well while the ones (C+O and O+O) that only use ordinal values perform worse than SMART and AHP regardless of using cardinal weights or not.

Table 1. The winner frequency for the methods

Combined	SMART	AHP	CAR	O+C	C+O	O+O
3 | 3	87.8	84.0	91.9	88.4	84.3	81.8
3 | 12	72.2	82.5	85.8	79.4	74.6	71.3
6 | 6	81.4	79.6	88.0	83.6	75.7	73.6
6 | 12	74.5	81.0	85.6	79.9	73.7	70.8
9 | 9	78.9	80.2	85.1	81.6	73.5	71.9
12 | 3	85.7	76.3	89.3	88.4	82.1	81.6
12 | 12	77.6	81.0	82.7	80.6	72.1	71.3

The CAR method performed the best overall as expected. But the interesting observations are made among the other candidates. One of the candidates, O+C, does perform better than all other methods except CAR. It puts a considerably less demanding cognitive load on the decision-maker by only requiring cardinality in the values, not the preference weights, making it a very attractive alternative. Its efficiency is due to the performance of the ordinal SR weights (Eq.3) originally developed in [8].

4 Concluding Remarks

Elicitation methods available today in MCDM are often too cognitively demanding for normal real-life decision-makers and there is a clear need for weighting methods that do not require formal decision analysis knowledge. We have investigated several methods, including state-of-the-art approaches for asserting surrogate weights with the possibility to supply information regarding preference strength and for assigning values to consequences by ranking them. It is known from [11] that the CAR method outperforms both SMART and AHP, but all these are still considered to be difficult for some decision makers. In search for a method with even less cognitive demand than CAR, three candidates have been put forward. One stood the test, performing better than the benchmark methods SMART and AHP. This new method is similar to CAR in assessing values but use only ordinal ranking of the preference weights. The choice between cardinal and ordinal ranking in the weights has an impact on efficiency, but much less than the values. The focus on cardinally ranking weights is misplaced, it should be on values instead. This, of course, has implication for other cardinal ranking methods such as Macbeth as well.

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Interactive vs. Non-Interactive Dictator Games*

Philip D. Grech[1]** and Heinrich H. Nax[2]***

[1] Chair of Negotiation and Conflict Management, ETH Zurich, Switzerland
[2] Chair of Computational Social Science, ETH Zurich, Switzerland

Abstract. Dictator games model situations where one person decides how to allocate payoffs between himself/herself and others. Such situations differ with respect to whether a given person is either exclusively on the dictating or receiving end, or whether he/she assumes both roles at the same time. In the former (non-interactive) situation, the decision of the dictator is determined by his distributional preferences alone, independently of others' decisions. The optimal allocation is generically intermediate, keeping some and giving some. In the latter (interactive) situation, one person's distribution choice depends on that of somebody else, and decisions are interactive so that non-trivial Nash equilibria exist. Generically, the resulting Nash equilibria are unique and characterized by extremal payments, where at least one of the players allocates either all or nothing to the other. This report on ongoing reasearch summarizes our theoretical analyses of these two situations and highlights key differences.

Keywords: Dictator games, CES utility functions, Distributional preferences, Social preferences

JEL Classification: A13, C72, D01, D64

1 Introduction

Dictator games, and their generalizations, are situations where one player decides how to allocate money between himself and a recipient. Such games are used to measure players' distributional and social preferences with important implications for human behavior in games in general, and, in particular, for cooperating, donating, negotiating, helping, etc.

In the original formulation of a dictator game [11], the dictator decides how to split a pie of fixed size. In the generalized/modified dictator game, the prize

* This extended abstract reports on recent progress from ongoing work, which we intend to make available soon, see [8]. We thank Kurt Ackermann, Raymond Fisman, Matthew Jackson, Tatyana Kovalenko, Ryan Murphy, Matthew Polisson, Henri Rästas and Stefan Wehrli for help and stimulating discussions. Nax acknowledges support by the European Commission through the ERC Advanced Investigator Grant 'Momentum' (Grant No. 324247).

** E-mail: pgrech@ethz.ch

*** E-mail: hnax@ethz.ch

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of redistribution p varies, that is, for every piece π of his pie that the dictator does not allocate to himself the recipient gets p times π.

From a narrowly selfish perspective, the dictator maximizes his payoff by allocating everything to himself and nothing to the recipient, independent of p. Nevertheless, starting with [11], various controlled laboratory experiments have shown that humans typically allocate positive amounts to the recipient, because individuals value the distribution of payoffs more broadly than just with respect to their own material benefit. The seminal study by Andreoni and Miller [3] and various extensions (e.g. [7, 6, 5]) have considered individual allocation decisions in multiple games (with various p's). Using the generalized axiom of revealed preferences (GARP), these decisions are fitted by utility functions of the constant-elasticity-of-substitution (CES) family.[3] As a result, a classification of individual preferences with respect to trade-offs of self-interest vs. altruism as well as equality vs. efficiency emerges.

2 Dictator Games as Proper Games

In this report on ongoing research, we point out an important aspect that concerns the nature of the underlying interaction that needs to be taken into consideration when performing such analyses. Namely, it is of crucial importance to distinguish between the following two types of (generalized) dictator games:

Non-interactive dictator games. The dictator's decision alone fully determines both his and the recipient's monetary payoff. Importantly, the dictator is no one's recipient, and the recipient is no one's dictator. In game-theoretic terms, this dictator game is not a proper game (i.e. it is degenerate), as decisions do not depend on each other. Hence, the analysis of this class of games reduces to decision-theoretic analysis.

Interactive dictator games. Each player assumes both roles, the role of a dictator and the role of a recipient, at the same time. Hence, each player's total monetary payoff is determined by (*i.*) the payment he receives from 'his' dictator and (*ii.*) the amount he keeps and does not give to 'his' recipient. Such games require a full game-theoretical analysis as they are proper, simultaneous-action, 'decomposed' [13] games with non-trivial Nash equilibria.

Figure 1 illustrates these different settings. In this report, we focus on the 2-player case, where both players are each other's dictator and recipient at the same time. However, note that the interactive dictator game may involve two or more than two players: a specific player's recipient may but need not be also his dictator. In principle, a dictator game is interactive as long as each dictator is

[3] GARP goes back to Samuelson [16], CES functions to Solow [17], and the method of estimating preferences to Afriat [1, 2]; see also [4]. A recent overview of the corresponding literature can be found in [9]. Other, simpler approaches to interpret decisions in dictator games include, for example, the 'ring measure' from social psychology [12, 14, 15].

also the recipient of someone (else), who is the recipient of someone (else), etc. – as long as this 'loop' closes. Analysis of the more general, $>$ 2-player case is left for the full paper.

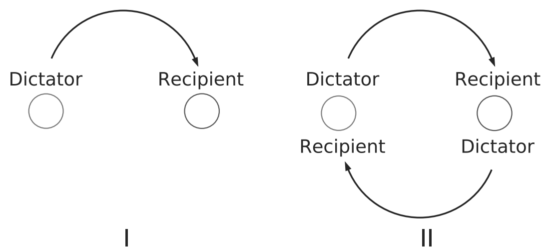

Fig. 1. *(I)* The dictator's own material payoff depends only on how much he keeps, and the recipient's material payoff depends only on how much the dictator gives. *(II)* Each player is both, the other player's dictator and recipient. Hence, a player's material payoff depends on how much he keeps (as he is a dictator) and on how much he receives (as he is also a recipient).

In the real world, there are many examples for both kinds of situations. When making a donation, for example, we can think of this decision as a non-interactive one: while one's own donation may depend on others' donations (to the same recipient), this decision does not depend on any decision taken by the recipient himself. Exchanging gifts, by contrast, is more naturally described interactively, as the gift one makes may depend on the gift one receives.

In the economic laboratory, dictator game experiments have been conducted both in interactive and non-interactive settings. Importantly, existing analyses of interactive implementations have not considered the kind of interactive interpretation that we propose here. In principle, whether or not an interactive dictator game is indeed viewed as such may depend on the circumstances: if an individual assumes both the role of a dictator and that of a recipient but ignores the latter –e.g. because he is framed accordingly– then he will play as if the game was non-interactive. An empirical investigation of dictator game decisions in interactive settings in order to test the new theoretic predictions reported here is part of the ongoing research of the authors.

3 Results

In this report, we restrict ourselves to a semi-formal discussion of results regarding optimal allocation decisions for both types –interactive and non-interactive– of (generalized) dictator games. A mathematical treatment is given in the full paper (including the general N-player case), where also we also present a re-analysis of recent experiments that corroborate our findings.

In our analysis, as is one of the standard assumptions [10], we assume utility functions of the following CES (constant elasticity of substitution) type:

$$v(o, s) := [co^{\rho} + (1 - c)s^{\rho}]^{\frac{1}{\rho}} . \tag{1}$$

Here, o and s represent the final material payoffs for *other* and *self*. Moreover, $c \in [0, 1]$ represents a player's *altruism-vs.-selfishness* preference, so that he is purely selfish if $c = 0$, impartial if $c = 1/2$ and purely altruistic if $c = 1$. The parameter $\rho \in (-\infty, 1]$ represents a player's *efficiency-vs.-equality* preference, so that he/she is completely equality-oriented for $\rho \to -\infty$ (Rawlsian) and completely efficiency-oriented for $\rho = 1$.

Our results summarize as follows. In the non-interactive case, for general CES utility functions, the amount allocated by a dictator to the recipient is an intermediate amount that increases monotonically ($i.$) in the efficiency concern of the player if $p > 1$ (if $p < 1$ it decreases with the efficiency concern), and ($ii.$) in the concern of the player for the other's payoffs, see also [10]. In the interactive case, things become more complex: generically, we tend to have unique Nash equilibria and bang-bang outcomes – that is, at least one of the players gives either nothing or everything. In particular, if both players have sufficiently low –yet not necessarily vanishing– concerns for each other's payoff, no payments are made at all, as opposed to the non-interactive case.

Let us expand on this point with an example contrasting the two cases. Consider the unit-pie dictator game when the price of redistribution is $p = 1$, and suppose players are perfectly impartial ($c = 1/2$ in Eq. (1)) and not fully efficiency-oriented ($\rho < 1$). In a non-interactive setting, such a dictator would split 50:50. By contrast, in an interactive setting, any strategy combination where both players make identical payments forms a Nash equilibrium as they implement a 50:50 outcome overall; in particular, so do zero payments. If, however, both players are even just slightly less altruistic, the degeneracy vanishes and zero giving becomes in fact the only equilibrium. Similarly, if both players are even slightly more altruistic, giving everything becomes the unique Nash equilibrium.

Our results have applications to experimental design. Many of the more recent dictator game experiments follow an interactive implementation while adhering to a non-interactive interpretation. Such implementations have prima facie a clear advantage from a data collection point of view: there are no passive subjects as every participant is required to take decisions that can be used for the subsequent analysis. However, what our results suggest is that zero-giving in an interactive experimental implementation of a dictator game need not stem from extremely selfish players, as is usually claimed. Instead, it may be the consequence of equilibrium play, as participants take into account giving decisions of others.

4 Future Research

We will extend our investigation in two directions. One direction is to analyze existing experimental data to identify behavioral differences between interactive and non-interactive settings (indirectly), and to conduct new experiments in order to test our predictions (directly). The other direction is to extend our theoretical investigation, as our present analysis does not cover interactive settings with incomplete information, arbitrary preference distributions, semi-interactive settings, or multi-player settings.

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Assessing Stakeholders Preferences About Healthcare Facility Location Using FITradeoff Method

Marta Dell'Ovo[1], Eduarda Asfora Frej[2], Alessandra Oppio[3], Stefano Capolongo[1], Danielle Costa Morais[2] and Adiel Teixeira de Almeida[2]
[1] Department of Architecture, Built Environment and Construction Engineering (ABC), Politecnico di Milano, via Bonardi 9, 20133 Milano, Italy
[2] Federal University of Pernambuco – UFPE, CDSID - Center for Decision Systems and Information Development, Av. Acadêmico Hélio Ramos, s/n – Cidade Universitária, Recife, PE, CEP 50.740-530, Brazil
[3] Department of Architecture and Urban Studies (DAStU), Politecnico di Milano, via Bonardi 3, 20133 Milano, Italy
marta.dellovo@polimi.it; eafrej@gmail.com

Abstract. This work aims to present a multiple criteria group decision model to locate healthcare facilities, using additive model with Flexible and Interactive Tradeoff (FITradeoff) elicitation method for scale constants of the criteria. Sitting complex facilities, such as hospitals, is a multidimensional decision problem due to the several issues to be taken into account and also regarding the different opinions of stakeholders that should be involved. The problem addressed here is the location of a new large healthcare facility in Lombardy Region, Italy. FITradeoff is an easy tool for decision makers, because it requires less effort from the DMs compared to other elicitation methods, and thus it is expected to have less inconsistency during the elicitation process.

Keywords: Healthcare facility location, Group Decision, Multicriteria Decision, Additive Model, FITradeoff.

1 Introduction

Weights assignment is a crucial step in the definition of the influence of criteria during the decision process. In detail, planning public services aimed to serve the community, it is important to understand how different parameters can be combined in order to achieve the final aim. The location of healthcare facilities could be a good example to consider in order to analyze this step, as it is a process that should consider many different stakeholders [1] with different expectations and competences.

Actors behave in order to achieve a certain goal that is influenced by specific interests and social factors [2]. Considering their preferences means involving the stakeholders, asking them to rank a set of criteria and comparing the results obtained.

The aim of the research is to understand and compare stakeholders' preferences using Flexible Interactive Tradeoff (FITradeoff) method able to perform several analyses in order to investigate and solve group decision problems.

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2 Healthcare Facility Location Problem

The topic analyzed and investigated for the specific aim of the research is the location of healthcare facilities. The selection of the most suitable area for hospitals' sitting, is a typical ill-structured decision problem, since "Site selection for sitting of urban activities/facilities is one of the crucial policy-related decisions taken by urban planners and policy makers." [3]; "Site selection, as one of the key principles of building planning, plays an important role and has a huge impact on the design of a proposed building." [4]

Starting from a deep literature review and studies of existing evaluation tools [5], focused on the assessment of hospitals' sustainability performance, a multicriteria evaluation framework, composed by a set of sixteen criteria, has been defined, consistent to the multidimensional nature of the decision problem under investigation.

In detail, criteria investigated could be divided in four dimensions -Functional; Locational; Environmental; Economic – according to the subject matter. The Functional dimension concerns intrinsic characteristics of the area to analyze and the neighborhood where it is located (1. Building density; 2. Health demand; 3. Reuse of Built-up areas; 4. Potential of the area to become an attractive point); the Location dimension is related to how and how much the area is served in terms of infrastructures, accessibility, etc. (5. Accessibility; 6. Existing hospitals; 7. Services; 8. Sewerage system); Environmental dimension is focused on the pollution and the context (9. Green areas; 10. Presence of rivers and canals; 11. Air and Noise pollution; 12. Land contamination); Economic dimension in related to the value of the area and its suitability to host a hospital (13. Land size and shape; 14. Land ownership; 15. Land cost; 16. Land use).

The case study analyzed concerns the location of "La Città della Salute" in the city of Milan (Italy), a project aimed to relocate two existing specialized hospitals in order to obtain a unique pole focused on research, teaching, science and training and able to meet new health demands of the population. During the last 15 years, six different areas located in the city of Milan and in the suburb have been proposed [6], but at the moment, the project is undergoing bureaucratic delay.

Given the multidisciplinary approach required to solve the decision problem and the multidisciplinary characteristic of the topic, several stakeholders have been actively involved in the process. In detail, taking into consideration the classification provided by [2], five categories, with specific interests, have been identified:

a. Political actors: Health and Urban Councilor;
b. Bureaucratic actors: Health and Urban General Manager;
c. Actors with special interest: Local Health Unit Director;
d. Actors with general interest: NGO; NPO; common people;
e. Experts: Architects; Urban Planners, Doctors; Urban Economist; etc.

After that, using the matrix of power and interest, the five categories have been further organized in four classes: Minimal effort, Keep informed, Keep satisfied and Key players (Table 1).

Many professionals have been selected for each corresponding class and questioned in order to understand and obtain their preferences for ranking the set of the proposed criteria. In detail, since it is a multidisciplinary problem related in particular to the urban planning and the healthcare field, experts involved belongs to these two categories, as listed in the previous description.

Table 1. Matrix of Power/Interest.

		INTEREST	
		low	high
POWER	low	Stakeholder: **Minimal effort** Nonprofit Organizations; Non-governmental Organizations	Stakeholder: **Keep informed** Common people
	high	Stakeholder: **Keep Satisfied** Health and Urban General Manager, Local Health Unit Director, Experts	Stakeholder: **Key players** Health and Urban Councilor

3 FITradeoff Method

The multiple criteria group decision problem of healthcare facility location addressed in section 2 is going to be solved by applying FITradeoff method [7]. The flexible and interactive tradeoff is a new method for elicitation of scale constants in additive models, based on the traditional tradeoff elicitation procedure [8]. This new method is easier for the decision-makers, because they do not need to give the exact indifference point which makes two consequences indifferent, which is a critical limitation of traditional tradeoff procedure. The number of questions answered by each DM is expected to be lesser in FITradeoff, and the questions made are cognitively easier, compared to the traditional tradeoff procedure [7].

The DMs give information about preference relation between two consequences, and this information is converted into inequalities that act as constraints for evaluation of the performance of the alternatives through LPP models [7]. With these constraints, a weight space is obtained, which is updated with DM responses in order to reduce the subset of potentially optimal alternatives. Since less effort is required from the decision-makers, it is expected to have less inconsistency during the elicitation process [7].

A discussion on the application process is considered based on the adaptation of FITradeoff to Group Decision [9], in which multiple decision makers' preferences can be considered and aggregated, in order to find a final compromise solution. The elicitation is conducted with four different classes of stakeholders and then the results will be compared and discussed, in order to find the best location for the healthcare facility problem. FITradeoff DSS is available for download on request at www.fitradeoff.org.

4 Conclusions

The stakeholders preferences' analysis is assuming a relevant and strategic role because it is possible to create an interaction among different actors, trying, moreover, to satisfy their expectations solving the decision problem. The complexity has been defined by [2] as the plurality of points of view that are present in a process, and in particular, the public policy process is characterized by this kind of complexity. The application of FITradeoff method with the stakeholders involved in the problem could facilitate the decision making process addressing validity and robustness to the methodology applied.

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Preference Non-Linearity and Concession Crossover in Electronic Negotiations

Real Carbonneau[1], Bo Yu[1], Rustam Vahidov[1]

[1]Concordia University Montréal
contact@realcarbonneau.com, bo.yu@concordia.ca, rVahidov@jmsb.concordia.ca

Abstract. In the past it has been suggested by some authors that negotiators utility functions over the issues may not be linear. In this case, a phenomenon called "negotiation crossover" takes place, in which a negotiator may switch issues on which they choose to make concessions at some point in negotiations. This work sets to investigate the validity of such claims. To this end we introduce several concession-making models and use them for testing hypotheses. We have used a dataset from online negotiation experiments featuring a contract – signing case. The results suggest that concession crossover does occur.

Keywords: Concession crossover, Electronic negotiations, Experimental studies

1 Introduction

Concession making behavior exhibited by participants in the negotiation process has a significant effect on the outcomes of negotiations [1]. Understanding the manner in which human negotiators choose to concede on the issues involved can help build effective support tools. When multiple issues are included in the offer exchange, there is always a possibility that the parties will have heterogeneous preferences on the issues. In particular, the importance of different issues will typically vary for a given participant, and it may also differ from the perspective of the counterpart. In this case a mutually beneficial solution can be found when negotiators make appropriate moves.

Under the assumption that issues contain approximately equally spaced options (e.g. $100, $120, $140, $160 for a price) the linear model of negotiator's preferences assumes that the utility values of those options are also equally spaced. In other words, going from one option to the next level results in the same utility difference regardless of the current option level. Northcraft, Brodt and Neale [2] showed that in such model a negotiator will always choose to concede on the same issue. They have proposed an alternative model where the utility functions are non-linear. They have shown that in such a model a phenomenon they called "concession crossover" may

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occur. In other words, a negotiator may switch between the issues at some point when making concessions.

In this work we investigate the presence of the concession crossover using a large dataset obtained from the experiments involving electronic negotiations. We propose alternative models of concession-making behavior in order to test our expectations.

2 Background

When multiple issues are involved in negotiations, it is likely that the negotiators' preferences over the issues will not match exactly. The difference in the importance of the issues of the opposing parties allows for the search of the mutually beneficial solutions. When preferences are kept private such a search can be facilitated by logrolling approach, i.e. making concessions on less important issues in order to obtain gains on more important ones [3, 4].

However, it is often assumed that utility functions of the issues involved are linear [2]. Under this assumption, the rate of utility change remains constant regardless of the current position on a given issue. Northcraft, Brodt and Neale [2] hypothesised that in the majority of cases actual utility functions are non-linear. They have used the same rationale that is used in Economics, i.e. the law of diminishing marginal utility. Under linear model, a negotiator would always prefer to obtain gains on the most important issue. However, under non-linear model, there would be a point where marginal gains on a less important issue will equal (and thereafter exceed) those on more important ones. That point is where negotiation crossover occurs. The authors describe the phenomenon as a concession paradox, whereby gains in less important issues become preferable.

The above work analyzed concessions from the point of view of the receiver. This allows drawing parallels with the law of diminishing marginal utility. In this work we will adopt the view of a concession-maker to detect concession crossover. Simple concession-making models have been introduced in [5]. In particular, one model was based on the assumption that a negotiator will make concession on an issue which has more "concession potential". We will adopt this model in order to detect concession crossover using a large dataset of online negotiations.

3 Models

We propose a series of tests to detect non-linearity of issue preferences as exhibited through concessions and concession crossover. Even though one may ask negotiators to explicitly define their preferences, the true measure of preferences is expressed by the concessions made. Even though a negotiator may make offers based on a strategy designed to send false signals, each offer can potentially be accepted by the counterpart, thus there is significant intrinsic incentive to make offers that closely follow the negotiators true preferences.

For a specific negotiator in a negotiation session, there is a total number of issues (I) and a total number of offers (O). Each offer ($o \epsilon \{1 \ldots O\}$) contains values ($v_{io}$) for each issue ($i \epsilon \{1 \ldots I\}$). The values will range between the minimum and maximum limits for an issue ($d_i = max(v_i) - min(v_i)$). A concession ($\Delta v_{io} = v_{io} - v_{i(o-1)}$) is made when the value of an issue for the current offer is lower than the value of the issue in the previous offer.

For modeling purposes, issue ranges are inversed when required so that they follow the same direction as utility, meaning a larger number is better for the negotiator. Thus, we always model from the perspective of maximizing utility. Buyers and sellers ranges are always inverse.

For a given issue, we can calculate the remaining concession potential as:

$$p_{io} = \frac{(v_{io} - min(v_i))}{d_i} \tag{1}$$

The baseline model used for the analysis here is the random model. Here the assumption is that a negotiator randomly picks an issue for concession-making at each step. A good predictive model must fit the data better than the random one. The random model simply indicates that the negotiator has no preference difference between issues and chooses a random issue that has remaining potential to concede on.

A negotiator who adopts a random sequence will behave as follows:

Let r be a random issue in the set $\{1 \ldots I\}$

$$(i = r \wedge p_{io} > 0) \rightarrow (\Delta v_{io} < 0) \quad \forall o, \forall i \tag{2}$$

The most basic assumption in modeling concession-making is that of linear sequence of issues to concede. Under this assumption, the negotiator will concede on the least preferred issue until there is nothing left to concede. Even if the counterpart has conceded on the negotiator's least preferred issue, the negotiator will still be willing to concede beyond the counterparts offer since any other issue concession will result in larger utility loss.

Therefore, we define Naive model as follows: A negotiator who adopts a linear utility model will behave as follows:

$$\left(\Delta v_{i(o-1)} < 0 \wedge p_{io} > 0\right) \rightarrow (\Delta v_{io} < 0) \quad \forall o, \forall i \tag{3}$$

The first and simplest model that can be used to test for concession crossover is the anti-naive model. In this model the next issue to be conceded on will be any issue other than the issue that was last conceded on, for which there is remaining potential to concede on.

Anti-Naive model: Concessions will be made as follows:

$$\left(\Delta v_{i(o-1)} \geq 0 \wedge p_{io} > 0\right) \rightarrow (\Delta v_{io} < 0) \quad \forall o, \forall i \tag{4}$$

A more complex model for explaining concession crossover considers how much the concession-making potential remains in each issue. The next issue for concession would be the one with the most remaining concession potential.

Max-Potential model: Concessions will be made as follows:

$$\left(i = argmax_{j\in\{1..I\}}(p_{io}) \wedge p_{io} > 0\right) \rightarrow (\Delta v_{io} < 0) \quad \forall o, \forall i \tag{5}$$

4 Hypotheses

Our basic expectations are that 1) concession crossover occurs, and 2) Max-potential model explains concession crossover better than other models. Thus we propose the following hypotheses.

H1: Random model will significantly outperform the Naive model in predicting the next concession issue.

Linear utility assumption implies that naïve model should do significantly better than the random one. Our expectation is that switching between the issues, even using random choice should do a better job at predicting the next issue, than the Naive model, which prohibits any switching, as long as there is a potential concession remaining on a given issue.

The Anti-Naive model will be the first test effect for non-linear sequence that result in concession crossover.

H2: Anti-Naive model (3) will significantly outperform the random model in predicting the next concession issue.

The second non-linear sequence model is the Max-Potential concession model, which specifies that the next concession will be on the issue with the most remaining potential.

H3: Negotiators will make the next concession of the issue with the most remaining concession potential (4)

Since we may have two different concession crossover models that explain the data, we might need to compare the Max-Potential model to the Anti-Naive model. If the more complex model is not shown to be a better explanation of the behaviour, it would be considered rejected.

H4: The Max-Potential explains the concession crossover better than the Anti-Naive model.

5 Results

The dataset used in the study comes from online bilateral negotiation experiments conducted regularly in the last 10 years and contains records collected from over 2000 subjects. The negotiation case is about signing a contract between a music company and a musician. The case has been described elsewhere, e.g. [6], hence here we will only briefly mention the issues involved. The negotiated issues included number of new songs (songs), royalties for CDs (royalties), contract signing bonus (bonus), and number of promotional concerts (concerts). No exact preference information was given to the subjects, but the relative issue importance and utility values were shown graphically in form of circles.

Because the negotiation issue had different numbers of predefined option levels, there are more concessions made on issues with more option levels. For example, Concerts has 4 option levels, Songs has 5, Royalties has 4 and Bonus has 3. Therefore, there will be more concession occurrences on Songs simply because there are more levels. We could simply predict that Songs would be the next issue to be conceded on and it would fit the data better than the Random model. However, since none of our models are issue specific, it has no impact on the tests. In addition, since the Random model is the baseline, and not simply a 25% (1 in 4 issues) prediction rate, any impact of an overall issue bias on the results is completely avoided.

Since the models evaluate the next concession based on the previous concessions, at least two offers are required from a negotiator. The negotiators who sent only one offer have been excluded in the analysis. After the filtering, there were 9024 offers in the Music negotiation case that were used for hypothesis testing. The results are presented below:

To test Hypothesis 1, we compared the Naive model versus the Random model. Since a negotiator may have conceded on more than one issue at the same time, only one of such concession issues was chosen randomly to provide a fair comparison. The Random model had an average fit of 18.01% and the Naive model had an average fit of 7.05%. The difference between the two means is highly significant (p-value 0.00000). Therefore H1 is supported.

The Anti-Naive model can select any or multiple issues with remaining concession potential that did not have a concession in the last offer. To make the comparison fair with the Random model and other models, a random issue will be selected from these issues. The average fit of the Anti-Naive model is 21.55% versus 18.01% for the Random model. Thus the Anti-Naive model fits the negotiator’s concessions better than the Random model with the difference between the two means being highly significant. Therefore, Hypothesis 2 is supported with a p-value of 0.00000.

The average fit of the Max-Potential model is 25.69%, which is higher than 18.01% for the Random model. Thus, the Max-Potential model fits the negotiators selection of issue sequence to concede 42.65% better than the Random model with the difference between the two means being highly significant. Therefore Hypothesis 3 is supported with a p-value of 0.00000.

Furthermore, the average fit of the Max-Potential model is 25.69%, which is higher than 21.55% for the Anti-Naive model. Thu, the Max-Potential model fits the negotiators preferences 19.18% better than the Anti-Naive model with the difference between the two means being highly significant. Therefore Hypothesis 4 is supported with a p-value of 0.00000.

These results provide evidence demonstrating that the negotiators will select a non-linear issue sequence to concede, when utilities are non-linear and that concession crossover does occur.

6 Conclusion

The purpose of this work is to demonstrate that the phenomenon of concession crossover will occur in negotiations involving multiple issues when negotiators' utilities are non-linear. To this end we have used experimental data containing records of bilateral negotiations featuring a contract signing case. We have used four concession prediction models in order to test the crossover effect. The results demonstrate that concession crossover does occur in negotiations.

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Self-other Perceptional Differences in a Negotiation Process: A Study of Culture Dimensions

Susane Gomes[1], Danielle Morais[1] and R. P. Sundarraj[2],

[1]Universidade Federal de Pernambuco, CDSID - Center for Decision Systems and Information Development, Av. Acadêmico Hélio Ramos, s/n – Cidade Universitária, 50740-530, Recife, Brazil
[2] Department of Management Studies, Indian Institute of Technology Madras, 600036, Chennai, India
susaneep@yahoo.com.br, dcmorais@cdsid.org.br, rpsundarraj@iitm.ac.in

Abstract. Human beings make decisions based on their values, beliefs and other aspects belonging to a set of particular individuals/group, known as culture. Negotiations processes also reveal cultural aspects of people. This work-in–progress considers negotiation contexts, and seeks to understand how people perceive themselves in this context vis-à-vis their perceived expectations of their negotiation counterparts. The overarching goal is to study the effect of culture on this self-other perceptional difference, specifically with Brazilians and Indians. We use Cultural Dimensions developed by Hofstede, and report very initial results with a small Brazilian sample. Currently data from India are being collected.

Keywords: Negotiation process; Cultural aspects, Negotiators perceptions.

1 Introduction

Culture is one aspect that can define the attitudes taken by people in making decisions. The term can be used in different formats such as nations, regions within nations, or even between some groups (ethnic or tribal) in a region [1]. Cultural differences have an impact on how individuals interact during the process of negotiation or group decision [2].

Not only in cross-cultural negotiations are the differences perceived. Even in one country (continental countries) the way of population reacts and their points of view can change significantly. This can be explained, according to [1], because each nation/culture has a diversity of individuals.

According [3] on the business negotiations study three phases are essential: antecedent phase, concurrent phase and consequent phase. These phases correspond to the three stages of negotiations in the real world: pre-negotiation analysis, conduct of negotiation and post-settlement analysis. Table 1 summarizes the main features of each stage of negotiations by [4]. It is possible see that before initiating a negotiation, in the earlier stage, is crucial to know better the opponent to best formulate the strategies to apply during the negotiation process.

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Table 1. Phases of the negotiation [4]

Business negotiation on literature	Negotiation in the real world	Characteristics
Antecedent phase	Pre-negotiation analysis	Situation, problem and opponent analysis; formulation of preferences (characteristics of negotiators); strategy; restrictions
Concurrent phase	Conduct of negotiation	Messaging and offers; the offer includes all issues; the compromise is reached or one party terminates the process and informs; analysis of the strategy and behavior, changes in the negotiation problem and the perception of the negotiators, and the dynamics of the negotiations
Consequent phase	Post settlement analysis	Evaluation of the negotiation results (commitment and satisfaction); if negotiation enables analysis and improvement of compromise efficiency, this improvement should be continued, post-trade questionnaire

The work published by [5] explores how valid can be studies with student samples, making a wide exploration of works already performed. One justification to conduct research with student samples is the difficulty of professional negotiators have available time to participate in surveys. Although there are some controversies by researcher groups affirming that students have no experience or these kind of studies could be better with MBA students only, the research showed satisfactory results to conduct studies in negotiation among students.

Focused on the experience issue the paper concludes that negotiators, because they have more experience, do not outperform students without experience. The difference between a trade made by professionals and students, detected in an experiment done by [6] was about the speed at which traders more expertise achieve faster results than students.

The famous study of Hofstede [7,8] about a metric scale to measure the cultural values has been widely used over the years. He considers five dimensions to measure the culture values of a set of individuals: Power Distance, Individualism x Collectivism, Masculinity/Femininity, Uncertainty Avoidance, and Long-Term Orientation.

The Power Distance dimension measures perceptions of authority and power. High power distance means that organizations/individuals are characterized by the strong sense of hierarchy where subordinates have a distant relation with their superiors. Individualism dimension measures if the values of certain community prioritize the needs of an individual or a group. Masculinity dimension reveals some masculine norms (achievement, material orientation) or feminine norms (base on relationships, people orientation, and quality of life). High level of masculinity means that a group/society values are more competitive, materials, assertive. The Uncertainty Avoidance dimension reflects the degree to which a person prefers security and stability. Finally, the Long-Term Orientation dimension shows the values oriented towards the future, such as perseverance.

Based on these five cultural dimensions proposed by Hofstede, the overall objective of this work-in-progress is to analyze the behavior of Brazilians and Indians regarding how they view themselves (and act during a negotiation process) in relation to the perceptions/reactions of their counterparts. The study has been started with Brazilian sample as a pilot and the current status is the data collection among Indians. More data from Brazil has to be collected and then compare the results.

2 Questions

The broad questions arising in this research program:

1. How do people perceive themselves when they are in a negotiation context?
2. Are these perceptions different from what they expect from their negotiation counterpart?
3. How does culture influence these perceptions and also the gaps between these perceptions?

A set of experiments done by [9] reports the relationship between the self-evaluation and the evaluation of others in social judgments. Three experiments were done in order to examine this relationship. It was found in one of the experiments that the self-evaluations were more favorable than the assessments of the other part, and the higher a person's self-esteem the more positive was their assessment of the other. This comparison between self-evaluation and self-esteem generates self-esteem, and these perceptions about the differences found may or may not motivate one part to negotiate with another. This becomes even greater when it comes to different cultures.

The activities already done as part of the pitot study are as follows.

3 Methodology

Survey Instrument

The experiment seeks to capture the perceptions of the participants about how they act on a possible negotiation process and compare these answers with what they expect their counterparts act in a negotiation environment using a questionnaire containing some situations that can occur in a negotiation scenario. Thus, there are two sub-sections in the questionnaire: one about how the participants act in a negotiation process and the other about the perspective of how they wish their counterparts act in the same scenario.

