AN APPLICATION OF MULTIATTRIBUTE UTILITY THEORY TO KNOWLEDGE MANAGEMENT

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ABSTRACT

This article deals with the relationship between knowledge management and the use of multicriteria decision aiding methods. As a case study, it presents an application of the multiattribute value function to the evaluation and selection of oil refining technologies. The analysis model used here was developed from interviews with technicians involved in the selection of technologies and was validated by its application to a selection process. It used a technique of swing weighting for the calibration of the multiattribute value function, with a sensitivity analysis. The final conclusion of the article is that multicriteria methods can constitute important instruments of knowledge management, provided that they have been previously modelled in systems which simplify their use, conferring agility to the decision making process. It is suggested that further studies of the application of decision aiding, as a knowledge management tool, be extended to other areas of application.

KEY WORDS: Multicriteria Decision Aiding - Knowledge Management - The Petroleum Industry - MAUT

RESUMEN

Este articulo presenta la relación entre gestión del conocimiento y métodos para el apoyo multicriterio a la decisión. Como es un caso de estudio, incluye la aplicación de una función de valor multiatributo para la evaluación y selección de tecnologias para refinar petróleo. El modelo de analisis empleado fue desarrolado a partir de encuestas con técnicos involucrados en el proceso de elección de tecnologias y fue validado por su aplicación a un proceso verdadero de selección. Se utilizó la técnica de swing weighting para la calibración de la función de valor multiatributo, con un análisis de sensibilidad. La conclusión final del articulo es que los métodos multicriterio pueden efectivamente constituir herramientas importantes para la gestión del conocimiento, dando agilidad al proceso de toma de decisiones.

PALABRAS CLAVES: Apoyo multicriterio a la decisión - Gestión del conocimiento - La industria de petróleo - MAUT

1. INTRODUCTION [1]

The relationship between knowledge management and Multicriteria Decision Aiding was first introduced by Zeleny (2005). This author then presented the broad reference scenario of Human Systems Management (HSM) as the integration of three basic business dimensions: knowledge, management and systems. Next, based on the recognition that HSM always deals with multidimensionality, Zeleny demonstrated, in the fourth chapter of the work cited, the impossibility of disassociating Human Systems Management - and, consequently, knowledge management - from the use of Multicriteria Decision Aiding Methods. Zeleny (2005) showed, in essence, that there is no knowledge management that passes outside the human process of decision making, with Multicriteria Decision Aiding being precisely the treatment suitable for such a process with its multiplicity of criteria and points of view. The integration between Multicriteria Decision Aiding and knowledge management has also been dealt with by authors such as Trinkaus (2006); Kain, Kärrman & Söderberg (2007); Feyzioğlu & Büyüközkan (2007) and Rauscher, Schmoldt & Vacik (2007).

Santos (2003) suggests that, in companies, the importance of initiatives which seek to create structures which support decisions analytically must increase and proposes studies of knowledge management problems which can be modelled quantitively, principally the simulation of knowledge producing environments.

Nonaka & Takeuchi (1995) present the concepts of tacit knowledge and explicit knowledge. Tacit knowledge is understood as personal knowledge, specific to the context, and, for this reason, difficult to be formulated and communicated; explicit or codified knowledge refers to knowledge transmissible in a formal and systematic language. Based on these concepts, many authors have stated that knowledge management must provide methods to manage both tacit and explicit knowledge in such a way that they can be used to solve problems, exploit opportunities or take decisions which improve performance. (Rauscher, Schmoldt & Vacik, op.cit.).

Once the relation between knowledge management and Multicriteria Decision Aiding had been established, it became evident that the adoption of analytical methods of decision support as an instrument of knowledge management appreciates the diverse viewpoints cited above.

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[1] The first version of this article was presented in the XLI Brazilian Symposium of Operations Research held in Porto Seguro, State of Bahia, Brazil, from September 1st to September 4th, 2009

The process of identifying the most important parameters and the modelling of the problem permit the conversion of the tacit knowledge of the specialists into explicit knowledge and the integration of this diverse specialized knowledge in favour of a common objective which is the decision making.

