Towards a new tacit knowledge-based approach for decision process

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Abstract

Tacit knowledge plays an important role in decision making that is why, in this paper, we introduce a new approach based on tacit knowledge for decision process. Our 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 for decision process with cost-benefit and multicriteria analysis based on a real-world case. 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 that purchases/sales second hand vehicles, we use the cost-benefit analysis. The goal is to help the company to make the best decision.
Keywords: tacit knowledge; decision process; cost-benefit analysis; multicriteria analysis.

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 not yet a formal method but 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. 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 case.

In this paper we present the 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) within a company there exists two main knowledge categories, and (iii) knowledge is linked to action. 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 ([Roy96]) and cost-benefit analysis ([Nas96]). 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.

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 reports our approach combining multicriteria

and cost-benefit analysis 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 [NW82] -, knowledge of the company's history and decision-making contexts, knowledge of the company environment (clients, competitors, technologies, influential socio-economic factors)) [GRSP03]. They characterize a company capability to design, produce, sell, support its products and services. They are representative of the company's experience and culture [DP98]. 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 Michael Polanyi [Pol67]. 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" [Pol67]. Our point of view can be found in the work of Ikujiro Nonaka and Hirotaka Takeuchi [NT95], two Japanese authors who, with reference to [Pol67] consider that "tacit knowledge and explicit knowledge are not totally separated but mutually complementary entities." For [NT95], 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 Herbert Simon [Sim77].

2.2 The Decision-making Process

A process is a combination of phenomena, conceived to be active and organized in time. 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 [Sim77] 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 defined in [Sim77], 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. In this respect, the "Investigation" (Intelligence) phase, being the first phase in Simon's decision-making process [Sim77], is primordial. The relevance of the entire process depends on this phase. It leads to the tacit knowledge.

2.3 Tacit Knowledge and the decision process

When [Pol67] 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

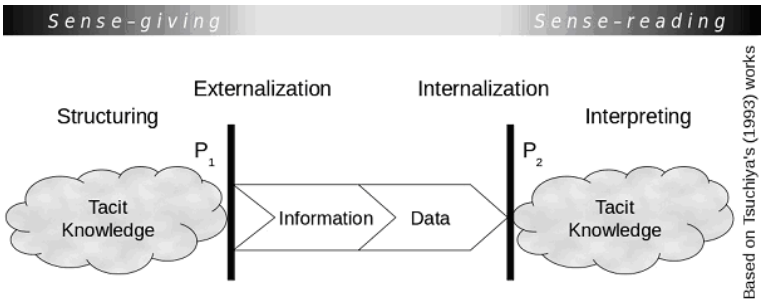

Figure 1: Tacit knowledge transfer

the way we endow our own utterance with meaning and our attribution of meaning to the utterances of others are acts of tacit knowing. They represent sense-giving and sense-reading within the structure of tacit knowing" [Pol67]. 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 colours, integrated words, data, during a process of sense-reading possibly creating new tacit knowledge for you (see Figure 1).

When a person P1 structures its tacit knowledge and externalizes it, he creates information. A person P2 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 ([AGRS13]). 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 [Tsu93] and by [Gru12].

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 scheme of the subject's memory. This postulate is based on the theories developed by Tsuchiya, who deals with the construction of tacit individual knowledge ([Tsu93]. 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. 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 (cf. Table 1), which can be explicitable or not.

Postulate 3: 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

[1]We consider, according to the distionary, that an object is anything visible or tangoible; a material product or substance.

KNOW-HOW (explicit knowledge)	**SKILLS** (tacit knowledge embodied by individuals)	
Collective knowledge	**Collective knowledge**	**Personal knowledge**
Knowledge that is formalized within documents and/or codified into data bases	Knowledge that is incorporated within models and regular and predictable behaviors	People's abilities, Professional knack, Knowledge of company history and decisional contexts, Knowledge of the environment (customers, competitors, technologies) and socio-economical factors
Information source of knowledge for someone	**Defensive routines** *Knowledge that are obstacles to change* **Constructive routines** *Knowledge that favors innovation and change*	**Specific knowledge belonging to each individual** *Knowledge that is volatile intangible resource, which depends on the continuity of the presence of employees in the company*

Table 1: Company Knowledge [GRSP03]

detached from the individual placed within the company, his/her actions, decisions and relations with the surrounding systems (people and artifacts).