Since the fundamental purpose of our research is about the role of culture, our questionnaire is also about the five culture dimensions. The questionnaire was based on instruments available in [10, 11, 12, 13], but the questions was formulated to a negotiation process environment.

The questionnaire has a total of 52 items in both sections. All the questions are measured using a five-point Likert scale. Table 2 show some questions for each of dimension from Hofstede’s work. The questions capture the aspects from the respondents about themselves. These same questions are made after in relation to their perspectives about their opponent.

Table 2. Partial questionnaire about negotiation perceptions based on cultural dimensions.

Cultural Dimension	Questions
Power Distance	▪ I think I should address my superiors with more politeness than I address my subordinates during a negotiation ▪ I work hard during a negotiation.
Individualism *versus* Collectivism	▪ I am very cooperative during a negotiation ▪ I prefer to work in groups or in pairs rather than working alone during a negotiation
Masculinity *versus* Femininity	▪ I am an ambitious person during a negotiation ▪ I am a reluctant person during a negotiation
Uncertainty Avoidance	▪ If my job is to negotiate, I prefer to work in the same place during a long period of time ▪ Usually, I get nervous or tense during a negotiation
Long *versus* Short-Term Orientation	▪ I am a persistent person during negotiations ▪ In negotiations, I try not to do anything that will embarrass me

It is notable that the goal of this questionnaire is capture the point of view of the respondents in some situations that can occur in a real world of a negotiation process.

Participants

The first step of this research program was start the conduction of data collection among Brazilians students, with participants having different levels of education. The survey was administered in one state of Brazil. While this is a limitation (note: Brazil has been found to have sub-cultures within its population), there are people in the sample who belong to other states. Subjects are university students. Although there have been issues raised with respect to the use of student subjects [5], one justification to conduct research with students is the difficulties that professional negotiators have in terms of time available to participate in surveys. Further, in one study with trades [6], it was found that the differences lie not as much in perception, but more in speed, as explained before.

Given this, we collected responses from 5 students from Brazil. All respondents participated in the research voluntarily and the data collection was done in December 2016. Participants from three institutions have participated with a varied academic background. On average the sample is 26 years old, ranging from 19 to 52 years old. Some demographics data from the survey participants are shown in Fig.1.

The next and current step is collecting data from Indians. In this stage, data collection is also being made among students from one state in India. At the present moment, a sample of 159 was collected. The sample is 24 years old, in average. The descriptive data are presented also in the Fig. 1.

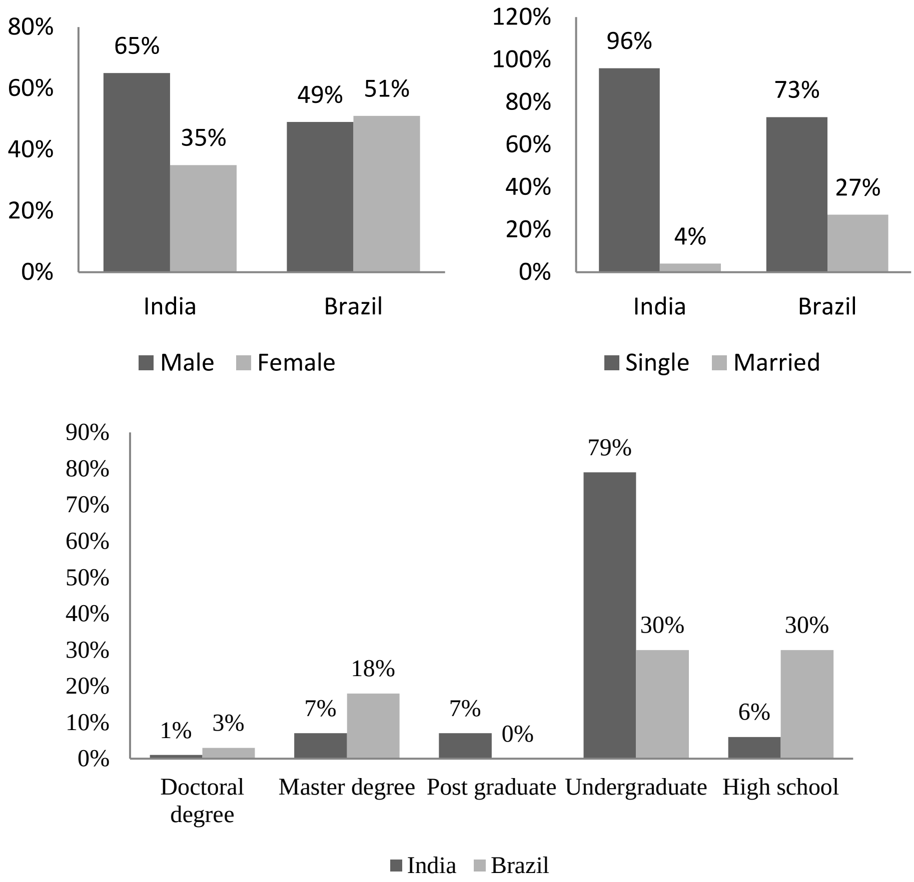

Fig. 1. Demographic data from the survey participants from three institutions in Brazil and three institutions in India

The data is also being collected in three institutions in India. The data present more male participants and a large portion of the sample is composed by single respondents. Most of the data has as the last education level the undergraduation.

4 Initial Findings

The first step is to do a factor analysis with the goal to group the variables with minimal loss of information. The extraction was based on principal components with varimax rotation. It was four factors for the self-evaluation and five for the counterpart's evaluation. We next analyze with the four factors given below with some descriptive statistcs..

- Power Distance dimension: Brazilians view themselves as a person who has low PD while it is not to clear about what they expect from their counterparts (some prefers negotiate with a counterpart who prefers low and others with high PD); Indians, however, has a high PD level and also prefer to negotiate with someone who has a high PD level.
- Uncertainty Avoidance dimension: when the Brazilians respondents believe to be risk averse and when they have to negotiate with someone the answers are divided among be averse or risk prone; Indians are risk neutral and prefer also negotiate with a risk neutral counterpart.
- Individualism and Long-term Orientation dimensions: in these dimensions the respondents have the same behavior, in both cultures. They believe be collectivist and expect to negotiate with collectivist counterpart and also they are oriented to the future and prefers negotiate with a person having this same profile;
- Masculinity: in both samples the respondents present a high level of Masculinity while prefers to negotiate with a counterpart who presents a low level in this dimension.

After the demographic analyses, we did a correlation test. The Spearman correlation test was applied to both evaluations (self-evaluation and counterpart's evaluation). This test gives us the information of the items how correlated the items are. The correlation of the items were evaluated to each factor and was observed that with p-value of 0.05 the variables were few correlated, except the items belonging to the Individualism x Collectivism dimension in both cultures (0.71 for self-evaluation and 0.76 in Brazil and 0.77 for self-evaluation and 0.61 for counterpart evaluation in India).

5 Expected Results from Future Work

The first step of this study was starting to collect some data from Brazilians. Data collection in India has begun in April 2017 and is still in the data collect stage and is expected to finish until July 2017.

The expected result from this research is to compare the cultural difference between Brazilians and Indians regarding their perceptions in negotiation processes. To get a significant and consistent result the factor analysis suggests that the number of respondents be five times the number of variables. So, this way, the number of the sample must be bigger to better compare individuals in Brazil and also in India.

The statistical analyses are being made with the sample from India. For future work the sample must be bigger and also collect more data from Brazil.

6 Conclusions

The main remarks of the proposed work is that study trying to obtain the gap between the perceptions about the respondents and what they think that their counterpart could be. Analyzing this gap, besides to see how the participants from both culture react and in this way it is possible to know more about the counterpart, we can observe how fast could be a negotiation, since the sample can act in a way however desiring to negotiate with a counterpart acts in another way could take time on the negotiation process. With this outcome the negotiator is able do best develop his strategies based on the strengths and weaknesses from his/her counterpart.

The current stage of this research is the data collection, from both cultures to have a representative sample and then compare the results. The questionnaire must be validated and then statistical tests have to be made.

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From Desirable to Feasible. Fostering Inter-Institutional Cooperation with Competence-based Multi Criteria Analysis

Geert te Boveldt[1], Koen Van Raemdonck[1], Cathy Macharis[1]

[1] VUB-MOBI, Pleinlaan 2, 1050 Brussels, Belgium

Abstract. Many contemporary policy issues require cooperation between institutions. Yet, cooperation is often hampered by problems including political transaction costs and the non-internalisation of externalities. The article presents a novel evaluation and group decision-making method, Competence-based Multi Criteria Analysis, which, in essence, is a framework for applying MCDA in a multi-actor, multi-level context. For each actor the desirability of different decision alternatives is derived from the actor's individual criteria and priorities. Individual actor results are aggregated with those of other actors that have the same role or function in the decision's implementation, yielding insight in the desirability of the decision alternatives for each of the groups whose support is needed for the decision's implementation. The article shows how COMCA can be applied for overcoming typical hurdles in inter-institutional cooperation by revealing policy options that are feasible considering the actors' competence to make or break a decision, or revealing policy options that are desirable from local or global points of view.

Keywords: multi-actor multi-level decision making, multi criteria analysis, project appraisal, inter-institutional cooperation

1 Introduction

In many situations decision makers are faced with problems that stretch beyond their institutional boundaries or fields of competence. Typical examples include global challenges that cannot be dealt with by single states, such as financial market regulation, climate policy, migration policy and others. Inter-institutional cooperation is also needed in smaller-scale issues, such as metropolitan transport infrastructure between cities and surrounding commuter municipalities.

This short paper presents a novel group decision-making tool that aims to foster inter-institutional cooperation: Competence-based Multi Criteria Analysis (COMCA). Its use is explained in how it can help facing two challenges associated with inter-institutional cooperation: 1) political transaction costs, and 2) the non-internalisation of externalities.

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The paper first explains COMCA and its origins in Multi Criteria Decision Analysis (MCDA). Then, the challenges of political transaction costs and the non-internalisation of externalities are discussed and the role COMCA can play to tackle these challenges. Next, ongoing research for the application of COMCA in the planning of metropolitan infrastructure is discussed.

2 What is COMCA?

In short, COMCA is a group evaluation and decision-making tool for problems with multiple actors with different tasks or levels of responsibility. It indicates which decision alternatives best meet the priorities of individual actors, but it also indicates the feasibility of decision alternatives by showing the support for each alternative among each of the actor groups that are accountable for each of the tasks needed for implementing the decision alternatives.

COMCA is a means for applying MCDA in a multi-actor, multi-level context. MCDA is a well-established branch of decision making methods. Its principle is to provide the decision maker with an indication of the desirability of several decision alternatives, usually in the form of a preference ranking, based on multiple, often conflicting, criteria.

Many real-world decision problems, however, do not concern just one but several decision makers. For this reason several methods have been developed for involving multiple stakeholders or actors in the process. Multi Actor Multi Criteria Analysis (MAMCA) (Macharis, 2005; Macharis, Turcksin, & Lebeau, 2012), for instance, juxtaposes the preference rankings of a common set of alternatives by multiple actors, each using an individual set of criteria.

In MAMCA, aggregation of individual preference rankings into a common preference ranking is usually omitted and focus is put on critical actors or critical criteria regarding a common decision. (Macharis et al., 2012) Indeed, aggregation of individual preference rankings only makes sense in cases where: 1) a single group judgement is required rather than an indication of obstructing factors, and 2) actors are interchangeable or are considered equivalent.

These conditions might be met in situations with a large number of actors, of whom no-one’s individual judgement is crucial (e.g. customers co-deciding on the launch of a new product), or in situations where MAMCA is adopted as a group decision-making method by actors that consider each other equivalent, i.e. when it is applied using a constructive approach (Roy, 1993), rather than a prescriptive or descriptive approach (Bell, Raiffa, & Tverski, 1988).

Thus, simple aggregation of individual preferences is not appropriate in most real-world policy-making situations. In certain decision problems, however, the number of actors is so high (e.g. citizens or customers) and the degree of influence so different (e.g. national vs. local government or citizens), that a mere juxtaposition of preference rankings would play down the preferences of crucial actors and leave too much complexity for decision makers to deal with. In such situations differentiation between actors is needed in order to structure their preferences.

Several methods differentiate between actors by assigning weights to stakeholders. This typically implies actors assigning each other relative degrees of influence (Hosseini & Brenner, 1992; Ramanathan & Ganesh, 1994; Van Den Honert, 2001). While this might be a sensible in a constructive approach, with all actors adopting 'the rules of the game', again, it is less likely to accurately reflect real-world power relations. Moreover, when actors evaluate each other, there is risk of coalition formation (Bogetoft, 1992; Van Den Honert, 2001).

In COMCA, the actors' degree of influence is not expressed with an absolute value. On the contrary, the actors' influence depends on their role in the implementation of the decision in question, i.e. their competence. Accordingly, actors are classified in competence domains; the smallest subsets of actors of which support as a group is essential for the decision's implementation. From this classification one can derive if actors constitute a competence domain on their own and are therefore to be considered as a veto players (such as permit-granting authorities), or as belonging to a group of whom only a substantial amount but no individual support is required (customers, citizens in participatory processes) and whose preferences are therefore eligible for aggregation.

Through preference ranking by competence domain one can derive the desirability of the different project alternatives for each of the actor groups accountable for implementing the decision. This also provides an indication for the feasibility of each decision alternative as a whole.

3 How does COMCA work?

In theory, within COMCA, any existing MCDA technique can be used, such as MAUT (von Neumann & Morgenstern, 1947), ELECTRE (Roy, 1968), AHP (Saaty, 1980), PROMETHEE (Brans & Vincke, 1985) or Verbal Decision Analysis (Larichev & Moshkovich, 1997). The social context of COMCA, however, requires maximum transparency, rather than mathematical sophistication. For this reason, in many cases, Simple Additive Weighting might be the most appropriate technique (Mayer & Stirling, 2004; Stirling & Mayer, 1999).

In summary, COMCA consists of the following steps: 1) determination of the planning problem and project alternatives; 2) determination of required competences; 3) identification of actors; 4) determination of criteria; 5) assessment of alternatives on criteria; 6) assignment of relative priorities to criteria; 7) determination of individual actor preferences; 8) determination of group preferences per competence domain; and 9) determination of overall group preferences. These steps do not have to follow each other in the stated order as more often than not, decision making is not a linear but rather a circular or chaotic process with multiple feedback loops.

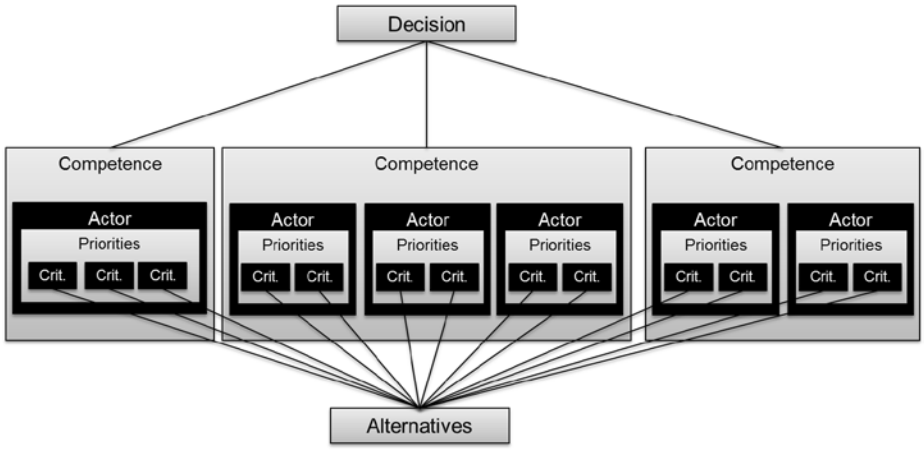

Fig. 1. Structuring multi-actor multi-level decision making with COMCA

4 Alleviating political transaction costs

For institutions such as local or regional governments, cooperation can be advantageous in many different ways, especially when the social-economic functioning of their respective jurisdictions is spatially entangled. However, even when potentially beneficial for all actors involved, inter-institutional cooperation can be hampered by political transaction costs. North (1990) defines transaction costs as the costs of 'measuring and enforcing agreements'. In inter-institutional cooperation the concept can be used to refer to the non-monetary costs of obtaining information on which issue to cooperate with which actors, but also the burden of negotiation on which decision to take might be perceived too high a cost for making cooperation attractive.

COMCA can help to alleviate political transaction costs. Any actor can initiate a process to explore the social-political feasibility of an inter-institutional project. COMCA provides information on which actors are likely to provide support for which project alternatives. Using this method helps actors to reveal previously unknown mutual interests. Negotiation costs are brought down as well, as actors stipulate the criteria that make decisions, in their perspective, acceptable or not.

5 Internalising externalities

Alleviating political transaction costs leads to win-win situations in projects that are beneficial to all actors. However, many inter-institutional projects do not generate equal benefits and costs for all. Infrastructure, for instance, is beneficial to those who use it to reach their destination, but disadvantageous for those who experience environmental nuisance. A waste incineration plant is indispensable, but undesirable for those living nearby. In other words, some actors have to bring sacrifices in favour of the common good.

This, however, is unlikely to happen in situations where each actor has a de facto veto right; a common sight in international politics (e.g. EU, UN) or within federalised states (e.g. Belgium). Rationally acting actors have no incentive to act in favour of the common good when it is not beneficial to their own situation. The problem is, indeed, that when the territories of jurisdictions do not correspond to the spatial functions they host, institutions do not experience the full impact of their decisions. As Hooghe & Marks (2003) put it: institutions do not internalise the negative or positive externalities of their decisions.

This situation leads to what Scharpf (1988) calls the joint decision trap; inter-institutional decisions do not reflect the social optimum, but rather the lowest common denominator, i.e. the decision accepted by all. Solutions that are desirable from a group perspective are not feasible because they are not desirable for each individual. Likewise, feasible solutions are unlikely to be the most desirable for the group as a whole.

In multi-level governance contexts, such as occurring in federal or EU politics, a higher-level institution cannot overrule a lower-level institution’s veto. This implies that in prescriptive decision analysis methods (Bell et al., 1988), their respective preferences should be held in equal regard.

Figure 2 shows the juxtaposed preference rankings of a hypothetical project straddling the border between two regions. Even if alternative A, the social optimum, is preferred by most actors, it is not a feasible alternative because certain actors (municipality 2 and to a lesser extent, region2) are unlikely to accept.

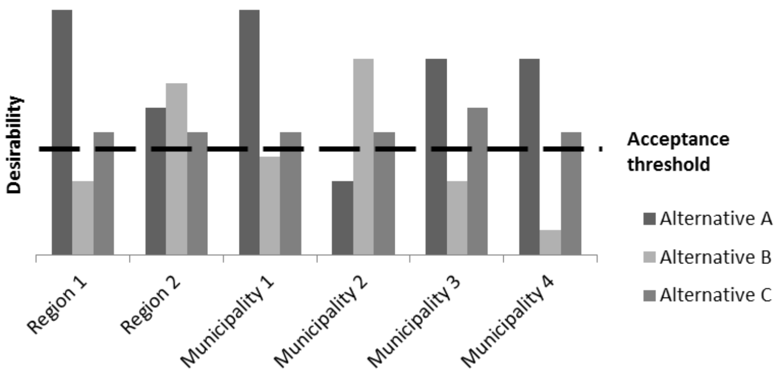

Fig. 2. Desirable vs. feasible decision alternatives

COMCA, or any group decision-making method for that matter, cannot change the institutional set-up to remove an institution’s veto right. Yet, in a constructive approach (Roy, 1993) where actors are incited to act beyond maximising local utility, COMCA can be used to reveal area-optimal solutions. That is, in inter-institutional projects with an uneven distribution of effects (as in any infrastructure project), institutions of the same level can be considered competitors for the project's amenities (and the avoidance of nuisance) and will favour different project alternatives. In a constructive COMCA approach, institutions of the same level can be considered equivalents, allowing for the aggregation of their preferences. The result reflects an area-optimal solution where local interests are compensated for by other local interests of the same level; externalities are internalised.

Figure 3 shows the aggregate preference rankings for each institutional level using the same project as for figure2. It shows that for the project area as a whole (which can either be divided into 2 regions or 4 municipalities) alternative A is the optimal solution. Yet, even if a constructive COMCA approach reveals group- or area-optimal solutions, the intermediary steps revealing critical actors and criteria remain useful for formulating compensation policies.

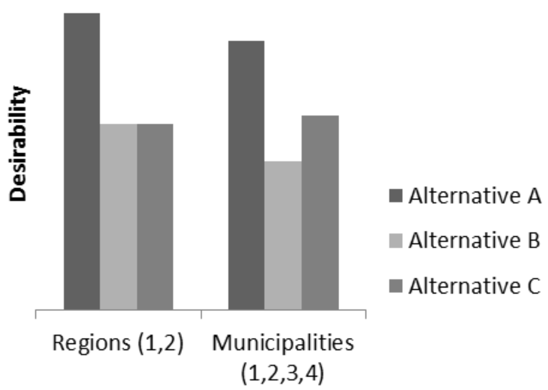

Fig. 3. Preferences aggregated by institutional level

6 Current applications

COMCA is currently applied in the metropolitan area of Brussels, Belgium, for the planning of several transport projects, such as highway feeder roads, suburban (light) rail and bus lines. This metropolitan area has the peculiarity that the central city (itself consisting of 19 municipalities) and its commuter belt belong to three different regions, each with a high degree of transport policy autonomy, without any coordination from a higher policy level. This has resulted in political deadlock and a virtual standstill of most metropolitan transport projects.

Applying COMCA, the authors aim to contribute in overcoming the institutional deadlock with innovative forms of cooperation and decision making. Simultaneously, experience is gathered for fine-tuning the method in terms of data input, stakeholder consultation, and modes of processing and aggregating stakeholder input.

7 Conclusion

Many contemporary policy issues demand an inter-institutional approach. Cooperation between institutions, however, is hampered by problems such as political transactions costs and the non-internationalisation of externalities. This article shows how a novel group and decision-making method, COMCA, can be applied to tackle these problems. It is potentially helpful in identifying feasible inter-institutional policy options and actor coalitions. Also, it helps to reveal which policy options are desirable for each actor individually, which options are feasible considering each actor's competence to make or break a decision, and which options are desirable from a global, rather than a local point of view. Potentially, COMCA can be applied in any decision problem with actors that have different roles in the decision's implementation.

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Cobb-Douglas Modelling for the "Me" Versus "Us" Strategic Decision in Dynamic Negotiation Process

Alexandre Bevilacqua Leoneti[1], Dmitry Gimon[2]

[1] Research Group in Decision Sciences, School of Economics, Business Administration and Accounting, University of São Paulo, Ribeirão Preto, Brazil, ableoneti@usp.br
[2] Park University, Parkville, MO, dmitry.gimon@park.edu

Abstract. This paper studies the application of the Leoneti utility function for multi-criteria decision problems to dynamic games with two players. In order to support Pareto optimality of the choices, the Cobb-Douglas function is used to combine players' utility function and the probability of playing altruistically. The latter is defined by the balance of the payoffs in past negotiations proposed by Gimon. A numerical example showed that the Cobb-Douglas function, when used as a utility function in dynamic games, results in alternations of the games' Nash equilibria. The payoff balance tends to converge to a single limit defined by the players' preferences and their aspirational payoff balances.

Keywords: multi-criteria decision-making, Nash equilibrium, dynamic games, dynamic negotiations, Cobb-Douglas function.

1 Introduction

In economic sciences, the branch dealing with individual and group decisions is the microeconomic field that is based on the idea of utility functions. Utility functions are mathematical models whose goal is to translate material goods into an ordinal scale that satisfactorily represents an individual's satisfaction with their choices [1]. Several of these functions have been proposed, many following the axioms proposed by von Neumann and Morgenstern [2], and form the basis of game theory. In general, the main characteristic of these functions is the measurement of utility in strategic interaction environments, where the choices of individuals in a group depend on each other choices.

At the individual level, a utility function with interesting mathematical properties is the Cobb-Douglas function [3]. This utility function, created by the mathematician Charles Cobb and the economist Paul Douglas, has similar characteristics to the convex monotonic indifference curves, also known as well-behaved indifference curves. This utility function allows one to describe the preferences of an individual with respect to two goods, x_1 and x_2, according to equation

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$$u(x_1, x_2) = x_1^c x_2^d \tag{1}$$

where x_1 and x_2 are, respectively, the amount of goods 1 and 2, and c and d are positive numbers that describe the preferences of an individual over the two goods.

In the context of group decision making, a recent example is the utility function proposed by Leoneti [4]. This utility function allows for the modeling of the strategic interaction that occurs between two or more decision makers who have different preferences for meeting the multiple criteria that are under evaluation and who need to make a joint decision. An example of this utility function for group decisions can be seen, for the case of two players, in equation

$$u_i(x_1, x_2) = \varphi(x_1, IA).\varphi(x_1, x_2).\varphi(x_2, IA) \tag{2}$$

where u_j is the utility for the player i = 1,2, IA is the maximum value that the player can obtain from x_1 and x_2 together and φ is an estimate for the trade-offs according to equation

$$\varphi(x_1, x_2) = \left[\frac{\alpha_{x_1x_2}}{\|x_2\|}\right]^{\delta} .\cos\theta_{x_1x_2}, where\ \delta = \begin{cases} 1, if\ \alpha_{x_1x_2} \le \|x_2\| \\ -1, otherwise \end{cases} \tag{3}$$

where, $\alpha_{x_1x_2} = \|x_1\| \cos\theta_{x_1x_2}$ is the scalar projection of the vector x_1 on the vector x_2, $\cos\theta_{x_1x_2}$ is the angle between the two vectors, $\|x_2\| = \sqrt{c_1^2 + c_2^2 + \ldots + c_c^2}$ is the norm of the respective vector with c criteria . The image of φ (range of the function values) varies between 0 and 1 (due to the conditional δ), meaning the closer it is to 1 the more similar are the alternatives. An example of modeling using this utility function in a group environment is the battle of the sexes game, where the husband and wife must decide where to go out together. These two players have different preferences and therefore different utilities. For example, let us consider that the husband and wife have different preferences over two criteria, “Adventure” and “Romance”. Consequently, they will have different utilities for going together either to “Cinema” or “Football”. Figure 1 shows how such a game would be modeled using the utility function of equation 2 and demonstrates the utility for each player depending on their choice and on the choice of the others.

	Football (F)	Cinema (C)
Football (F)	$u_1(F,F)$	$u_1(F,C)$
Cinema (C)	$u_1(C,F)$	$u_1(C,C)$

	Football (F)	Cinema (C)
Football (F)	$u_2(F,F)$	$u_2(F,C)$
Cinema (C)	$u_2(C,F)$	$u_2(C,C)$

Fig. 1. Framework for a game with two players (Husband left and Wife right) and two alternatives

In game theory, one way to solve the games is to use the concept of equilibrium. The most famous is the equilibrium proposed by John Nash Jr. [5]. When adopting the Nash equilibrium, the players involved have no incentive to change their preferences. This gives Nash’s solution an important property: stability. However, the Nash equilibrium has other important properties, one of them being that it may not be an optimal choice under Pareto. In other words, an equilibrium can be reached that is not optimal for the players involved and in some cases, can be even worse, where the equilibrium is formed by the worst choices for all players (lose-lose situation). On the other hand, in negotiations, an important aspect to be considered is one's own utility and the utility of the others involved in the process, which is known as a win-win situation [6].

In this sense, Gimon [7] states that it is beneficial for an agent to take into account how beneficial his concession is for the opponent as well as how many unforced concessions the opponent has made in the past for that agent. The author states that the negotiator's rationale is dynamically changing in a series of negotiations with the same opponents, and this change could be represented through refined utility function. The author proposes a refined utility function where the original utility value for each alternative is adjusted by a component that represents how beneficial the alternative is for the opponent compared to the agent's ideal alternative and taking into account the balance of concessions made in the past. Therefore, Gimon [7] refined utility function considers not only individual utility, but also the utility of their opponent. This quality makes this function closer to a real-life negotiation. The refined utility function is presented in equation

$$u_{i,n}(x_1, x_2) = u_{i,n}(x_1, x_2) + f(C_i(x_1, x_2), B_{i,n}^{cum}) \tag{4}$$

where $u_{i,n}$ is the utility for the player i = 1,2 in the negotiation round n, C_i is the concession value given by the player in this round (difference between the alternative chosen and his ideal alternative), $B_{i,n}$ is the accumulated value of all balances (difference between the two players' concessions). However, this refined utility function is limited to describe utility function dynamics in problems with a single criterion. To expand this limitation we propose to use Leoneti's [4] utility function for multi-criteria negotiations, refining this utility functions within a negotiation series.

In this sense, we propose modeling the refinement proposed by Gimon [7] (equation 4) by using the utility function proposed by Leoneti [4] for group decision making (equations 2 and 3) in the form proposed by Cobb-Douglas [3] (equation 1), where the preferences in a negotiation would be defined by the player's preference between its own utility "me" and the utility of other players "us"[1]. A numerical example is presented to illustrate its application.

2 Materials and Methods

In order to make a more straightforward use of equation 1, we propose a monotonic transformation of this equation, as suggested by Varian [3]. Let us suppose that we are starting with the Cobb-Douglas function as proposed in equation 1. By

[1] Although intuitively the idea of the modeling is suitable for situations with more than two players, in this paper it is presented in situations with only two players.

raising utility to $\frac{1}{(c+d)}$ power, and defining $a = \frac{c}{(c+d)}$ we get equation 4, where the property of the sum of the powers is equal to 1.

$$u(x_1, x_2) = x_1^a x_2^{(1-a)} \tag{5}$$

Definition 1 (Player payoff function *π*): Let *π*: $\Re_+^2 \to [0,1]$ be the payoff for a player *i* from the set of 2 players defined as equation 2, where $\pi_j(x_1, x_2)$ is the utility value for the player when considering the basket composite by the alternatives x_1 and x_2 from the set of *A* alternatives. We have, therefore, the payoff function defined by equation

$$\pi_i(x_1, x_2) = \varphi(x_1, IA).\varphi(x_1, x_2).\varphi(x_2, IA) \tag{6}$$

where φ is given by the pairwise comparison function φ: $\Re_+^c \to [0,1]$, according to equation 3.

Definition 2 (The altruistic willing function *ω*): Let *ω*: $\Re^2 \to [0,1]$ be the altruistic willing function for a player *i* from the set of 2 players defined as

$$\omega_i = \frac{1-(\beta_i - \gamma_i)}{2}, where\ \beta_i = \frac{\mathrm{B}_i}{\mathrm{B}_i + \mathrm{B}_j}, i, j \in \{1,2\}, i \neq j \tag{7}$$

where $\mathrm{B}_i = \sum_{k=0}^{n} \pi_i^k$, where π_i^k is player's *i* payoff on negotiation round *k*, and *n* is number of negotiation rounds conducted; γ_i is aspirational balance of the player *i* negotiating with player *j*. The rationale behind the function *ω* is the same as in the one proposed in Gimon [7]; that is, a player is more likely to play altruistically when the outcomes in the past negotiations were better for him.

Definition 3 (The player preference strategic decision *ψ*): Let *ψ*: $\Re_+^c \to [0,1]$ be the player preference strategic decision for a player j from the set of 2 players defined as equation 5, where *π* is the utility value for the player, considering the basket composite by the alternatives x_1 and x_2 and *ω* its probability of playing altruistically. We have, therefore, the player preference strategic decision defined by equation

$$\Psi_i(\pi_i, \omega_i) = \pi_i^a \omega_i^{(1-a)} \tag{8}$$

In this refined utility function (equation 8), we define the first component as the payoff for the player itself ("me" component) and the component as the probability of playing altruistically ("us" component). We calculated the results of thirty rounds of negotiations between two players. In order to test the "me" versus "us" strategic decision in a dynamic negotiation process, the parameters of a and γ_i were modified in twelve different environments[2] to test the players' behaviors.

3 Results and Discussion

To verify the "me" versus "us" strategic decision in a dynamic negotiation process, we have calculated outcomes in the 2x2 battle of sexes game repeated 30 times for the same pairs of players with varying values of a and γ_i. The games were modeled from the multi-criteria decision-making approach using equation 6, where two criteria were chosen ("Adventure" and "Romance") in order to evaluate two alternatives "Cinema" and "Football". The preference matrices and the weighing vectors used in the calculations are given in Table 1.

Table 1. Preference matrices

	Adventure	Romance
Football	10	0
Cinema	0	10
Weight vector	0.8	0.2

a) Husband

	Adventure	Romance
Football	10	0
Cinema	0	10
Weight vector	0.2	0.8

b) Wife

Table 2 reports the results of the calculations. All chosen Nash equilibria were Pareto optimal.

Table 2. Calculation results

	a (both)	No. of football	No. of cinema	% of football	% of cinema	β_1	β_2
			$\gamma_1 = 0.2, \gamma_2 = 0.8$				
Envir. 1	0.3	5	25	17%	83%	0.21	0.79
Envir. 2	0.5	6	24	20%	80%	0.21	0.79
Envir. 3	0.7	6	24	20%	80%	0.2	0.8
			$\gamma_1 = 0.5, \gamma_2 = 0.5$				
Envir. 4	0.7	15	15	50%	50%	0.5	0.5
Envir. 5	0.5	15	15	50%	50%	0.5	0.5
Envir. 6	0.3	15	15	50%	50%	0.5	0.5
			$\gamma_1 = 0.5, \gamma_2 = 0.8$				

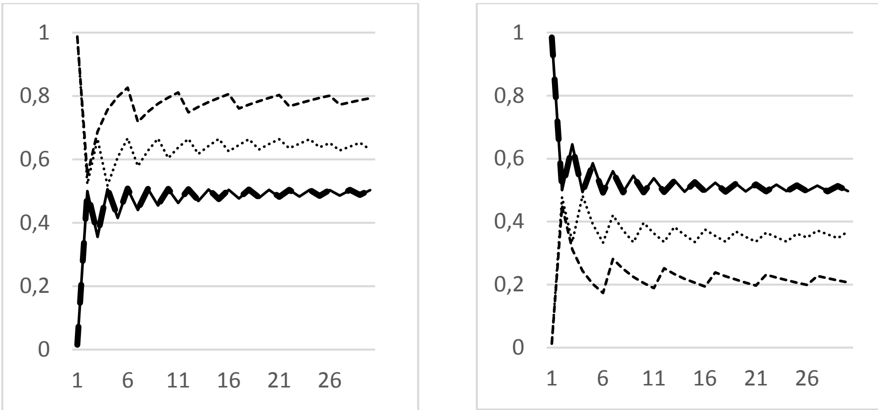
[2] We define "environment" as the combination of parameters a and γ_i which represents the percentage of concern regarding one's own payoff ("me" component) and the aspirational balance that a player *i* is aiming for in each game ("us" component), respectively.

