How to compromise the best price?

A group tacit knowledge-based multicriteria approach

Pierre-Emmanuel Arduin, Brice Mayag, Elsa Negre, Camille Rosenthal-Sabroux

LAMSADE, Université Paris-Dauphine, France

pierre-emmanuel.arduin@lamsade.dauphine.fr
brice.mayag@lamsade.dauphine.fr
elsa.negre@lamsade.dauphine.fr
camille.rosenthal-sabroux@lamsade.dauphine.fr
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Tacit knowledge plays an important role in decision making that is why, in this paper, we propose a group tacit knowledge-based multicriteria approach for decision process. This approach is based on a practical case study in the field of second hand vehicle purchase. This paper proposes ideas and research issues on how to tackle tacit knowledge in group decision processes with cost-benefit and multicriteria decision analysis. Because tacit knowledge cannot always be explicited, we use the multicriteria decision analysis tofittingly explicit tacit knowledge which can be explicited. In order to respect the financial policy of the company that purchases/sales second hand vehicles, we continue using the cost-benefit analysis already implemented. The goal is to help the buyer and the seller to compromise the best price.

**Keywords:** tacit knowledge; decision process; cost-benefit analysis; multicriteria decision analysis; group decision.

1 Introduction

We know that tacit knowledge plays an important role in decision making that is why, in this paper, we will discuss a new way to take into account tacit knowledge for decision-making process. Our approach is based on a practical case study in the field of second hand vehicle purchase. To the best of our knowledge, in the literature, no research addresses this kind of approach. Based on our previous work (Arduin et al., 2013b), this paper proposes ideas and research issues on how to tackle tacit knowledge for decision process with cost-benefit and multicriteria analysis based on a real-world compromise case.
In this paper we present the (group) decision making process, then we emphasize tacit knowledge in the decision making process. Our work is based on three postulates, which are (i) knowledge is not an object, (ii) knowledge is linked to action, and (iii) within a company there exists two main knowledge categories. We also present the industrial context of our study: purchase and sale of second-hand vehicles. Actually in the company they have already defined a decision process to sell a car but tacit knowledge is not taken into account.

We propose to combine multicriteria analysis (Roy, 1996), particularly ELECTRE TRI method (Figueira et al., 2005) and cost-benefit analysis (Nas, 1996). Because tacit knowledge cannot always be explicited, we use the multicriteria analysis to fittingly explicit tacit knowledge which can be explicited. In order to respect the financial policy of the company, we use the cost-benefit analysis. So it is possible to make the best decision regarding the purchase price according to the different available criteria. Thus we help the company that purchases/sales second hand vehicles, to realize the best deal in this compromise context of group decision.

Note that we started from ground observations and that the approach proposed in this article is specific to the case that we met. Note also that, to the best of our knowledge, there exists no formal modeling, especially with multicriteria analysis, of tacit knowledge. Finally, we are aware that multicriteria analysis can be used alone (without combination with cost-benefit analysis), but because cost-benefit analysis is already implemented and used by the society, we propose an approach combining multicriteria analysis and cost-benefit analysis.

This paper is organized as follows: Section 2 introduces tacit and explicit knowledge and decision process. Section 3 presents the context of our real-world case while, in section 4, we describe the existing problem
in such a case. Section 5 explicits how to elaborate a tacit knowledge decision model to take into account tacit knowledge in decision process. Finally, Section 6 concludes this paper and provides future work.

2 Tacit and explicit knowledge and decision process

2.1 The company’s knowledge

The company’s knowledge consists of tangible elements (databases, procedures, drawings, models, algorithms, documents used for analyzing and synthesizing data) and intangible elements (people’s abilities, professional knack, “trade secrets”, “routines” - unwritten rules of individual and collective behavior patterns (Nelson and Winter, 1982) -, knowledge of the company’s history and decision-making contexts, knowledge of the company environment (clients, competitors, technologies, influential socio-economic factors)) (Grundstein et al., 2003). They characterize a company capability to design, produce, sell, support its products and services. They are representative of the company’s experience and culture (Davenport and Prusak, 1998). They constitute and produce the added-value of its organizational and production business processes.