3 Context: Purchase/sale of second-hand vehicles

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.
Figure 2 displays this process.

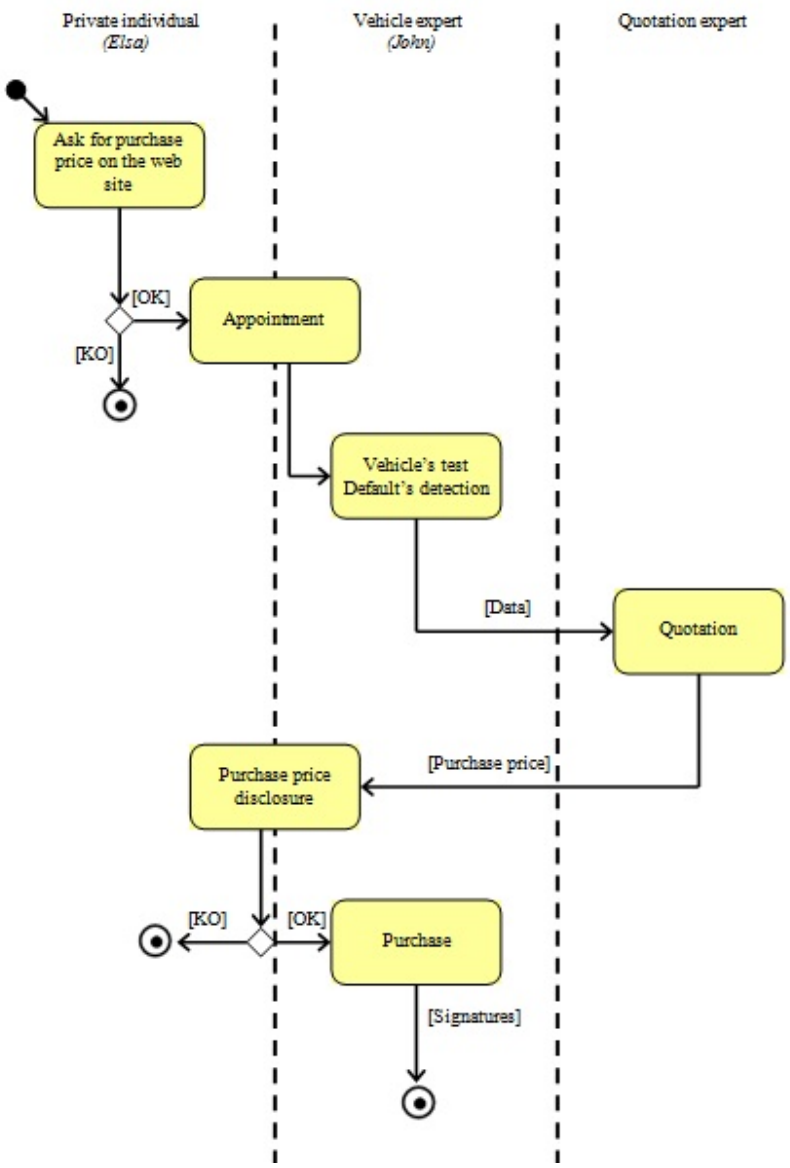

Figure 2: Sell a car, How does it work?