This being so, the purpose of this article is to demonstrate how an Analytical Decision Aiding Method can constitute a knowledge management instrument through the application of the multiattribute value function to the comparison and selection of oil refining processes. For a presentation of the main characteristics of a wide range of analytical methods of Multicriteria Decision Aiding see Figueira, Greco & Ehrgott (2005).

2. KNOWLEDGE MANAGEMENT

There are two standpoints concerning knowledge management: the learning centric and the information centric approach. The learning centric view emphasizes that knowledge is the capability to act effectively and is derived from learning. In this view, knowledge management is a function that accelerates learning . On the other hand, the information centric approach considers Knowledge Management as a " a discipline that promotes an integrated approach to identifying, managing and sharing all of an enterprise´s information assets as well as unarticulated expertise and experience resident in individual workers". (Morey et all, 2002)

In other words, "Knowledge Management can be defined as the systematic strategy of creating, conserving, and sharing knowledge to increase performance, providing methods for managing both explicit and tacit knowledge". (Rauscher, Schmoldt & Vacik, op.cit.)

3. MULTICRITERIA FOCUS

In 1789, Daniel Bernoulli introduced the concept of utility as a unit of measurement of preference. Bentham defined utility as "that property in any object, whereby it tends to produce benefit, advantage, pleasure, good, or happiness...or...to prevent the happening of mischief, pain, evil, or unhappiness" (Bentham, 1789).

The formalization of utility theory carried out by Von Neumann & Morgenstern, in 1947, later refined by Fishburn (1970) and Keeney & Raiffa (1976), served as a base for the formulation of a preference theory for choices involving risks, in other words, "lotteries or games with outcomes which depend on a set of mutually exclusive and exhaustive events" (Dyer, 2005 p. 271).

Keeney & Raiffa (op. cit.) extended the concepts of utility theory to aiding decision making problems in which each alternative can be described by a list of attributes. The authors proposed the construction of a mathematical function capable of aggregating the information from multiple attributes so that each alternative could be associated with a value measurement. This makes it possible to prepare ranks of preference among the alternatives. These authors defined a function of representation of preference under conditions of certainty, as a "value function" and a function of representation of preference under conditions of risk, as a "utility function".

The multiattribute utility function can have diverse mathematical forms and its application, as a decision aiding tool, depends on meeting certain requirements. One of these requirements is the construction of a model which allows the analyst to compare the alternatives based on a set of criteria, in other words, a model which permits the establishing of preference relations between alternatives.

The most common approach for the evaluation of multiattribute alternatives is to use an additive representation, that is:

$$v(x1,...,xn) = \sum_{i=1} vi(xi) \qquad (1)$$

where v_i are value functions of the single attribute x_i.

The key condition for the use of the additive representation is that there is mutual preference independence between the attributes x_i. The attributes x_i and x_j are preferentially independent if the trade-offs between x_i and x_j are independent of all the other attributes. Mutual preference independence requires the preference independence to be sustained for all pairs x_i and x_j, in other words, the indifference curves for any pairs of attributes must be unaltered for fixed levels of the remaining attributes. In cases in which an additive representation cannot be used, a multiplicative form must be considered. In this case other stricter conditions must be satisfied (Keeney & Raiffa, 1976; Clemen & Reilly, 2001; Dyer, 2005).

Multiattribute Utility Theory, underlying the use of the multiattribute utility function, involves the use of a compensatory procedure (Bouyssou, 1986). The concept of compensation in multiattribute preference structures refers to the existence of trade-offs, in other words, the possibility to counterbalance a disadvantage in relation to one attribute with a sufficiently large advantage in another attribute. Various authors have concentrated their work on the identification of how compensatory the relations of preference may be in relation to the multiattribute alternatives. In this way, a preference relation is not compensatory if there is no occurrence of trade-offs and compensatory if the opposite is the case (Bouyssou, op. cit.). Bouyssou (op. cit., p.153) also defines the concept of aggregation convention as "the way in which an analytical process transforms the information in order to reach a ranking of preferences".