Envir. 7	0.5	11	19	37%	63%	0.37	0.63
Envir. 8	0.7	11	19	37%	63%	0.37	0.63
Envir. 9	0.3	10	20	33%	67%	0.35	0.65
			$\gamma_1 = 0.8, \gamma_2 = 0.8$				
Envir. 10	0.7	15	15	50%	50%	0.5	0.5
Envir. 11	0.5	15	15	50%	50%	0.5	0.5
Envir. 12	0.3	15	15	50%	50%	0.5	0.5

By means of illustration, “Environment 1” simulates a scenario in which the Husband has an aspirational balance of 0.2 (γ_1), whereas the Wife has an aspirational balance of 0.8 (γ_2). From this profile, we can assume that Husband is more likely to play the game altruistically, while the Wife will not. Also, the parameter *a* (for both players) says that, apart from their standard behavior given by γ_1 and γ_2, they will adjust their behavior for playing with each other by giving less importance to their own utility (“me” component) than to the utility of others (“us” component), according to equation 8. It results that, despite the Wife’s strong trend to play unaltruistically, the amount of times that they decide go to football and cinema closely matches the aspirational balance of each.

When two aspirational balances $\gamma_1 + \gamma_2 = 1$, the percentage of desired outcomes matches the balance allocation β, thus proving the model. Note that our simulations include symmetric mirrored preferences only (in this case “0.8 and 0.2” to husband and “0.2 and 0.8” to wife for the criteria “Adventure” and “Romance”, respectively). When $\gamma_1 + \gamma_2 > 1$, it is impossible to satisfy both players’ aspirational balance and the negotiation series would result in compromise balances, which are determined by the aspirational balances of both players and their preferences. In the case of symmetric preferences, the balance of the payoffs tends to converge to a limit equal to $\beta_i' = \frac{\gamma_i + (1-\gamma_j)}{2}$.

Figure 2 shows the dynamics of balance allocation in a series of 30 negotiations. We present the cases when *a*=0.5 only. In the first round of negotiations where the balance is 0 and an outcome would fully satisfy either one or the other player results in a model with alternations and the period depending on γ_1, γ_2. Figure 1 shows that the balance fluctuates around the aspirational balance or around a compromising balance value when achieving aspirational balance is not possible. The calculations confirm that the balance always tends to converge to a single limit.



a) Husband's balance b) Wife's balance

Fig. 2. Dynamic balances in negotiation series ($a = 0.5$). Environment 2 ($\gamma_1 = 0.5, \gamma_2 = 0.5$, $long\ thick\ dashes$), Environment 5 ($\gamma_1 = 0.2, \gamma_2 = 0.8$, $short\ dashes$), Environment 8 ($\gamma_1 = 0.5, \gamma_2 = 0.8$, $dotted\ line$), and Environment 11 ($\gamma_1 = 0.8, \gamma_2 = 0.8$, $solid\ line$) are shown on the chart.

4 Conclusions

This paper studies dynamic negotiations considered as a multi-criteria game with two or more players. We propose using the Cobb-Douglas function to describe a refined utility function as a weighted product of the user's utility ("me" component) and the probability to play altruistically ("us" component). The function uses a utility function proposed by Leoneti [4] for multi-criteria decision problems with two or more players. We proposed to change this utility function after each negotiations using the approach proposed by Gimon [7] to calculate the probability of playing altruistically based on the balance of past outcomes.

The numerical example shows that when the proposed function is used in dynamic games, the Nash equilibria (i.e. optimal strategies) of the game will alternate. These alternations tend to satisfy the players' aspirational outcomes when they are achievable. Otherwise, they result in compromising outcomes.

The outcomes of the modeled games were also Pareto optimal. However, further research should study Pareto optimality with preferences other than the mirrored preferences used. Also, we considered aspirational balances to be constant during the series of negotiations. However, research literature suggests that aspirations may change over time. Further research should be done to incorporate dynamic aspirations into the model.

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Designing Preference Modeling for FITradeoff Method with Decision Neuroscience Experiments

Lucia Roselli[1], Eduarda Asfora Frej[1], Adiel Teixeira de Almeida[1]

[1]Universidade Federal de Pernambuco, CDSID - Center for Decision Systems and Information Development, Av. Acadêmico Hélio Ramos, s/n – Cidade Universitária, Recife, PE, CEP 50.740-530, Brazil
luciarpr@hotmail.com, eafrej@gmail.com, almeida@cdsid.org.br

Abstract. Neuroscience approach has presented advances in connection with other areas of knowledge by providing understanding about brain function and promoting improvements in systems, in general. For instance, Decision Support Systems (DSS) may be challenging for providing proper preference modeling tools, which can be benefited from neuroscience experiments. This work deals with neuroscience experiments for preference modeling in decision making with FITradeoff method. The FITradeoff is a flexible and interactive method for coping with multicriteria additive model. It uses graphical visualization in some steps to support decision makers in the elicitation process and for decision analysis, if a few incomparable alternatives are found at the end of the process. So, this work shows which kind of contribution neuroscience can provide for designing DSS and for improving the support of analysts in multicriteria decision making, particularly dealing with preferences in group decisions for MCDM.

Keywords: Decision Neuroscience, Neuroeconomics, Multicriteria Group Decision Making, FITradeoff method.

1 Introduction

Preference modeling in group decision making is not an easy task, since in most cases different and conflicting perceptions of the problem are involved in the analysis. Recent advances in cognitive neuroscience and neuroeconomics can help this process, since analysts can better understand how decision makers think and act when they are making decisions. This field of research related to neuroscience is uncovering the neural system of cognitive, emotional, social and rational process. These advances are offering new insights into the complex interplay between areas, promoting studies and improvements in marketing, information processing and systems, decision making, game theory psychology and economy [1, 2, 3, 4, 5].

In this context, this approach provides an interdisciplinary research that aims to analyze the neural systems and its implication for human behavioral. In decision making, the study is relevant to support the analyst to understanding how decision makers use information from the environment to make decisions, and thus aid

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preference modeling and improve decision support systems (DSS) in group decision. So this work intends to relate the importance of decision neuroscience in the design of a new elicitation method for aiding multicriteria decision making (MCDM) problems, FITradeoff method. In the presentation, the methodology will be clarified in more details with the experiment design and examples will be given in order to support the conclusions by numbers and graphics.

2 Preference Modeling with FITradeoff

The FITradeoff method [6] is characterized as a flexible and interactive method for elicitation process in multicriteria decision making problems. This new method is based on the traditional tradeoff procedure [7], keeping its axiomatic structure.

In the traditional tradeoff elicitation process, the decision makers compare consequences trying to find indifferent relations between them, which are not an easy task, leading to inconsistencies in the process. The difficulty of elicitation questions in the tradeoff procedure leads to 67% of inconsistency in final results, according to behavioral studies [8].

Therefore, one of the main benefits of FITradeoff compared to the tradeoff is the absence of these difficult questions in the process. Instead, in FITradeoff method decision makers have to give only strict preference statements, which are much easier to provide.

Another benefit of FITradeoff is the flexibility in the process. This method uses partial information about the decision makers' preferences, so the DMs do not need to complete all the steps to find the solution. In this method, after each question answered, partial results can be observed and decision makers can decide whether to select one of the potentially optimal alternatives (POA) and stop the process, or to continue answering the elicitation questions. Besides that, graphical visualization with the potentially optimal alternatives can be used to support this process. Therefore, this method compiles a strong axiomatic structure with flexibility in the decision making process.

3 Decision Neuroscience Experiments

As described in the introduction, neuroscience is an approach that involves interest of many areas of knowledge. Because of its importance, many tools were developed to measure brain process related to decision making. Some examples of tools applied to these studies are: the eye tracking, responsible to measure eye movements and pupil, the electroencephalogram (EEG), responsible to measure the areas of brain.

Related with design preference modeling in FITradeoff method [6], represented basically by graphics in elicitation process and in partial results, the study about neuroscience is important to understand how decision makers understands the elicitation questions using the design and how they select an alternative in a group of potentially optimal alternatives (POA).

In this context, some measures can be analyzed to answer these questions above and improve the design of FITradeoff method, being useful in evaluation of group decision preference modeling. Related with the design of FITradeoff, the combination of metrics offered by the eye tracking and EEG can be a great option.

The eye tracking is responsible for measure the eye movements, some important metric for this analyses is the pupil diameter. The changes in pupil diameter, called pupillometry, is a function of cognitive processing. In situations with difficult decision making, pupil dilatation can inform decision thresholds [9]. Besides that, the pupil diameter can be used as an implicit metric of uncertainty [10]. So with this metric the analyst can evaluate if the design used represent low or big cognitive effort for decision makers. The experiment was designed with several set of graphical visualizations, changing the number of criteria and alternatives (three to five) [11].

The EEG is responsible for capturing the electrical signal generated in transmission of information between the neurons. In this context, the use of EEG in the graphical visualization in FITradeoff is important to investigate the areas of the brain that are activated during the elicitation process [11]. Thus, based on this information, the analyst is able to evaluate which information within the design of DSS is generating highest conflict for decision makers.

4 Conclusion

The potentially use of neuroscience for aiding preference modeling in group decision making problems, especially when multiple criteria are involved, is briefly described in this work within the specific case of FITradeoff method, with partial results of this researches in progress. The FITradeoff is a flexible and interactive method that uses the graphical visualization in two steps, the elicitation process and the partial results. So, to improve the design of this method and give more information to the analyst about all the elicitation process, the neuroscience with its tools can be used to bring insights for the decision making process, and thus contribute for preference modeling in group decision for MCDM.

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An Open Data Model for Fostering Innovative Policy Options to Enable a Triple Bottom Line

Colin Williams[1*] and Liping Fang[1]

[1]Environmental Applied Science and Management Graduate Program
Ryerson University, Toronto, Ontario, Canada
[*]Corresponding author, e-mail: c.williams@ryerson.ca

Abstract. Cities are regularly being recognized as a focal point for producing public service innovations and supporting economies at the local and national levels. The increased focus on cities to deliver economic vitality, social development, and environmental sustainability (otherwise known as the triple bottom line) is resulting in new public administrative approaches that identify beneficial policy options. This proposal advances an unconventional approach for the application of open data, to identify stakeholders, formulate innovative, viable options and assist with preference ranking of states to develop policies that derive a positive triple bottom line. A case study using this approach is then applied to leverage procurement processes to achieve beneficial policy outcomes in Toronto, Canada.

Keywords: decision-making, innovation, open data, policy, values

1 Introduction

It has been accepted that open data will become increasingly important for the stimulation of new, innovative public services [1]. This open data movement is a worldwide phenomenon, with governments around the globe making their data accessible to the public by publishing it on the web [2]. From an ideological perspective, the publication of such data aims to increase democratic accountability, enhance transparency, foster civic engagement, and stimulate economic growth [2]. However, as Chauhan et al. [3] identifies, merely publishing data does not necessarily result in achieving value. While the publication of open data is becoming a more popular activity, the approaches to apply and integrate open data within the policy cycle remain poorly understood, with limited scholarly research available.

Currently, the majority of policy recommendations are primarily based on alternative-based approaches; which only consider objectives or criteria to evaluate alternating solutions after potential solutions (or alternatives) are identified [4]. In contrast, a value-focused approach enables a decision-maker to focus on strategic activities essential to the problem, before any contemplation of a solution [4]. This type of approach enables more appealing solutions and identifies more appropriate policy issues to address [4]. By integrating open data analytics with a value-focused approach to policy formulation, a more strategic alignment of policy objectives and outcomes

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can be synthesized. It is also important to identify that policy recommendations are not formulated in a vacuum; they are a composite of multiple stakeholders' preferences.

Despite open data being freely available, policy formulation models have yet to involve open data and promote a positive triple bottom line (positive economic vitality, social development, and environmental sustainability). The generation of any value-focused policies involving open data is far from straightforward and poorly understood within the scholarly literature. The central question remains: How can governments harness a value-focused, open data approach to driving a positive triple bottom line while deriving benefits for an ecosystem of heterogeneous stakeholders, all with their own objectives? The aim of this study is to exemplify an open data analytical approach that enables government decision-makers to identify stakeholders, their options and associated preferential rankings when formulating innovative policy recommendations. This approach is then applied within a case study context involving the City of Toronto, Canada, to demonstrate its efficacy.

2 Innovation and the Smart Cities Movement

By its definition, innovation is simply any process that leads to a novel outcome [5]. From a government perspective, open data analytics enables the potential to access information from data collected through various sources [6]. At present, these data sources primarily include smartphones, computers, sensors, cameras, global positioning systems, social networking sites, commercial transactions, and games [6]. At a foundational level, open data analytics has great potential to help drive innovation and identify new opportunities within governments and their public services. In addition, open data analytics is proposed to enable smarter policy recommendations.

A 'smart city' is broadly defined as a city seeking to address public issues via information and communication technology-based solutions on the basis of a multi-stakeholder, municipally based partnerships while ensuring that benefits are realized in a manner unique [7] and consistent with its core values of economic, social and environmental vitality [2]. Smart city initiatives encompass a diversified set of publicly funded activities: from building public transportation systems to supporting creative innovation, or designing energy-saving policies [7]. Fundamental to a smart city's success is how it acts as local innovation platforms, bringing together all involved stakeholders [1]. As Keeney [4] has already identified, values, being the principles for evaluating the desirability of any possible alternative or consequence should be the driving force for decision-making. To this end, a smart city must identify a positive triple bottom line as a value, in addition to enabling innovation platforms and involving stakeholders, when formulating policies.

3 Value-focused, Open Data Driven Approach to Policy Formulation

Any value-focused, open data-driven approach is designed to focus the decision-maker on essential activities [4], stakeholders and objectives before they formulate any policy recommendations. This type of approach assists in uncovering hidden policy objectives and can lead to more productive information collection [4]. Furthermore, it has been shown to improve the communication among all parties involved in policy recommendations, facilitate the involvement of multiple stakeholders, and enhance the coordination of interconnected decisions [4]. From this perspective, policy value refers to the necessity of innovation that enables citizens and their local government to integrate, analyze and visualize different kinds of solutions [3]. Through the incorporation of open data analytics within a value-focused open data approach, a more thorough and integrated policy recommendations will result.

According to Tukiainen et al. [8], the first step for a city to become drivers of innovation using open data is to act as orchestrators that connect various parties to create and maintain sustainable ecosystems. Within a policy development context, there are a substantial amount of stakeholders including elected officials, government administrators, suppliers, interest groups, residents, think-tanks, consultants, non-governmental organizations, and policy entrepreneurs [9]. It has been suggested that stakeholders, within an open data context, can work as receivers or senders of information (or both) [9].

This study asserts that the formulation of any policy recommendation should involve multiple stakeholders, and apply open data analytics to assist with the identification of policy options and stakeholder preferences. Tukiainen et al. [8] asserted that cities should establish an active dialogue with their citizens, and private and public sector actors to co-create, develop, test and offer service innovations that utilize diverse sets of platforms. This process requires an effective stakeholder management approach that utilizes a technological platform to interact with and gather information from stakeholders. To readily access the potential value of open data, this study will propose an open data analytical methodology to identify (1) stakeholders involved; (2) policy options; and (3) stakeholders' preferences.

4 Case Study: City of Toronto, Canada

The City of Toronto is currently developing an Open Data Strategic Plan which will aim to improve the delivery of public services, make information more accessible and support initiatives that build public trust in government. The public procurement process provides local governments the opportunity to leverage spending to achieve specific economic, social and environmental outcomes, which strategically align with the principles of developing a smart city.

As part of this initiative, the City of Toronto is also proposing to make public procurement data readily available online. The recent addition of the Social Procurement Policy in the City of Toronto, provides an opportune framework to apply the proposed value-focused, open data approach and apply open data analytical methods to illustrate the effectiveness of the approach. For this study, an online surveying platform will be applied to gather information from identified stakeholders and utilize the open data made available by the City to determine policy options and stakeholder preferences.

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Problem Structuring for Participatory Water Management

Marcella Maia Urtiga[1], Danielle Costa Morais[1]

[1] *Production Engineering Department, Universidade Federal de Pernambuco, P.O. Box 7462, 50722-970 Recife, PE, Brazil*

maia.urtiga@gmail.com, dcmorais@cdsid.org.br

Abstract. This work presents a methodology to assist participatory decision-making in integrated water management and planning. A group approach of Value-Focused Thinking is used to identify the decision-makers' values. Based on these values, alternatives are created and attributes identified to evaluate these alternatives. The process stimulates interaction and communication and enables the problem to be modelled based on the perspectives of the group rather than on those of single individuals. A multiple-attribute value function aggregates the group's preferences. A virtual case-study is used to illustrate the applicability of the methodology.

Keywords: water resources management; value-focused thinking; group decision; participatory decision-making.

1 Introduction

Many countries around the world, such as France, China, Brazil and India, have adopted an integrated approach to managing the use of water resources (Deng et al. 2016). An Integrated Water Resources Management (IWRM) takes into consideration that fresh water is a finite resource, however essential to sustain economic development, life and the environment. An IWRM also bears in mind that the management of water must include the participation by the community, policy-makers and water users (Hassing et al. 2009; Urtiga and Morais 2016, Medeiros et al 2017).

In group decision-making two or more DMs must together choose an alternative from a set of two or more alternatives that will represent the group's objectives. Usually, decision-making methods tackle a decision problem by considering that a set of alternatives is given, following which the objectives and criteria are considered. However, the DMs could consider the values of the group prior to identifying the alternatives, in order to choose the solution that bests represent the group's objectives. Baring this in mind, a methodology is proposed to assist the DMs from the beginning of identifying the problem and structuring objectives for the group members. It also assists the DMs to identify common attributes so as to measure the objectives and to identify relevant alternatives for the group. Thus, the DMs are able to make decisions

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considering the group's perspective of the problem, but without losing sight of the individuality of each member of the group, since the evaluation is made by each DM individually and subsequently aggregated for the group evaluation. The methodology promotes communication, interaction and structures the problem as part of the group decision process. A virtual case-study on a watershed conservation problem in Brazil is used to illustrate its applicability.

2 Results

The steps of the methodology are presented in Figure 1. A virtual case study is is presented which is based on a realistic decision problem of a Watershed Committee having to decide which option it should take to address a problem of pollution and degradation in the watershed they represent. Three DMs are considered: i) a representative of the local community; ii) a representative of the local authority; iii) a representative of industry.

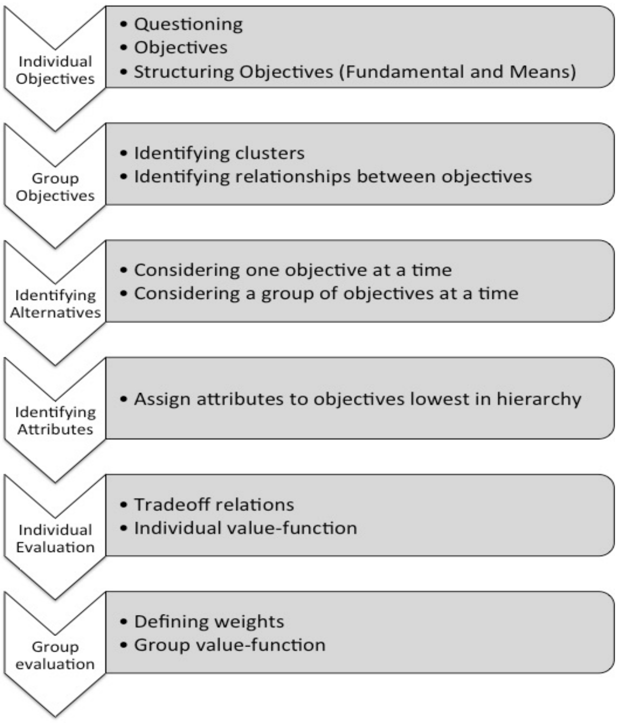

Fig. 1. Structure of the group-decision framework

The process starts by identifying and structuring the DMs' objectives using Value-focused Thinking (VFT) techniques. As means of illustration, the structuring of objectives for the DM "representative of the local community" is presented in Table 2.

Table 2. Hierarchy of Objectives for the representative of the local community

To maximize the quality of life	
1.	To maximize income
1.1	To maximize the employment rate
1.1.1	To keep production and services in different economic sectors
1.1.1.1	To guarantee water for the community's multiple economic uses
2.	To ensure good health and well-being
2.1	To have good water for leisure and sports
2.2	To have water in an amount that meets people's basic needs
2.2.1	To improve sanitation
2.2.2	To guarantee clean water for people and animals
2.2.2.1	To maximize the quality of water

Having obtained the hierarchy of objectives for each DM individually, the facilitator can start the process of identifying clusters and the relationships that exist between the objectives if the DM is different. This is important because when similar objectives are identified this means that there is a common point between the DMs. Thus it is possible to identify alternatives that will help the DMs achieve that common objective. However, all alternatives suggested by the DMs should be considered. If a DM finds that an alternative is not appropriate, he or she can evaluate it poorly according to his/her objectives.

Based on the DM's objectives, alternatives are identified and the attribute to evaluate the alternatives regarding that objective are also identified. The following attributes were identified for all DMs: i) the tax rate percentage, ii) the concentration of coliforms/100milliliters, iii) the number of new job vacancies, iv) the number of hectares of planted riparian vegetation and, v) the response time, which refers to how long an alternative implemented takes to show results. Six alternatives are identified based on the DMs' values: i) implementation of a sewage system (A_1), ii) new treatment station (A_2), iii) construction of a landfill site (A_3), iv) educational campaign to reduce pollution (A_4), v) protection of the dam (A_5), vi) improve collection of waste material (A_6).

After identifying the attributes and alternatives, each group member evaluates the alternatives based on an individual additive value function. The individual values are aggregated in a group value function. For each DM_i, there is a value-function to evaluate the alternatives, such as shown in Equation 1.

$$v_i(a) = \sum_{j=1}^{n} k_j v_j(a) \qquad (1)$$

where k_j are the constant scales that reflect the trade-offs between the attributes, $\sum_{j=1}^{n} k_j = 1$, and v_j the value given to the performance of each alternative in each criterion j.

The group function will be determined by Equation 2.

$$V(a) = \sum_{i=1}^{m} w_i v_i(a) \qquad (2)$$

where w_i is the weight of the evaluation of each DM for the group evaluation also considering his/her relative importance, and $\sum_{i=1}^{m} w_i = 1$.

Having obtained the group's evaluation of alternatives, the alternative chosen is A_3 (construction of a landfill site), which is the best alternative for the government representative and second best for the Industry and community representatives. Alternatives A1, A6 and A3 are preferred to alternatives A2, A5 and A4 by all DMs.

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A Cooperative Multicriteria Group Decision Aiding Tool – A Guided Tour of the Desktop Application

Sérgio Fernandes[1, 2], João Clímaco[3], M. Eugénia Captivo[4, 2]

[1] Escola Superior de Tecnologia — Instituto Politécnico de Setúbal, Campus do IPS, 2910-761 Setúbal, Portugal
[2] Centro de Matemática, Aplicações Fundamentais e Investigação Operacional, Faculdade de Ciências, Universidade de Lisboa, 1749-016 Lisboa, Portugal
[3] Instituto de Engenharia de Sistemas e Computadores de Coimbra, Rua Sílvio Lima, Pólo II, 3030-290 - Coimbra, Portugal
[4] Faculdade de Ciências — Universidade de Lisboa, Campo Grande, 1749-016 Lisboa, Portugal

Abstract. The main features of the adaptation to a face-to-face cooperative group approach of an interactive decision support tool previously developed with the aim of supporting decisions concerning multicriteria location problems are described. In the application implemented there is no inter-criterion aggregation, so there is no need to reduce the various evaluation dimensions into the same scale. It allows for the individual intervention of several elements of the group, includes some logical tools as well as the possibility of introducing constraints. Furthermore, it propitiates an extensive use of interactive graphics. A guided tour of the desktop application emphasizing its potentialities and limitations is presented.

Keywords: Cooperative group decision, Multicriteria analysis, Interactive decision support tool

1 Motivation

In the past, the authors of this communication developed an interactive decision support tool named SABILOC. It is aimed at supporting decisions concerning multicriteria location problems [1]. The tool combines an interactive bicriteria mathematical programming module with a multi-attribute analysis module allowing the decision makers to proceed with a more detailed analysis of a subset of solutions selected from the first interactive phase. The application of this DSS to problems involving environmental issues involves complex and multi-disciplinary tasks dealing with psychological, sociological, cognitive and political issues. In these circumstances, we designed a multi-attribute module adequate to combine ill-structured Human intervention with the computational decision support. The first version of the software is described in [2, 3] and it is based on an interactive implementation of the conjunctive method, enabling the consideration of up to three performance thresholds, having in mind to classify the objects under evaluation, and extensively using graphic tools in order to improve human-computer interaction. This

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software is in essence very simple. There is no inter-criterion aggregation, so there is no need to reduce the various evaluation dimensions into the same scale, thereby avoiding all possible associated distortions, which are very common for instance when the aggregation is based on the use of weights. Reducing the multidimensional evaluation of objects to a scalar by recurring to aggregation procedures enables, the ranking of those objects, but it is our conviction that these procedures are reductive, in many situations, since, even in the cases where the used aggregation rules are technically acceptable, they involve a subjective character and often an ideological charge. So, the contents and the architecture of those indices are conditioned by the ideological/interest positions of the involved politic, economic and social actors.

In [4] this approach was tested by assessing the Rio de Janeiro State's Green Economy considering the most representative sectors of activity. It was a success namely because it avoids the use of a single index of green economy. Furthermore, [5] carried out a study regarding the quality of life and sustainability. Both studies show the usefulness of the approach in complex decision problems involving very subjective options of the decision makers. Furthermore, these problems usually involve multiple actors suggesting the necessity of adapting the software to this issue. It must be reminded that Group Decision is a complex process involving multidisciplinary topics from psychology, sociology, organizational and political sciences, etc. Effective Group Decision Support Systems involve not only new information and communication technologies (ICT) and Operations Research/Management Science (OR/MS) models, but also take into account behavioral issues.

The main features required to a face-to-face cooperative group approach were suggested in [6], based on the above referred to case dealing with quality of life and sustainability. Recently this work was deepened and the software implemented. This communication consists in a guided tour of the desktop application emphasizing its potentialities and limitations.

The next section starts by a review of the original software. It continues by presenting the main features of the Group Decision module, namely:

a. Allowing the individual intervention of several elements of the group. The graphical representations put in evidence the actions of the different actors and, when there is no consensus, the software allows identifying how far apart they are;
b. Some logical tools allowing a simple identification of the conclusions supported by all elements of the group or by any pre-specified subset of them; those supported by at least one element of the group; and those supported by at least a pre-specified number of elements of the group;
c. The software allows the introduction of hidden constraints on the feasible variations of the above referred to thresholds. It will be put in evidence that this issue is particularly useful in what concerns group decision settings.

The conference presentation is supported by a software demonstration.

2 A summary of the desktop application's guided tour

2.1 The single user software tool – a brief review

To illustrate the software, we will use the case study of a real-world problem applied to waste transfer station siting. This case study was used in [1], at the time considering just a personal appreciation of objects under evaluation by a single decision-maker. In short, the problem consisted in identifying a suitable site where the company responsible for the treatment, recovery and disposal of urban solid waste produced in some municipalities should build a waste transfer station. As it is known, site suitability depends on numerous technical, environmental, economic, social and political criteria.

The software's desktop interface (Fig. 1) presents on the left-hand side the performance matrix, in which each row describes an alternative (potential site to install a waste transfer station) and each column describes the performance (quantitatively or qualitatively) of the alternatives against each attribute (attributes 1, 2 and 3 represent environmental issues; attribute 4 represents accessibility, attributes 5 and 6 represent costs, attributes 7 and 8 represent equity measures of environmental effects, and attributes 9 and 10 represent equity measures of accessibility). On the right-hand side of the desktop interface the performances are represented through a radar chart, enabling the decision-makers to easily visualize the peculiar differences between alternatives when facing all the criteria. On this radar, each axis represents an attribute and the performances of alternatives are plotted along the axes. Each alternative is represented in the chart through a star, filled or not, in which the vertices lie on the axes (in example of Fig. 1 we can see the filled star relative to alternative 3 in the foreground).

Some tools are available to start analyzing the performance matrix. The application allows the users to disregard redundant criteria, by inactivating those in which all the alternatives have exactly the same or similar (considering a small tolerance) performance values. Moreover, it also allows the users to inactivate dominated, or even quasi-dominated[1], alternatives (in example of Fig.1 alternatives 4, 6, 7 and 9 to 12 are inactivated, so they appear in red).

As already mentioned, the multi-attribute analysis module stands for an interactive implementation of a version of the conjunctive method[2]. To put into practice the method, the software enables the consideration of up to three performance thresholds, having in mind to classify the alternatives under evaluation into four classes: "unacceptable", "acceptable", "good" and "excellent". For details about the manipulation of the application, please see [1, 2, 3].

[1] The concept of quasi-dominance extends the concept of dominance between alternatives considering a tolerance $\varepsilon > 0$.

[2] In its elementary version consists in eliminating alternatives that do not reach specific performance levels for all the criteria here considered.

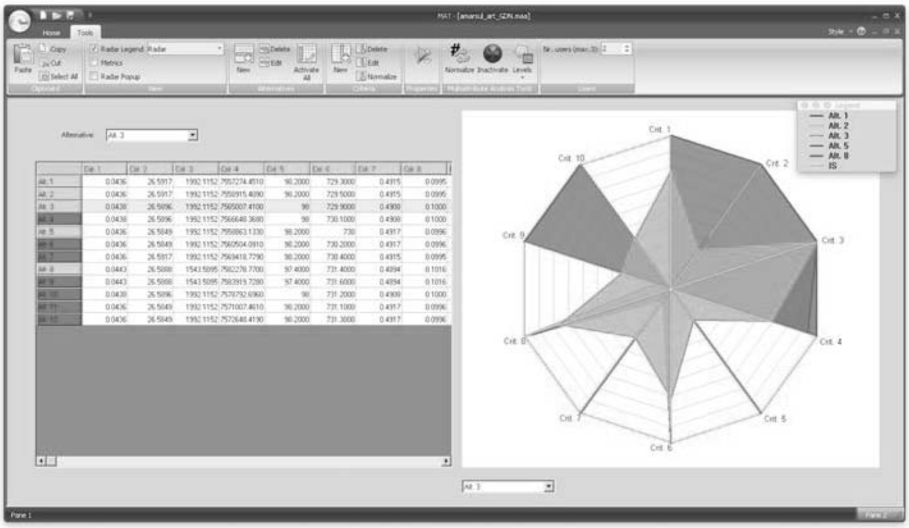

Fig. 1 Software's desktop interface.

2.2 Main features of the Group Decision module: outline and exemplification

2.2.1 Individual intervention of the elements of the group

The process of setting the thresholds for the various attributes (through the sliding controls – see left side of Fig. 2 - or through the adjustable pinpoints on the radar chart – see right side of Fig. 2) may be carried out by each one of the decision-makers. The representation of the thresholds in the radar chart to delimitate classes is made through different colors, depending on the threshold and on the decision-maker.

Fig. 2 shows the windows where the elements of the group can set their thresholds, in this case the first two decision-makers, and the matrix of the objects under evaluation with the corresponding performance on each attribute. To select a site to build a waste transfer station, a balance needs to be achieved among the multiple decision-makers that might have conflicting objectives. For example, a site centrally located in the area where waste is generated would be economically better but it would disturb the wellbeing of people living or working near the site, causing public concerns and opposition. Here we assume that the first decision-maker is more concerned with the costs, being more demanding with attributes 5 and 6, but also with attributes of accessibility. On the other hand, as we can see in Fig. 2, the second decision-maker is more concerned with the environmental impact caused by waste transfer stations, i.e. attributes 1, 2, 3, 7 and 8.

When a user manipulates/changes the thresholds, the first column of the matrix automatically informs through colors which class the objects under study belong to, giving an immediate feedback about his/her choices.

The representation in the radar chart of the three thresholds, corresponding to level 0, level 1 and level 2, is made through unfilled polygons using colored solid, dashed and dotted lines. Depending on the user, the colors are different but in any case, the dark color represents level 0, the intermediate color level 1 and the light color represents level 2. Since the implemented algorithm uses the conjunctive rule the alternatives will appear with the following colors: red if at least one of its attributes does not reach the reservation level (level 0 or "acceptable" threshold); orange if every attributes satisfy level 0 but at least one attribute does not reach the "good" threshold (level 1); yellow if every attributes satisfy the "good" threshold but at least one attribute does not reach the "excellent" threshold (level 2) and green if every attributes satisfy the "excellent" threshold.

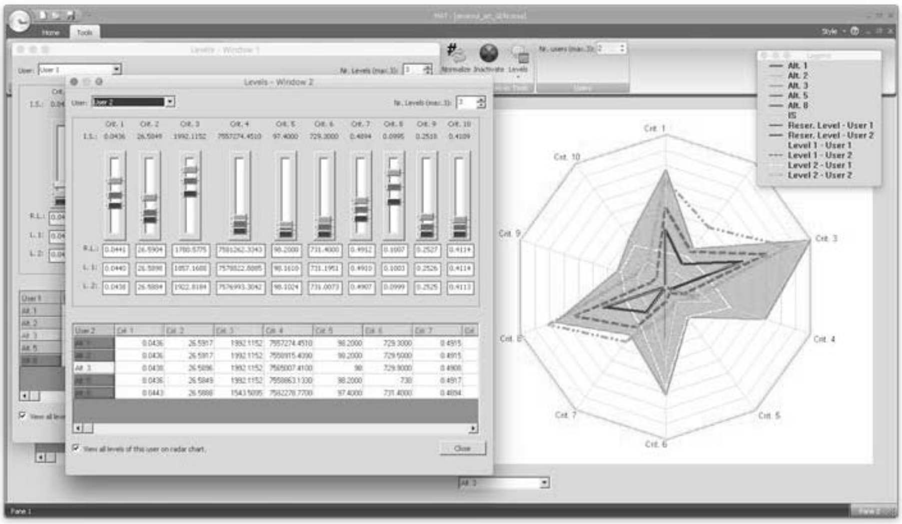

Fig. 2 Setting of thresholds.

By moving the mouse over a cell relative to an alternative, the application gives some important information about it, namely:

- The performance thresholds, defined by the user, responsible for the current classification of the alternative;
- For each threshold identified in the previous point, and considering each dimension, how far (in absolute value and also in percentage) is the alternative's performance from the corresponding value of the threshold;
- Also for each threshold identified, in the absence of consensus between decision-makers, the comparison between the user requirements.