Tangible elements are “explicit knowledge”. Heterogeneous, incomplete or redundant, they are often marked by the circumstances under which knowledge was created. They do not express the unwritten rules of those who formalized knowledge, the “unspoken words”. They are stored and disseminated in archives, cabinets, and databases.

Intangible elements are “tacit knowledge”. Acquired through practice, they are adaptable to the situations. Explicitable or non-explicitable, they are often transmitted by implicit collective apprenticeship or by a master-apprentice relationship. They are located in people’s minds. Here we are referring to the knowledge classification of Polanyi (1967). He classifies
the human knowledge into two categories: tacit knowledge and explicit knowledge. “Tacit knowledge is personal, context-specific, and therefore hard to formalize and communicate. Explicit or 'codified' knowledge, on the other hand, refers to knowledge that is transmittable in formal, systematic language” (Polanyi, 1967). Our point of view can be found in the work of Nonaka and Takeuchi (1995), with reference to (Polanyi, 1967), consider that “tacit knowledge and explicit knowledge are not totally separated but mutually complementary entities.” For Nonaka and Takeuchi (1995), explicit knowledge can be easily expressed in written documents but is less likely to result in major decisions than tacit knowledge, which is to say that the decision process stems from knowledge acquired through experience, albeit difficult to express in words. These observations concerning knowledge in the company context highlight the importance of tacit knowledge. They point out the interest in taking into account tacit knowledge in decision process.

In the following paragraphs, we will first present the general principles that underlie decision support research, and especially the formalized decision-making process by Simon (1977).

2.2 The decision-making process

A process is a combination of phenomena, conceived to be active and organized in time. A process is a sequence of activities that produces a result of observable value in UML terms. It can be expressed as different diagram (sequence, collaboration or activity). As such, a decision-making process comprises everything that takes place in reality, like actions, activities and phenomena that lead to the choice of the final decision. According to (Simon, 1977) a decision-making process passes through four different phases: the “Investigation” (Intelligence) phase, the “Design” phase, the “Choice” phase, and the “Review” phase. With respect to the process de-
fined in (Simon, 1977), an additional important aspect, which underlies all phases, is the communication and interaction dimension. The emphasis on communication and interaction means fostering a minimum on tacit knowledge. Today, with Information and Communication Technologies (ICT), thanks to social network and others software, people can share tacit knowledge. In this respect, the “Investigation” (Intelligence) phase, being the first phase in Simon’s decision-making process (Simon, 1977), is primordial. Human are not technology and the decision process cannot be design as a program that individual can follow precisely and without thinking. It leads to the tacit knowledge of people. The relevance of the entire process depends on this first phase.

It is important to remark that, within a company, decisions can be made by individuals. However, most of the decisions come from a working group which can contribute or make a group decision. (Fülöp, 2005) indicates that “Group decision is usually understood as aggregating different individual preferences on a given set of alternatives to a single collective preference. It is assumed that the individuals participating in making a group decision face the same common problem and are all interested in finding a solution. A group decision situation involves multiple actors (decision makers), each with different skills, experience and knowledge relating to different aspects (criteria) of the problem. In a correct method for synthesizing group decisions, the competence of the different actors to the different professional fields has also to be taken into account.”

2.3 Tacit knowledge and the decision process

When (Polanyi, 1967) introduces the concepts of sense-giving and sense-reading, we simply observe that we continuously appropriate information which is not ours. He defined them as follows: “Both the way we endow our own utterance with meaning and our attribution of meaning to the ut-
terances of others are acts of tacit knowing. They represent sense-giving and sense-reading within the structure of tacit knowing” (Polanyi, 1967). As the authors of this paper, we have got tacit knowledge that we have structured into information during a process of sense-giving. As the readers of this paper, you have interpreted this information perceiving forms and colors, integrated words, data, during a process of sense-reading possibly creating new tacit knowledge for you (see Figure 1).

When a person $P_1$ structures its tacit knowledge and externalizes it, he creates information. A person $P_2$ perceiving some data from this information and internalizing it, possibly creates new tacit knowledge. Thus knowledge is the result of the interpretation by someone of information (Arduin et al., 2013a). This interpretation is done through an interpretative framework that filters data contained in the information and the use of previous tacit knowledge as presented by Tsuchiya (1993) and by Grundstein (2012).