Thus, an aggregation convention is minimally compensatory if, for a set X, the ranking of preferences can produce a preference relation in which I minimally compensates J, for any I and J, and, non compensatory, if the opposite occurs. Within this focus, the underlying convention to the additive representation of a value function is clearly minimally compensatory.

Bouyssou (op. cit.) highlights that, in spite of the fact that the greater part of work related to multicriteria decision aiding methods are based on the idea that these methods must be minimally compensatory, the non compensatory methods present characteristics which can be interesting in certain contexts, as for example, in highly complex and conflicting decision making processes in which the explicitation of trade-offs may not be the best approach.

The author also considers that it is possible to have situations in which it is suitable to use an analytical procedure, of sufficient flexibility, to admit compensation for small differences of preferences and non-compensation in other points.

Presentations of the foundations of multiattribute utility theory and its analytical representations can also be found in Belton & Stewart (2002); Souza (2002); and Gomes, Gomes & Almeida (2009). The Wallenius et al. article (2008) shows the latest advances and suggests future developments for multiattribute utility theory.

4. CASE STUDY: THE SELECTION OF OIL REFINING TECHNOLOGIES

The oil extracted from the well does not have a direct application; its use occurs by means of its derivatives. The process of converting oil into derivatives suitable for diverse consumption is called oil refining. The best known oil derivatives are: liquefied petroleum gas, petrol, nafta, diesel oil, aviation and lighting kerosene, fuel oils, asphalt, lubricants, maritime fuel, solvents, paraffin and petcoke.

The main refining processes normally used in refineries are: desalination, atmospheric and vacuum distillation, catalytic cracking, hydrocracking, hydro treatment, recovery, cocking, alkylization, isomerization, as well as auxiliary treatments which aim to adequate the quality of the products and the effluents to be discarded (Gary et all, 2007).

There are some licensors for each of the refining processes, whose technologies may differ in various aspects. The selection of refining technologies is a task which requires the integration of specialized knowledge, involving diverse perspectives and often conflicting objectives; it is a decision making process which involves technical and economic issues.

The case study in question was based on the evaluation process of three technologies of a determined refining process and the selection of the one which best met the proposed objectives.

4.1. Methodology

The choice of the multiattribute value function as the multicriteria method for modelling the problem stemmed from the fact that this method presented a solid axiomatic base, in the sense of seeking to describe the behaviour of individuals in the decision making process. Associated with this, it was the method which was shown to be most suitable to the characteristics of the problem, in the sense that it permitted a representation of the different axes along which the technicians who perform the task of technology selection justify their preferences.

The modelling was developed based on the assumption that each technology must meet a set of basic objectives, established by technicians from diverse specialities. Each of the basic objectives can be composed of a set of attributes organized hierarchically. Weights are attributed to the basic objectives, as well as to the attributes lower down in the hierarchy, according to the degree of importance conferred by the technicians.

Finally, the global value function is calculated which will permit the selection of the technology which presents the greatest value for the set of objectives established.

4.2. Constructing the attributes tree

For each basic objective, attributes were defined which were capable of expressing the basic objectives in a measurable way. The attributes themselves which could only be expressed in numerical values had these values adopted as measurement criteria.

For those attributes which were not directly quantifiable, scales were established which permitted the conversion of qualitative variables into quantifiable ones. Table 1 presents the tree resulting from the systematics described.

Basic objectives	First level attributes	Second level attributes	Third level attributes
Maximize the net present value	Net present value		

Maximize ease of maintenance	Ease of maintenance	Equipment dimension	Furnaces
			Reactors and vessels
			Towers and trays
			Compressors
			Filters
			Heat exchanger
			Pumps
			Vessels
			Drivers
		General facilities	Equipment redundancy
			Horizontal layout
			Interchange of parts
			Systems liberated without general stoppage
			Various entrances and exits in equipment
			Use of common material
			Systems in the form of skids
			Easy opening devices
			Area occupied
Minimize environmental risks	Environmental risks	Liquid emissions	H_2S
			NH_3
			Oily water
		Gaseous emissions	CO_2
			SO_x
			NO_x
			COV
			Particulates
		Solid waste	Solid waste
Minimize technological risks	Technological risks	Number of plants in construction/project	
		Number of plants in operation	
Minimize energy consumption	Energy consumption	Energy index	
Minimize water consumption	Water consumption	Volume of water consumed	