For the example shown in Fig. 2, the information associated with alternative 3, for decision-maker 2, is, in short: a) the classification in class "good" is due to the level 2 thresholds not satisfied by attributes 2, 7 and 8; b) the alternative's performance is 17% worse than level 2 threshold of attribute 2, 4.8% worse than level 2 threshold of attribute 7 and 4.3% worse than level 2 threshold of attribute 8; c) for all attributes, the other decision-maker is less demanding. For the other user this alternative is classified in class "excellent".

This way, the manipulation of the controls and the analysis of the information provided by the software allow users to gradually become aware of the problem under study and give rise to a complete understanding of the behavior of the alternatives when dealing with the levels required for the criteria.

2.2.2 Logical tools

In order to facilitate the perception of all the information, the software allows making logical operations between the considerations of the users. At present, the operations implemented are disjunction and conjunction between 2 or 3 users. In case of the operator disjunction, an object is classified in the class corresponding to the highest threshold if satisfies for at least one of the users involved in the operation. The operator conjunction assigns an object to the class corresponding to the highest threshold it satisfies for all the users involved in the operation. Fig. 3 shows the result of disjunction and conjunction operators between decision-makers 1 and 2, in the same window where the attribute's thresholds of both users are presented. In this case, alternative 3 is yellow for the conjunction and green for the disjunction, confirming that it is good for one of the users and excellent for the other. In a situation with more users this can be useful. Once again, some new information can be attained by moving the mouse over a cell relative to an alternative in an operator column. Finally, it is also possible to identify the class that guarantees the satisfaction of at least any two decision-makers. Of course, if considering more than three users/decision makers it should be possible to make this analysis for any sub-set of users.

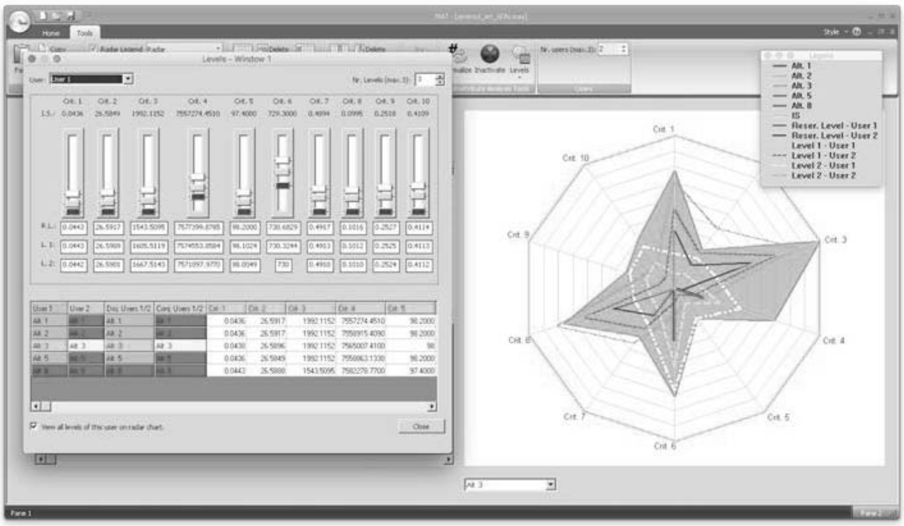

Fig. 3 Disjunction and conjunction operators.

2.2.3 Constraints on threshold variations

Another tool presented here, which can be very useful, especially in the case of several decision agents, is the possibility of including hidden constraints in the definition of each one of the thresholds, for each one of the decision-makers.

In many situations, there are dependencies among dimensions and so among the corresponding thresholds. The computational tool under development can be very useful, because it allows the introduction, in the background, of linear constraints on the variations in the thresholds, limiting or imposing their joint variation / fixation. The tool supports numerous forms of functional and logic processing semantics. Fig. 4 shows an example in which two constraints, in level 2 threshold, were added for the first decision-maker.

The first constraint

$$C6 := 2*C5 \tag{1}$$

assigns the double of increase or decrease of the value of level 2 threshold in criterion 5 to the same threshold variation (in %) in criterion 6. So, any change in the value of level 2 threshold of criterion 5 has implications on the level 2 threshold of criterion 6.

The second constraint

$$\text{if } (C9 > 0)\ C10 := C9 \tag{2}$$

assigns the increase, and only the increase, of the level 2 threshold value in criterion 9 to the same threshold variation (in %) in criterion 10.

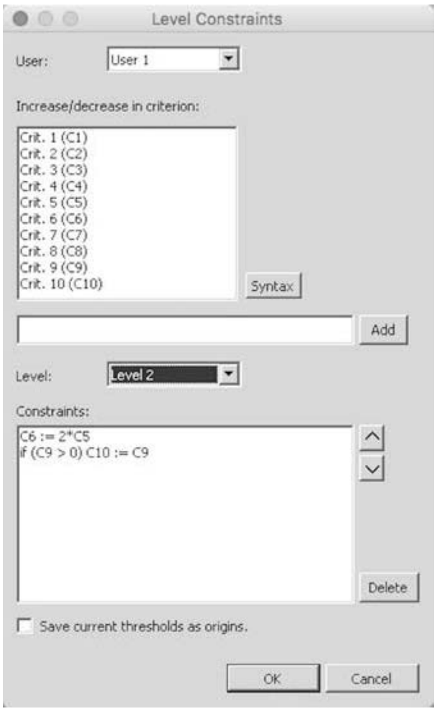

Fig. 4 Level threshold constraints dialogue box.

3 A case study: Software test in progress

Previously, it was concluded that the usefulness of the single user/decision maker version of this software is mostly due to its simplicity, both conceptually and from the operational point of view, as well as to the extensive interactive graphic representations and to its flexibility of use. In the previously mentioned case study referring to a real-world problem applied to waste transfer station siting, as in [4], we realized that one of the limitations of the application was not being able to deal explicitly with a cooperative and diversified group of actors involved in this complex problem. Of course, this was one of the motivations for the development of the new module of the desktop application here presented.

The software demo in the conference presentation will be supported by the case study referring to waste transfer station siting, simulating the cooperation of two decision makers privileging economic and environmental issues, respectively. This experience, now in progress, will be reported in a paper to be submitted after the conference.

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A Group Decision and Negotiation Framework for Hiring Subcontractors in Civil Construction Industry

Rachel Perez Palha[1], Adiel Teixeira de Almeida[1], Danielle Costa Morais[1],

[1] Universidade Federal de Pernambuco, CDSID - Center for Decision Systems and Information Development, Caixa Postal 7462, Recife, Pernambuco, 50630-970, Brazil
{RachelPalha, Almeida, DCMorais}@cdsid.org.br

Abstract. The literature presents several supplier section models, which discuss what features might be present in this type of analysis. A given problem might be evaluated differently depending on the DM, due to his/her having different objectives for the same problem and, due to the diversity found in civil construction projects, different activities have to be hired, and these have different effects on the project. In addition, the hiring process might end up with a negotiation phase between the contractor and the top rated subcontractors. Thereby, in order to support DMs of contractors to follow a structured decision process to reach a better deal, this article proposes a framework to aid DMs in selecting subcontractors considering three models to deal with each phase of the hiring process. One for sorting of activities into classes, then the selection and aggregation of DMs' preferences and finally a negotiation step takes place.

Keywords: *voting procedure; preference elicitation; Additive-veto model; sorting problematic; negotiation*.

1 Introduction

Outsourcing different services and searching for flexibility is a reality of current supply chain management [1]. Due to the need to outsource or subcontract services, several problems have been addressed in the literature, such as a single supplier and multiple firms forming a coalition for cooperative replenishment [2], for the purposes of jointly setting the control policies for production and subcontracting while taking environmental legislation into account [3], to evaluate the price of the product to be supplied [4], and to select outsourcers/subcontractors [5]. Outsourcing activities in the CC is part of the culture of this sector [6], about which several authors have expressed concern. The oversupply of specialist firms and the ease with which they can enter the marketplace are two of the main concerns [7]. This directly affects procedures for selecting such subcontractors, because it is necessary to verify if they are reliable. In addition, Keshavarz Ghorabaee *et al.* [8] classifies the selection process as a Mul-

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ticriteria problem, because DMs have to take into account qualitative and quantitative criteria.

In order to reduce the problems created by contractors, Holt, Olomolaiye and Harris [9] proposed using prequalification of subcontractors before the selection. Gonçalo and Alencar [10] proposed to sort activities and materials into classes according to their impact on the company´s strategic results by using PROMSORT [11] prior to the selection itself. The main idea was to focus on activities or products that had the greatest effect on the results of the business. This approach allows DMs to save time that would otherwise be spent on the selection process on an activity that does not cause a positive effect on the project. Palha, de Almeida & Alencar [12] proposed to sort alternatives into classes based on the risk and impact that the activities cause to a CC project for which they used ROR-UTADIS.

In today's businesses scenarios, decisions are no longer individual; they often require a group to participate in them [13]. The idea is to reduce the risks that might be caused by one single DM and to allow DMs to make decisions in a decentralized environment. De Almeida [14] states that the group decision aggregation is divided into those that aggregate DMs' initial preferences, such as in Chen [15], and those that aggregate DMs' individual choices, such as in Karsak and Dursun [16]. Some models do not aggregate at all, but instead present DMs with a general evaluation to help them reach a consensual decision as in Shemshadi *et al.* [17].

Because groups of DMs increasingly make managerial decisions [18], their preferences have to be aggregated in order to reach a social choice and to do that one of the aggregation procedures considered to be democratic is that of voting [19]. Because an analyst chooses the voting procedure, it may not be suitable for the decision process faced by the DMs. Therefore, de Almeida and Nurmi [18] proposed a framework to help DMs choose the voting procedure by considering their preferences with respect to the problem. The choice is made by considering the voting procedures as alternatives and their properties as criteria. In addition, Nurmi [20] presented a set of properties to be evaluated as binary. Also, research interest in a voting procedure, which deals with partial information is growing [21,22]. Therefore, a criterion that considers this property should be included in the analysis.

In addition, the supplier selection problem also involves a negotiation process, because the suppliers present different performances in different criteria and these performances might be negotiated to make the alternative competitive [23]. In business environments, the use of NSS may aid DMs to find a better solution faster. Several NSSs have already been built with different propositions, and in none of them one party have information about the preference structure of his/her opponent. Vetschera [24] emphasized the importance of knowing about one's own preferences and the opponent's preferences to find a superior agreement. Usually DMs have difficulties in presenting their own preferences [25] and difficulties in inferring the opponents' preferences [24]. In addition, in negotiation process, agents are employed to work on behalf of one party. Yu and Wong [26] proposed a multi-agent model, where they use synergy to evaluate multi-products supplier selection and run a negotiation with top-ranked suppliers evaluating the synergy among products. Dzeng and Lin [27] proposed agents for supporting construction procurement negotiation using genetic algorithms. Later on, the authors run an experiment to evaluate its efficiency of their agents and verified and improvement in negotiations from 1.1% to 9.8% when compared to the ones dealt by humans [28]. Vetschera [24] presented a model to aid the negotiator to infer the preferences of the opponent. Non-biased mediators were found in the literature to provide advice in the post-negotiation phase [29] or to elicit preferences from negotiators [25].

Usually, when the selection process is considered as a group decision, the proposed methods consider DMs have the same objectives regarding the problem. When they aggregate DMs' individual choices, they do not consider that the DMs might have different objectives and different rationalities. In addition, there is no proposition to evaluate the activities and subcontractors differently, in line with their effect on a project. The literature does not take into consideration that after receiving a bid, a negotiation is required and the process might be impacted by the effect that the activity and/or the subcontractor has on the project. Therefore, it is important to propose a framework to aid DMs to conduct the process for hiring subcontractors in a more informed and structured way to include the nuances of the CC environment with a view to reducing the number of liabilities, delays and avoiding additional costs. This framework should take into account the whole hiring process, from the identification of activities to be hired to the negotiation of the contract between contractor and subcontractor to accomplish the activity.

2 Context of the Problem

In the heavy construction industry, contractors work with a decentralized structure. This configuration is due to geographical and communication constraints imposed by the type of projects to be engaged on, such as constructing a highway, railways, airports, harbors, bridges and industrial buildings. These types of construction usually are far from urban centers, and thus require DMs to have autonomy to make decisions. However, the Chief Executive Officer (CEO) of the company has to guarantee that the Director of Construction (DC) in charge of the project will maintain the values of the contractor. Thus, usually the managers are treated as DMs and legally answer for the project as well. The DC behaves as a Supra Decision-Maker (SDM), and he/she has to choose his/her team and win the contract and the client. The managers and the DC behave as the board of the company and a group of DMs makes all the decisions guided by the governance defined by the contractor. The DMs present different characteristics and backgrounds. Therefore, it is important to use a framework to guide this decision process in the CC context from which the DMs can benefit by being flexible and fitting their needs to the aims of the project in terms of structure and information.

In a construction project, the actors involved are the DMs, the analyst, the experts and the stakeholders. The DMs of a project normally include a Director of Construction (DC), a Finance Manager (FM), an Engineering Manager (EM) and an Operations Manager (OM). Depending on the size and type of project, a Maintenance Manager (MM) and the Client may also take part in the procedure. The analyst is usually an individual who is head of his own team, and who organizes the processes of the subcontractors and deals with them, with regard to payments, documents, and managing the contractual relationship. The analyst should have some background on decision theory to be able to structure the processes and guide DMs during their evaluation. The expert usually is not involved in the selection processes of subcontractors itself but is knowledgeable about the activity to be selected or has specific knowledge about the project itself. The stakeholders are environmental agencies, the Ministry of Labor, the City Hall, the Government, the population affected, the Union and the Client, as the enterprise, which actually hired the whole project. The Client might be from either private or public sector and may play the role of DM in Alliance Contracts or Cost-Plus Contracts because it will be one of the hiring parties in all outsourced contracts.

Nowadays, the process for hiring subcontractors does not follow a structured model in contractors. Usually, three companies are invited to take part in the selection during which information such as the nature of the structural project, deadlines, localization and documents required are presented. These companies visit the construction site to evaluate subjective issues, such as labor conditions, labor union of affiliation, interaction with other activities, the need for lodgings, and transportation conditions. During the selection, the companies present their proposal, including price, time needed to start the activity, time needed to undertake the service considering the price presented and their assumptions about the project. DMs evaluate rank the proposals based on cost.

Once the subcontractors are ranked, a negotiation process starts. The subcontractors' proposals usually are evaluated based only on cost, however, previous experiences with the subcontractor can be taken into account and a tradeoff may occur intuitively. This negotiation is made with the top-ranked subcontractors, only with the companies the DM feels to be the most reliable. Sometimes a pre-qualification step is included to analyze legal documents and verify if the company fulfills the legal requirements. The negotiation process ends when the DMs find a subcontractor who fulfils all legal requirements, by presenting documents to prove they do not have legal issues, and technical requirements, such as the lowest price, best working practices and are able to accomplish the activity in the schedule planned for the project. Criteria such as quality, maintenance service level, and experience are evaluated based on information inferred during the negotiation step.

The hiring process starts with a manager requiring a service to be outsourced and furnishing the analyst with all technical information a subcontractor would need to formalize a bid. During the selection and negotiation phases, all DMs get involved in the analysis and interactions with the subcontractors in every possible hiring process, which is a time demanding activity. The question is: do all DMs actually need to get involved in every hiring process all together or if they could split this effort and evaluate the hiring processes as a group only on those activities that could bring more issues to the project?

An objective of this research is to offer DMs and analysts a framework to enable the costs associated with the hiring procedures to be reduced by reducing the time and number of DMs devoted to make decisions and play a role in negotiation when hiring subcontractors in the CC industry. The idea is to allow the actors to focus on situations that are truly dangerous to the project and relax the constraints imposed on those that do not strongly affect it. Therefore a framework to aid contractors to hire subcontractors in the CC industry is proposed.

3 A framework to aid subcontractors' hiring in the CC industry

A Framework to aid DMs in the Civil Construction (CC) Industry to hire subcontractors is proposed and presented in figure 1. This Framework takes into account that different activities are hired during a project that represents different impact to the project, also, the DMs have different objectives regarding the problem. Therefore, it is necessary to apply a method to aggregate DMs' individual choices, meaning that the aggregation will take place at the end of the process, over the individual ranking of the DMs. Moreover, the framework also includes a peculiarity of allowing the analyst to apply different methods so that the DM can rank alternatives, depending on the DM´s rationality. By the end, a negotiation between contractor and subcontractors takes place.

De Almeida *et al.* [14] proposed a twelve steps procedure considering that the modeling process includes analysis of several possibilities that are associated with different hypotheses. This analytical process works as a funnel in which the possibilities are refined to obtain a model compatible with the DM´s preference structure and the information available. This funnel's filtering layers are usually the actors involved, the DMs' rationality; the attributes used to describe the alternatives and; the alternatives themselves. Therefore, the selection of subcontracts should take into account not only the characteristics of the project but also the DMs' rationality.

The framework presented in Figure 1 to aid DMs to hire subcontractors in a CC project follows the procedure proposed by de Almeida *et al.* [14] to model multicriteria decision problems. This framework uses two models to support contractors in their hiring processes in the CC industry.

The analysis has to start by listing and describing the activities of the project, and which of them will be outsourced. It is important to describe them based on information that later shall be used as criteria for the sorting model. Before sorting activities into classes, it is necessary to verify which DMs are to be involved in the process of sorting and of choosing. These will not necessarily be the same ones.

Once the preliminary phase is finished, the first proposed model is used, which consists of sorting activities into classes by applying the Additive-veto model for sorting problematic [30]. Hence, the selection process will not necessarily have to involve all DMs, requiring only the Supra Decision Maker (SDM) to get involved in this phase of the framework.

Depending on the impact, a contract will assign to the project or the contractor, the hiring process and its management are handled differently. In addition, the negotiation process is modified depending on the effect such a contract has on the project, and will involve assigning more DMs to higher impact activities and fewer DMs to the lower ones. Hence, by applying a sorting model prior to the selection, one can improve the decision process by decreasing the risks of liabilities and costs associated with the selection and negotiation of hiring a subcontractor. Moreover, lower impact activities have less strict requirements compared to higher ones. Therefore, by managing each activity in a proper manner, money can be saved. In this model, the contractor has the possibility of making more realistic and wiser decision, since he/she concentrates on reducing risk and liability at a higher level.

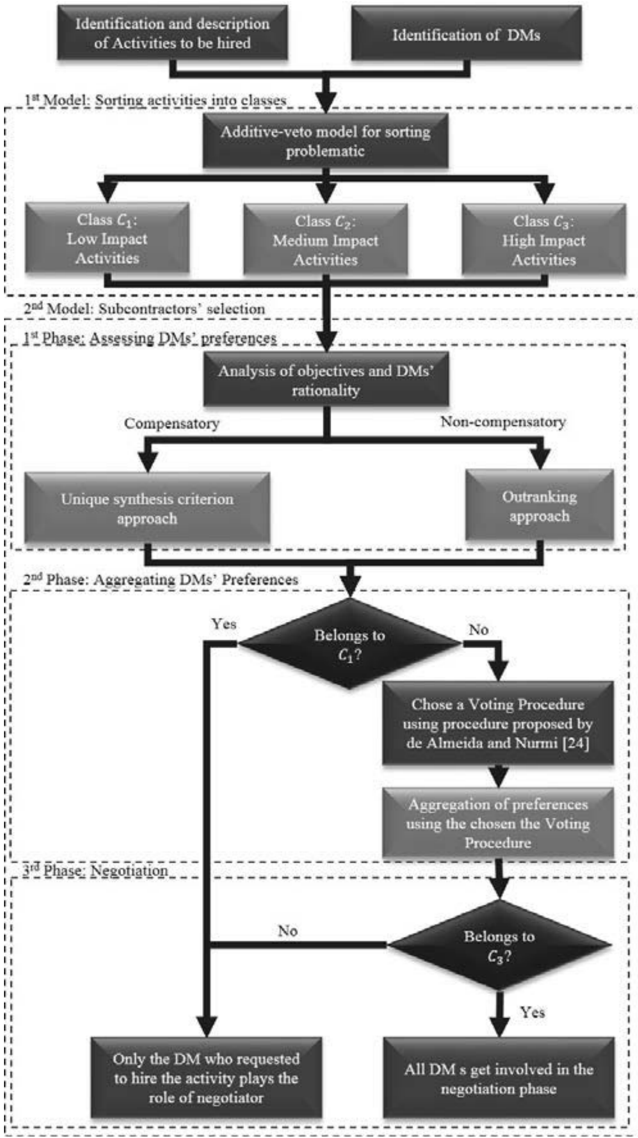

Fig. 1. Flow-chart of the framework proposed

Within the CC context, the managers usually present a compensatory rationality when evaluating the risks they might face by outsourcing an activity. Therefore, some trade-off [31] among criteria might be required. This characteristic eliminates outranking sorting methods. Moreover, this step of analysis usually takes place right at the beginning of the project. Projects vary in size, budget, location and types of activities. Thus, it is very difficult for a DM to present preference information based on holistic assignment, since he/she does not have information a priori. In addition, by using SAW (Simple Additive Weighting) [31], the alternatives are sorted based only on thresholds, ignoring some nuances of the sorting problematic.

After all activities were grouped according to their effect on the project, the selection model is used. This model is divided into two phases: the preference modeling and the aggregation of DMs' preferences. In the first phase of this model occurs the assessment of each DMs' preferences to allow all DMs to rank the subcontractors', which took part of the selection process. At this moment, the analyst might decide to use a compensatory method or a non-compensatory method. This decision will depend on the DM´s rationality, which might be evaluated following the questions presented by Roy and Slowinski [32] or by using the definition of non-compensatory rationality presented by Fishburn [33]. The second phase only occurs in higher impact classes, because in those the process will be that of a group decision. Therefore, an aggregation process is proposed. The output of this model will be a ranking of the subcontractors, either by being analyzed by a single DM or by the group. After the subcontractors were ranked in each activity, the last phase of the second model takes place. Differently from what is found in projects in the CC industry, in this framework, only activities that were sorted in higher impact classes have their contracts negotiated by all DMs. The other activities are only negotiated by the manager who required to outsource the service or the DC. This phase consists of negotiating with the top three or four bidders to decide which one would best suit the project. In this step, the negotiators provide preference information by using the FITradeoff method [34] and a mediator agent be used to reduce the number of interactions before reaching a compromise solution.

Thus, the proposed framework was built to aid analysts and DMs in contractors to structure the hiring processes of subcontractors from the very beginning. This way, the team is able to manage the subcontractors and activities in a way compatible with the danger they might bring to the contractor, the project and the client while saving money and time of the DMs involved in the project.

4 Numerical Application

In order to validate the framework it was applied over the problem presented by Palha *et al.* [12]. Here, we used the Additive-veto model for sorting problematic to sort alternatives into classes. We considered four decision makers would be involved in the selection itself and had to provide preference information to choose the best voting procedure to aggregate the ranking provided by each DM and a negotiation step with the top-ranked subcontractors was taken into account. The DMs were a Director of Construction (DC), an Operations Manager (OM), an Engineering Manager (EM) and a Finance Manager (FM).

Table 1 presents the classification of each activity into each class. To illustrate the second model, were considered the selection process to hire a subcontractor to accomplish the CFA pile activity, which later would be negotiated with the top three subcontractors. This activity was sorted as class C2 in Section 4.2.2 and class C3 in Palha, de Almeida & Alencar [12]. As an activity sorted in class C2, all DMs took part in the selection process. Even though the DMs could use different criteria to run the selection, as a matter of simplification, all DMs used the same criteria which were cost (g_1), Time needed before starting the service (g_2), Time needed to conduct the service (g_3), quality (g_4) and Maintenance service level (g_5). By using the procedure proposed by de Almeida and Nurmi [18], the voting procedure chosen was Kemeny's Rule [35] and the solution found was S02 P S01 P S07 P S05 P S03 P S04 P S06.

Table 1. Classification of activities by using the Additive-veto model for sorting problematic.

Classes	Activities
C3	Concrete; Concrete Paving
C2	CFA; Earthwork; Food Supply; Gypsum Liner; Heavy Equipment; Hydroseeding; Molds, shoring and scaffolding; Precast Concrete; Property Security; Transport of personnel; Waterproofing
C1	Air Conditioning; Asphalt Paving; Containers; Vegetation Suppression

In the last phase, for activities sorted in class C2, the DM who required the service or the DC has to negotiate the activity with the top ranked subcontractors. In the case of the CFA pile activity, the OM required the service. Thus, he has to negotiate with top-ranked subcontractors. These are S02, S01, and S07. During this negotiation, the OM can learn about each of the negotiators and use his knowledge of previous experiences in this process, as well as the mediator agent gives advices on the best alternatives to concentrate on.

5 Final Remarks and Managerial Impacts

The framework allows the DMs to make quicker and less costly decisions by saving their time during the selection process. It is easy to use and is a novel methodology in the sense that methods compatible with the DMs' rationality will be used. Besides, it permits the DMs to express their own objectives and evaluate the alternatives based on their perception of the criteria. The procedure presented by [18] brings to the methodology a characteristic that makes the process flexible yet robust, by allowing the DMs to use their preferences to choose a voting procedure compatible with the problem faced. The idea of presenting a set of methods for the selection process has been previously addressed in the literature, without evaluating in the same model the DMs' rationality. In addition, the last phase of the framework is a negotiation step, which varies according to the class of assignment of the activity.

The proposed framework presents a different way of dealing with selecting subcontractors, namely by allowing the DMs to manage hiring procedures in a manner compatible with their impact over the project. In addition, it allows the DMs to use a method which fits their rationality. Moreover, the DMs do not have to consider the same criteria, and thus, can take their own objectives towards the problem into account. Finally, they can feel more secure about the aggregation procedure, since it is chosen based on their preferences.

In sum, the framework offers a flexible form of analysis to the supplier selection process in the CC context and other environments, which select workers, projects, etc. It allows a detailed and structured analysis process that might help DMs to feel more comfortable about decisions during a project.

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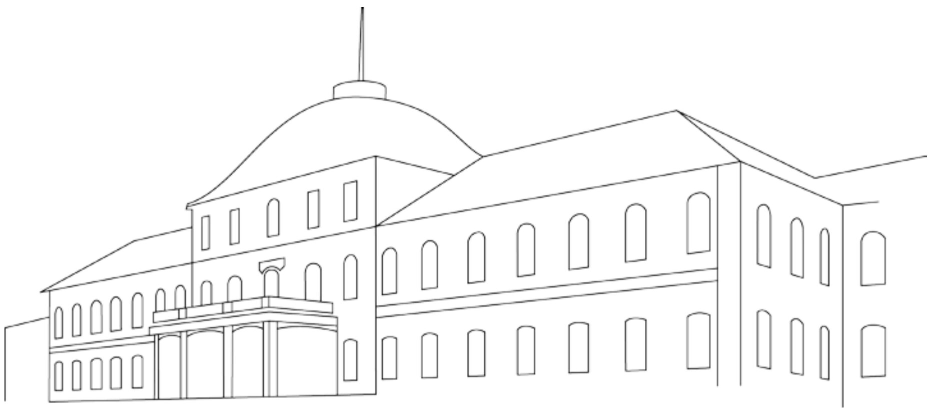
Micro-Processes of Group Decision Making Support

Stream Organisers:
Mike Yearworth, University of Exeter, UK
Leroy White, Warwick Business School, UK
Fran Ackermann, University of Strathclyde, UK



University of Hohenheim

Knowledge Acquisition Using Group Support Systems

Colin Eden[1*], Igor Pyrko[1], Susan Howick[1]

[1] University of Strathclyde, UK

[*] Corresponding author, e-mail: colin.eden@strath.ac.uk

Abstract. This paper reports on a project in which a Group Support System (GSS) was used to 'acquire knowledge' from seven European cities with respect to the interactions between risk events faced by the cities. The aim of the project was to develop a Risk Systemicity Questionnaire (RSQ) which is an interactive tool designed to support cities in improving their resilience. A series of GSS workshops was organized in which participants co-created the risk scenarios that formed the main content of the tool. This paper presents an approach to using a GSS to inform specific research questions rather than to develop new solutions which participants can take ownership of and implement immediately in their work. In turn, the use of GSS in such non-traditional context poses a number of important methodological considerations of which GSS facilitators should be aware.

Keywords: group support systems, knowledge acquisition, city resilience

1 Introduction

Group Support Systems (GSS) have been used extensively to support productive meetings as they provide advantages over traditional meetings such as improved procedural justice and the ability for all participants to add their contributions at the same time (Ackermann et al., 2016; Nunamaker et al., 1991; Valacich et al., 1991). GSS have also been applied for various purposes, such as making strategy or project management, and in work with organizations of different sizes and sectors (Ackermann and Eden, 2005, 2011b). In a typical GSS-facilitated session, participants are asked to consider a specific set of problems that is relevant to their work, and by pooling their expertise they co-create new options to address those problems. Thus, the focal points of the session become the solutions which participants should ideally feel ownership of, and subsequently agree to act upon, in order to change their projects or organizations for the better (Bryson et al., 2014; Tavella and Franco, 2015).

In this paper, we present a 'non-traditional' approach for using GSS in a group meeting where representatives of seven cities were asked to feed their knowledge into the requirements of a European-funded research project titled *Smart Mature Resilience* (SMR). The purpose of the SMR project is to develop five tools which will support cities in developing their resilience against different kinds of risks, and

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thereby form a new European Management Guideline. In this paper, we report on the production of one of the five tools called the *Risk Systemicity Questionnaire* (RSQ) which aims to support cities in thinking about non-obvious interactions between risks and their consequences.

Thus, instead of designing strategies or solutions which participants would subsequently implement in their own organizations, the role of the participants was to respond to a number of risk scenarios and share their views with respect to 1) the possible complex negative ramifications of different risks happening in their cities, and 2) the ways in which their city could mitigate the negative ramifications. Due to this design of the workshops, even though participants were highly committed to providing valuable contributions for the needs of the design of the RSQ tool, they had no obligation or sense of ownership with regards to immediately implementing the outcomes of the workshop. Instead, it was only the final tool which they would consider implementing.

Consequently, the contribution of this research is in demonstrating how GSS can be used for 'acquiring knowledge' from participants who take the role of active study participants rather than 'clients' who expect to immediately benefit from the workshop. We elaborate on the important considerations which need to be taken into account by the researchers and the workshop facilitators where the goal of the session is to contribute to specific research questions instead of trying to directly benefit the participants' organizations. This way, we expect to enrich and broaden the possible uses of GSS beyond action research or working with a client. Moreover, we demonstrate how the acquired knowledge can be structured and organized so that it can offer valuable insights into the context of a research project.

2 Organizing GSS-facilitated sessions to construct Risk Systemicity Questionnaire

The Risk Systemicity Questionnaire (RSQ) builds on previous attempts in the literature to move away from thinking about risks as independent from each other, which is encouraged, for example, when using risk registers, towards considering risks and their consequences as being interconnected with one another (Ackermann et al., 2007; Ackermann et al., 2014; Williams et al., 1997). The RSQ also addresses the increasingly recognized need to support today's cities in improving their resilience with regards to different kinds of risks (Boin and McConnell, 2007; Crichton et al., 2009; Labaka et al., 2015; van der Vegt et al., 2015). Thus, *Group Explorer*[1], a type of GSS, was used in this research due to its proven effectiveness in capturing causal relationships between concepts (in this case risks) which participants add onto a shared model (a causal map) during the course of a facilitated session. By capturing risk events and their interconnectedness this way, it was possible to develop networks of risks, or risk systemicity scenarios that would inform the RSQ.

[1] Copies of the software are available from the authors (contact colin.eden@strath.ac.uk) free of charge

As part of the reported research, seven GSS-facilitated workshops were organized in different European cities which all actively participated in the project: San Sebastian, Spain; Rome, Italy; Riga, Latvia; Glasgow and Bristol, UK; Kristiansand, Norway, and Vejle, Denmark. During the sessions, three different risk themes were explored: critical infrastructure, climate change, and social issues. Three of the workshops were focused on the development of risk scenarios, three workshops were focused on embellishing the policies previously added by participants, and one workshop was focuses on testing the initial draft of the RSQ.

At every session, each of the seven cities was typically represented by 1-3 participants. The invited participants were mainly city employees responsible for risk and resilience, and so most of them could be considered as possessing generalist knowledge with respect to the three covered themes rather than being specific topic experts. As a result, the facilitated discussions tended to operate at a fairly general level in terms of how the different types of risks interacted, instead of dwelling on technical details.

During the sessions there was a high level of involvement by all city participants who produced a high number of contributions in a relatively short amount of time. Thus, the three causal maps resulting from the workshops were large and messy. The first ‘critical infrastructure’ workshop ended with 183 statements and 339 causal links, the second ‘climate change’ workshop ended with 339 statements and 515 links, and the third ‘social issues’ workshop ended with 427 statements and 764 links. The continuing increase in map complexity was the result of 2 factors: i) increasing experience of the participants in using the GSS (more than a half of participants were recurring between the workshops and so they helped other participants to familiarize themselves with using the GSS); and ii) the increasing complexity of the theme. When designing GSS workshops for knowledge acquisition it is critical to consider the order in which topics are considered in order to exploit fully the growing experience of using the GSS. The series of workshops needs to be planned in advance as a whole rather than as separate sessions, and it is useful to recognize whether different topics for the workshops have distinct levels of difficulty and complexity. Thus, the workshops are likely to be more productive (e.g. with respect to the number of gathered concepts, quality of links) when the researchers ensure that those ‘less complex’ workshops take place first. In this research it was appreciated that ‘social dynamics’ was a more complex and demanding topic for participants than ‘critical infrastructure’ and ‘climate change’ due to its very high level of interconnectedness between the various sub-themes. However, in our case we had not considered how important this factor would be and so the good outcome was the result of serendipity rather than good planning.

The three causal maps were subsequently merged together by identifying the shared patterns and commonalities between the maps. Upon merging the maps, 16 key themes were identified such as ‘social inequalities’, ‘flooding’, and ‘air pollution’ – these themes subsequently provided the structure and the content for the RSQ, with each topic comprising of a number of risk scenarios.

3 Methodological considerations of knowledge acquisition with the use of a GSS

The reported research can be considered as a valuable case study describing knowledge acquisition using a GSS because it included participants from different countries who did not know each other before who were asked to use their existing knowledge to address different kinds of generic risk events (for example ‘the city becomes overwhelmed by flooding’), and who had not participated in this type of GSS session previously As a result, it was important for the researchers to address a number of methodological questions which appeared to become more relevant as opposed to more ‘traditional’ GSS sessions when working with people from the same organization and who would be discussing their own problems. The considerations experienced in this research included:

- How to engage participants around problems that may not directly affect their own cities or their work practices? (For example flooding imposes higher risk for Glasgow than for Riga).
- How to structure the session so that participants find enough commonality to co-create a shared model during the workshop? (Considering that participants had very different experiences from their own work settings).
- How to plan the order of a sequence of knowledge acquisition workshops bearing in mind: i) growing experience of using the GSS, and ii) the relationships between topics.
- How to analyze the resulting model when the researchers cannot draw on a comprehensive understanding of the participants’ organizational contexts? (Considering the international character of the participant sample combined with the restrictions on time and resources enforced by the research project).