Our work is based on three postulates:

Postulate 1: Knowledge is not an object\(^1\)

Generally, knowledge cannot be treated as an object. It is the result of the encounter of data and a subject and it is processed within the interpretative

\(^1\)We consider, according to the dictionary, that an object is anything visible or tangible; a material product or substance.
scheme of the subject’s memory. This postulate is based on the theories developed by S. Tsuchiya, who deals with the construction of tacit individual knowledge (Tsuchiya, 1993). According to his research, the tacit knowledge which resides within our brain is the result of the meaning we attribute - through our interpretative schemes - to the data that we perceive as part of the information that we receive. This individual knowledge is tacit and it can or cannot be expressed.

Postulate 2: Knowledge is linked to action
From a business perspective, knowledge is created through action. Knowledge is essential for the business’s functioning and is finalized through its actions. Hence, one has to be interested in the activities of the actors - decision-makers, engaged in the process contained in the company’s mission. This vantage point is included in the use of the concept of knowledge, which cannot be detached from the individual placed within the company, his/her actions, decisions and relations with the surrounding systems (people and artifacts).

Postulate 3: Within a company, there exist two main knowledge categories
Within a company, knowledge consists of, on the one hand, explicit knowledge comprising all tangible elements and, on the other hand, tacit knowledge, which comprises intangible knowledge. Hence, knowledge within a business organization comprises two main categories: formalized and explicit knowledge, which can be called “business know-how”, and the individual and collective tacit knowledge, which can be called the “business skills”, and which can either be made explicit or not, which can be explicitable or not.
3 Purchase/sale of second-hand vehicles: How does it work?

The context of this work has already been presented in (Arduin et al., 2013b).

3.1 The idea of buying a second-hand vehicle

The company we are interested here, offers a purchase service of second-hand vehicles without conditions. Indeed, to sell a vehicle to a distributor, this vehicle must be in good condition and not too old. More generally, in France, a distributor buys your car only if you buy a new one in his company. He can afford to offer a higher purchase price because he will make a significant profit margin with the car you will buy. The promise of this company is to buy all cars, regardless of their condition and without obligation to buy an other vehicle.

3.2 Sell a car, how does it work?

When a private individual, Elsa, wants to sell her vehicle, she asks a prior valuation of the second-hand vehicle on the company website. She gives information about the main characteristics of the vehicle such as brand, model and age. Following this query, she obtains a valuation of the purchase price of the vehicle. The system does not take into account the wear on the vehicle and it believes that the vehicle is in good condition. When querying to obtain a first valuation on the website, Elsa leaves her address and telephone number, she will be contacted by the company to have an appointment in an agency of the company. When Elsa goes to the agency, she is received by a vehicle expert, John. He examines the vehicle and values the costs to recondition the vehicle. This step is very important because it controls the working state of the vehicle, John must do a road test and identify anomalies. The data are inputed and stored through a computer platform in order to ask the quotation experts the vehicle valuation.
The value that John will get from the purchasing department through this platform will be the best proposal and John will not have scope on this proposal.

4 How to take into account tacit knowledge?

How vehicles are evaluated is not discussed here. However, this valuation is unpredictable because it depends on each quotation expert. To better estimate the market, these experts go on different ad sites selling vehicles on the web and examine prices. They valuate the vehicle so that it is well placed among similar ads. This approach sometimes leads to the purchase price offered to the private individual is not consistent with the real resale price.

The profitability of the purchase/sale business is based on one principle: buy second-hand cars and sell them more expensive, with a profit margin nearly constant. The issue of valuating vehicles is to know how much the vehicle may be sold. Therefore one has to calculate a purchase price, removing the wanted profit margin. Nowadays, quotation expert valuations do not always correspond to the reality of the market. Sometimes the company does not break even: the purchase price is too high compared to the final resale price or profit margins are too large while the company could offer a better price. The company studied the margins. This study shows that the wanted profit margin is achieved in less than half of the vehicles.