Table 1 – Hierarchical Tree (H2S: Hydrogen sulphide, NH3: Ammonia, CO2: Carbon dioxide, SOx: Sulphur oxides, NOx: Nitrogen oxides, VOC: Volatile Organic Compounds)

4.3. Determination of measurement scales

In order to determine the first hierarchical scale “Net present value” attribute, a numerical monetary scale was adopted. The first level “Ease of maintenance” attribute was sub-divided into 2 second level attributes: “Equipment dimension” and “General facilities”. A cardinal scale, with amounts expressed in tons, was adopted for the “Equipment dimension” attribute.

In the case of the “General facilities” attribute, an ordinal scale converted into a numerical scale was adopted, in which the best result should be expressed by the highest mark; i.e., the three technologies analysed were ordered according to their performance in relation to each one of the third level attributes which constitute the “General facilities” level. The technology which was ranked the best attribute received a mark of 3 and the one which was ranked the worst received a mark of 1. Value 1 was attributed to the technology which obtained the greatest global mark and value 0 to the one that obtained the smallest mark for the “General facilities” attribute. Thus, after having defined the two extremes of the scale, the value for the third technology was obtained by direct interpolation.

The first level attribute “Environmental risks” was sub-divided into three second level attributes: “Liquid emissions”, “Gaseous emissions”, and “Solid waste”; a weighted numerical scale was adopted for these attributes, expressed in tons/month.

The first level “Technological risks” attribute was sub-divided into two second level attributes: the “Number of plants in construction or project” and “Number of plants in operation” , which were expressed by a numerical scale.
These attributes can be related to the maturity of technology, taking into consideration that the largest number of plants in operation is an indication of more mature or consolidated technology and that, consequently, imply less technological risk.

The first level “Energy consumption” attribute was expressed by the “Energy index”, a dimensionless numerical value, normally used to calculate the assessment degree of energetic optimization of the process. The “Water consumption” attribute was represented by a numerical scale, expressed in cubic metres/hour.

4.4. Assessment of the occurrence of interaction among the attributes

The assessment of the occurrence of interaction among the first level attributes was made using the methodology suggested by Keeney & Raiffa (1976), which allows us to verify the existence of the influence of one given attribute over the others, in terms of choice (Clemen & Reilly, 2001).

Technicians from the various specialties were questioned if the fixation of each one of the first level attributes, at diverse values, would change the choice in relation to the other attributes. Negative responses were received for all the attributes, which characterized the non-existence of interaction among the attributes.

4.5. Determination of weight attributes

4.5.1. Weight attributes of the first hierarchical level

In order to determine the weights of the attributes of the first hierarchical level, the swing weighting method was used, which "consists of a direct individual comparison of attributes imagining a hypothetical result" (Clemen & Reilly, 2001, p.547).

The assigning of weights carried out by technicians took various factors into consideration, such as the technological process involved, the strategic objective and the location of the plant. A multidisciplinary group was used to assess and arrive at a consensus regarding the weights to be adopted for each set of technological processes. The weights obtained for the first hierarchical level attributes are listed in Table 2.

Assessment	Attribute	Order	Points	Weight
Benchmark (worst result)	Net present value Environmental risks Ease of maintenance Technological risks Energy consumption Water consumption	7	0	0.00
Best	Net present value Environmental risks Ease of maintenance Technological risks Energy consumption Water consumption	1	100	0.27
Best	Net present value Environmental risks Ease of maintenance Technological risks Energy consumption Water consumption	3	70	0.19
Best	Net present value Environmental risks Ease of maintenance Technological risks Energy consumption Water consumption	4	50	0.13

Best	Net present value Environmental risks Ease of maintenance Technological risks Energy consumption Water consumption	2	80	0.22
Best	Net present value Environmental risks Ease of maintenance Technological risks Energy consumption Water consumption	5	40	0.11
Best	Net present value Environmental risks Ease of maintenance Technological risks Energy consumption Water consumption	6	30	0.08
	Total		370	1