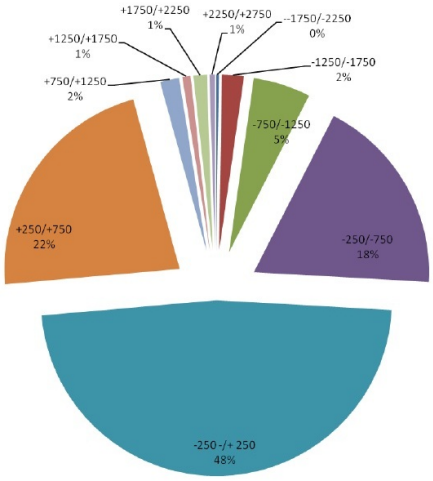

Figure 3: Difference between the real and the predicted profit margin [dlB12]

4 Problem: Tacit knowledge is not taken into account

The vehicle valuation method is not discussed here, but for now, it is unpredictable because this valuation depends on each quotation expert. To estimate the market, these quotation experts go on online vehicle ad websites and evaluate market 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 and allows therefore 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, because the purchase price is too high compare to the final resale price or profit margins are too large while the company could offer a better price. Figure 3 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 make the activity uncertain and decrease the quality of the service offered by the company. In addition to make the business management difficult to predict, it changes the behavior of the quotation experts. 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 some tacit knowledge would improve the vehicle price valuation:

- 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 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,
- The location of the vehicle. For example, the experts know that some vehicles will be sold differently depending on their geographical location. Figure 4 shows that the same vehicle is not sold at the same price in the north or the south of France, the same difference exists between countries, as displayed Figures 5 and 6,

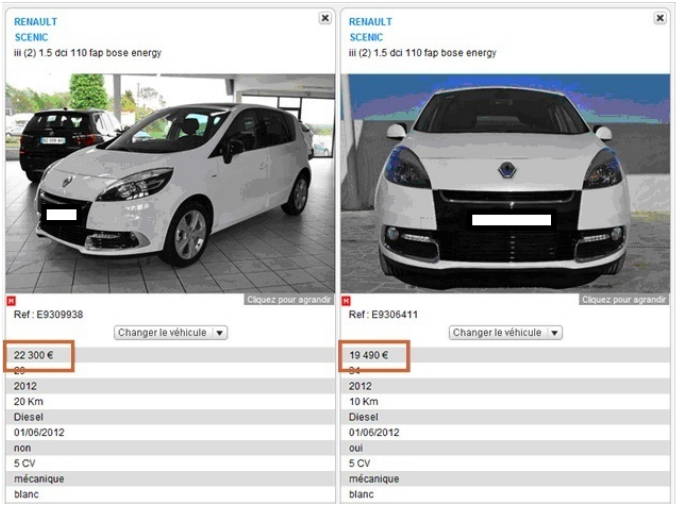

Figure 4: Two similar vehicles sold in France (North and South) (*www.lacentrale.com*)

Figure 5: Similar vehicle sold in Germany (*www.autoscout.de*)

- 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.

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 loose 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 ([Nas96]) to respect the financial policy of the company and the multicriteria analysis ([Roy96]), so that John makes the best decision regarding the purchase price according to the different available criteria.

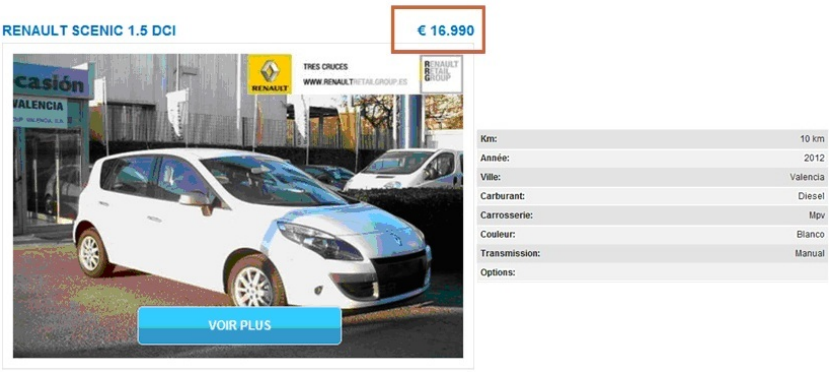

Figure 6: Similar vehicle sold in Spain (*www.ooyyo.es*)

5.1 Cost-Benefit Analysis

Cost-benefit analysis (see [Nas96] for more details) is a systematic process for calculating and comparing benefits and costs of a project. The main purpose is to provide a basis for comparing projects, i.e. comparing 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.