These errors, whether against or in favor of the private individual, decrease the quality and the image of the company and make the activity uncertain. Thus, the business management is difficult to predict and the behavior of the quotation experts changes. To protect themselves from a possible market decline, the quotation experts propose purchase prices
lower than they should. Private individuals are disadvantaged and it creates dissatisfaction and discontent among the private individuals who come to sale their vehicle.

Taking into account tacit knowledge would improve the vehicle price valuation: the context of a particular sale, the repair costs, the location of the vehicle and the market.

Note that data corresponding to the concerned vehicles are stored in a database (in the next section, vehicles are called actions in the multicriteria analysis). Furthermore, the following knowledge have been obtained through interviews and exchanges with experts and sellers.

*The context of a particular sale.* For example, financial or family problems can cause an urgent need to sell the vehicle regardless of the price or otherwise can cause an attempt to negotiate the price as high as possible. The context of the sale could have a strong influence on the final price and that is the reason why it has to be considered by our proposition. This context is important for the seller and impacts his final decision. We have three cases: the owner is in no hurry to sell his car (T1), the owner is moderately hurry to sell his car (T2) or the owner is in a hurry to sell his car (T3). More the context is supported, more the rating will be high. Here, T1 is better than T2 and T3.

*The repair costs.* For example, a simple scratch can cause the replacement of an important part of the vehicle and only an expert can know that. Repair costs can be difficult to evaluate notably when the car cannot be studied in detail. Our proposition gives to John, the vehicle expert, the opportunity to say rapidly if and how much according to him the repair costs influence the vehicle final price, although the car is not studied in detail. John can be able to say, for example, if a simple scratch will cause the replacement
of an important part of the vehicle body. These repair costs impact John and the company final decision. We have four cases: any repairs (just polished) (R1), some repairs (single scratch) (R2), a certain number of repairs (some costs required) (R3) or many repairs (R4). More the repair costs are supported, more the rating will be high. Here, R1 is better than R2, R3 and R4.

The location of the vehicle. For example, the experts know that some vehicles will be sold differently depending on their geographical location. The location impacts John (the vehicle expert) and the company final decision. We have three cases: the vehicle is located in a geographic area where vehicles are sold at low prices (L1), at medium prices (L2), at high prices (L3). More the location is supported, more the rating will be high. Here, L3 is better than L2 and L1.

The market itself. For example, if a vehicle is very popular, the company will keep it in stock less time, so it will be cheaper. However, if a vehicle is not popular, it will spend a longer time between the purchase of the vehicle and its resale, so there is an additional storage cost for the company. The market impacts John (the vehicle expert) and the company final decision. We have four cases: the vehicle is not popular (M1), the vehicle is moderately popular (M2), the vehicle is popular (M3) or the vehicle is very popular (M4). More the market is supported, more the rating will be high. Here, M4 is better than M3, M2 and M1.

Note that we can speak about group decision because the final compromise decision has to take into account knowledge that affects the seller (Elsa) decision and knowledge that affects John and the company decision.
5 Our proposition

The context presentation shows that John, the vehicle expert who receives the private individual seller Elsa, has no leeway on the proposed purchase price. However, it would be interesting to give him a minimum of opportunities to try to reconcile the purchase price and the sale price wanted by Elsa. Indeed, sometimes, because of a few euros, a sale may or may not occur. However, John must also stay close to the expectations of company, namely, “business is business” and because the company will not accept losing money.

Our proposal is to develop a tool for risk analysis in terms of decision making. In such a way that this tool would allow John to slightly higher modify the proposed purchase price while ensuring that the company will still be able to make his profit margin and especially not to lose money. It is therefore to take into account the various available indicators (relational context, emergency of the sale for the private individual, ...) to cross these indicators with the vehicle-related criteria (the market, repairs, ...) and test the impact on the financial expectations of the company. More specifically, it is to combine the cost-benefit analysis (Nas, 1996) to respect the financial policy of the company and the multicriteria decision analysis (Roy, 1996), so that John makes the best decision regarding the purchase price according to the different available criteria.