As part of addressing the above problems, an extensive literature review was conducted targeting city resilience in the context of the three covered themes in the workshops. The review of literature helped to identify a number of resilience-related concepts that could help to appeal to all participants, for example ‘bouncing forward’ (using the risk events as an opportunity for the organization to learn and to transform itself) (Malalgoda et al., 2014; Manyena, 2006; Taleb, 2013), or the notion of unintended consequences of cities’ responses to risks events (Eusgeld et al., 2011; Rinaldi et al., 2001). In other words, the use of relevant technical concepts helped to establish a common language for the participants which they could all use as a shared point of reference. Furthermore, an additional review was conducted covering the characteristics of the participating cities, which revealed further commonalities between the cities that could be drawn upon (such as geographical or demographic characteristics). The results of the literature review were subsequently used to draft the script for the workshops, including the starting questions, in order to enable everyone’s active participation.

Whereas a rigorous preparation allowed the group to work together effectively during the workshops and contribute in a very productive manner, at the end of the sessions participants felt little ownership of the resulting model because the co-created content was fairly generic and not tailored to each city's particular circumstances. Another reason for the lack of ownership was the result of no organizing of the data in the workshop, whereas, in contrast, in a strategy making or a problem structuring workshop the material is continuously being organized into meaningful chunks. As a result of the limited ownership of the map, there was a smaller chance for participants to be able to 1) recall and understand the content of the maps after the session, 2) appreciate that they have contributed to all of the key clusters that have been recognized by the group as being important, 3) 'find their way' through the structure of the maps in a familiar manner, and 4) immediately act upon the outcome of the workshop (Ackermann and Eden, 2011a; Bryson et al., 2014). However, in the knowledge acquisition session it is more important to address the specified research question rather than achieve the four above points. Thus, one tension is acquiring more knowledge versus less knowledge but more understanding from participants – and considering the knowledge acquisition nature of this research we chose the former.

In addition to this, a considerable amount of effort had to be dedicated to tidying the models after the sessions in order to remove duplicate statements, to link the isolated concepts with the rest of the model, and to correct the direction of arrows so that they made sense 'in the spirit' of the overall style of contributions. Also, the material had to be carefully validated through different means: 1) the three researchers' cross-validation, 2) referring to relevant academic literature and governmental reports, 3) asking city participants to validate parts of the material after the sessions. It must be noted that the analysis of data and the preparation of risk scenarios based on the findings took more than a half of the 1.5 year duration of the research.

4 Conclusion

Overall, the products of the workshop enabled the design of the RSQ, and the co-created risk systemicity scenarios embedded in the RSQ were received enthusiastically by the cities as they found them highly insightful. Thus, although knowledge acquisition with the seven cities was considered successful, researchers intending to conduct projects of similar nature are advised to appreciate the demands which such projects can impose on them. Firstly, due to the various methodological considerations discussed above, the GSS sessions were particularly demanding on the part of facilitators (this was mitigated by the fact that the lead facilitator had substantial experience in the practice of GSS facilitation), and so the GSS sessions required careful preparation of the script in advance of the session. As part of the preparation, where there are a series of consecutive meetings, it is essential to plan the scripts of the sessions in a way that the topics allow for incremental increases in the complexity of discussions so that the participants can conveniently build on the material contributed in the preceding sessions. In other words, in knowledge acquisition the incremental complexity should be considered intentionally during planning the research design, whereas, for example, in strategy workshops the increasing complexity can emerge more organically. Secondly, when working with participants who share little commonalities or do not have a shared stake in the discussed problems, it is essential to find the structure for the session that can be attractive to all participants. In this research a rigorous exploration of the subject literature helped to overcome the difficulties associated with the researchers' limited understanding of the participants' particular work context and to establish the ground for common understanding between participants. And thirdly, due to the highly divergent and scattered nature of the resulting models, researchers had to be prepared to invest a large amount of time on the analysis of the gathered data which covered the majority of the allocated work hours on the project.

Whereas knowledge acquisition using GSS can be seen as a challenging endeavor, especially when working with a diverse sample of participants, it can also lead to important insights and valuable results which may not be possible to be achieved through other means. Further refinement of the approach disused in this paper is therefore seen as a promising direction for future research. In the complex, changing world, the ability to integrate the knowledge of different experts can be considered particularly important, and an informed use of a GSS can be a good way of enabling such valuable group collaboration.

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Towards a Typology of Roles in Strategy Making Workshops – Building on the Use of the GSS Data Logs

Igor Pyrko[1*], Colin Eden[1], and Fran Ackermann[2]

[1] University of Strathclyde, UK
[2] Curtin University, Australia

[*] Corresponding author, e-mail: igor.pyrko@strath.ac.uk

Abstract. This paper reports on research which explores a typology of roles which participants undertake during the course of strategy making workshops facilitated with the use of a Group Support System (GSS). The reported research draws on a series of data logs generated in a number of strategy workshops with senior management teams in both public and private organizations. The data logs enable detailed tracking of the participants' contributions over time. This level of richness and detail of analysis, in turn, is used to build the foundations for the proposed typology. The typology may contribute to a better understanding of how GSS can be used effectively to conduct productive strategy making meetings. The typology provides guidance to facilitators of GSS, and especially those who are new to the facilitation practice.

Keywords: group support systems, strategy making, microanalysis

1 Introduction

Group Support System (GSS) have been effective in helping make group meetings more productive by allowing benefits such as anonymity and ability to gather information from multiple participants at the same time (Nunamaker, Dennis, Valacich, Vogel, & George, 1991; Valacich, Dennis, & Nunamaker Jr, 1991). Whilst GSS have been used successfully in variety of settings and with organizations of different types and sizes (Ackermann & Eden, 2011b), one application of the GSS that has been elaborated in the literature and through practice is the facilitation of strategy making workshops (Ackermann & Eden, 2011a). In these strategy making sessions the GSS is used to structure and prioritize the key issues participants believe the organization faces when seeking strategic success. However, group facilitation, using a GSS, is demanding for the facilitator. During a meeting, the facilitator needs to attend both to the content and the process of the discussion, and be able to make 'on the hoof' analysis judgments (Bryson, Ackermann, & Eden, 2014) and also understand the behavior patterns of participants. For this reason, it is important for facilitators to inform their interventions and guidance to the group with refined

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concepts and theories based on 'real-world' practice (Clawson, Bostrom, & Anson, 1993; Kaner, 2007; Schwarz, 2002).

This paper reports on a pilot research project that explores a typology of participant roles during a GSS strategy making workshop. Thus, this typology, which is, in some respects, an elaboration Belbin's (1981, 2010) popular *Team Roles at Work*. The typology characterizes a range of behaviors which people demonstrate at different stages of strategy workshops. It must be stressed that, typologies, as with all categories, are likely to be imperfect (Taleb, 2008). The inherent inaccuracy of categories is due their *radial structure* (Weick, 2009), which means that each category consists of *prototypical members* at its stable core (that is members who appear to fit well into that category), but it also comprises of *non-prototypical members* who may not seem to fit into that category as well as the prototypical members (Tsoukas & Chia, 2002). For example, it is clear that an elephant is a mammal (a prototypical member of the category), but it can sometimes be surprising for one to find out that a dolphin is a mammal and not a fish, or that platypus is a mammal and not a bird. Thus, whereas categories are essential in providing a resource for people to make sense of the world, they always remain simplifications of the lived world which, from time to time, need to be refined and updated (Weick, 1995).

Whilst recognizing that categories do not offer 'perfect' representations of reality, at the practical level, a typology can provide valuable insights for GSS facilitators in three ways. Firstly, the typology of roles in strategy GSS workshops can inform the facilitator about typical behaviors that the participants demonstrate, and so the facilitator may be able better to identify and manage the group. Secondly, a typology offers a language and a point of reference that can be used by facilitators to negotiate *a good practice* and thereby increasingly draw on mutual experiences. And thirdly, the typology can be linked with recommendations for the facilitators that have been informed by extensive practice of facilitating strategy making workshops using a GSS. In addition, a typology of strategy making roles, with different roles not being exclusive to the specific person, also contributes to a better understanding of the flexibility required from practitioners who need to adapt their skills and experiences to the needs of the situation in the strategy workshop rather than resort to 'what has already worked before' (Katzenbach, 1997).

2 Methodological approach - using the GSS log

The research, with its focus on the participants' roles in strategy making sessions, is designed to make extensive use of the data generated from the previously conducted 'real-world' workshops. This entails taking a micro perspective on the participants' activity, where each recorded action is investigated on a second-by-second basis (see also Ackermann & Eden, 2011b; Ackermann, Eden, & Pyrko, 2016; Paroutis, Franco, & Papadopoulos, 2015; Tavella & Franco, 2015). The GSS applied in this research (*Group Explorer*[1]) allows the recording of every interaction with the system over time. Thus, the computer based activity of each participant, and of the

[1] Copies of the software are available from the authors free of charge (contact colin.eden@strath.ac.uk)

facilitator, is known. The data sets used in this research come from a number of previously facilitated strategy workshops, conducted with a variety of organizations within different sectors.

The GSS log is saved in Excel spreadsheet format, which means that it can be analyzed in detail. The data is presented as a series of individual contributions listed in order of their appearance on the strategy model (a causal map) that is co-created by participants during the session. These contributions are separated by a range of different activities initiated by the facilitator, for example this can be an activity during which participants are asked to focus on entering statements with respect to a given topic, or participants may be invited to evaluate a selection of previously added statements which appear to be of considerable significance in their view. This in turn provides a detailed record of the facilitated activities which may not be possible to obtain through other means (e.g. by hand-written notes and observations).

As a result, it is assumed that the richness of data enabled by the use of the data log is valuable in the construction of the roles typology because it allows for identification of key patterns of behavior (as also seen in Shaw, Ackermann, & Eden, 2003). The method of analysis builds on the approach for analyzing GSS data logs presented during the GDN 2016 conference. However, in this reported research, the method of analysis is refined further.

Of course, such a log misses non-verbal behaviors and discussion that is not recorded through the GSS. However, participants are aware that agreements and records of the meeting are derived solely from the GSS and so most discussion does appear in the log. Thus, while the log is inevitably incomplete, it does provide an important perspective on roles.

3 Exploring strategy making roles

While the analysis used in this project is expected to capture emerging patterns in data, these patterns are not fully grounded in the data but rather are prompted by a preliminary conceptualization of the possible strategy making roles. These preliminary roles are based on both the established Belbin roles for teams, as well as the researchers' hypotheses based on experience of conducting strategy workshops. Thus the reason for identifying possible different team roles before conducting data analysis was to inform and frame an initial understanding of what patterns to look for in the data, what coding to apply, and what kind of analysis can be feasible to conduct on the data logs. Moreover, to ensure a reasonable degree of inter-coder reliability, we tried to apply such coding which could be easy to use and explain. The initial roles included:

Roles based on facilitators' hypothesis

Pathbreaker. Adds early contributions which help other team members as a point of reference.

- Coding: count the number of contributions by each user with respect to the different stages of the session.

Active contributor. Adds a large number of contributions in relation to other members.

- Coding: count the total number of contributions by each user for the whole session.

Adds generic options. This category relates to high level, general statements such as: ‘have a strong governing body’, ‘become a first choice employer’.

- Coding: assess whether the given statement provides a general direction for making strategy, but at the same time it would require further elaboration in terms of the more specific actions in order to understand better how to actually achieve that more general option.

Connecting different participants’ contributions vs connecting mainly own statements. Whether the participant uses causal links to connect other participants’ contributions on the shared causal map, or the participant concentrates on linking their own statements.

- Coding: the percentage of causal links added by the participant in which the participant a) links only their own statements, b) links one of their statements with a statement added by another participant, and c) links two statements added by other participants.

Synthesis of options. This category relates to a situation when through the wording of a statement it can be seen that a statement brings together, or draws upon, other statements. For example, ‘become an excellent social housing agency’ and ‘focus on regenerating deprived areas’ could be combined into ‘achieve excellence as a social housing agency known for regenerating activities ’. This category may often overlap with the category ‘develops existing options’.

- Coding: look for statements which wording demonstrates that it had been based on at least two previously added statements.

Roles based on the Belbin team roles mode

Plant – generator of new ideas. Creates (explores) new options with regards to strategic change, rather than develops (exploits) existing options added already during the session. This role can be observed when a participants adds a new idea on the causal map which has not been covered yet in the session.

- The main concern in coding is the meaning and wording, as well as the possible position of the statement in the means-ends hierarchy in the shared causal map. For example, John adds a new option: ‘create excellent customer service’ – and this is a new option in the session because no-one has added a similar option before. However, if at a later stage Kathy adds an option ‘develop our ability to provide great customer service’ – then this is not a new option, but an elaboration of the existing option. On the other hand, if a participant offers a more detailed option *how* to 'create excellent customer service', such as 'hire new staff who are good at customer service', then this can be considered a new option. Moreover, explanations *why* it is important to develop customer service are also likely to lead to a new option. Note that this category can be overlapping, but it does not have to, with the generic role described above.

Resource investigator - focused outside of the team, connects stakeholders. Refers to options which require that a number of stakeholders are connected together. For example, 'have a better understanding of customer value at all organizational levels', 'have a clear strategy for collaboration with suppliers'. This category can be applied to the same statement together with other coding categories described above.

- Coding: look for wording/meaning which represent the need for different agents to work together (e.g. collaborate, integrate, stakeholders, networks, inter-team, inter-organizational).

Specialist who develops few themes vs develops many themes. Whether participant adds contributions to many themes identified in the session, or whether they prefer to focus on a small number of themes. The 'themes' are agreed by participants and determined by the position of statements in the shared causal map, as for example busy statements with large numbers of links around them tend to be key theme 'candidates'.

- Coding: the distribution of participant's contributions across the themes identified during the session.

Monitor evaluator. Provides impartial, logical assessment of the options added by the team. For example, in response to a statement 'create a new product line', Kathy added a statement expressing a constraint 'insufficient budget' which she then linked to 'create a new product line' with a negative arrow. Subsequently, Kathy added a new statement 'improve the current product line rather than create new product line' as a new option.

- Coding: look for critical evaluation of the previously added options, situation where a participant weight up the available options.

With respect to the described roles, from the perspective of *facilitating* strategy workshops, there can be observed important differences between the roles described above. For example, whilst some participants are effective in developing key themes during the session, it is important for the facilitator to ensure that other participants also contribute to those themes as otherwise they may have no sense of ownership of the developed strategy. Furthermore, some participants will be more ready to devise new options rather than necessarily stick to the existing options (perhaps an equivalence to Belbin's "plant" role), and so the facilitator may be advised to encourage the more defensive participants to give it a try to consider creating new strategies based on the pooled knowledge of all participants. Another example in which the typology might aid facilitators is in gaining an increased clarity with respect to the importance of participants' formal leadership during the session (active contributor role) and to what extent formal leadership translates into leadership performance during the GSS supported session - since in a GSS session all contributions are anonymized, the influence of formal authority is significantly constrained, but it may find other ways to influence the sessions (such as better strategic knowledge).

4 Preliminary results of the analysis

At this stage of the reported research, one data log resulting from a strategy workshop was coded following the coding described in the previous section. As part of the analysis we were looking for clear patterns in the coding which could validate the initially conceptualized roles, or perhaps lead to new roles. The results, with respect to the different roles identified, are shown below:

> *Pathbreaker*. Two participants, who were in leadership positions, were adding many contributions early in the session. For example, after the first 6 minutes each of them had contributed at least 8 statements, whilst other participants on average had around 4 statements or less each by that time.
>
> *Active contributor*. The same two participants who were *pathbreakers*, also ended up adding the biggest number of statements in the whole session. One of these two participants added 25 statements and the other added 24 statements, whereas other participants did not have more than 10 statements.
>
> *Summarizer: Adds generic options*. For one participant 50% of contributions could be seen as being generic, high level contributions, whereas an average for the whole team was 25%.
>
> *Consensus Builder: Connecting different participants' contributions vs connecting mainly own statements*. One participant concentrated on linking only their own statements in 91% of cases, whilst for most of other participants this percentage amounted to 56-57%.
>
> Belbin *Plant* – generator of new ideas. For one participant 78% of contributions were 'new options', whilst the team average was 49%,
>
> Belbin *Specialist: who develops few themes vs develops many themes.* One participant used 80% of their causal links to connect at least 3 themes at the same time (as some statements belong to more than one theme), whilst the team average was 68%.

And some possible roles that did not show through the data analysis, but will still remain as possible during further analysis of other workshops.

> *Practitioner: Synthesis of options*. This category has proved to be difficult to code in the data log. Firstly, the synthesis of options is a highly tacit act, and therefore it is not easy to make a judgment whether the given option synthesizes the previously added options, as this may not be clear through wording.
>
> Belbin *Resource investigator* - focused outside of the team, connects stakeholders. Based on one the analysis of one data log no clear patterns was identified. However, it can be expected that by analyzing a larger number of data logs, some patterns illustrating this role might be obtained.
>
> Belbin *Monitor evaluator.* No clear patterns was identified in the analysis of data. This category proved problematic because in strategy making workshops participants are typically advised by facilitators to focus their efforts on creating alternative options to the options which they do not like rather than criticize the options which they do not agree with. However, it is then not always possible to track based on the data log which options were added in response to which other options.

The preliminary results show that this research is likely to develop a typology of roles which are expected to contribute to the research and practice of making strategy. Many of the emergent roles do map onto those identified by Belbin, as expected. By describing different patterns of behaviors which participants may demonstrate during a meeting or a workshop, this typology can be helpful in facilitating the process of making strategy. Moreover, this research also helps to understand better what kind of analysis is feasible when working with data logs, and what additional information can be extracted from them in addition to, for example, the analysis of causal maps or facilitators' handwritten notes.

5 Conclusion and Where Next

In summary, the research offers a contribution to both the theory and practice of facilitating GSS-supported strategy workshops. The resulting typology is expected to improve the current understanding of the different roles and behaviors which can be anticipated during strategy making sessions, and thereby serve as a useful point of reference for facilitators. Furthermore, the available data is explored using a new method of analysis of GSS data logs, and therefore in addition to offering an original contribution to our understanding of the process of negotiation in strategy making, this research also develops further the methodological knowledge of applying data logs in research.

This pilot project has supported the research aims by demonstrating that many of the hypothesized roles, both those suggested by facilitators experiences and from

Belbin, have not been repudiated. The research has indicated that further analysis of other data logs of strategy workshops is likely to be worthwhile. In addition, so far, the data analysis has focused on the submission of statements in the GSS and has not analyzed the behaviors in relation to importance ratings and changing preferences for options.

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Theorizing Playful Model-Driven Group Decision Support with Situated Affectivity

Katharina Burger[1], Leroy White[2], Mike Yearworth[3]

[1] University of Portsmouth, Portsmouth Business School, Portsmouthm UK
Katharina.burger@port.ac.uk
[2] University of Warwick, Warwick Business School, Coventry, UK
Leroy.White@wbs.ac.uk
[3] University of Exeter, Business School, Exeter, UK
M.Yearworth@exeter.ac.uk

Abstract. An integrative approach to theorizing behavioral, affective and cognitive processes in model-driven group decision support (GDS) interventions is needed to gain insight into the (micro-) processes by which outcomes are accomplished. This paper proposes that the theoretical lens of situated affectivity, grounded in recent extensions of scaffolded mind models, is suitable to understand the performativity of affective micro-processes in model-driven GDS interventions. An illustrative vignette of a humorous micro-moment in a group decision workshop is presented to reveal the performativity of extended affective scaffolding processes for group decision development. The lens of situated affectivity constitutes a novel approach for the study of interventionist practice in the context of group decision making (and negotiation). An outlook with opportunities for future research is offered to facilitate an integrated approach to the study of cognitive-affective and behavioral micro-processes in model-driven GDS interventions.

Keywords: Group support systems · Group decision support · Model-driven approaches · Emotions

1 Introduction

The theoretical lens of situated affectivity [1-3] may help to conceptualize the complex affective processes in model-driven group decision support (GDS) interventions in a novel way. Our aim is to consider the potential of this theoretical lens to understand the interplay in practice of the behavioral, cognitive and affective resources that may make GDS interventions meaningful and yet playful work.

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2. Emotions in model-driven GDS

Whilst a significant prior amount of research exists on emotion and affect in the area of group decision support, and whilst emotions have been considered in and for models of behavior in negotiation settings, particularly regarding electronically supported negotiations, there appears to be limited prior explicit theorization of social emotional processes that find their expression in the form of positive affective behavior during model-driven GDS interventions. Yet, positive affect is likely to be particularly beneficial for improving performance in problem restructuring situations because it is assumed to support flexible and creative thinking that can lead to more effective resolutions than compromise can. For example, prior research on humor in negotiations suggests that it can be used to improve cohesion, signal cooperation, cope with a difficult situation, and release tension [4]. As such, humor can be viewed as interpersonal emotion management with the aim to manage the emotions of others as well as of the self [5]. However, further research is called for to advance the understanding of affect in group decision development contexts and particularly observational and ethnographic studies of "live" encounters are needed [6]. We therefore propose a theoretical lens for the study of extended affective scaffolding processes 'in-the-wild'.

3. Situated affectivity

The situated affectivity lens proposes that human emotions are best understood as active engagements with the world and not, as 'traditional' philosophy of emotion proposes, as passively undergone experiences [7]. Scaffolds in the environment are not just part of a background, but rather have a central causal role in bringing about cognitive-affective capacities [7]. The term scaffolding can be used to refer to the potential of amplifying cognitive capacities through productive engagement with material artefacts and people in a situational context [8, 9]. It has furthermore been suggested that emotions could be usefully conceptualized as resulting from the circular interaction between affective qualities or affordances in the environment and the subject's bodily resonance [10]. As such, the practices of seeking to sustain and amplify our behavior-in-practice, i.e. including the expression and influence on our epistemic and affective processes, through engagement with resources in the environment can be characterized a process of niche construction [11]. In affective niches, by virtue of scaffolded affectivity, further cognitive capacities can be developed [7]. The emphasis on agentic engagement with the world makes the lens of situated affectivity particularly interesting for the study of creative model-driven GDS which aims to engage participants in the active construction of a shared future plan for action [12, 13]. Figure 1 illustrates possible relationships between the concepts.

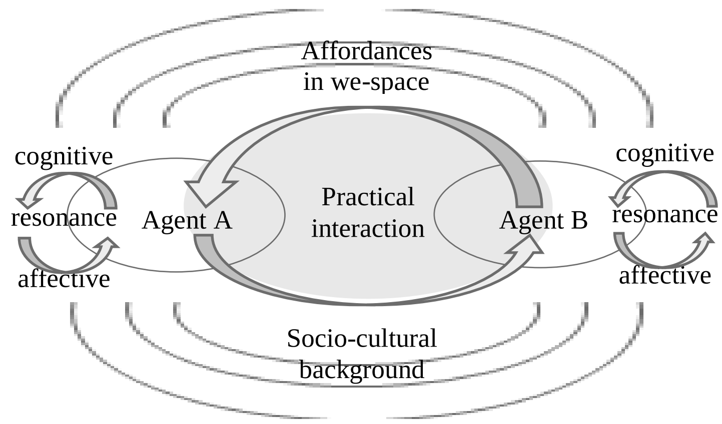

Figure 1: Situated affectivity as niche co-construction (informed by [10] and [14])

4. Play frames in we-spaces

To illustrate how the lens of situated affectivity lens deepens our understanding of environmental, and in particular, interpersonal fuels for shared planning, we use the concept of a ‘play frame’. This concept is informed by Bateson [15]’s work who considered different modes in communication and the specific social recognition afforded to humor. Our vignette is drawn from a model-driven GDS intervention that took place in an urban planning context (cf. [16]). The vignette illustrates the intertwining of materiality beyond the model (e.g. bodies), instruments beyond the tools provided (e.g. linguistic patterns) and interaction rituals beyond the model-driven GDS script (making fun to move the conversation forward) [17]. However, rather than being random or the product of individual differences, the sequence and flow of these interactions appear patterned – in our example by a humorous play frame with a shared focus on conversational rhythm- illustrating how the collective regulation of action in-situ draws on collective cultural resources. Thus, the micro-moment illustrates how situated affectivity can be constitutive of effective model-driven GDS interventions, by connecting participants and creating common experiences that shape shared feelings and social cognition. To understand the performativity of model-driven GDS it seems important to consider not ‘just’ the physical and epistemic interactions with a model as a tool in knowledge generation processes, but also the interpersonal emotional commitment(s) in interaction with cultural artefacts, including models, which we use to scaffold group decision formation processes. An abstract characterization of such resources and processes is likely to tell only half the story, as resources appear to be constituted equally by the situated affective patterns in activities of manipulation or inference of the participants who deploy the resources.

5. Purposeful play

Model-driven group decision support (GDS) interventions are thought to scaffold constructive active group reasoning processes. However, despite practitioners' confidence that model-driven GDS will deliver enhanced outcomes, we do not yet fully understand how changes in collective behavior are stimulated by the provided scaffolds as there is a historical shortfall of research into the actual behaviors of the actors involved [18]. To this date, the design and implementation of model-driven GDS are often treated as 'black boxes' - full of unidentified processes and practices with little clear interdependencies. Model-driven GDS practice thus needs to be more extensively studied in-depth to identify how the use of methods may be associated with changes in the participants' ability to take effective collective action in problematic situations.

The perspective of situated affectivity, which has not yet been applied to the study of model-driven GDS, may offer a potentially very relevant approach to the study of practice. Applying this perspective to study what's going on inside the black box of a model-driven GDS intervention, we have illustrated a micro-moment of human creativity in-situ which may be seen as indicative of our joint ability, drawing on reciprocal scaffolding processes, to overcome obstacles in the context of model-driven GDS. The use of humor, as reported in the micro-moment, may appear trivial but its performative function is surprisingly easy to overlook. Through playful cognitive-affective scaffolding, participants move forward in messy problem situations. The decision support provided by low tech GD interventions may thus, at least partly, lie in giving space to purposeful (play)(work).

The micro-level view (re)emphasizes the need for integrative perspectives for the study of behavioral, cognitive and affective processes in-situ that take into account the complex role of the environment in scaffolding affective collective performance. Situated affectivity in model-driven GDS interventions might be understood as the nuanced interweaving of individual and collective resources for effective performance, contributing the development of a social(ised) logic of OR practice. More research from a micro-process perspective on situated affectivity would thus be desirable to further explore behavior in model-driven GDS interventions as serious (play)(work), undertaken and enabled by a(n) (OR) community alive in play.

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How Autoethnography Based Upon a Small Student Experiment Assisted a Novice Researcher in Developing the Design of a Larger Study

Eleanor Reynolds[1]

[1]Warwick Busines School, Gibbet Hill Road, Coventry, CV4 7AL, England
Eleanor.Reynolds.15@mail.wbs.ac.uk

Abstract. The primary intention of this formative experiment was to obtain practical experience of running an experiment. I obtained survey responses, video data and task outputs from three small groups of students working first to generate options and then to select and develop an idea for a student run start-up business. Using an autoethnographic approach to analyze this experience I share how this small study has influenced the development of my design for an organizationally situated study. Based upon empirical data this account provides insight into the impact of practical experience upon the development of a novice researcher.

Keywords: Student experiment, problem structuring, autoethnography, idea generation, group decision making, Business Model Canvas (BMC)

1 Introduction

The initial motivation for this student experiment was to gain practical experience of designing and running an experiment. With the support of faculty and the cooperation of three small groups of undergraduate students I achieved the collection of some experimental data. Through autoethnographic analysis of this experience I derived benefits similar to those identified by Tavella [1] in her use of autoethnography as a framework for addressing the problems of novices seeking to research and publish on Problem Structuring Methods (PSMs). Tavella [1] identifies autoethnography as enabling access to real-world interventions, enhancing confidence and aiding identification of research and publishing opportunities.

I identify the main benefit of my autoethnography as similar to Tavella's [1] finding about research and publishing opportunities because the experience has had a significant impact on the design of my main PhD research activities. My research is an organizationally situated study of naturally occurring group problem structuring activity. That is, activity that can be identified as problem structuring, although the participants have no conscious design or intent to follow a method that operational researchers would recognize as problem structuring [2, 3, 4, 5]. This benefit is similar to Tavella's in its alignment with postgraduate research. As a PhD student, an experience that helped me make choices about how to conduct my study of naturally

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occurring group problem structuring is relevant to my progress towards longer term research and publication objectives.

I also identify a benefit of increased confidence as I developed my personal research capabilities and gained new insight into my personal research preferences. This is similar to Tavella's findings concerning building confidence in facilitating PSMs.

Tilley-Lubbs [6] describes how, when we use our personal experience as autoethnographic data, we write stories. In relation to understanding PSMs in action, White [7] has discussed the need for us to do this, to draw on autoethnographic method to increase our understanding of what happens during problem structuring activity. In this paper I tell the story of increased confidence first, because it can be more easily combined with providing background information about the student experiment. Then I build upon that story to identify how the experience contributed to the design of my organizational study. These accounts are personally situated interpretations from which I have made discoveries about my own experience [8, 9].

2 Increasing researcher confidence

Within my overall program of study this opportunity to prepare and run an experiment took just a few weeks. Earlier in the year I had a similar opportunity to practice ethnographic observation and interviewing. Neither study was critical to the progress of my research project, so each represented a safe environment [1, 10] in which I could experience being a researcher. Both were opportunities for embodied learning [10], or "learning by doing", which I reflect upon in relation to my experiences pre-experiment, during experiment and post-experiment.

2.1 Pre-experiment activities

I began with no previous experience of running experiments and with the constraints that my experiment must be a group experiment, and must be run in 110 minutes on a particular date with student volunteers from a particular module. My first reaction was that establishing an appropriate group task and design of groups was quite a challenge. My final design was for three groups each tasked with generating options and developing a plan for a student run start-up business based on the University of Warwick campus. One group was to have a non-student experienced facilitator and another was to be facilitated by a student volunteer from within the group. The third group would be my control, with no facilitator. Only two lecture classrooms were available. I decided to place the group with the non-student facilitator in the smaller room with the remaining two groups sharing the larger room. This was because I did not want the other two groups to notice the non-student facilitator and perhaps be tempted to watch and copy that group.

In both pre- and post-surveys I used Rammstedt and John's BFI-11 items [11]. In the post survey I also included items to measure satisfaction [12, 13], group decision process [14] and group effectiveness [15]. As I searched for standard items that had been developed and validated by other researchers I made compromises. The items available did not exactly match what I hoped to measure. I also found that many of these item sets would require that I ask my participants to answer several pages of questions.

A total of six video cameras were used, two for each group. These created a verbal and visual data record. I also made observational notes during the experiment, although of course I could not observe all three groups at once.

Although I did not specify how groups should generate options and select an idea to develop I did request that they should make some form of record. To develop their selected idea I asked each group to produce a Business Model Canvas [16, 17]. The students had previous experience of using the Business Model Canvas during the module and I provided brief guidelines based upon the lecture materials as a reminder.

Overall then, I planned to gather three types of data: surveys, observations and task outputs.

2.2 During the experiment

My experiment took place on the afternoon of the last Friday of term, just before Christmas. Each participant was offered a GB£15 food and drink voucher for use in campus outlets on completion of the experiment. Seventeen volunteers signed up earlier in the term and twice I arranged for a table of names to be included in lecture slides to remind students of their commitment. During the days and hours running up to the experiment I was concerned about how many students might drop out. In the week prior to the experiment three students withdrew and on the day one student failed to turn up. The remaining thirteen students were randomly divided into three groups, one of which was joined by an experienced facilitator who had been briefed on the task earlier in the week. The student participants did not know the task details in advance.

During the experiment it was a rush to get the video cameras set up in time, I felt rather disorganized, but my schedule was broadly adhered to, the time allocated for the group task was not reduced and the participants completed all planned activities. So although I felt disorganized, perhaps this was not as visible to others as I felt it must be. During the task I observed the groups. Noting that only the non-student experienced facilitator asked me to confirm the time allowed for the exercise I made the decision to let each group know when they were halfway through the total time allowed (50 minutes). I also observed that some group members sought eye contact with me instead of being fully focused on the task. I reflected on this and felt that perhaps it was more disruptive to move between three groups to observe than it would be to stay still and observe just one group. Another possibility could be that during the module I had been supporting group work activities, so these particular students were accustomed to me asking about their progress and assisting them as they worked together on group tasks.

Within my schedule I allowed time to ask participants for individual written reflections on the exercise. I gave each participant a sheet of A4 paper and I was surprised that only one student produced less than half a page of notes.

Overall I noted that although running the experiment was a new and unusual experience for me it was not a role that I felt uncomfortable with. However, I did feel less comfortable in this role than I had been when undertaking ethnographic observations or conducting interviews. Reflecting upon this difference I noted that running the experiment was a more formal and processual role. I needed to maintain more distance as an observer; to direct more of my attention toward managing time, maintaining the separation between the participant groups and controlling the flow of activities. Previous experience of running workshops has given me the transferrable skills to do this, and yet I was more comfortable with observer and interview roles that I'd never attempted before. So, my next step was to challenge myself to think about why this could be. In contrast to an experimental researcher, a participant observer does not control the environment and flow of events, and so does not have to give attention to this. In an interview, the researcher does have more control. However, in each of my interviews this role was performed in response to a single interviewee. The implication of these differences was that I felt closer to the participants and their embodied experiences when I was in the observer and interviewer roles. For me, joining the group felt comparatively more comfortable than maintaining distance from the group.

2.3 Post-experiment activities

I was aware that having only two rooms for three groups would create problems with my audio data. I placed the two groups in the same room as far away from each other as I could, but I still found that it was difficult to follow the recorded conversation.

Later I discovered two types of problem with my survey data. One student had missed out a question and another had recorded two answers to the same question. Also, the student facilitated group failed to create a list of the ideas generated, although I was able to partially reconstruct this using the video data. These appear to me to have been genuine mistakes.

Whilst it feels exciting to have my own data, I am concerned that with only thirteen participants and three groups my statistical analysis is necessarily limited. I am aware that I feel most drawn to the written reflections and the video files. As I downloaded and typed up my data for secure storage, my most interesting finding was that the written reflections support the principle that a facilitator role is desirable for members of a working group because it allows participants to focus on content rather than process [18].