[Arg10] 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
10. Make a decision

The cost-benefit analysis recognizes that each choice has a cost and makes explicit hidden costs and 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 analysis

Multicriteria analysis (see [Roy96] for more details) provides a framework to enable decision-makers to overcome difficulties in handling large amounts of complex information and establishes preferences between options, i.e. a set of identified objectives, and for which measurable criteria have been established to assess the extent to which these objectives have been achieved. 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 between solutions. That is why "solving" such a problem can be interpreted in different ways. The two main purposes are: 1) the "best" alternative from a set

of available alternatives, 2) a small set of good alternatives.

[Arg10] breaks down the multicriteria 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
7. Conduct sensitivity analysis

The multicriteria 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. Unfortunately, weightings are hard to obtain and sometimes, there is a lack of methodological rigor.

5.3 Combining Cost-benefit and multicriteria analysis

Our proposition consists in combining cost-benefit analysis and multicriteria analysis ([KBV+05], [DB09], [BMM11]). Even though, [DB09] seems to interpret that the multicriteria approach goal is worst than the benefit-cost approach goal, cost-benefit analysis and multicriteria analysis share some similarities:

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

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 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 analysis for the "non-measurable" costs (qualitative ones), i.e. the tacit knowledge that can affect the purchase price.

Using cost-benefit analysis will not be discussed in this paper which will focus now on the strengths of multicriteria analysis in order to consider non measurable costs and benefits, i.e. the tacit knowledge embodied in John's mind. Pseudo-criterion such as context, repair costs, location and market will be confronted in order to decide if and how much the final price could be increased by John, the vehicle expert. The possible actions are then: no increase, increase at most 5% of the vehicle estimated price, increase at most 10% of the vehicle estimated price, increase at most 15% of the vehicle estimated price, increase at most 20% of the vehicle estimated price, and increase at most 25% of the vehicle estimated price. These levels have been defined by us according to the circumstances of a vehicle sale and the influence we consider that tacit knowledge can have on a vehicle final price. They could of course be refined with John, the vehicle expert, in future works.

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. More the decision is supported by the context, more the rating will be hight, as shown in Table 2. Repair costs can be difficult to evaluate notably when the car cannot be studied in detail. Our proposition gives to John, the vehicle expert,

Support of the pseudo-criterion	Strongly support	Support	Disagree	Strongly disagree
Rating	4	3	2	1

Table 2: Rating of the pseudo-criteria

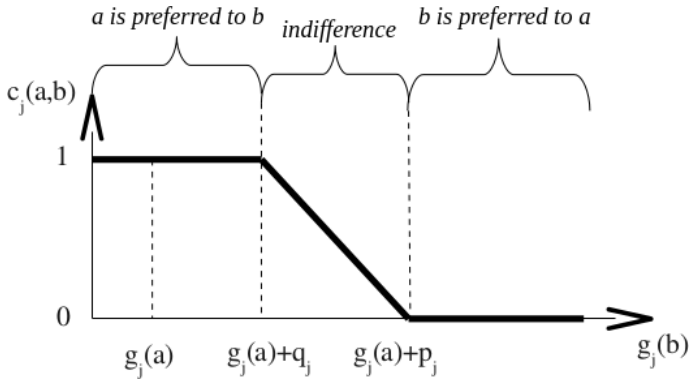

Figure 7: Partial concordance index behavior for a pseudo-criterion j

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. More the decision is supported by the repair costs, more the rating will be hight, as shown in Table 2. The same reasoning is followed to rate the influence of location and market on the vehicle final price.