5.1 Cost-Benefit Analysis

Cost-benefit analysis is a process that calculates and compares benefits and costs of a project (see (Nas, 1996) for more details). The main purpose is to compare the total expected cost of each option against the total expected benefits. Note that benefits and costs are expressed in monetary terms. It helps predict whether the benefits outweigh its costs, and by how much relative to other alternatives.
(Argyrous, 2010) breaks down the cost-benefit analysis into 10 steps: (1) Determine if the cost-benefit analysis worth doing, (2) Identify objectives and policy alternatives, (3) Determine who has standing, (4) Identify the costs and benefits of each alternative, (5) Sort into measurable and non-measurable costs and benefits, (6) Measure costs and benefits that can be measured in money terms, (7) Conduct sensitivity analysis, (8) Compare costs-benefits across alternatives, (9) Adjust for non-measurable costs and benefits and (10) Make a decision.

The cost-benefit analysis recognizes that each choice has a cost and makes explicit hidden costs and benefits. As results, cost-benefit analysis returns some indicators such as a ratio of costs divided by benefits. Unfortunately, the valuation of life is difficult or impossible and this kind of approach is ignorant of the political context of decision-making.

5.2 Multicriteria decision analysis

Multicriteria decision analysis (MCDA) is the activity which provides a decision maker (DM) with a prescription on a set of decision alternatives (options), when facing multiple, usually conflicting points of view also called criteria. In fact, there does not exist a unique optimal solution for such problems and it is necessary to use decision maker’s preferences to differentiate solutions. For instance, Table 1 presents a set of seven alternatives (207 Peugeot cars) evaluated on the four criteria Context, Repair Cost, Location and Market.

Usually, three types of problems are put forward in the MCDA context (Roy, 1996, Figueira et al., 2005):

- the choice problem which aims to recommend a subset of alternatives, as restricted as possible, containing the “satisfactory” ones;
Table 1: A performance matrix of selling 207 Peugeot cars

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Model</th>
<th>Context</th>
<th>Repair Cost</th>
<th>Location</th>
<th>Market</th>
</tr>
</thead>
<tbody>
<tr>
<td>a1:</td>
<td>207 1.6 HDI Trendy 3p</td>
<td>T1</td>
<td>R1</td>
<td>L1</td>
<td>M2</td>
</tr>
<tr>
<td>a2:</td>
<td>207 1.4 HDI Premium 5p</td>
<td>T3</td>
<td>R2</td>
<td>L1</td>
<td>M2</td>
</tr>
<tr>
<td>a3:</td>
<td>207 1.4 HDI FAP 5p</td>
<td>T2</td>
<td>R2</td>
<td>L2</td>
<td>M2</td>
</tr>
<tr>
<td>a4:</td>
<td>207 1.6 HDI Sport 3p</td>
<td>T1</td>
<td>R1</td>
<td>L1</td>
<td>M3</td>
</tr>
<tr>
<td>a5:</td>
<td>207 1.6 HDI Executive 5p</td>
<td>T3</td>
<td>R2</td>
<td>L1</td>
<td>M1</td>
</tr>
<tr>
<td>a6:</td>
<td>207 1.6 HDI Sport 3p</td>
<td>T1</td>
<td>R4</td>
<td>L3</td>
<td>M3</td>
</tr>
<tr>
<td>a7:</td>
<td>207 1.4 HDI Urban Move 3p</td>
<td>T3</td>
<td>R1</td>
<td>L2</td>
<td>M2</td>
</tr>
</tbody>
</table>

- the sorting problem which aims to assign each alternative into predefined categories or classes;

- the ranking problem which aims to order the alternatives by decreasing order of preferences.

(Argyrous, 2010) breaks down the multicriteria decision analysis into 7 steps: (1) Establish the decision context, (2) Identify the value/performance criteria, (3) Describe/rate the performance of each option against the criteria, (4) Assign weights across criteria, (5) Combine the scores and weights, (6) Examine the results and review and (7) Conduct sensitivity analysis.

The multicriteria decision analysis provides an audit trail, especially in situations where decision-making is required to follow rules and to be justified in explicit terms and is based on weightings. Because weights are in general difficult to obtain in a direct discussion with the DM, some methods, like ELECTRE TRI, propose to elicitate them in indirect way. To do this, these methodologies ask to the DM some preferences over the set of alternatives.