2.4 Reviewing how the experience increased my confidence

I had anticipated several of the problems that I actually experienced in running my experiment. Although it was somewhat frustrating to "learn" things that I had expected to occur, the fact that I had anticipated them was reassuring. For example, the availability of only two rooms for three groups was a constraint that I might not have tolerated if this experiment had been vital to the success of my research.

Through the problems that I anticipated and the aspects of the experiment that went well I was able to appreciate the relevance of transferrable skills. In contrast to Tavella's account [1] I would make a distinction between general and specific facilitation. During my experience I felt that my previous general experience of facilitation was relevant and did give me some measure of comfort in the new role of an experimental researcher.

At a small scale I now have personal experience of ethnographic observation and interviews and of running an experiment. These embodied learning experiences have given me a more nuanced appreciation of the challenges that these different types of research present [10]. I now feel more competent to read (and in some cases reread) relevant experimental papers with an improved understanding [19, 20, 21]. I also feel that I will be better able to determine when and where an experimental approach would be appropriate in my own research.

3 Developing research design

The journey of reflection I have taken through my early research experiences has given me a better understanding of those experiences [1, 6, 7, 8, 9], and I have applied my learning to reflect upon issues that are relevant to my PhD research project, an organizationally situated study of naturally occurring problem structuring.

3.1 Practicalities and preferences

Many of the areas in which autoethnographic reflection upon my student experiment supported improvement in personal capability and confidence were practical. For example, recognizing transferrable skills, using new equipment and noticing the ways in which paper based surveys may be incorrectly filled out. Whilst these experiences all give me confidence that my second attempt at an experimental study will be better, recognition of personal preferences is also a valuable learning outcome. Through comparing my student experiment experience with my earlier pilot study in observation and interviewing I was able to recognize my preference for the ethnographic type role over that of the experimental type role. However, two issues that I discovered during my small experiment led to deeper reflections and to significant changes in how I thought about the design for my organizational study.

The first of these issues relates to standard item surveys. During my experiment all participants completed the surveys, although there were small errors. Initially my response was to consider making the surveys electronic so that such errors could be identified and corrected before each survey submission was accepted. However, as I reflected further and began to draft out plans for the groups of organizational employees whom I might soon be asking to fill out surveys the focus of my concern changed. My main concern now centered upon the number of the questions and the feasibility of asking busy employees at a variety of hierarchical levels to fill out such long surveys. This brought my earlier concerns about finding appropriate items to the fore again. I had managed to find a short BFI survey [11], but there were 40 items in the group decision process set that I used [14]. I also began reading more about surveys and noted that depending upon the type of standard items that I used I might have trouble attributing any changes to specific group activities [22].

The second issue was that I became increasingly concerned about how many surveys I would need and whether my statistical analysis should be at the level of the individual or of the group. If the focus of my research was to be upon the experimental aspect and my statistical analysis concerned differences between groups I would need to study many more groups in order to increase my sample size. Whereas statistical analysis for many groups rather than a few would increase my analysis time a little, video analysis of in increased number of groups would represent a relatively greater increase in analysis time needed.

From these first two issues a third emerged. I began to reflect more deeply upon the appropriate balance of quantitative and qualitative research content for my study. As academics asked questions about my research project and I engaged in conversations about my student experiment I began to question whether I should be referring to my study as a field experimental [23]. Perhaps it should be positioned as a set of case studies [24, 25] in which I would use a quasi-experimental design [22]. This prompted me to reexamine why my research should be interesting to an academic audience and how it would build upon existing research.

3.2 Refocusing research contributions

My belief that naturally occurring problem structuring should be of interest to the academic community is based upon previous experience as a novice PSM practitioner in the workplace. When work colleagues heard that I had received training that might enable me to help them with situations that academics might recognize as messes, swamps or wicked problems [26, 27, 28, 29] I received far more requests for help than I could possibly respond to. This experience was quite the opposite to that reported by Tavella [1] in the case of novice facilitators struggling to find opportunities to conduct academic research in the area of problem structuring. These requests for help made me feel nervous because although I had begun to study PSMs and successfully passed Masters level assessments I had very little practical experience of using PSMs in the workplace. It also made me curious about naturally occurring problem structuring; activity I described in my introduction as identifiable as problem structuring, although participants have no conscious design or intent to follow a recognized problem structuring method. I knew that these teams would respond to these situations with or without the assistance of a novice or expert problem structuring practitioner. So I became curious about how they would do this. My experience of running a student experiment caused me to reflect upon the type of data I sought and led to the realization that in relation to my research topic a more naturalistic dataset would be more appropriate.

White [30, p823] uses the words “systematic”, “purposeful”, “agent”, “PSM” “change” and “improvement” in his definition of a problem structuring intervention. Defining problem structuring as “purposeful action by agents to create change or improvements” would recognize that the agents might not be “systematic” and might not be using a “PSM”. It would include agents using a wider set of concepts and frameworks such as theory of constraints, game theory, negotiation support or multi-criteria decision analysis, and also the activity of agents who are not consciously using any type of decision support approach. Decoupling the "problem structuring" and the "intervention" was deliberate as I considered the possibility that agents' naturally occurring problem structuring need not be viewed as a time bounded activity. Within the context of ongoing organizational flux and change a study of those managing ongoing situations [31] might be possible.

Having watched and participated in groups structuring problems (without PSMs) for over a decade, I reflect upon these observations and realize that they have not led me toward the generation of hypotheses. Rather I have a conviction that naturally occurring problem structuring is prevalent in organizations and that its resemblance to the problem structuring that occurs within PSM interventions may lie in the interaction and behavior of agents rather than the tools and approaches used. For this reason I am drawn to naturalistic data in which I can analyze interactions in detail, analysis that might be described as behavioral operational research [32, 33].

Through autoethnography I have arrived at a personal belief that an organizationally situated study of naturally occurring problem structuring will be of more interest and value than an attempt to study this phenomenon via an experimental approach.

3.3 Reviewing the design of my PhD research project

Perhaps the most tangible results of reviewing my student experiment through an autoethnographic frame are that I have identified the detailed analysis of video data as central to my research and the gathering of naturalistic data as appropriate to studying naturally occurring problem structuring. In addition to general learning about ethnomethodology using video data, close reading of other operational research studies using video analysis [34, 35, 36] will now be necessary.

For me, this will represent the next stage of my journey, and my reflections will continue. For example, I still need to identify and justify selection of the theories that will drive my video data analysis. I must still also consider the ongoing role of standard item based survey data in my project, and how I might use findings from quantitative survey analysis to focus my qualitative analysis.

In addition, positioning my research as a set of case studies using a quasi-experimental design does not close my consideration of how much data I will need. Whilst researchers can now produce guides for PSMs practitioners based upon their personal experience of working on a wide range of interventions [37], the number of cases it is feasible to expect a student to work on within a PhD project will not be comparable. However, it will still be necessary for me to consider how much data I can feasibly collect and analyze, how many different groups this will represent, and how many repetitions of interaction patterns I may expect to see.

4 Discussion

The achievement of expertise in problem structuring is positioned as critical to the academic community in relation to the development of researchers [38]. White [7] identifies the value autoethnography may bring to understanding what happens during PSM interventions and Tavella's study [1] provides an example of doing so from the perspective of a novice facilitator. I have shared my autoethnographic story of how a pilot experiment has contributed to the development of my PhD project and aligned the benefits I derived through the use of an autoethnographic frame with two similar benefits identified by Tavella [1]. A point of difference in my findings is that I was not seeking access to a real-world intervention and therefore could not experience this benefit. However, as I join the academic community from an industry background, I have found that gathering my first small datasets gives me more to talk about as I begin to participate in academic conversations.

Within the literature on studying for a PhD, the journey of a student is often portrayed as lonely, or as a time when you might feel vulnerable to feelings of inadequacy. My personal experience has been that the opportunity to trial methods early in my studies has helped me understand my own strengths and weaknesses and enhanced my understanding of how different types of research may feel for the researcher. This understanding then delivered value for me as it guided decisions about my research design.

Bochner [39] identifies the purpose of self-narratives as being to extract meaning. He quotes Geertz's [40] view that alternative ethnography frees us to shape our work according to necessity rather than given rules. And my experience has been that reflecting upon my early efforts at gathering data was necessary to the progression of my studies. Through reflection I arrived at a coherence that as Bochner says "was not available at the original moment of experience" [39, p270]. The greatest personal impact of this work was arrived at following several cycles of reflection and relates to the relative value and role of standard item surveys and video data in my research project.

In sharing my autoethnographic findings I have attempted to deliver the five key features of analytic autoethnography identified by Anderson [8]. Analyzing my own role as a researcher, my introspection was intended to better understand my own attitude to research and how to position my research amongst existing and future contributions to advance our knowledge of problem structuring. Although I cannot generalize from the "*N* of one", I did place myself at the center of my narrative, using empirical data to gain an insight into the practical process of research. I hope that my account is of interest both to those concerned with problem structuring and those concerned with the development of novice researchers.

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Imbrication between Human and Material Agencies in Decision Making in the Police Work Force: Affordances Explained in Practice

Matthijs J. Verhulst[1], Anne-Françoise Rutkowski[1]✉
[1]Department of Management, Tilburg University, Warandelaan 2, 5037 AB Tilburg, The Netherlands
{m.j.verhulst, a.rutkowski}@tilburguniversity.edu

Abstract. Task complexity has been an important part of analyses of the Group Support System literature and relates to both task performance's process and outcomes. The entanglement between the human agency (e.g., users) and the material agency (e.g., technology) should not be underestimated when considering decision-making enacted through technology usage. A relational concept of technology, affordances and constraints facilitates the organizational understanding of the potential of a technology as well as its sometimes unintended use. In order to assess the interaction between human and material agencies, we draw from the "imbrication" metaphor on sociomateriality. In this article, we combine the perspective of affordances with the McGrath task typology/circumplex) to study the material and human agency in the context of decision making in police work. Our approach is illustrated with field data collected during decision-making of police officers in practice. The approach proves useful to determine the outcomes of technology on High Reliability Organizations. It outlines differences between intended technology use and technology affordance as it is enacted in practice.

Keywords: Group Support Systems, Affordances, Constraints, Imbrication, Collaborative Technology, High Reliability Organizations

Introductions

Since decades, Decision Support System (DSS) have been designed to aid decision-making processes [1]. Decision-making activities relate to problem-solving and is task related [2]. Both freight in difficulties when groups are involved. Group-thinking is a well-known example of defective decision-making style characterized by excessive concurrence seeking by homogeneous group members under stressful condition [3]. The field of Group Decision Support System (GDSS) has tackled defective decision-making, such as group thinking, in providing sets of methods and technologies to encompass such challenges. Technologies have been designed as a group support of specific tasks through tight processes. The tasks ranged from the gathering of statements or information, ranking or categorizing statements, rating or evaluating and also monitoring, through combined use of human agency (i.e., participants, chauffeur

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or facilitator) and material agency (i.e., Decision Explorer, Group Explorer, Group Support System, Strategic Options Development and Analysis, thinkLet). Different ontological approaches underpinned the development of major GDSSs [4, 5]. GDSS scholars have been pioneers in addressing to both the human and material agencies at the operational and strategic decision-making level of groups in organization. The aim of this study is to understand and explore material and human agency in decision making in HROs. Specifically, we look at the impact of material and human agency on the decision-making processes of police officers.

Task complexity has been an important part of analyses of the Group Support System literature and relates to both process and outcomes of task performance. Complexity plays a key role in differentiating task environments [6]. Task complexity depends at least on four elements: outcome multiplicity (i.e., more than one desired outcome), solution scheme multiplicity, conflicting interdependence (i.e., adopting one scheme conflicts with adopting another possible solution scheme), and solution scheme/outcome uncertainty [7, 8]. Solution scheme/outcome complexity is the extent to which there is uncertainty about whether a given solution scheme will lead to a desired outcome. For example, earlier research has demonstrated the importance of the fit between the task and the technology for effective GSS use [8]. Other scholars in the field have directly mapped the level of collaborative capabilities to be influenced by a form of "intellectual bandwidth" fitting to the organizational tasks [9]. However, in 1998, Zigurs and Buckland [8] regretted "that no generally accepted theory of task/technology fit had emerged yet" (p. 313). Also, scholars in the GDSS field recommended "being cautious of being driven by the opportunities that technological developments provide" [4]. In other words, we converge and state that one should not underestimate the entanglement between the human agency (e.g., users) and the material agency (e.g., technology) when considering decision-making enacted through technology usage. Congruently, past research has also demonstrated that enacting reciprocal interdependence (i.e., intersubjectivity) in dyads using cognitive mapping technology lead to better ethical decision-making [10].

Technology Affordances and Constraints Theory (TACT) [11] has emerged answering partly to Zigurs and Buckland's [8] wishes for a theory to understand the fit between tasks and technology. TACT's essential premise is that one must consider the dynamic interactions between people and organizations and the technologies they use to understand its consequences [11]. The ontological status of technology led to a controversy in the TACT literature. However, TACT scholars agree that having a relational concept of technology affordances and constraints distinct from features and purpose, facilitate the organizational understanding of the potential of a technology as well as it sometimes unintended use (for more details see [11]). They propose focusing on the interactions between material agency (i.e., technology) and human agency (i.e., people) rather than on technological features or human attributes separately to afford or hinder (i.e., enact) for example collaboration. According to Majchrzak and Markus [11] affordances and constraints emerge when users engage with technology, affordance refers to an "action potential", that is, what a user can do with a technology for a particular purpose . Constraints address the way technology may limit the users or an organization. Affordances by definition are sociomaterial as they emerge from the entanglement between social and material in practice [12, 13]. Orlikowski [14] defined sociomateriality as "the recursive intertwining of humans and technology in practice" (p. 1437). The later may not enact, for instance, knowledge sharing and therefore biased part of the decision-making process. A differentiation amongst individual, collective and shared affordances was introduced when considering the use of technology at the group level [15]. Shared affordances emerge in cases of *reciprocal* interdependence [15]. In the context of GDSS, shared affordances are crucial for success, since successful collaborations can only take place when there are shared affordances.

Collaborative technology takes on an important role in today's organizations. Organizations may achieve significant business improvement streamlining their collaborative work practice [16]. De Vreede et al. [17] state that especially "The widespread availability of smart phones has given whole societies opportunities to participate in large-scale sensemaking, problem solving, and efforts to organize collaborative action" (p. 1). In the context of High Reliability Organizations (HRO), for instance emergency response or firefighting brigades, smartphone applications embedding collaborative features have been successful in supplying role-specific information independent of time and place, and afforded collaboration [18].

Police work & Sociomateriality

We studied human and material agency and affordance in the context of a HRO, the Dutch Police We focus on the operational work of police officers, and address the mobile-technologies currently used by the Dutch Police. The day-to-day-activities of the 'blue' officers cover responding to emergency calls, enforcement of the law, and maintaining public order. Mobile police technologies are defined as the technologies that can be used irrespective of time and place. We limit our research to the technologies that are carried-by the officers on their person, excluding the (mobile) information technology in police vehicles and information technology at police stations.

Research conducted in the context of police work demonstrated that the highly entangled relationship between technology and the organizational life is one of the driving factors behind the implementation of mobile technology [19, 20]. On one hand, mindful workarounds around technological constraints benefited the organization. On the other hand, the lack of enactment of certain affordances by the officers imposed potential risks for the organization [21]. Leonardi [22] states "that people's work is not determined by the technologies they employ" (p. 148). In other words, users are free deciding how they use a certain technology [22].

Uncertainty is associated in the literature with a lack of information [e.g., 23]. Therefore, the logic would be to increase the amount of information in order to decrease uncertainty. However, in the context of HROs and IT usage, more information may add uncertainty. In other words, more information may paradoxically increase equivocality as the amount of solution scheme/outcome uncertainty may expend. In this article we defined equivocality as "the existence of multiple and conflicting interpretations about an organizational situation" [24, p. 357]. Research has demonstrated that reducing equivocality relying on technologies may be challenging [24]. Technology usage may simply add complexity to the tasks. We defined task complexity as the amount of processing or attention required by a task, or the amount of structure or clarity provided by a task [25]. Nowadays, many decisions are being taken even faster and with more connectivity then before. Instead of functioning as a tool in the hands of the worker, technology is developing agency of its own [22, 26]. While technologies are often developed to reduce task complexity, if human agency is not considered properly, technologies can be a burden to otherwise routine tasks increasing equivocality, especially in group decision-making. The distinction between individualized, collective and shared affordances is essential in the study of collaborative technology as the level of affordance is reflected in the *level of decision-making.* Individual decision-making may require only individualized affordance. Yet, when multiple group members are involved in decision making, depending on the interdependence, collective or shared affordance may be appropriate. This relationship between the level of affordance and the level of decision-making is two-fold. First, there may be a direct relationship between decision-making and the level of affordance, i.e. individual decision making implies an individualized affordance of retrieving information to reduce uncertainty. In group decision-making, collective affordance emerges, where the ability for the group to achieve a goal is a sum of the individual affordances. Second, collaborative communication technologies' affordance affect the level of decision-making. A shared affordance enables shared decision-making, in cases where synchronous communication is required for decision-making. In addition, collective affordances may enable shared decision-making, in the case of pooled interdependence in the decision-making task. For example, each of the group members may supply different pieces of information required for the group to make the decision.

The data collection and method previously applied in healthcare setting [27] is outlined below, followed by an overview of the technologies currently available to the police, categorized based on the McGrath circumplex [28].

Data Collection & Method

In the Netherlands, the police has been given the task of law enforcement and providing assistance to anyone who is in need of help. Throughout 2016, 80 hours of police work was observed at three police stations in the Netherlands. Data was collected using a smartphone with a note-taking application. Video recording equipment was not used in order to avoid legal implications for police, victims, suspects and others parties involved Observations were written down on any kind of impressions that were witnessed, this rather than deciding before data collection which elements were relevant [29]. Within 24 hours, additional information was added to those field notes and they were structured. Full disclosure regarding the research purpose was given to the police officers. This made it possible to engage and listen to their rich experiences with technology in practice. In addition to the field observations, weekly meetings of the Business Support of the organizational program charged with development and implementation of the smartphone at the Dutch police were attended. Lastly, to determine the intended use of technology as seen from the perspective within the organization, internal documents were collected and studied. These documents contained the business case for the implementation of the smartphone, as well as the implementation plan.

Table 1, Overview of technology functionalities categorized based on McGrath [28]

Technology/functionality	**McGrath segment**	**Interdependence**
Radiotelephone		
Voice communication through radio	Planning (1),	Reciprocal interdependence
Status messages through radio	Planning (1)	Reciprocal interdependence
Emergency button	Psychomotor-performance (8)	Reciprocal interdependence
MEOS Smartphone		
Mobile ID	Intellective tasks (3)	No interdependence
Information Retrieval	Decision-making (4)	Pooled interdependence
Fine	Performance/psycho-motor (8)	No interdependence
Secure E-mail	Intellective tasks (13),	Reciprocal interdependence
Camera	Psychomotor-performance (8)	No interdependence

In the affordance tradition, we focus on how humans enact the technologies to operate in teams. Particularly, we categorized the affordances as individualized, collective or shared, depending on the interdependence of the task in combination with the affordances as it was classified in the McGrath [28] circumplex. As demonstrated in Leonardi's study [15], we witness a range of individual, collective and shared affordances in context [15]. Individualized affordances revolve around officers solving intellective tasks, i.e. making sure someone is who he says he is. Yet, in some cases, we see a similar affordance being used as part of a collective affordance. For example, when one officer looks up information about an address and shares this with his colleagues in his vicinity as input for a discussion on what went down in that situation. The situations where shared affordance can be witnessed involve planning tasks where officers communicate through their radiotelephone. There is a high level of reciprocal interdependence, and all the officers enact the affordance of the radiotelephone in a similar fashion.

Conclusion & Limitations

In this paper, we assess the interaction between the social and material in practice through the lens of affordances. From the illustration in the context of mobile technology use in the police context, a number of insights emerge. By design, the majority of functionalities are intended to be used as individualized affordances. However, in practice, those individualized affordances are enacted as collective affordances, due to the pooled interdependence within the group.

In the part of the circumplex that involves solving problems with correct answers a number of individualized affordances can be identified. Collective affordances were witnessed in decision-making with no right answers. Usually, due to the more complex nature of the decision-making tasks, multiple officers are involved. In these situations, collective affordances emerge, where the officers work together to achieve a group goal through different affordances. During planning tasks, which require coordination, shared affordances were used as they were intended.

In this exploratory research, we aim at a better understanding of the imbrication between the human agency and the agency performed by technology – material agency in the context of police work. Concluding, our approach has shown the value of studying affordances in a non-functional way, by assessing their means to reach a social, emotional [30] or in this case: collaborative end. In fact, in studying the impact of technology on organizations, this approach lines up with the sociomaterial perspective in studying human agency which is similarly defined as the ability of an agent to reach their goal [31].

This study has shown that only in practice [32], the enacted can be studied, as those affordances may differ from those intended by the organizational decision-makers. Clearly, it is from those actualized affordances that the effects on the organization will emerge [33]. These findings may prove useful to practitioners, as it gives an insight in the limited predictability of the use of technology functionalities. From a theoretical perspective, the task technology fit approach is surely useful, but it is difficult nowadays to develop the proper method to study teamwork, when not considering imbrication or entanglement.

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Getting "Cyber Organized": Information Overload and Collaborative Action in a Small-Scale Economy

Kristel de Nobrega[1], Anne-Françoise Rutkowski[2]

[1]EMITA CFCM, Information Security Officer, and member of the Aruba Bankers Association Security and Investigations group, Aruba Bank N.V, Camacuri 12, Aruba
[2] Department of Management, Tilburg University, Warandelaan 2, 5037 AB Tilburg, The Netherlands
Kristel.deNobrega@arubabank.com, A.Rutkowski@tilburguniversity.edu

Abstract. Risks to cyber infrastructure are rising and becoming ever more complex. In that respect, situational awareness, knowledge and understanding are key factors when dealing with cyber threats. Information Technology managers and practitioners are faced with enormous computer-processed data coming in at ever increasing speed. IT-related overload impacts the associated ability to process this information safely and efficiently. Altogether, it is a big challenge for IT managers to conduct a dedicated cyber defense agenda. In most cases the overload occurs because of limitations in time or human processing capacity, or defective team communication. This is exacerbated in a small-scale economy where resources are often very limited. While financial consequences may not seem substantial to the world, for an island it may be economically devastating. This research in progress focuses on collaboration between private and public sectors to implement a resilient national cyber defense agenda.

Keywords: Cyber Security, Information Overload, High Reliability Organizations, Collaborative Action.

1 Introduction

The Caribbean islands, with their geographic proximity to South America, together with their historic ties to Europe, have a strategic advantage regarding their triangular geographical location with South America and historical roots in Europe. Tourism is the main pillar of the national GDP income in many Caribbean islands. In Aruba, it is expected to rise to 94.0% in 2025 [9]. Relative to their size and number of inhabitants, the islands form a self-sustaining "microcosm", rich of various infrastructures (e.g., airports, banks, ISP's, hotels). Expanding the position of the Caribbean as a logistical hub for trade is therefore cardinal to diversifying and thereby fortifying its local economies. In the example of Aruba, well-functioning infrastructures, services, as well as promotion of entrepreneurship are critical success factors for developing towards such a diversified economy. In that context, a sound reputation for safety and

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security is crucial. Keeping up with technological trends, especially those related to Information Technology (IT), is a key factor both for ensuring sustainability of Aruba's main economic pillar and for its development towards being a commercial gateway between South America and Europe. By extension, cyber-resiliency will increasingly underpin Aruba's economic development. However, in the last few years, conform the worldwide trend, concerns for cyber security in the public and private sector have been growing in Aruba. For example, cyber-attacks may pose significant threats to financial services relied upon by tourists and entrepreneurs on the islands. Locally, collaborative efforts to mitigate these risks are in motion, but sill struggle to formalize.

Currently, the island of Aruba is not on the attack radar like large countries. The Caribbean islands have not been under heavy cyber-attack as is the case with countries such as USA, China and Russia. No major incidents have been recorded in Aruba. The main reason for not being so high on the target list may be due to an actual low political interest or the relatively limited capital of potential target companies. At best the Caribbean basin may be utilized as a sandbox to test out hacks, viruses and malware. On the other hand, most islands in the Caribbean have increased their bandwidth in a rapid pace. This fact, combined with relatively low cyber security awareness poses a new set of possible threats for misuse by cyber criminals. For example, insufficiently protected devices could serve as potent botnets for cyber-attacks. A targeted attack on an island such as Aruba or any other Dutch, French or British Caribbean island would potentially have highly detrimental effects on the local economies and possibly even have a significant impact on their relationship with the motherland. Politically motivated cyber-criminals may therefore consider the Caribbean islands to be low hanging fruit for such attacks. This is especially true in the case of Aruba, where bandwidth has increased dramatically, yet digital literacy is still trailing.

As cyber defense risks are rising, collaboration on a national scale, both micro and macro, becomes increasingly important. At the micro level, difficult posing data, situational awareness and understanding associated to cyber defense are lacking, increasing these risks. Particularly, IT managers and practitioners are bombarded with computer-processed data linked to cyber-threats. This situation of IT-related overload (i.e., excessive number of inputs delivered through IT) impact the associated ability in processing efficiently these amounts of information [5, 6]. The cyber security budget is in most cases part of the overall IT budget. The cyber security budget is under pressure as business initiatives often do not explicitly include the necessary controls to adhere to the cyber risk appetite of the organization. In the struggle for resources, between choosing the best set of defenses based on the information assets that need protecting and building a scalable network, commercial interests usually have the upper hand. Additionally, implementing end-user awareness programs and monitoring comes at the costs of slowed down and less flexible business operations. Security measures only briefly fall into perspective after a security breach is exposed, either internally or in worldwide examples such as the recent WannaCry ransomware infections. It is usually only during the aftermath of such a security breach, that risk owners are engaged and motivated to take measures to ensure the security of their operations. In this case, the development of remediation plans and collaboration with security partners to aid vulnerability resolution and meet expected trust levels of its clients are among the temporary activities. The strength, however, of the IT security practitioner is to combine external intelligence with internal sources to lower cyber risk exposure in the long term. In fact, cyber security recommendations advocate that one of the important mandates of the IT security practitioner should be to ascertain that cyber security has a permanent and prominent place on the organizational risk management agenda. In organizations driven by profit, the cyber security agenda will usually be perceived to be in a trade-off with the organization's commercial interests or even with the execution of its strategy. Therefore, cyber security is likely to become subject to negotiations in such organizations. It is crucial for the IT security practitioner to be properly equipped to handle these situations and to be able to convince decision makers of the likeliness and impact of the relevant cyber-related risks. Collaboration between IT security practitioners across the industry and the government can help them obtain the necessary baggage to perform their mandate individually, which should ultimately yield collective gains across the industry and nation.

Cyber has become an adjective that is accolated to nouns such as security, space, crime or even bullying. It is an abbreviation of cybernetics that is according to the Oxford dictionary *the science of communication and automatic control systems in both machines and living things*. Cybernetic is born in the 1980's with the appearance of the first computer as a results of the cognitive revolution [2]. The aim of the first computers was to mimic and later assist higher cognitive processes such as decision-making. While facing information overload one may hope Quantum computing and Quantum Information Processing (QIP) will solve the big data issue, helping in managing processes. However, it is clear that the challenge will remain human and collaborative in nature. These QIP technologies are expected to improve computing communication and cryptographic systems [2]. QIP will surely help chunking data and may lead to automatization of some decisions. This futuristic view of "cyber" will be an emerging area of research, with implication in searching in large databases, cloud storage or intelligence repositories. The advantages of QIP will be key to the cyber security. Cyber will not be limited to the ability of a new generation of super-computing in solving the big data problem. At the strategic level, QIP will give superiority. However, as is well-known in the cyber security domain, such technical superiority never lasts due to what is known as the challenge and response mechanism. Data is not information. Information is contextual and to that respect human decision making will remain key to making informed and strategic decisions. Decisions are emotional not logical [1]. Groundbreaking discovery in neuroscience revealed that when one cannot feel emotion, one cannot decide properly. Hot and cold cognition form a dichotomy within executive functioning in charge with the decision-making process. There has been support for separation into "hot" affective aspects and "cold" cognitive aspects.

At the macro level, social regulation as well as business competition make sharing relevant cyber intelligence difficult. Indeed, most companies that would benefit from sharing information related to cyber security are often each other's competitors. However, we assume collaboration is possible and desirable to cope with cyber threats. Indeed, data and information carry different values for different industries. This information could be categorized and shared when relevant for mitigating cyber-attacks. In order to foster collaboration between industry sectors, it would be beneficial to support a sharing platform where incidents and relevant information regarding cyber security would be shared. An independent platform and associated policy to report and or share breaches would be beneficial. Also, it would provide a better picture at the intelligence level in order for governments to be able to take proper actions in the event of an attack. Such platforms for collaboration would foster awareness and understanding of cyber security both at the national level and organizational level. Relevant information could be shared amongst private and public entities, while being properly categorized.

The banking and telecom sector are front runners in cyber intelligence sharing on the island of Aruba. They function as High Reliability Organizations (HROs). Vogus and Sutcliffe (2007) [8] defined HROs as “organizations that operate hazardous technologies in a nearly error-free manner under trying conditions rife with complexity, interdependence, and time pressure” (p. 2). The introduction of new technologies is not trivial as it also impacts organizational routines and decision-making [3, 7]. Threats also increased in the banking sectors as more IT leads to more potential security breaches. While financial consequences of cyber-attacks may seem small for the world, for a small and highly inter-dependent island, it can have enormous economic impact. In the last years, as globally, concerns for cyber security in the public and private sectors has raised in Aruba. Both sectors are highly dependent on information technologies, conform to worldwide standards. A cyber resilient Aruba is an important prerequisite for economic growth. Cyber threats may affect financial services for tourists and entrepreneurs on the islands.

The authors postulate that the Caribbean basin is an exceptionally and interesting environment to implement such a cyber resiliency agenda at both the micro and macro levels. This research in progress focuses on the collaboration between private and public sectors to create a resilient national cyber defense. Ultimately, the goal is to implement an innovative agenda for cyber defense based on the premises previously underlined in the text.

Our vision encompasses an analysis at three core levels. The first one regards information management (e.g., data and information processing), the second level addresses to the sharing of knowledge and creation of shared understanding (e.g., individual and team learning) and the third to decision-making encompassing shared understanding and wisdom. In order to build such an agenda, a survey is being run on the island of Aruba to capture the current state of situational awareness, knowledge and understanding regarding cyber security as well as the consequences of information overload on main cyber security stakeholders.

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Architectural Design and Planning Talk to Each Other: a Dialogue via Strategic Choice Approach (SCA)

Elena Todella[1] (0000-0001-9107-7000), Isabella Maria Lami[2] (0000-0002-6468-3184), Alessandro Armando[1] (0000-0003-0399-9764)

[1] Politecnico di Torino, Architecture and Design Department, Viale Mattioli 39, 10125 Turin, Italy
[2] Politecnico di Torino, Interuniversity Department of Regional and Urban Studies and Planning, Viale Mattioli 39, 10125 Turin, Italy
elenatodella@gmail.com, {isabella.lami, alessandro.armando}@polito.it

Abstract. The paper proposes the use of the Strategic Choice Approach as a way of structuring the architectural design process, partly individually and partly supported by meetings and interviews with DMs, experts, and stakeholders. SCA is employed as a designing tool to provide alternative transformation scenarios. We reflect on the possible use of SCA to determine prescriptive conditions on physical form at a scale that is still intermediate between the building and the urban tissue. In this sense, planning and architectural design talk to each other via SCA. It represents a way of approaching the challenge of planning in an uncertain world, but moreover it produces an architectural transformation. SCA can work in a physical sense, not only eliciting guidelines and strategies. This proposal shows an application to a real-world problem, currently under debate by the City of Turin (Italy), the re-use of abandoned barracks located in a prestigious residential area.

Keywords: Strategic Choice Approach – Architecture – Planning – Design tool

1 Introduction

Strategic Choice Approach [9] belongs to Soft Operational Research fundamental methods, developed in order to manage practical problem situations [14]. In particular, Soft OR and Problem Structuring Methods (PSMs) deal with “wicked problems”[15], or ill-structured problems [13], with difficult resolution, marked out by multiple actors, many conflicting values and points of view, a large number of possible solutions and high uncertainty [12]. The traditional use of SCA is here enlarged with an experimental use as a designing tool.

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We observe that SCA is traditionally used, in urban and regional development, in order to manage uncertainty and to deal with such planning difficulties in a strategic way [8]. There is an extensive literature that offers account on the SCA use in a tradition that comes from planning, in particular urban planning [8, 10, 13]. In fact, there are many public planning situations characterised by different levels of uncertainty, in which SCA applications provide what different possible actions might be undertaken [8] and which functions should be located. On the opposite, as far as we know, there is a gap in the literature of SCA application in the architecture realm. By shifting the analytic focus from urban planning to architecture, our research shows the SCA cooperating with the design process.

Therefore, this paper is a first attempt to explore the feasible interface between two disciplines: PSMs and architecture. We study the possible use of SCA in buildings transformation at a district level, to determine prescriptive conditions on physical form at a scale that is still intermediate between the single building and the urban tissue. In this sense, planning and architectural design talk to each other via SCA. It still represents a way of approaching the challenge of planning in an uncertain world [5], but moreover it produces an architectural project or transformation: it works in a physical sense, not only eliciting guidelines and strategies. We argue that, when SCA is used to design physical form and spaces - as geometric ones and not only as a functional target - then we use the method as a tool to realize or transform an architectural outcome, as buildings.

2 SCA, Urban Planning and Architecture

The approach to planning known as the Strategic Choice Approach originated in the late 1960's, during a research project in the English city of Coventry: the aim was to understand the processes of strategic decision making in city government [8] and the project was conducted by a mixed team of operational research scientists and social scientists. Through several meetings, they found solutions about some issues, as the redesign of the city's road network, the development of housing land, the renewal of inner areas [8], and others. After that, SCA method has been applied to different kinds of planning situations, in fields like local community development [8, 10, 13], or environmental policy [7], or in decisions about transports [8]. So, the Strategic Choice Approach is often used in public planning, in order to solve political and technical challenges about urban design. The aim is the construction of a shared view of the nature of the decisions [8], in which planning is a continuous process of strategic choice [9] and people play interlocking roles. SCA is usually experimented in public participation, to respond to uncertainties and take good decisions, in which analysis, planning and design are interwoven: in this sense it is a rational basis for comparison of competing solutions. In general, in urban processes, SCA is used as a tool that supports decision makers in shaping problems [7], a sort of preliminary "platform" for designers, builders, developers and urban planning authorities involved in the process itself. PSMs help planners in early design stages, characterized by a high level of complexity and not clear definition [8]. Therefore, SCA can be a framework, a starting point for future activities. From the point of view of the architectural design, the challenge is to consider SCA methods as an integrated device and not as a mere complement or external support to the design action. We have considered the process of design production as an open phase (Fig. 1), which is intertwined with decision-making [17]. Architectural design is a practice based on the production and exchange of documents [6] or "registered acts", where decisions are embedded into the drawings. Thus, it is fundamentally a "strategic" practice, which can be combined with a large set of tools.