Table 2 - Weight attributes of first hierarchical level

4.5.2. Weight attributes of second and third hierarchical levels

The assignment of weights to second and third hierarchical levels attributes was made directly by specialist technicians from the industrial maintenance, operational, project and environmental areas, based on their experience regarding the refining processes which were being analysed. This is one of the points in which we are able to identify a real conversion process of tacit knowledge into explicit knowledge, which when structurally organized allows periodic reviews and improvement, thus forming an organizational learning process.

Table 3 shows the weights of second and third hierarchical levels attributes.

Second level attributes	Weight	Third level attributes	Weight
Equipment dimension	0.50	Furnaces Reactors Towers and Trays Compressors Filters Heat exchangers Pumps Vessels Drivers	0.11 0.11 0.11 0.11 0.11 0.11 0.11 0.11 0.11

General facilities	0.50	Equipment redundancy	0.11
		Horizontal layout	0.11
		Interchange of parts	0.11
		Systems freed without general stoppage	0.11
		Various entrances and exits of equipment	0.11
		Use of common material	0.11
		Systems in the form of skids	0.11
		Easy opening devices	0.11
		Occupied area	0.11
Liquid emissions	0.33	H_2S	0.33
		NH_3	0.33
		Oily water	0.33
Gas emissions	0.33	CO_2 0.2	
		SOx	0.2
		NOx	0.2
		VOC	0.2
		Particulates	0.2
Solid waste	0.33	Waste index	1.0
Number of plants under construction/project	0.20		
Number of plants in operation	0.80		
Intensity of energy index	1.0		
Water consumption	1.0		

Table 3 - Weights of attributes of second and third hierarchical levels (H_2S: Hydrogen Sulphide, NH3: Ammonia, CO2: Carbon dioxide, SOx: Sulphur oxides, NOx: Nitrogen oxides, VOC: Volatile organic compounds)

4.5.3. Determination of the value function

After having determined the weights, it is possible to calculate the global value function for different technologies. Taking into consideration that the test for the existence of interaction among attributes associated with the technology resulted in a negative result, the utilisation of an additive value function is an adequate approximation for the establishing of the global value function.

The model for the additive value function assumes that there is a set of individual value functions, V(x1),….V(xn) for the different n attributes and that each of these functions assumes the values of 0 and 1 for the worst and best result, respectively. The additive value function is equivalent to the weighted average of these different value functions, namely,

$$V(x1,......, xn) = k1\, V(x1)+....+ knV(xn) = \sum_{i=1}^{n} kiV(xi) \qquad (2)$$

The weights k1 ,…, kn, in (2) are all positive and Σ ki =1. The additive value function assumes values 0 to 1 for the worst and the best possible result respectively.

Thus, for each technology, the value function can be expressed as:

$$V(NPV,ER,EM,TR,EC,WC)=$$

$$K_{NPV}(V_{NPV})+K_{ER}(V_{ER})+K_{EM}(V_{EM})+K_{TR}(V_{TR})+K_{EC}(V_{EC})+K_{WC}(V_{WC}) \qquad (3)$$

In (3), we have: NPV = Net Present Value, ER = Environmental Risks, EM = Ease of Maintenance, TR = Technological Risks, EC = Energy Consumption, WC = Water Consumption.

4.5.4. Results

The assessment of technologies that served as a basis for the application of the model presented the results shown in Table 4 and Figure 1.