**ELECTRE TRI method**

ELECTRE TRI (Figueira et al., 2005) is a MCDA method which deals with the ordinal ("qualitative") sorting problematic. Because our aim, in this section, is to show that the aggregation of tacit knowledge through a
MCDA method is possible, we present hereafter a simple version of ELECTRE TRI without elicitation of preference thresholds and veto. Therefore this version is sufficient in our context. The preference thresholds and the vetoes can be added and elicited by the practician, in interaction with the DM, when he faced with a more complex decision problem.

Let us denote by $A = \{a_1; a_2; \ldots; a_m\}$ a set of $m$ alternatives or options, $N = \{1; 2; \ldots; n\}$ a set of $n$ criteria, $C = \{C_1; C_2; \ldots; C_t\}$ a set of ordered categories ($C_1$ is the worst one and $C_t$ is the best one) and $B = \{b_0; b_1; \ldots; b_t\}$ a set of profiles (reference alternatives) that separate consecutive categories. Each category $C_i$ is limited by two profiles: $b_i$ is the upper limit and $b_{i-1}$ is the lower limit.

The assignment of alternatives to categories is based on the concept of outranking relation on $A \times B$. An alternative $a_i \in A$ outranks a profile $b_h \in B$ (denoted $a_i S b_h$) if it can be considered at least as good as the latter (i.e., $a_i$ is not worse than $b_h$), given the evaluations (performances) of $a_i$ and $b_h$ at the $n$ criteria. If $a_i$ is not worse than $b_h$ in every criterion, then it is obvious that $a_i S b_h$. However, if there are some criteria where $a_i$ is worse than $b_h$, then $a_i$ may outrank $b_h$ or not, depending on the relative importance of those criteria and the differences in the evaluations (small differences might be ignored). Roughly speaking,

$$a_i \text{ outranks } b_h (a_i S b_h) \iff \sum_{1}^{n} k_{j} c_{j}(a_i, b_h) \geq \lambda.$$  

Where

- $c_{j}(a_i, b_h) = \begin{cases} 1 & \text{if } a_i \succsim_{j} b_h \\ 0 & \text{otherwise} \end{cases}$.

The relation $a_i \succsim_{j} b_h$ means that the performance of $a_i$ on the criterion $j$ is at least as good as the performance of $b_h$ on the same criterion $j$. 
• $k_j$ is the importance (weight) of criterion $j$ such that $\sum_{1}^{n} k_j = 1$.

• $\lambda$ is the cutting level i.e. a threshold that indicates whether the credibility is significant or not. This parameter is often taken between 0.5 and 1.

Hence ELECTRE TRI assigns the alternative $a_i$ to the highest category $C_h$ such that $a_i$ outranks $b_{h-1}$ i.e.

$$a_i \text{ belongs to category } C_h \iff a_i S b_{h-1} \text{ and not } (a_i S b_h)$$

### 5.3 Elaboration of a tacit knowledge decision model

Because cost-benefit analysis is already implemented and used by the society, in this section, we focus on MCDA, in order to concentrate on non-measurable costs and benefits.

Thus, in this section we show how to construct a decision model from the tacit knowledge embodied in experts and John’s mind i.e. how they will be confronted in order to decide if and how much the final price could be increased by John, the vehicle expert. Given a vehicle evaluated on Context, Repair Cost, Location and Market, the aim of John here is to assign it to one of the following six pre-defined categories or classes: no increase ($C_1$), increase at most 5% of the vehicle estimated price ($C_2$), increase at most 10% of the vehicle estimated price ($C_3$), increase at most 15% of the vehicle estimated price ($C_4$), increase at most 20% of the vehicle estimated price ($C_5$), and increase at most 25% of the vehicle estimated price ($C_6$). These parameters, as well as most of the parameters introduced in this study, have been defined by the considered organization and its financial policy. Moreover, relying on previous sales and on his expertise, John, the vehicle expert, is able to value the influence of tacit knowledge on a vehicle final price.
John’s problem can be viewed as a MCDA sorting problem. Therefore we solve it by using the software IRIS which implements the ELECTRE TRI method seen above. IRIS is available at http://www.lamsade.dauphine.fr/spip.php?rubrique64 and requires as the input the set of profiles $B$ associated to the six categories $C_1, \ldots, C_6$. In Table 2, we have the seven profiles given by John. According to these profiles, the assignments of vehicles of Table 1 and the parameters of the model constructed are given in Figure 2.