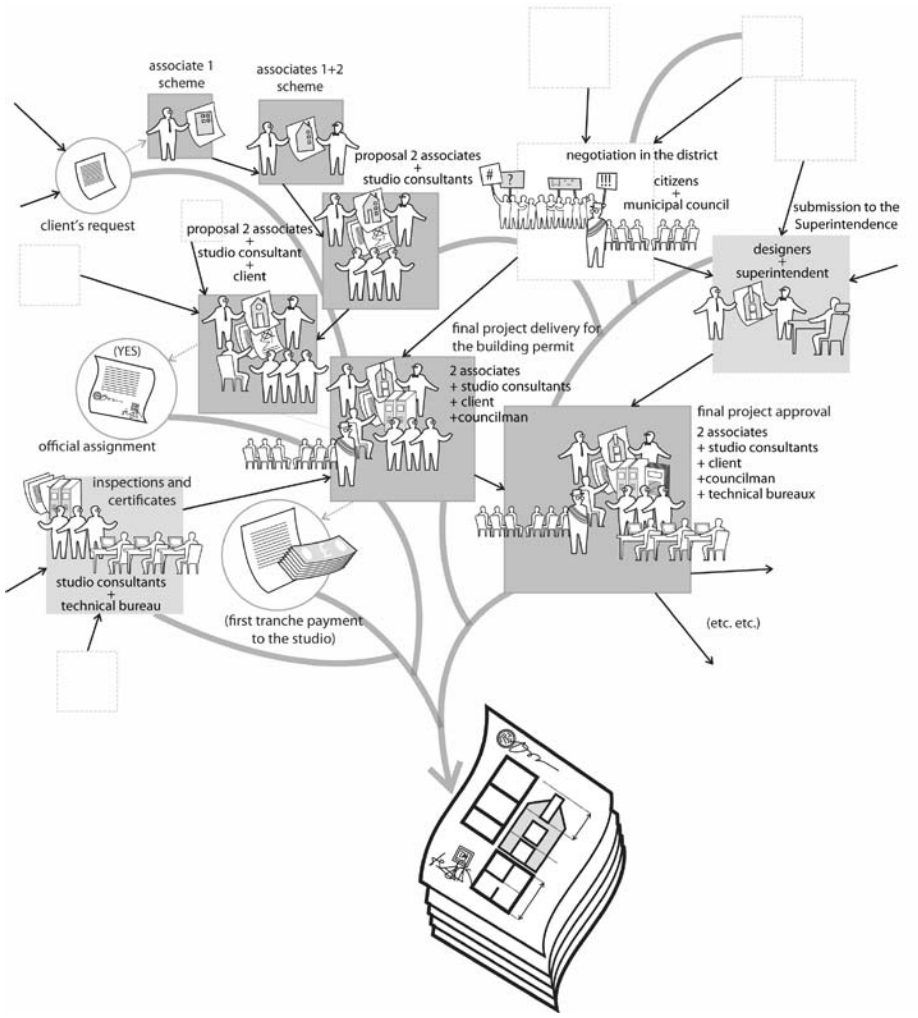

Fig. 1. The project can be seen as a contract between different parts. Source: adapted from Armando and Durbiano [3].

3 The Case Study: the La Marmora Barracks (Turin, Italy)

SCA is tested as a tool to support the creation of alternative design scenarios for abandoned barracks: the method, in its setting in phases, in the definition of options and with the comparison of alternative courses of action, has allowed to include in the process different points of view, which contributed to the definition of alternative reuse strategies of the property. The context is a highly topical theme in Italy, that is the reuse and enhancement of properties originally belonging to the Ministry of Defense, then property of the State Property Agency. As a matter of fact, over the last two decades, a process of divestment has occurred, offering interesting opportunities to private developers and to the Public Administration as a chance to enhance urban renewal operations. The former barracks, often situated in central urban areas, can be an important opportunity for development and rebalancing of local realities. The La Marmora barracks in Turin are a late nineteenth century property of the Ministry of Defense that are no longer used; they have become a void to be reinvented. The aim of the research is to consider the several aspects of the decision problem related to the barracks in its complexity. The attempt was focused on combining the architectural aspects of the project along with the testing of the SCA decisional method. At an institutional level, the situation is defined: the bureaucratic process has been completed with the approval of the urban variation and the sale to *Cassa Depositi e Prestiti*, a significant Italian financial institution, acting within the Italian economic system essentially as a State bank. The property, however, was occupied from April to November 2015 by some members of the association of social promotion *'Terra del Fuoco'*, who were protesting against the current abandonment and asking for a use respectful of the memory and the value of to the barracks, which during the Second World War were used as a prison. The establishment was vacated in mid-November 2015, following a further occupation carried out by an anarchist collective and some nomads. Currently the barracks is part of a feasibility study, developed by an important architecture firm in Turin. The situation is a reflection of a reality far from being clarified, especially concerning the requests coming from "the bottom”. The research takes place in parallel with the process itself, changing and adapting to current events and the on-going discussions. In this context, the SCA is perceived to be an ideal test method, due to its focus on uncertainty management in conflict or unclear situations, with the aim of defining the problem and solve it by identifying and comparing alternatives. In order to involve the main actors, the organization of a participatory workshop was put forward. But the on-going events (the two squattings of the site) have caused the refusal by institutional actors to participate. The use of SCA method partially in individual form was then pioneered, supported by meetings and interviews with individual DMs, experts, stakeholders (a councillor of the City of Turin, an executive of the Urban sector of the City of Turin, the director of the association which squatted the barracks, the district representative, a design expert). In fact, the asset transformation involves some key players, whose interests and powers has been analysed with a stakeholders analysis [4], elaborated since several meetings, at the barracks (with the occupants), but also after institutional gatherings (with municipality and district officials).

3.1 Method Application: SCA and Architecture

The SCA application takes place after a series of "unstructured" meetings with the mentioned key players involved, in order to explore more deeply their different positions. In some cases these meetings give birth to conflictual situations (i.e. the collaboration with the executive of the Urban sector of the City has been initially difficult, due to the fact that we also have met and discussed with the occupants). Consequently, as mentioned before, the first two phases of the method are experienced without a participatory workshop. In the shaping mode (Fig. 2), some feasible interventions were first brought out, identified as decision areas: the demolition of the building used as a warehouse (*demolition*); the realization of an underground parking (*underground parking*); the reconstruction of the demolished quantities (*reconstruction*); the study of permeability, routes and accessibility (*ground*); the buildings, in terms of space and possible uses (*buildings*). The way of structuring in morphological and tangible way every step of the reasoning, it was a way to test an interaction between the method and the logical thread of the design. In fact, the definition of these decision areas is equivalent, in the architectural project, to discover the "space" of transformation. According to the method, there is a definition of the connections between the decision areas and of the most important and urgent ones (*i.e. the demolition is an urgent decision*).

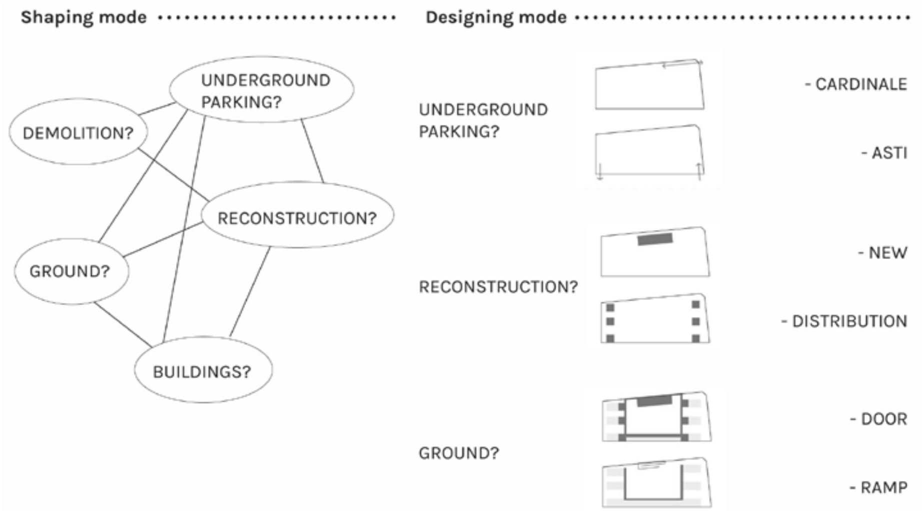

Fig. 2. The decision areas in the shaping mode (on the left); the decision options in the designing mode (on the right).

Next, the decision options for each decision area are defined in the designing mode (Fig. 2). The alternative solutions for the underground parking are to create a new entry with a two-lane ramp from Cardinal Maurizio street (*Cardinale*), or to maintain

the current entries from Asti street (*Asti*) and to create two different ramps. About the reconstruction, it is possible to imagine a new building on the previous demolition area itself (*New*), or a volume distribution on the barracks roofs (*Distribution*). Then, the different possibilities for the ground are to design a new building as a door that open a portion of the barracks wall, connecting the existing walkway on the first floor in a complete ring of public use (*Door*), or to imagine a ramp in the same place, without the possibility of a ring at the first floor (*Ramp*). Through a combination in the option graph, the probable incompatibilities between the options are then defined.
Therefore, it is possible to combine in sequence the options in an option tree, excluding their incompatibilities, and to obtain two decision schemes and different transformation scenarios. The other two phases are the occasion to support the process by meetings and interviews with some of the main stakeholders involved. Turning to the comparing mode, it is possible to compare the two scenarios, according to a series of criteria. The interviews are conducted firstly in order to modify the comparison criteria – firstly considered autonomously – and to validate them, in their final form. These meetings are structured in different steps. First of all, the previous two phases of the method are shown and the schemes and drawings are explained to the interlocutor. Second, the focus turns into the comparing mode itself and the interviewed gives his/her opinion about the comparison areas chose, by answering some questions. In some cases the disagreement is about the label given to a specific criterion (i.e. “usability” changes in “inclusiveness”); in other cases the criterion itself is discussed and transformed.

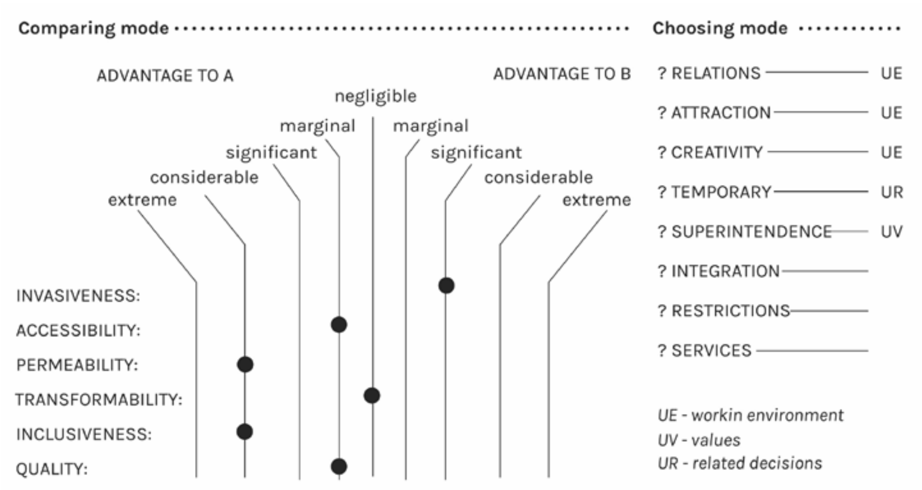

Fig. 3. The advantage comparison in the comparing mode (on the left); the uncertainty areas in the choosing mode (on the right).

After that, using these criteria, the key-actors play an important role in defining the relative assessment and the advantage comparison between schemes A and B: the scheme A seems to be the most suitable. The choosing mode (Fig. 3) is also tested thanks to the interviews. The key-actors help to define the uncertainty areas of the transformation. So, it is declared any doubt or concern about the scenario. This SCA application, by the output of a decision scheme (scheme A) and a list of uncertainty areas, becomes a framework, a starting point for future projects: starting from SCA, it is finally thinkable to define different levels for the transformation.

4 Discussion

The refusal by institutional actors to participate to a collective workshop stimulates a switching in the SCA application. In fact, this originally participatory kind of intervention is here experimented first individually, then in a series, through one-on-one interviews. This case study, as a real-life problem solving situation, is a subject to behavioural issues and effects [11], referring in particular to the interviewees in relation to the context and the models of the application. In other words, the comments here mentioned concern both the process and the content [2] of these relationships between the social, behavioural and the material entities involved in the interventions. In these, behaviours and human factors are crucially important to address [16]. In fact, in these interventions the aim is to represent a model of viewpoints and beliefs to enhance people involved to understand the conflictual situation, in order to let them able to solve it [16]. In this particular case study, the concern is with individuals and the representation or models are instrumental (relating to the framework for behavioural OR in [16]). The qualitative method of SCA can be analysed with a focus on understanding these micro-processes that affect the interviewees. First of all, as mentioned before, we have met the different key players in several occasions without any a priori ideas or specific aim. This fact allows a comparison (even if only qualitative) about their changes in way of thinking, opinions and behaviour afterwards, during the SCA application. We argue that, in some meetings, this simplified model of a real-world problem has helped in clarifying the different implications of various choices and the role itself of the researchers (i.e. the executive of the Urban sector of the city definitely distinguished our role from the occupants' role), by removing the previous prejudice. Moreover, during the first step of the interviews (the explanation of shaping and designing modes), we notice that a growing interest has gradually emerged, probably due to the increasing understanding of the case study. It is also interesting to underline that, in some cases, the comparing mode just has started from the first question set up and then the themes investigated in the following questions has naturally come to light from the person interviewed. We suppose that it happens thanks to the fact that this method is similar to the way of thinking of who usually meditates on this kind of "wicked" spatial problems. In this sense, it also sounds quite interesting the merging between the method and the architectural process, given the wicked nature of how design sits within the planning process. The main similarity between these two processes is related to the experimental context in which they take place. In PSMs interventions, as well as in some kind of architectural design actions, the research is a continuous "in progress", due to the fact that it occurs simultaneously with the process itself. It is therefore logical to bring these processes together, as similar “running labs” about real-life problematic situations. The interesting difference – and possible field of study – between PSMs an architectural research is the fact that the project, moving from policies, tackling conflicts and negotiations, and taking shape into documents, produces some clear material effects [4], that is what we can see in the physical places considered. These, as the real points of arrival of institutional actions, are practical and concrete outcomes of the interaction between several entities, including people, documents and space as social objects [6]. Thinking about micro-processes, in architectural design process it becomes very clear that every step of negotiation about an issue is a micro-project led by the drawings and schemes proposed, as “documental traces” [6] registered and capable to produce material effects [4]. In this sense, we argue that this link between PSMs and architecture leads to considering the micro-processes on the basis of the “traces” they leave [6].

5 Conclusions and Future Studies

In this paper, we identify the possible use of SCA as a design tool. The architectural project is intended here as a process and a decision problem, for which there are multiple answers and alternative solutions. Therefore, the SCA, in its setting in phases, is a useful scheme through which the architect (individually and as facilitator) can reason, defining alternatives with sketches and drawings. We believe that, dealing with “wicked problems”, a more structured approach in the process of choosing alternative transformations could have an impact on the quality and the results of the project. Despite its potential, improvements are needed to consider SCA as a support for architectural design. Two main areas of future research are proposed. First, it would be of interest to test the method on other architectural issues, at a different geographical scale (the case here illustrate can be considerate at an intermediate level between “urban” and “building”) and concerning different architectural problems (i.e. infrastructural issues or new expansions of the town). Second, there is a problem connected to the possibility of “measuring” the effectiveness of the architectural project counting on the method. Our research about the effects of OR processes on knowledge, behaviour and action has some limitations, due first of all to the fact that we focus on a single case study; second, we only analyse the notes and schemes produced during the interviews, without a video or audio recording. However, it is important to say that the majority of these studies “are based on little more than authors’ reflections on single case studies” [16]. It has to be mentioned that this is a general limitation of the architectural projects, where the functionality, the aesthetic, the cost, the sustainability, etc. can be considered fundamental parameters to be evaluated in themselves and in their synergies. Research designs that include testing the SCA in different urban contexts, potentially including also a MCDA, would help to implement this proposed agenda.

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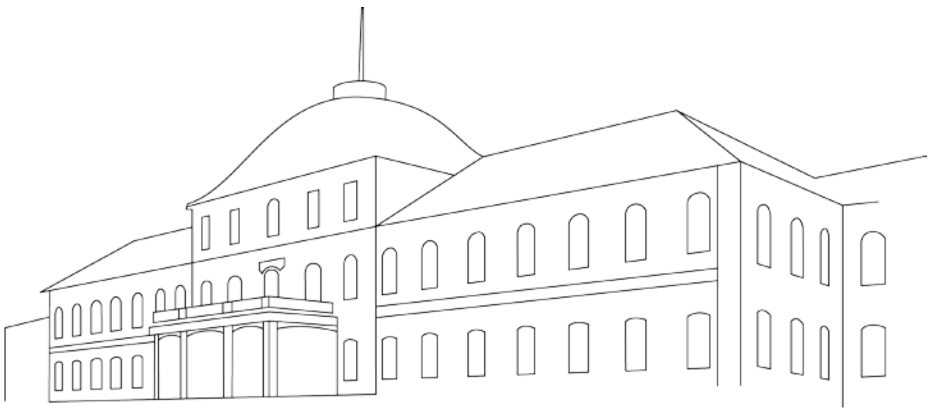
Student Stream

Stream Organisers:

Mareike Schoop, University of Hohenheim, Germany
Philipp Melzer, University of Hohenheim, Germany



University of Hohenheim

Enhancing the Flexibility of Electronic Negotiation Protocols Using a Workflow Management System

Andreas Schmid[1]

[1] Department of Information Systems 1, University of Hohenheim,
Schwerzstr. 40, 70599 Stuttgart, Germany

a_schmid@uni-hohenheim.de

Abstract. A negotiation protocol defines a set of rules, which governs the communication and decision-making processes of the parties and may e.g. specify the number of participants, their roles, possible actions and the sequence of these actions. Electronic Negotiation Systems (ENSs) often implement only one negotiation protocol or a subset of negotiation protocols. Consequently, these ENSs restrict the range of supported negotiation problems. This paper presents a novel approach to increase the flexibility of electronic negotiation protocols by integrating a BPMN 2.0 Workflow Management System in an existing ENS. The results show, that freely configurable protocols can be executed during the runtime of the ENS. Furthermore, the utilisation of BPMN 2.0 may increase the understandability of negotiation protocols for the negotiators.

Keywords: flexibility, negotiation protocol, electronic negotiation system, workflow management system, BPMN 2.0

1 Introduction

A negotiation is "[…] an iterative communication and decision making process between two or more agents (parties or their representatives) who 1) cannot achieve their objectives through unilateral actions; 2) exchange information comprising offers, counter-offers and arguments; 3) Deal with interdependent tasks; and 4) Search for a consensus which is a compromise decision" [1, p. 316]. The negotiation process is structured by a negotiation protocol, i.e. the protocol defines a set of rules which govern the communication and decision making processes of the parties [2].

In face-to-face negotiations, the parties are relatively free in defining a protocol or may not even define an explicit protocol at all [2, 3]. In contrast, negotiations conducted in an ENS require precise protocols defining the activities undertaken by a human negotiator or the system [3].

Negotiations differ in many aspects: e.g. the negotiation type (bilateral, multilateral, auction) or the involvement of a neutral third party (arbitration, mediation) [4]. There are also mixed negotiation types, e.g. it is quite common in procurement scenarios to start with an auction focussing on the price only, followed

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by a negotiation determining the other attributes of the transaction [5]. Furthermore, there is a large number of existing and emerging agreement scenarios in business negotiations [6]. Current ENSs implement only one negotiation protocol or at most a small subset of protocols [7].

However, for an adequate electronic negotiation support, a fit between the real negotiation problem and the electronic negotiation protocol is essential. Consequently, ENSs are required that support various negotiation scenarios and allow to define new protocols that fit the negotiation problem during the runtime of the ENS [2, 6–9].

In this work, the need for more flexibility in ENS is addressed by focussing on the following research question:

How can the flexibility of electronic negotiation systems, i.e. the support of various negotiation protocols, be increased by the integration of a Workflow Management System?

Several previous approaches using a Workflow Management System responsible for executing the negotiation protocols have been developed [8–11]. This paper presents a novel approach by using the Business Process Model and Notation (BPMN) 2.0 to model and execute the negotiation protocols [12].

2 Methodology

The presented research question requires a methodology that supports the creation and evaluation of a software artefact. Therefore, a Design Science Research (DSR) approach is applied [13].

As a first step, an integrative literature review is conducted focusing on foundations of electronic negotiations, electronic negotiation protocols, and existing approaches for the design of ENS. Approaches based on workflow technologies are of particular interest. Using the explanatory design theory [14] for DSR demands the definition of general requirements and components of the software artefact. The literature review provides these requirements for the artefact and explains the derived general components for the artefact to design.

The design and development of the artefact includes the integration of the Workflow Management System (WfMS) in the electronic negotiation system Negoisst [15, 16] and the implementation of the general components. Negoisst provides a holistic view on electronic negotiations by integrating communication, decision, and document support [16] and is thus appropriate to study the potentials of a WfMS executing negotiation protocols.

Following the design of the artefact, the evaluation is a crucial activity in DSR [13]. The focus of this paper is the technical feasibility of an approach integrating a WfMS. Thus, as a first step of evaluating this artefact, this paper follows a purely technical evaluation strategy, which does not involve organisations and human users [17]. The evaluation presented in this paper includes the analytical evaluation of the artefact [13]. As a last step, the presented approach is critically discussed and compared with existing solutions for flexible ENSs [18]. The goal is the creation of an artefact, which represents an improvement to current approaches aiming at increasing the flexibility [18].

3 Theoretical Background

In the following a brief theoretical background on electronic negotiation protocols and workflows will be presented. Furthermore, the state-of-the-art on ENSs using workflows for negotiation protocols will be investigated.

3.1 Electronic Negotiation Protocols

An electronic negotiation is not only mediated by information and communication technology, but "[…] it is restricted by at least one rule that affects the decision-making or communication process, if this rule is enforced by the electronic medium supporting the negotiation, and if this support covers the execution of at least one decision-making or communication task" [19, p. 147].

The negotiation is structured by a negotiation protocol, which defines a set of rules governing the communication and decision making processes of the parties [2]. The protocol "[…] may specify possible actions and their sequence, allowable offers and messages, timing of offers and messages" and may also "[…] specify the syntax and semantics of the messages, and mechanisms in which alternatives are determined and assessed, offers are constructed, and concessions are made" [1, p. 316]. The protocol restricts the range of available activities and the permissible inputs for each activity. The ENS passes information about the successful or unsuccessful completion of an activity to the embedded protocol, which selects and returns the next activity [3].

One or multiple activities form a negotiation state [3]. An activity may be assigned to multiple states. States in turn belong to a certain negotiation phase [20]. This means, that electronic negotiation protocols may also differ in the support of various negotiation phases [21].

3.2 Workflows

Processes or workflows in organisations are nowadays often controlled and executed by a WfMS. The Workflow Management Coalition describes a workflow as being "[…] concerned with the automation of procedures where documents, information or tasks are passed between participants according to a defined set of rules to achieve, or contribute to, an overall business goal" [22, p. 6]. Transferring the description and idea of a workflow to an electronic negotiation, the overall business goal of the involved parties is reaching an agreement and the negotiation process and information exchange follows the negotiation protocol.

The workflow is executed by a Workflow Management System, which assigns the tasks of a workflow to human or IT resources. A WfMS is defined as follows:

“A system that completely defines, manages and executes ‘workflows’ through the execution of software whose order of execution is driven by a computer representation of the workflow logic” [22, p. 6].

A WfMS needs to execute workflows defined in a computer interpretable language. Different workflow languages have been developed in the last years, e.g. the Business Process Execution Language (BPEL) and the BPMN. The following chapter focusses on flexible ENS approaches utilising workflows.

3.3 Workflows in flexible Electronic Negotiation Systems

Rolli and Eberhart [10] published an auction reference model and created a generic Java runtime environment (RTE) covering the basic functionality of various auction types. In their opinion, protocol designers only need to define a restricted set of directives using a graphical BPEL designer. Their RTE already covers recurring auction processes. Finally, a script converted the BPEL model to Java-code and the protocol was executed in the runtime environment.

A web-service enabled marketplace architecture was proposed by Kim and Segev [8]. In their architecture, the negotiation web-service enforces the rules of the selected negotiation protocol, while leaving intelligence for decision making to the services and systems of the parties connected with their marketplace. The protocols were modelled in BPEL and could be deployed on the BPEL WfMS integrated in their marketplace. One of their limitations was the expressiveness of BPEL: arbitrary cycles of activities were not allowed and some important Workflow Patterns [23] were not supported.

Another approach also designed a web-service enabled e-marketplace using the Statechart formalism to model negotiation protocols [11, 24]. The created Statechart models were automatically mapped to BPEL process models, which could then be executed within the marketplace. The authors argue for the Statechart formalism, as it is intuitive and easy to learn and the created protocols are compact and clear, helping the negotiators to understand the protocols. However, there were some issues regarding the mapping of Statechart models to BPEL models.

Koumoutsos & Thramboulidis [9] developed a framework for complex, pro-active and service-oriented ENSs. They also address the need for adaptable negotiation protocols by utilising a layered protocol architecture. The bottom layer forms the basis of every negotiation protocol and includes functionality required in each negotiation. On a higher layer, new negotiation protocols can be created with a WfMS using the XML Process Definition Language. Their workflow language selection was mainly driven by the criteria to provide a user-friendly visualisation of the protocol.

4 Explanatory Design Theory for Electronic Negotiation Protocols

In order to develop the artefact, the general requirements and the derived general components have to be defined [14]. They are summarised in Table 1 and are discussed in the following.

The first requirement relates to this paper’s research question and demands to support the definition and execution of various protocols. A possibility to define and execute new protocols during the runtime of the ENS is required. Consequently, new protocols can be added without the need to implement new code and deploy the ENS again. The component realising this requirement is the integration of a WfMS in the ENS. Similar solutions have already been applied by [8, 9].

The second requirement is a graphical protocol representation. A user-friendly protocol visualisation enables the negotiators to understand the protocol models [9, 11] and communicate his/her protocol requirements. In this approach, the requirement was realised by using the BPMN 2.0. The BPMN has a standardised graphical protocol representation and was especially developed for non-IT experts, such as the negotiators, to understand and communicate their process models [25, 26]. In addition, the BPMN includes an executable meta-model, which allows the execution in a workflow engine. Thus, a mapping algorithm between the graphical representation and the executable workflow language [11] is not required.

Third, the artefact needs to handle the states and activities of a protocol. The ENS passes information about the successful or unsuccessful completion of an activity to the embedded protocol, that selects and returns the next activity [3]. Activities are executed either by the users or automated by the system. There might be states, in which the user can select from a number of next activities [3] all of which need to be presented to the user. For this purpose, an interface between the WfMS and the ENS is required to retrieve the current state of a negotiation and the feasible next activities of the negotiators. The ENS passes required information to the WfMS, e.g. the user completing the task and additional variables needed for further processing.

Last, the artefact needs to authorise users and manage their roles in different negotiations. In a negotiation, multiple negotiators may represent a party [4]. Furthermore, different parties may have the same potential activities in a protocol. They can be categorised as a group, e.g. as a group of bidders in an auction protocol [24, 27]. For protocol activities assigned to a group of several users, the component should grant access to complete the activity to all users assigned to this group, i.e. the members of one group in a negotiation do all have the same authorities.

Table 1. General requirements and components.

No.	General Requirement	General Component
1	Support Definition and Execution of Various Protocols	Integration of a WfMS
2	Graphical Protocol Representation	Workflow Language with standardized graphical representation and an executable meta-model (BPMN 2.0)
3	Management of States and Activities	Interface between the WfMS (managing protocol states and orchestrating activities) and the ENS (executing activities, managing user activities and requests)
4	Authentication, Group and Role Management	Authentication and role component managing access to negotiation activities with a defined role

5 Implementation and Protocol Example

The general components described in the previous chapter were integrated in the negotiation support system (NSS) Negoisst [15]. NSSs are a subtype of ENSs [4]. Negoisst, currently developed in its fourth version, is a web-application based on the Spring Framework. The BPMN WfMS chosen for the integration in Negoisst is Activiti since (1) it supports the BPMN corresponding to the second general requirement; (2) the license of the WfMS corresponds the open-source requirement of the NSS Negoisst; (3) its engine can be easily integrated in a Spring application [28].

Activiti provides seven core interfaces to interact with the WfMS [28]. Using an integrated architecture for a web application based on the Spring Framework and the Activiti engine [29], both the web application and the Activiti engine share the same Spring container. This shared container allows the NSS to interact with the WfMS, as well as the WfMS to call service-methods in the NSS.

Figure 1 exemplary shows an extract from an English auction protocol in BPMN. Once the participants enter the bid process, the *User Task* for bidders to write and submit new bids is triggered. When a bidder submits a new bid, the system compares it with the current highest bid. This function checks whether the utility of the new bid is higher than the utility of the highest bid. Additionally, in this example a minimal increment *D* [30] of value one is used. Thus, a new bid's utility has to be at least greater than the current highest bid by one. If the new bid's utility is lower than in the protocol defined, the system refuses the bid and the protocol returns to the write message task. If the new bid fulfils the condition, the bid process ends and is momentarily left to update the highest bid (not displayed in this extract) and returns to the bid process. An English auction may close when no new bids have been submitted within a certain period of time [30, 31]. Thus, the bid process has a boundary timer attached to it. If this process was not left in the last 24 hours, i.e. there were no new higher bids, the event is fired and the auction ends (also outside of this extract).

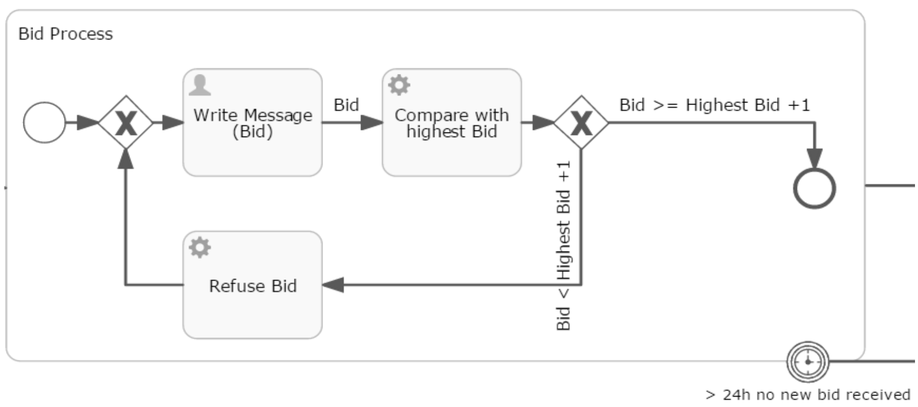

Fig. 1. Extract from the BPMN English Auction Protocol

6 Evaluation

Following a purely technical evaluation strategy [17], as a first step the artefact is evaluated analytically [13]. Kersten and Lai defined six properties desirable for negotiation protocols [3], which will be discussed with regard to this work:

Input consistency refers to the use of all available information for protocol processing and the validation of inputs. Validity is ensured by the Negoisst system on the user interface, whereas the use of information for protocol processing depend on the protocol and only required information (e.g. the user completing a task or decisions by the user) are passed to the WfMS. *Transparency* requires an understandable protocol. By using the BPMN developed for non-IT experts, users can understand the activities in the protocol visually. Furthermore, the direct execution of the BPMN model in the WfMS allows retrieving the current state of a negotiation in a graphical representation, highlighting all current activities. *Explicability* demands justification of a specific activity selection, whereas *tractability* is more general and demands justification of all potential protocol activities. First, Negoisst provides document support, i.e. all messages are persisted and visible to the negotiators [15]. Second, the activities can be justified by the graphical syntax of the BPMN modelling elements [12]. Third, the WfMS documents all completed tasks in an audit trail [28]. *Satisfiability* describes the possibility to reach a concluding state in a negotiation. *Completeness* demands for all activities a path to a concluding state. The graphical modeller of Activiti assures, that there is a path between the start and end event of a process, thus fulfilling the satisfiability property. The completeness however, needs to be assured by the protocol designers.

Furthermore, the utility of the artefact is shown by two negotiation case studies from the literature. For reasons of limited space this evaluation cannot be discussed in detail. For more details on all evaluations performed please cf. the corresponding master thesis [32] (if you would like to access the master thesis, please contact the author of this paper).

7 Discussion and Future Research

In the first part of this section, the design decisions of the approach are critically reviewed, before the approach is compared with the systems presented in 3.3.

As described in chapter 5 we selected the BPMN WfMS Activiti. Unfortunately, during the modelling process some workarounds were necessary, since Activiti's BPMN implementation did not always conform to the BPMN specification [12]. These findings correspond with the evaluation of open source engines regarding their BPMN conformance by Geiger et al. [33]. They evaluated three open-source engines, including the Activiti engine. As a result, they found that these engines support only a subset of the BPMN specification and implement BPMN features differently. Similarly, different and non-standard conformant BPMN *Service Task* implementations in the open source engines were found [25].

Some of the problems are considered to be rooted in the BPMN standard itself [34]. Several BPMN constructs are underspecified or ambiguous, thus making it difficult for BPMN engine vendors to follow the standard. As a result, the BPMN engines only support a subset of the standard, vary in their implementation and are not compatible with each other. Therefore, the BPMN cannot be used for web service orchestration [25], such as presented by [8, 11]. Thus, the BPMN would only be suitable for standalone negotiation systems, as presented in this approach.

In comparison with the systems presented in chapter 3.3, the designed artefact provides one new feature: The graphical definition and the execution of the protocol in BPMN allows to retrieve the current state of a negotiation in a graphical representation, highlighting all current activities. Thus, the graphical BPMN representation is not only useful for the definition of a protocol, but also during the negotiation to trace the activities and increase the transparency of the protocol [3].

Kim & Segev's approach provides a pattern-based approach to design new protocols [8]. Choosing from several a-priori defined parameters a new protocol can quickly be developed and executed. Compared with the presented approach, their marketplace allows for a quicker development of protocols. However, the flexibility of the protocols is restricted to the given patterns, whereas this work provides more flexibility with the disadvantage of a longer protocol development phase.