Weight	0.27	0.19	0.13	0.22	0.11	0.08	Multi-attribute Value Function
Attributes	V_{NPV}	V_{ER}	V_{EM}	V_{TR}	V_{EC}	V_{WC}	
Tec. A	0.87	0.40	0.53	0.73	0.73	0.56	0.67
Tec. B	0.00	0.18	0.73	0.20	1.00	1.00	0.36
Tec. C	1.00	0.16	0.68	0.80	0.00	0.00	0.56

Table 4 - Multi-attribute value function - Base case

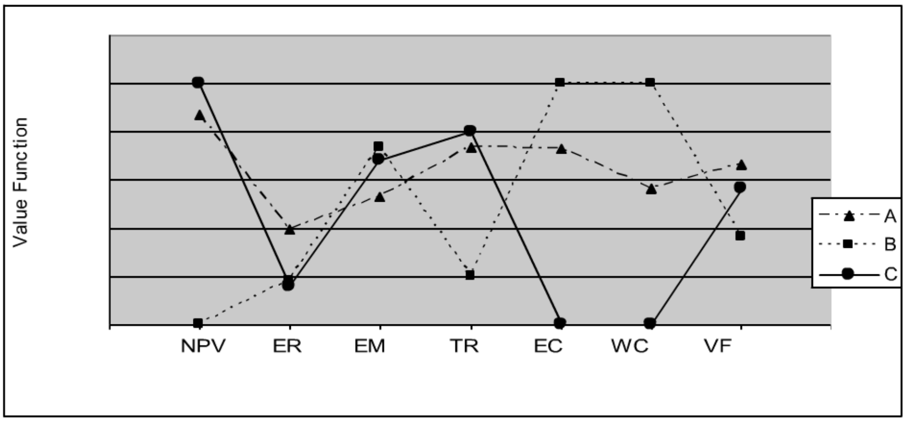

Figure 1 - Multi-attribute value function - Base case

Technology A was the function that presented the greatest global value function, followed by Technology C. Technology B was the one that scored worst.

Technology A, despite presenting NPV, EM and TR value functions lower than Technology C, gives a significantly better performance relative to the ER, EC and WC value functions, which in general give a better performance.

An interesting indicator suggested by Figure 1 refers to Technology B, which in comparison to all the others, seems to be the most optimized in terms of utilization of resources such as water and energy, as well as Ease of maintenance, which from an operational point of view, could be very interesting. The fact that this technology presents the lowest NPV value function, in spite of the good result regarding other functions, may indicate a point to be questioned with the technology licenser, especially regarding the concentration of efforts in order to increase that value function.

4.5.5. Sensitivity Analysis

The weights attributed by specialists to various attributes will be dependent on the scenario in question, and there will always be a certain degree of subjectivity. Thus, it is recommended that a sensitivity analysis regarding the weights of attributes be applied, in order to assess the degree of robustness of the choice made.

In the base case, the “Net present value” and “Technological risks” attributes were prioritized, i.e., larger weights were attributed to these attributes. However, in a different scenario, the weights allocated to these attributes could vary considerably, leading to a different choice. Thus, for example, in an environment in which the water supply is scarce, the weight of the “Water consumption” attribute could be larger. In the same way, in a context in which the plant location is such that the access for large construction equipment is very difficult, the “Ease of maintenance” could be prioritized.

Therefore, in order to assess the robustness of choice, the weights allocated to first level attributes were varied, alternating two by two with relation to the base case. Table 5 shows the alternative cases which were considered in the sensitivity analysis and Figure 2 shows the respective results of the multi-attribute value functions.

Figure 2 shows indeed the results of multi-attribute value functions for each one of the technologies as a function of different weights of first level attributes.

V	V_{NPV}	V_{ER}	V_{EM}	V_{TR}	V_{EC}	WC
Base Case	0.27	0.19	0.13	0.22	0.11	0.08
X_1 Case	0.19	0.27	0.13	0.22	0.11	0.08
X_2 Case	0.13	0.19	0.27	0.22	0.11	0.08
X_3 Case	0.22	0.19	0.13	0.27	0.11	0.08
X_4 Case	0.11	0.19	0.13	0.22	0.27	0.08
X_5 Case	0.08	0.19	0.13	0.22	0.11	0.27
X_6 Case	0.27	0.13	0.19	0.22	0.11	0.08
X_7 Case	0.27	0.22	0.13	0.19	0.11	0.08
X_8 Case	0.27	0.11	0.13	0.22	0.19	0.08
X_9 Case	0.27	0.08	0.13	0.22	0.11	0.19
X_{10} Case	0.27	0.19	0.22	0.13	0.11	0.08
X_{11} Case	0.27	0.19	0.22	0.11	0.13	0.08
X_{12} Case	0.27	0.19	0.22	0.11	0.08	0.13
X_{13} Case	0.27	0.19	0.13	0.11	0.22	0.08
X_{14} Case	0.27	0.19	0.13	0.11	0.08	0.22
X_{15} Case	0.27	0.19	0.13	0.22	0.08	0.11