According to these profiles, the assignments of vehicles of Table 1 and the parameters of the model constructed are given in Figure 2. For instance, one can see that the weight associated to the criterion “Context” is 0.1825, the value of the cutting level $\lambda$ is 0.5825 and the categories assigned to $a_1$ and $a_7$ are respectively $C_4$ and $C_5$.

Given the preferential information given by John, the results obtained by applying ELECTRE TRI of IRIS show that:

- There is no vehicle assigned to the three categories No increase ($C_1$), Increase at most 5% of the vehicle estimated price ($C_2$) and Increase at most 25% of the vehicle estimated price ($C_6$).
- The vehicles $a_2$ (207 1.4 HDI Premium 5p) and $a_5$ (207 1.6 HDI Executive 5p) are assigned to the category Increase at most 10% of the vehicle estimated price ($C_3$).

<table>
<thead>
<tr>
<th></th>
<th>Context</th>
<th>Repair Cost</th>
<th>Location</th>
<th>Market</th>
</tr>
</thead>
<tbody>
<tr>
<td>$b_0$</td>
<td>T3</td>
<td>R4</td>
<td>L1</td>
<td>M1</td>
</tr>
<tr>
<td>$b_1$</td>
<td>T3</td>
<td>R3</td>
<td>L1</td>
<td>M1</td>
</tr>
<tr>
<td>$b_2$</td>
<td>T3</td>
<td>R3</td>
<td>L1</td>
<td>M2</td>
</tr>
<tr>
<td>$b_3$</td>
<td>T2</td>
<td>R2</td>
<td>L2</td>
<td>M2</td>
</tr>
<tr>
<td>$b_4$</td>
<td>T2</td>
<td>R2</td>
<td>L2</td>
<td>M3</td>
</tr>
<tr>
<td>$b_5$</td>
<td>T1</td>
<td>R1</td>
<td>L3</td>
<td>M3</td>
</tr>
<tr>
<td>$b_6$</td>
<td>T1</td>
<td>R1</td>
<td>L3</td>
<td>M4</td>
</tr>
</tbody>
</table>

Table 2: Profiles of the categories defined by John
Figure 2: A MCDA tacit knowledge model computed by IRIS

- The cars $a_1$ (207 1.6 HDI Trendy 3p) and $a_3$ (207 1.4 HDI FAP 5p) are assigned to the category Increase at most 15% of the vehicle estimated price ($C_4$).

- The last three vehicles $a_4$ (207 1.6 HDI Sport 3p), $a_6$ (207 1.6 HDI Sport 3p) and $a_7$ (207 1.4 HDI Urban Move 3p) are assigned to the category Increase at most 20% of the vehicle estimated price ($C_5$).

- The weights associated to the criteria “Context”, “Repair Cost”, “Location” and “Market” are respectively 0.1825, 0.3525, 0.2825 and 0.1825. Hence “Repair Cost” appears as the most important criterion.

- The value of the cutting level $\lambda$ used is 0.5825.

As a reminder, Elsa wants to sell her car to the company that employs John. She wants to obtain the highest possible price. John, without prejudicing Elsa, must propose a reasonable price in line with the policy of the company that sold later the Elsa’s vehicle to another individual. The purchase price of the Elsa’s vehicle is first proposed by the quotation experts and is based on the technical characteristics of the vehicle.
Hitherto John was limited to just offer the price given by the quotation experts. Our approach allows to give some leeway to John on the price given by the experts.

In our context, Elsa is the only decision maker. Indeed, following the proposal of John, Elsa has the ability to accept or refuse to sell her vehicle to the company of John. However, the process of compromise on the price of the vehicle is a process of group decision making since it takes into account the “preferences” of:

- John, who is representing the interests of the quotation experts and the company,
- the quotation experts who have the technical expertise,
- the society, for whom “business is business”,
- Elsa who wishes to obtain the highest possible price and do not want to feel prejudiced.