So, regarding on the pseudo-criteria John has to rate the different possible actions (no increase, increase at most X%, etc.). We have also to determine with him the value of the preference and the indifference thresholds for each pseudo-criterion. We can then compute the partial concordance indexes $c_j(a,b)$ for every couple of actions (a,b) for each pseudo-criterion j. The partial concordance indexes are defined as follows [Roy96]:

- $c_j(a,b) = 1$ if $g_j(a) \geq g_j(b) - q_j$ (a is preferred to b)
- $c_j(a,b) = 0$ if $g_j(a) \leq g_j(b) - p_j$ (b is preferred to a)
- $c_j(a,b) = p_j - \frac{(g_j(b) - g_j(a))}{p_j - q_j}$ else (indifference, see figure 7)

Thereby we can construct a payoff matrix and study the relations between actions and pseudo-criteria. It is interesting for us to see how John, the vehicle expert, will construct the pseudo-criteria according to its tacit knowledge. Within this process he will try to elicit it although he is not using it as if he was methodically estimating a car for example. In so far as new non-measurable costs and benefits can be identified, our proposition may have to grow estimation after estimation.

In the case of Elsa's vehicle example, for the multicriteria part, there is no emergency for her to sell her car, that is the reason why the context of the sale could influence the final price to grow, in a reasonable measure (see Table 3, indicated values come from Table 2). For example, the last line of Table 3 ("*increase at most 25%*") means that, because of the current context, repair costs, location and market (1), it is out of the question to propose an increase of at most 25%. Repair costs have been identified as being minor by the expert, that is the reason why they could influence the final price to grow. Furthermore and according to the vehicle-expert conclusions, this sale is located in an area where Elsa's vehicle is very demanded, instead of having no popularity in the market. It is the case for some vintage vehicles, which are demanded but not popular. It induces

	Context	Repair costs	Location	Market
no increase	3	3	3	4
increase at most 5%	4	4	3	3
increase at most 10%	3	3	4	2
increase at most 15%	2	2	3	1
increase at most 20%	1	1	2	1
increase at most 25%	1	1	1	1

Table 3: Behavior of the pseudo-critera in the case of Elsa's vehicle *(indicated values come from Table 2)*

the behaviors of the pseudo-criteria location and market in the Table 3. If Elsa was hurried to sell her vehicle, the behavior of the context pseudo-criterion would have been different (for example, if she was hurried, she should accept a cheaper price). If a scratch on her vehicle could lead to machine the body of the vehicle, the behavior of the repair costs pseudo-criterion would also have been different (for example, the more repairs there are, the less the purchase price increases). So the multicriteria part of our approach considers all of these non-measurable elements to estimate the value of a vehicle and thus highlights tacit knowledge. The aim is to obtain a value closer as possible as the seller could wish it, and a value higher as possible for the company. The confrontation between the different issues (no increase, increase at most X%, etc.) and the computation of the partial concordance indexes $c_j(a, b)$ will not be presented in this paper due to confidentiality aspects of the preference and indifference thresholds for each pseudo-criterion. Finaly, in our example, John can propose an increase of at most 5% to Elsa for her car thanks to the materialization of his tacit knowledge about the context (4), the repair costs (4), the location (3) and the market (3).

A real strength of our proposition is that not only it considers all the measurable costs and benefits of a vehicle sale, but also its non-measurable costs and benefits, which are in the head of John, the vehicle expert, and that he is not always aware. Our proposition facilitates the use of tacit knowledge by John, the vehicle expert, because it encourages him to consider it, to take it into account to propose a vehicle price as closer as the seller could wish it according to the real state of its vehicle and not only following an evaluation proposed by the purchasing department on which he had no scope in the past. The increased price should ensure that the transaction will be done, that it will satisfy the seller, and most of all that it will be profitable for the company. Cost-benefit analysis gives to John, the vehicle expert, an estimation regarding on measurable data, and multicriteria analysis allows him to know, regarding on the considered tacit knowledge, if and how much he can increase this estimation in order to ensure the transaction will be more profitable as possible for the company. We are aware that our approach does not take into account all tacit knowledge but only a part, the explicitable part of tacit knowledge.

6 Conclusion and future work

In this paper we emphasise the strengths of tacit knowledge in the decision making process in addition to decision support systems. Thus, we propose to combine multicriteria analysis and cost-benefit analysis. 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.

In the future, our works will focus on identifying and formalizing the explicitable part of tacit knowledge. This work is a first step for a more formalized method. The materialization of tacit knowledge opens the way towards some new research perspectives, specially for user-centered design of information and knowledge systems.

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