Table 5 – Alternative weights for first level attributes (VNPV: "Net present value" value function, VER: "Environmental risks" value function, VEM : "Ease of maintenance" value function, VTR : "Technological risks" value function", VEC ;"Energy consumption" value function, VWC : Water consumption" value function)

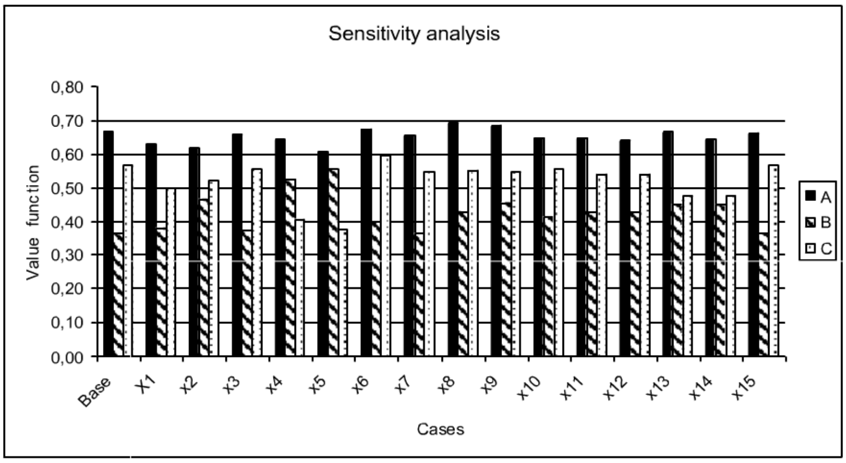

Figure 2 - Multi-attribute function - Alternative cases

The analysis of Figure 2 allows us to conclude that, even with the changes made to the allocated first level weights, technology A is still the best option, demonstrating that it is a robust choice, capable of suiting different contexts.

In 87% of the cases analysed, technology C was shown to be the second-best option, however, in 13% of the cases, technology B was the second best option, indicating that, for any specific scenario, the choice can vary.

Due to this, it is always recommended that the sensitivity analysis regarding the attribute weights be used to assess the degree of robustness of choice.

5. CONCLUSION

The case study presented in this article demonstrated how analytical methods of decision aiding can be used as tools for knowledge management in certain technological areas. Through the application of the multi-attribute value function for technology selections in the process of petroleum refining, we have tried to demonstrate how adequately structured information allows one to capture the tacit knowledge of specialists, converting it into explicit knowledge, in addition to improving the quality and rendering the decision process more agile.

The multi-attribute value function was the method that, due to its characteristics, proved to be the most suitable method to tackle the problem; however, it is important to emphasize that the choice of the method will always depend on the characteristics of the problem at hand.

The analytical methods of decision aiding often present such a degree of complexity that makes it difficult to be used as a routine methodology in companies. The way to tackle the problem is to develop previously modelled systems, specifically for each application; systems that are able to convey the necessary agility in the decision process and that constitute themselves as tools that are able to convert tacit knowledge into explicit knowledge, bearing in mind that these systems will be constructed from the theoretical and day to day practice of specialist technicians. However, it should be noted that it is fundamental that the users be aware of the premises of the analytical methods used and that the models will be continuously subject to reassessments, revalidations and updates. It is only in this way that they will be considered tools of organizational learning.

In spite of various empirical works demonstrating that individuals do not always make decisions coherent with the axioms proposed by decision theories, it is the consensus amongst several authors that it is expected that decision makers, related to the public or third party interests, adopt strategies that can be justified based on logical and explicit principles; from this follows the contribution of multi-criteria methods in the context of organizations.

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