Therefore, the fact that no vehicle is assigned to $C_1$ (no increase) and $C_2$ (increase at most 5%) indicates that Elsa should not feel prejudiced because John will be able to raise the price. Similarly, the fact that no vehicle is assigned to $C_6$ (increase at most 25%) indicates that the company does not take much financial risk and its employee, John, has a limited flexibility. Thus, the fact that the categories $C_3$ (increase at most 10%), $C_4$ (increase at most 15%) and $C_5$ (increase at most 20%) are the most probable indicates that the final decision is a good compromise (a decision group), which takes into account all the “preferences” of all stakeholders.

In reality, the vehicle $a_2$ (207 1.4 HDI Premium 5p) was quoted 9890 euros by the quotation experts. John, before our proposal, had no flexibility on the price. Thus, when he proposed this price to Elsa, she refused.
Indeed, in France in particular, there are levels values. In fact, if John had proposed a price slightly higher than 10000 euros, Elsa would have accepted. Finally, thanks to our approach, in a similar situation, John now has a leeway of at most 10% (see previously, \( a_2 \) is assigned to \( C_3 \), i.e., John can offer prices belonging to the bounded interval \([ 9890, 10879 \] (containing, for example, the level value 10000 euros) and Elsa will agree to sell her vehicle to the company of John.

It should be noticed that John’s problem can be also solved by any MCDA classification or sorting methods such as Dominance-based rough set approach (DRSA) (Greco et al., 2001). In this case, because each MCDA sorting method lead to a decision model different to another method (they do not have the same inputs and the same parameters), it will not be surprising to have a different result compared to what we have obtained above.

5.4 Combining cost-benefit and the tacit knowledge model

Even though, (Dobes and Bennett, 2009) seems to interpret that the multicriteria decision approach goal is worst than the cost-benefit approach goal, cost-benefit analysis and multicriteria decision analysis share some similarities:

- both are frameworks for assessing options facing decision-makers,
- both try to construct a metric for comparing options,
- both are sensitive to assumptions, but these assumptions are different.

Remember that cost-benefit analysis is already implemented and used by the society and MCDA is efficient for non-measurable costs and benefits. The society wants only one system. So, we have to proceed into two steps / analyses and then, to combine them.
We argue to benefit of the advantages of each kind of analysis. The cost-benefit analysis is pertinent and easy-to-use for measurable costs and takes into account the expectations of the company (“business is business”). The multicriteria decision analysis is pertinent to make decision and allows to bring into play some “non-measurable” costs. Thus, our proposition consists in using the cost-benefit analysis for the measurable costs (quantitative ones) and using the multicriteria decision analysis for the “non-measurable” costs (qualitative ones), i.e. the tacit knowledge that can affect the purchase price. The combination of these two approaches can be done by using a MCDA approach with two criteria:

- The first criterion will concern the cost-benefit;
- The second criterion will be an aggregation of the tacit knowledge, as done above using the ELECTRE TRI method, where the evaluation of a vehicle on this criterion will be one of the six pre-defined categories $C_1$ to $C_6$.

This combined approach is presented in Figure 3 as a hierarchy of criteria. Because data concerning cost-benefit were not provided by John’s company, we tried to model only, in this hierarchy, the node associated to tacit knowledge.

6 Conclusion and future work

In this paper we emphasize the strengths of tacit knowledge in the decision making process in addition to decision support systems. Thus, we elaborated the MCDA model based on four criteria (context, repair costs, location, market). In order to respect the financial policy of the company, we continue using the cost-benefit analysis already implemented in the field. Our MCDA model plays an important role in refining the vehicle final price, so that not only the financial expectations of the company are
In the future, our works will focus on identifying and formalizing the explicitable part of tacit knowledge. The materialization of tacit knowledge opens the way towards some new research perspectives, specially for user-centered design of decision and group decision systems. In addition, an MCDA model being able to take into account measurable costs, we are now studying the capability of our MCDA model to integrate not only non measurable costs, but also those which are considered through a cost-benefit analysis in the studied field. The company will then hold a new group tacit knowledge-based decision system covering every parameters in order to compromise the best price.

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