The Invite platform integrates several negotiation systems on one platform [7]. Similar to [8], the systems allow specifying some parameters for the protocols with the same advantages and disadvantages listed above.

The marketplace by Benyoucef and Rinderle utilised the Statechart formalism for modelling protocols [11]. While the Statechart formalism is more reductionist than the BPMN models, the mapping to another workflow language can cause mapping problems for certain constructs [24]. Thus, using a workflow language, that can be graphically represented and executed in a WfMS, is superior to mapping approaches.

This work and the approach by Koumoutsos & Thramboulidis [9] have several aspects in common: Both provide a user-friendly visualisation of the protocol in an executable workflow language; the protocols are freely configurable and they provide basic functionality used in any protocol. However, their approach additionally uses rules to define strategies for agents on top of these protocols.

Summarising all findings, the flexibility of the presented artefact is only restricted by the expressiveness of BPMN, which already provides manifold constructs [12], and the BPMN support of the selected WfMS.

The results of this paper call for future research in several areas: First, since the creation time for a new protocol can be time-consuming, it would be useful to determine recurring negotiation workflow patterns, which are offered in the graphical modelling tool and may ease the process of protocol creation. Second, as the protocol is dependent on the problem and the negotiation context [3], a guide suggesting appropriate protocols should be developed. At last, the offered transparency by retrieving the current state of the negotiation requires further investigation regarding its usefulness and impact on the negotiation process and performance.

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How to Learn to Negotiate: An Interactive University Teaching Concept in Negotiation Management from a Students' Perspective

Jennifer Krieg[1], Lena Maier[1], Michael Schreiber[1]

[1] University of Hohenheim, 70593 Stuttgart, Germany
{Jennifer.Krieg, Lena.Maier}@uni-hohenheim.de
Schreiber.Michael@hotmail.com

Abstract. Teaching negotiation skills poses a twofold challenge to lecturers: Firstly, negotiation is inherently practical and thus requires teaching other than solely traditional lectures. Secondly, the way we negotiate is individual and thus teaching it to students should be done in a way that supports their individual learning and negotiation styles. In this paper, we discuss a novel and interactive course concept teaching negotiation skills at the University of Hohenheim from a students' perspective. Based on an assessment of our own learning styles, we evaluate how the course's unique structure and methodology caters to the students' individual predispositions and helps them to achieve their learning goals effectively and efficiently.

Keywords: Negotiation Management, Learning Style, Negotiation Teaching

1 Introduction

Every one of us faces at one time or other the distinct feeling of opposition, the challenge of another person's differing opinion on a matter we deeply care for, and the pressing urge to achieve a particular goal despite such obstacles. We may then choose to flee, to fight – or to negotiate, i.e. to find a constructive way to come to an agreement where other means might prove futile or in the worst case even destructive. Thinking about our social interactions, we may find that negotiations are not an abstract concept from the realm of theoretical sciences – they are rather an inherently practical aspect of our everyday life.

So why take a course in negotiation management? Why not simply read a book or learn it on the job? Because a good negotiator combines two sets of skills: The knowledge about the basic concepts and dynamics involved in successful negotiation, as well as the self-awareness, social skills and practical training to put them into action. A combination of both enables to judge conflicts correctly and act confidently. For this reason, the Chair for Information Systems I at the University of Hohenheim

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has developed a novel, interactive teaching approach which enables their students not only to study, but also to experience the benefits and challenges of negotiation [4]. The course in Advanced Negotiation Management (ANM) features a mix of interactive teaching methods selected to equally address students with different learning styles. This is achieved by a combination of solitary and group work tasks during phases of preparation, application and reflection. In short: by knowing, doing and understanding.

The aim of our paper is to assess the innovative form of teaching from the viewpoint of students, answering the question whether this type of teaching achieves its main goal, namely teaching the students how to negotiate in an effective manner. The authors thus assess their learning journey w.r.t. the above question by writing this paper in an essay style. In the following section we will assess our own learning styles based on Honey and Mumford's Learning Styles Questionnaire (LSQ) [2]. This will serve as the background against which we evaluate our experience with and the perceived usefulness and benefits of the course concept as well as of selected teaching methods in section 3. Finally, we conclude the paper in section 4.

2 Learning Styles

We start by giving a short introduction to the idea behind the concept of learning styles in general and the LSQ in particular. Based on the LSQ, the authors' individual learning style is described in more detail.

2.1 The idea of different learning styles

Learning is crucial to our success at university and in the workplace. In fact, learning is the most important capability we have, since it is the gateway to every other desired capability [3]. Interestingly, teachers as well as researchers find that the speed, manner and confidence of picking up, processing and using new information and ideas vary greatly between individuals. For this reason, research during the past decades has put much effort into the investigation of learning styles and has developed several approaches to describe individual learning behaviour [1]. One of these approaches is the Honey and Mumford's Learning Styles Questionnaire (LSQ) [2], which was applied by the lecturers in the beginning of the ANM course to determine the students' individual learning styles.

2.2 Honey and Mumford's Learning Styles Questionnaire

The LSQ offers practical help to understand one's dominant learning style(s), to enhance one's strengths, and to improve on still weakly developed learning styles. Referring to the four stages in Kolb's learning cycle, Honey und Mumford [2] differentiate between an Activist, Reflector, Theorist, and Pragmatist style.

Activists are flexible and open minded, thus happy and optimistic when they are exposed to new situations. They learn best from new experiences and challenges, competitive teamwork, leading discussions or giving presentations. On the other hand, they find it hard to learn by performing solitary, passive or overly repetitive tasks like reading, writing and simply observing.

In contrast, Reflectors are thoughtful, thorough and methodical. They are good listeners and observers, and they assimilate information quickly, which is why they rarely jump to conclusions. Therefore, Reflectors learn best if they are allowed to do detailed research and take their time to think things through before acting or commenting.

Theorists are logical thinkers and have a very low tolerance for uncertainty, ambiguity, or even contradiction. They long for clear structures and purpose, which explains their particular fondness of formal models and theories. Theorists are experts in spotting and exploring the underlying concepts and interrelationships behind a subject.

In contrast to Theorists, Pragmatists think in a practical and realistic way and tend to judge any piece of knowledge by its perceived applicability and usefulness. Pragmatists learn best if they can test their knowledge in practice. They appreciate coaching and feedback from experts, but they struggle if guidelines are unclear or if they cannot observe the benefit of what they are learning [2].

2.3 Our own learning style

The authors themselves determined their learning styles in the beginning of the course. Since we found our individual dominant styles to be mostly identical, we will treat them as the authors’ learnings style prototype in this paper. It can be best described as a strong mixture of the Theorist and Reflector with few Pragmatist elements. Interestingly, we spend more time theorising and reflecting in the beginning of the semester, whereas we experience a stronger tendency towards pragmatic learning once the exams move closer. Like typical Theorists, we start the learning process by making ourselves acquainted with the general concepts and the structure of the learning content. We tend to construct a mental logical framework of the concepts involved and link them to others we have learned before. This approach allows us to draw conclusions concerning similar problems. Moreover, the use of such a generalised framework can facilitate the process of memorising the material, since its logical corner marks can serve as cognitive cues with which deeper, more detailed layers of knowledge can be simply associated. In this stage of the learning process, we experience that our performance can be best enhanced by teaching techniques which offer a clear representation of the logics behind a concept and the interrelationship between its parts.

We then try to apply the gained knowledge by doing exercises. This serves as a checkpoint at which we can assess whether we really understood all of the material and can reproduce and apply its key aspects. In general, the further the course progresses, the more pragmatically we proceed. We observe a shift of focus from very time-consuming, purely intellectual investigations towards a more pragmatic approach, dedicated to the material’s applicability in real life and, not to forget, in the upcoming examination.

We feel that the concept and methodology of a lecture play an essential role in our learning process: The better a teaching concept is tailored to meet the requirements of our learning styles, the easier and more sustainable our learning process becomes. Chapter 3 discusses our personal experience with some selected concepts and methods explicitly chosen by the lecturers to enhance our learning experience based on our individual predispositions.

3. An Interactive Concept of Teaching Negotiation Management – Fit between course structure and our learning styles

The ANM course is offered for around 130 Master students of Management, and Information Systems and has been completely revised from a traditional lecture course with a case study to a flipped classroom [4]. The course consists of three alternating phases, namely a preparation phase, a presence phase (the actual lecture) and a reflection phase. Every stage features different teaching methods and activities for the students to participate in. This section discusses some of the most prominent methods and their perception from the viewpoint of students as those learning to negotiate. The preparation phase is supported by an e-learning tool, whereas the presence phase offers a mixture of the traditional lecture and several group tasks such as discussions, role plays, or the fishbowl. The reflection phase consists of a learning journal written by the students.

E-learning. To facilitate e-Learning, the University of Hohenheim uses the Learning Management System ILIAS. Besides getting access to the lecture slides, we used ILIAS to perform the mandatory preparation tasks and to create our learning journal during the ANM course. Each preparation unit consisted of different tasks such as reading summaries of the upcoming lecture's topics or answering research questions after reading scientific papers or watching videos. At the beginning of the course, it was recommended to perform the E-learning tasks as group activities. However, all three of us did not join a group.
When it comes to acquisition of knowledge, group learning activities and relying on others may seem difficult for Theorists due to their low tolerance for uncertainty [2]. We find it hard to trust other group members whose personality traits and way of learning and thinking we do not know. We also have difficulties appraising the other person's motivation and diligence. This makes it impossible to assess the completeness and correctness of the knowledge gathered and conveyed to us by other group members. In previous courses we experienced that we remember information better if we gather it on our own, since we know best how we prefer the learning material to be served. Online exercises and quizzes helped us to test and reflect on our newly acquired knowledge. From our perspective as Theorists and Reflectors, e-learning was a helpful tool because it allowed us to do thorough research and accumulate knowledge in our own pace and without time pressure. This had facilitated the formation of a coherent initial framework of each topic, against which the Theorist then evaluated further knowledge acquired in the subsequent phases. Since the learning tasks could also be performed in groups, not only Theorists and

Reflectors but also Activists benefited from this form of learning. E-learning offered us the flexibility to learn theoretical issues where and when we wanted to. However, this freedom required a certain degree of discipline which not all students had. In every lecture we observed students who were not prepared. As a result they struggled in following the lecture because theoretical knowledge was a prerequisite.
Thus, forced to constant preparation, we soon realised its positive effects and even continued the habit of preparing (e.g. repetition of presented learning contents) in other lectures.

Group tasks. Whereas in the preparation group activities were voluntary, they played a more important role in the presence phase. Since the presence phase focused more on the actual application of the knowledge, the lectures included group tasks, i.e. discussions, role plays and the fishbowl. For performing role plays, the students usually were supposed to form groups of two to four people and each person chose a role. Then the lecturer revealed the task and gave us a few minutes to prepare ourselves before we started the role play. Whereas in the role play every student participated actively, for the fishbowl the lecturer picked some students to perform a task in front of the course. Afterwards, the students in the audience were asked to tell their opinion and to discuss what they had observed. For example, one of the tasks consisted of negotiating a case with secretly predefined negotiation styles. After every negotiation the audience had to guess the respective negotiation style and had to explain their decision.

In discussions we tended to be reflectors and so we felt most comfortable being quiet observers at the beginning, listening to all the opinions of the other participants. This perspective allowed us to collect information and thereby we contextualized the different perspectives and got a broad picture of the subject. Furthermore, this perspective supported us to evaluate whether our knowledge seemed to fit into the context or whether we might have to adjust our knowledge. In addition, this raised our awareness for aspects otherwise overlooked. By evaluating we had weighted and tested the arguments against our own state of knowledge and jumped in with critical questions or statements once we had found a discrepancy between our own knowledge framework and the point of the argument or lecture. Hence showing that we rather contributed to a discussion in a reflective way by carefully listening and revealing discrepancies. When we felt that we had collected enough information and considered sufficient perspectives, we started adding our own ideas. When it came to conclusions we were careful and preferred working towards an appropriate solution without time pressure.

In fact, negotiations are inherently practical processes and therefore should be experienced to understand their underlying concepts and dynamics. Through participating actively in the role plays we were able to deploy theoretically learnt concepts in practice and try out different strategies and tactics within a protected environment and without fearing any consequences. Some role plays not only focused on the actual negotiation process but targeted also other intercorrelations, e.g. the impact of cultural differences. So the active participation allowed us also to identify issues which we hadn’t thought of before and take those into further considerations when thinking about negotiating. Moreover, we identified weaknesses and strengths of ourselves. In contrast to the pure role play, the fishbowl allowed every student to observe the same situation and therefore have a common experience. As people might perceive situations differently and focus on different issues, talking about this common experience allowed the students to get an insight into other viewpoints. Comparing other viewpoints and opinions with one's own thoughts and knowledge contributed to reveal discrepancies and incorporate different perspectives to get a more holistic view of the whole subject. The activists and pragmatists were able to observe how the learnt concepts can actually be applied in practical examples or even try it out on their own. The reflectors, however were able to get an insight into different viewpoints and evaluate those insights against the own knowledge and understandings.

Summing up, in the presence phase we deepened our knowledge and transformed it from a factual knowledge to a real understanding achieved by doing. The fact that we could link the learnt knowledge to an experience helped to better remember this knowledge. This was quite motivational and stimulated the interest for the subject matter also among those who hadn't paid attention before. Since we had prepared the subject matter earlier in the preparation phase, this phase did not only meet the learning styles of the pragmatists and activists, but also our learning styles. Although group tasks typically suit Activists better, in this stage of the learning process we had no difficulty collaborating actively with other students to fulfil the tasks because we had already extracted the main aspects of the material and established a coherent mental framework to build on. This highlights that theorists and reflectors do not hesitate group work principally but rather benefit from them if they have the chance to prepare themselves before.

In the past group activities were our least preference due to the above mentioned aspects. This course sharpened our awareness of surrounding circumstances (e.g. time for preparation) that also matter. The positive experiences within the course have made us more open for other learning approaches. Regarding our negotiation skills, we have recognized that the learning contents, with which we dealt during the role plays, are still (several months after passing the course) embedded in our minds and we remember them unconsciously in the right situations. For example, we have a higher cultural awareness when communicating with other people. We also observed that we prepare more properly for any kind of negotiation and negotiate more confident because of the practice gained through the role plays. Therefore we perceive the role play as the most effective form because of its sustainable impact. Nevertheless all forms helped us to achieve our learning goals.

Learning Journals. The predominant activity which was supposed to support the reflection was the writing of journal entries which were mandatory and graded by the lectures who reviewed our journals. We were given tasks which we should answer with a predefined amount of words which had to be met at least. The task concerned the issues learnt in the lecture and in the preparation phase. So, for example, we had to evaluate whether our identified predominant learning style fitted our actual learning behaviour and had to link our learning style to our conflict style.

Being able to write a coherent text requires an understanding of the interrelations between the different topics treated in the text. The fact that the minimum number of words was rather high which ensured that it wasn't enough to just address the topic superficially, but one had to deal with the topic intensively. Thus, we were forced to make an honest, substantial reflection of the learnt topics instead of just a simple repetition. This helped us to make sure that we had understood the different topics treated in the lecture and in the preparation phase thoroughly and that we could bring them into a meaningful context. In case there were misunderstandings or discrepancies the lecturers commented on those, which further contributed to the disclosure of misunderstandings and the clarification of such. The fact that the sum of the journal grades made up 50 percent of our final grade ensured that every student (who wanted to pass the course) participated in the journal writing. This supported the review of the learning content in a timely manner. Thus, also learning types which usually don't follow up the lecture in a timely manner were animated to do so.

Writing the journal entries was rather time-consuming but at the same time supported us to not only repeat the course content in a quick recapitulation but in a substantial reflection. This paid out when learning for the exam. Through continuously examining the course content the effort for learning for the exam at the end of the semester was reduced.

Negotiation Simulation. An activity which combined the application and the reflection of the subject matter was the negotiation simulation. Before the actual simulation phase started every student had to attend a mandatory briefing, in which we got acquainted with the Negotiation Support System Negoisst [5] that was used to conduct the simulation. The simulation consisted of three phases, namely the preparation, the actual simulation and the postprocessing. First, every student received an e-mail containing the case study for the Negotiation Simulation. It gave information about the case itself, the counterpart and the own role including preferences and interests. The students were required not to pass any of this information of the case study. Furthermore, the case study revealed who had to start the negotiation and determined the deadline until the negotiation had to be concluded, either by an acceptance or a rejection. We got three days to prepare for the role and the negotiation. It followed the simulation itself, in which we negotiated with our counterpart via asynchronous messages. Finally, we used the postprocessing phase to write a journal entry about the negotiation simulation and the preparation.

The simulation was the broadest activity as it required both theoretical knowledge as well as the application of such. The preparation enabled us to go through the theoretical background again and apply first concepts regarding the negotiation preparation. This offered us the opportunity to experiment with different strategies and tactics. In addition, the simulation allowed us to perceive the mutual correlations of the participants' attitudes, emotions and interests and thus learning by doing. The fact that the messages were exchanged in an asynchronous way allowed us to act reflected and evaluate different possibilities before actually acting. The writing of the journal entry facilitated a careful reflection of one's own behaviour, recognition of one's own weaknesses and strengths and areas of improvability. Moreover, it helped us to interlink the theoretical concepts learnt in the lecture with practical experiences and therefore contributed to the coherency of our "inner" framework. The reflection of the process was supported by the possibility of reviewing the exchanged messages saved on Negoisst at any time.

4. Conclusion

Both students by the end of the semester and the authors by the end of this paper must answer for themselves the same question: Does this type of teaching achieve its main goal, namely teaching the students how to negotiate in an effective manner? In comparison to any conventional lecture it should be clarified at this point, however not surprising, that the course demands a much higher amount of time and effort by the students. This serves as an additional hurdle which the benefits of the course must stand up to. We have experienced these benefits of the course's interactive design in a twofold way: Firstly, we are strongly convinced that we have learned to negotiate in a more effective, specifically in a more comprehensive manner than we might have in a traditional front lecture. The phase structure, leading us from a theoretical preparation, over to phases of discussion and reflection, and finally towards our first own endeavours into practical application catered to the needs of all the learning styles and pushed us far beyond learning the facts by heart. It allowed us to fully fathom, probe and evaluate for ourselves all aspects of negotiation. From a students' perspective, we appreciate this as an important and long overdue step in the German university system towards a more hands-on style of education in certain fields of study. The way we see it, negotiation undoubtedly qualifies for such an approach. Secondly, we feel that we have learned a lot about ourselves as well as about our beliefs and behaviours in similar situations. Beginning with an evaluation and understanding of our own learning and conflict styles, every opportunity of interaction during the course, each discussion, role play, or reflection has posed on us an opportunity to challenge our own positions, opinions and behaviours.

To come to a conclusion, we must acknowledge that not all of the students may have appreciated the results before the background of the high amount of time and effort necessary to achieve them. This is especially the case for those with only limited interest in the subject, but for whom the course was a mandatory part of their programme. For all the others, i.e. those seeking the challenge and eager to learn and develop themselves actively, the course offers an ideal platform to explore negotiations from all perspectives as well as various opportunities for personal and professional growth.

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The GDN Research Map - An Overview of Research Flows and Their Interrelated Links

Muhammed Kaya[1], Serkan Sepin[1]

[1] University of Hohenheim,
Information Systems I,
70593 Stuttgart, Germany
e-mails: Muhammed-Fatih.Kaya@uni-hohenheim.de
Serkan_Sepin@uni-hohenheim.de

Abstract. The international conference of GDN covers various highly interesting research streams. Within the framework of this paper, a research map is prepared which provides a first overview of the topics submitted at the conferences 2012 to 2015. The research map shows the density of the topics and the respective thematic links between them. To be able to determine the topics from the submitted articles, a GDN-specific categorisation scheme was iteratively developed. Furthermore, a subsequent coding process of 250 articles was conducted which enabled the quantifiability of textual data.

Keywords: research map, group decision and negotiation, literature review, categorisation, open coding

1 Introduction

The international conference on Group Decision and Negotiation (GDN) is one of the most important and largest international conferences within the research areas of decision-making and negotiation. So far, 16 conferences have taken place including countries such as United States, Poland, France and Sweden. The GDN conference provides an important melting pot for the acquisition and exchange of knowledge for future scientists and doctoral students from the fields of business administration, psychology, management of information systems, computer science, mathematics and many other areas. As incoming PhD students and science-oriented information systems students course the University of Hohenheim, we have recognized that considerable effort is necessary to gain an overview of the existing research areas within the GDN. Furthermore, there is no conference introduction for young researchers, which allows a thematic research overview.

Leaving the egocentric perspective and to facilitate the entry for all GDN-interested young researchers, we decided to conduct literature review of the GDN proceedings. Literature reviews are implemented to create the essential basis of a research project. They intend to reflect the current state, to provide a guide for future

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research, to facilitate the theory development for the researchers and to close the areas where a research gap exists (Webster & Watson 2002).

The main goal of this research project is to design a research map. In particular, we tried to examine which topics predominate the GDN conferences (RQ1), how these topics are connected (RQ2), and how the temporal distribution of research areas is designed (RQ3). These links can be used by researchers of a specific area to identify relationships between own and adjoining research areas.

In summary, the readers from the GDN research map will be able to see which areas dominate the GDN, which topics are addressed less, and how the topic-specific linking of these topics is interrelated. As a database, 250 GDN articles from 2012 to 2015 were used for the evaluation of literature. Thus, this research is an initial outlook for the GDN research spectrum and not a final result. This research is still in progress and hence it intends to deliver preliminary results and collect feedback which can be incorporated in this early stage.

2 Methodology

There is no standardised way to conduct a literature review as there is for empirical work. Consequently, modern literature provides various indications how a literature review can be conducted (Toracco 2005). Vom Brocke et. al (2009) introduced a renowned framework for conducting an IS literature review (cf. figure 1).

We defined our review scope specifically for current GDN participants as well as for future ones. The second phase, conceptualisation of topic, can be disregarded as there is no need for providing working definitions or the like (Zorn & Campbell 2006). In a next step, literature search was realised. As mentioned in the introduction, our literature consists of GDN conferences between 2012 and 2015.

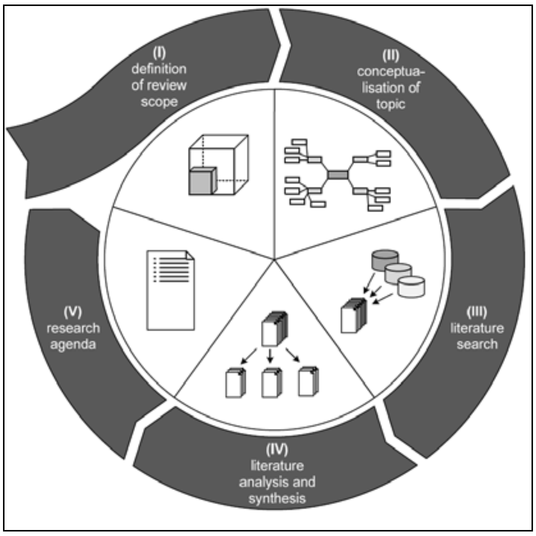

Figure 1: Framework for IS literature review (Vom Brocke et al. 2009, p.8)

After defining the review scope and considering the relevant articles through the literature research, a literature analysis was conducted with the application of certain methods (cf. figure 1). In order to be able to analyse the qualitative data from the articles quantitatively through the use of descriptive statistics, the data had to be systematically processed according to a certain scheme (Kelle & Kluge 2010).

Within the framework of this research work two main steps are defined with regard to the methodology: (1) The consideration of an existing categorisation scheme or the development of a new categorising scheme by applying the open coding process and (2) the implementation of the active coding process, which takes place within the framework of the hypothetical conclusion.

When integrating an already completed categorisation scheme, we have the advantage of avoiding the data overload. The risk in data overload is that imprecise coding classes will be overloaded, while other classes are rarely used (Miles & Huberman 1984). In the research area of GDN such literature search has not yet been carried out so that there is no pre-formulated categorization scheme. Therefore, the second approach of open coding was chosen, in which a pre-formulated categorisation scheme is kept off. In open coding (Glaser & Strauss 1967), a thematic categorisation scheme is developed adaptively over several iteration steps. This ensures that unsuitable concepts are avoided and that a schema matching of respective research area is obtained.

For the creation of the categorisation scheme, two young researchers were taken into account in order to minimize the subjectivity of the development of the categorisation scheme. In order to be able to cover the subject areas for the beginning in a rough frame, both coders have passed through the four GDN proceedings with samples and have defined first classes via joint discussions. Subsequently, both coders have coded a test-proceeding data set over the years 2012 to 2015 and have assigned the articles to the appropriate classes according to Reichertz (1991). The test data set formed 20% of the total data. In a next step the coding results of the test data set were compared and discussed. In the case of deviations, the affected classes were refined and merged. Furthermore, new classes were added through qualitative induction if the article could not be assigned to any of the classes (Peirce 1991). After the adaptation of the scheme, new test data were generated and the adapted classification scheme was tested again. Within the framework of our work, three iterations were required for the creation of the GDN categorisation scheme until the finalised state was reached.

In total, 37 categories have been formed in the finalised state. For instance, categories such as environmental management, software agents, game theory, multicriteria decision making, and negotiation support systems were determined.

A class is a research stream, which is gradually assigned to the articles in the following coding process of step (2). The assignment takes place with taking into account of certain criteria, which will be explained in the following sections.

The second implementation step of the higher-level methodology is the active coding process that takes place within the framework of the hypothetical conclusion. The hypothetical conclusion represents a conclusion or an assignment of classes based on known rules for the respective case (Reichertz 2003). Each of the GDN articles is assigned to at least one or more classes of categories created in step (1). The reason for multiple assignments is the fact that the most scientific work cannot be assigned to any research flow unambiguously. Many of them, just in the GDN, cover several research areas and serve as bridges of interdisciplinary subject areas. The criteria for the coding assignment are the title, the abstract and the related keywords of the respective article. On the basis of these three decision-making criteria, an assignment is implemented.

The entire coding process works as follows: Initially, both coders take the finalised categorisation scheme from step (1) into account. Subsequently, the coding is performed parallel and independently of one another. This time the coding is done over all articles of the four proceedings (in total 250 articles). After completing the coding process, the two coding files are compared and unified in the following step. Here, the assigned classes of the both coding files are matched by means of a comparison function.

For articles with no match the two coders have to discuss the differences, so that in the end one of the two versions is agreed. This finalised version is used as qualitative database to generate analytical insights of the GDN research environment.

3 Results

In this chapter, we present our results based on the IS literature framework described in chapter 2. At first we will look at the predominating topics of the GDN conferences between 2012 and 2015, followed by the temporal distribution of the research areas. In the end, strongly connected research areas will be pointed out.

3.1 Predominating topics (RQ1)

In total, 250 different papers of the GDN conferences were taken into account, coded and analysed. Figure 2 illustrates the 20 out of 37 most used topics of the submitted papers during the GDN conferences 2012-2015:
The bigger circles are shaped, the more frequently respective topics were discussed in the proceedings. The thicker connected, the more respective topics were associated to the same article. So, lines connecting two topics demonstrates the quantity of papers that were assigned to both topics and the description of the respective lines indicate to the quantity of topics assigned to the same papers.
Figure 1 does not contain every connection due to a better readableness.

Group decision making (41), conflict resolution (36), multicriteria decision making (35), preferences (34), followed by *graph models (27)* are the top 5 fields of research identified by the coders. Lowest 5 identified research domains are *social media (5), negotiation models (4), group discussions (4), mediation (3), and communication support system (2).*

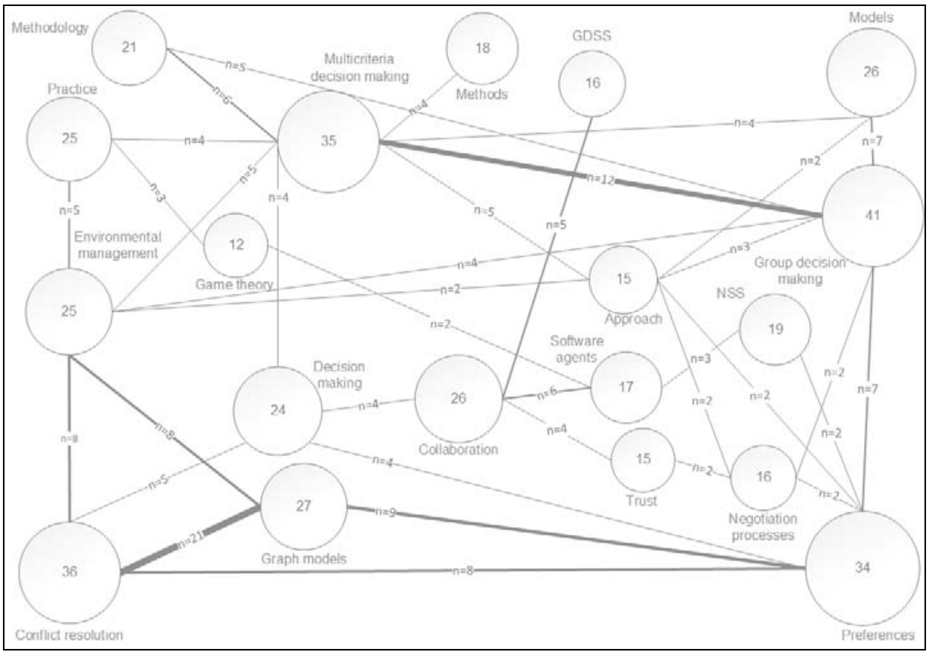

Figure 2: Network of the top 20 most used topics

3.2 Strongly connected research areas (RQ2)

Figure 2 includes every connection with (n > 4) and some less in order to show as many connections as possible while keeping it neatly arranged. The network shows a strong threesome connection between *conflict resolution* and *graph models* (n=21), *graph models* and *preferences* (n=9), and *preferences* with *conflict resolution* (n=8). Furthermore, *environmental management* is heavily linked with *conflict resolution* (n=8) and with *graph models* (n=8). Another noticeable relation is between *multicriteria decision making* and *group decision making* (n=12).

3.3 Temporal distribution of research areas (RQ3)

Figure 3 outlines the temporal distribution of noticeable topics within our defined scope. X-axis illustrates chosen categories related to 2012 - 2015 while y-axis represents the relative value of publications in respect of the categories. *Collaboration* falls continuously while *conflict resolution* peaks in 2014. Hereafter, it levels off. The most coded category, *group decision making*, reaches in 2014 its minimum point with 4 papers focusing respective research area. *Multicriteria decision making* starts with a high value in 2012 but then it becomes gradually inessential for the GDN conferences.

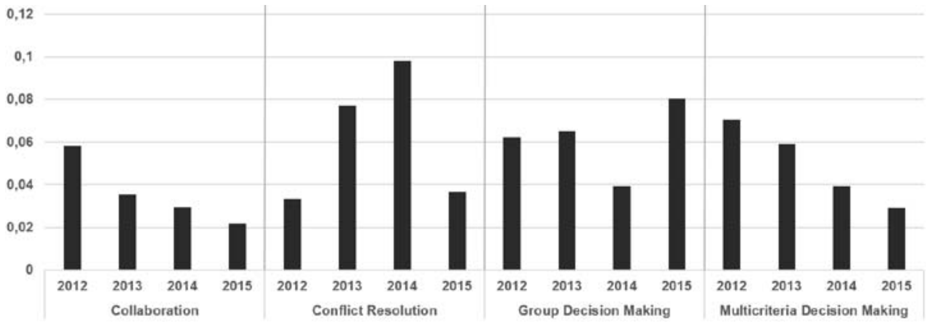

Figure 3: Temporal distribution of research areas

4 Discussion

In our literature review, we focused on the most addressed research topics in the context of GDN conferences between 2012 and 2015. For this, we used a mixed-method approach which includes a qualitative-quantitative literature review. By analysing the collected data, we tried to examine which topics predominate the GDN conferences (RQ1), how these topics are connected (RQ2), and how the temporal distribution of research area is designed (RQ3). Hence, in this section we will discuss each research question in a structured way, followed by limitations on our finding.

With respect to RQ1, *group decision making*, *conflict resolution*, *multicriteria decision making* are the most predominating research areas. These accords with the "group decision" part of the conference title. On the other hand, the submission of research concerning group decision making and negotiation via *social media* (n=5) is surprisingly low. This might be rooted in the fact that there are conferences with a stronger focus on social media. Accordingly, authors submit their research to these conferences.

Regarding RQ2, figure 2 shows research areas which have only one or two connections to another one, e.g. *GDSS* and *methods*. One reason is due to the fact to keep the network neatly arranged, we mainly illustrated connections with n > 4. Another reason could be the scope of applications as, for example, new research *methods* can be used in many different research areas and, therefore, the distribution is at a very high level leaving only links with n < 4.

In RQ3, we focused on the temporal distribution of research areas. Altogether, figure 3 shows a decrease of respective research areas except for *conflict resolution*. By considering the volume of each conference taken into account, 2014 has the lowermost number of articles between 2012 and 2015. All the more it is interesting to see that *conflict resolution* peaks in 2014 whereas other research areas decrease. An explanation is yet to be found.

There are specific conditions which limit the generalisability of our results. Firstly, our coding process required the title, abstract and keywords, not the content itself. Consequently, the coders did not have a full insight of the article when coding. Secondly, no GDN conference organiser demanded to choose keywords out of a standardised keyword-list which would have improved the comparability of all proceeding articles. Additionally, the proceedings also included articles without any keywords. As a result, one of the coding criteria could not be applied. Lastly, you need to consider all proceedings to make valid as well as sound arguments but like we said above, it is a research in progress.

5 Conclusion

This literature review reports on the predominating research areas of the GDN conferences, how they are linked as well as their temporal distribution. Although, being a research in progress, we can already conclude that *group decision making*, *conflict resolution* as well as *multicriteria decision making* play a bigger role than *mediations* and *communication support systems*. Furthermore, we can say that there is a multiple dependency between *conflict resolution*, *graph models*, *preferences* and *environmental management*.

In its completed form, our research can give all conference participants detailed insight of GDN history. For example, we could outline which nations contribute most articles and their focus of research. We also could reveal fields which have been researched a lot and at the same time showing fields of research which have been neglected identifying research gaps.

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University of Hohenheim
Dean’s Office of the Faculty of Business, Economics and Social Sciences
Palace Hohenheim 1 B
70593 Stuttgart | Germany
Fon +49 (0)711 459 22488
Fax +49 (0)711 459 22785
E-mail wiso@uni-hohenheim.de
Web www.wiso.uni-hohenheim.de