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Decision Making Methodology to Support the Project Implementation of Knowledge Management in Business

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Abstract: Normally the decision to implement investment projects in companies has an orientation toward a goal: prioritization of technical/financial (profit maximization or cost minimization), although there are other important objectives for the company. In this case, it is assumed that the other objectives are implied in the central objective. Because of this, objectives leading to non-profitable goals are often underestimated (such as managerial, coordinating, organizational, human, cultural, among others), which often leads to mistakes in the implementation stage of projects. In Knowledge Management (KM) Projects something similar can occur since important aspects can be ignored and this can help avoiding mistakes in their execution. Thus, some authors believe that when it comes to decision-making processes with different objectives, centralized tools or techniques on a single target are not the most relevant. Because of this, since the nineteen seventies, decision-making tools under multi objective or multi criteria approach have been developed. These tools allow a broader and comprehensive decision-making process in companies. In this sense, this paper proposes a methodology for guiding multi criteria decision-making processes to support the implementation of KM projects in companies. The method considers the stages of a decision-making process, besides the usage of multi objective analysis techniques. The proposed methodology gives a comprehensive view of decision-making, using qualitative and quantitative tools to support the implementation of KM projects in companies. The proposal stems from a reflexive qualitative research on the processes of implementation of KM in Colombian companies.

Key words: decision making; projects; knowledge management; multi-objective analysis
JEL codes: C02, D80, M1

1. Introduction

The development of knowledge management over the past two decades has suggested including fundamental issues such as cooperation, participation, interdisciplinarity, and a common vision of an organization. These aspects are considered to be crucial in the process of creation, appropriation, transformation, dissemination and use of knowledge in the organization.

While decision-making has traditionally been thought from economic approaches, technical and/or financial, it usually leads to a uni-disciplinary approach that addresses a single criterion or objective that generally relates to

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optimization processes (profit maximization or cost minimization). Despite this approach's success in handling companies' affaires, the complexity required to implement knowledge management projects necessarily suggests considering multiple objectives or criteria.

Paradoxically, even with the theoretical developments made for decades in the Decision Making Theory, it has not permeated relevant issues relating to knowledge management in industrial organizations. On the contrary, the theoretical proposal of knowledge management (most recently created) which has induced changes in decision-making processes by emphasizing those fundamental points. This multi-disciplinary view could lead companies implementing knowledge management projects to avoid mistakes, failures, economic viability and implementation problems to the extent that there is a broader and enriched view.

Accordingly with the knowledge management theories, this paper proposes a methodology to guide the decision-making processes for implementing KM projects within companies. This will consider the existing guidelines, processes and models for decision-making and problem solving, plus the usage of multi criteria analysis methodologies. This work seeks for a broader view that integrates qualitative and quantitative tools in decision making processes into implementing KM projects in businesses. The proposal stems from a reflexive qualitative research on the processes of implementation of KM in Colombian companies.

The paper is organized as follows: section 1 presents the classical decision-making process in companies. Section 2 presents the multi-criteria nature of investment decision-making in KM projects. Section 3 outlines the paradigm of Multi-criteria Decision Making (MCDM). Section 4 presents a methodology to guide decision making process for implementing KM projects. Section 5 presents a case study, using the methodology for multi-criteria decision making in KM projects. Finally, Section 6 concludes the article with some suggestions on the proposed use of the elements (process).

2. The Decision-making Process

According to Anderson, Sweeney, Williams et al. (2010), a decision-making process within a company broadly comprises the following phases or steps: Problem identification and definition; Selecting the set of alternative solutions; Identification of the indicators used to evaluate alternatives; Assessment of alternatives; Choosing the best alternative solution.

3. Multi-criteria Nature of a Knowledge Management Project

Knowledge Management (KM) is a concept applied in organizations, which aim at promoting in its members, the ability to creating, processing, using, distributing and sharing knowledge. Its objective is to manage the diverse forms of tacit and explicit knowledge the members of the organization possess so it can be used as a resource by the organization to achieve objectives. It also tries to set actions, steps and strategies to develop the use this knowledge to distribute it and later use it to create new intangible assets.

KM's objectives should be aimed at creating a suitable environment for people in the organization to learn, innovate, share, use and distribute knowledge in order to meet business strategies and organizational goals. Paniagua et al. (2007) define some of these objectives:

- Selecting and developing organizational strategies allowing proper KM.
- Implementing KM strategies.
- Generating a continuous-learning organizational culture among the workforce.

- Encouraging employees to share knowledge.
- Promoting continuous improvement of business processes, especially in those that allow knowledge generation and use.
- Monitoring and evaluating the benefits of KM.
- Managing knowledge as an asset.
- Reducing time and costs associated with continuous improvement (products and processes).

Therefore, the decision of investing in a project implementing Knowledge Management (KM) in a company, usually intends achieving several objectives. At the same time, investing in this type of projects involves using resources of various kinds, physical, financial and human. However, decision-making processes usually tend to focus on economic-productive, profit-improvement aspects. This is why there is a tendency to express every project objective in economic terms, and thus, simplify the decision-making analysis process to achieve one goal; achieving the greatest economic benefits possible. This suggests a process of decision making under a single-decision criterion.

This approach to decision-making is often called in international literature the mono *criterion paradigm*. From this viewpoint, it is relatively "easy" to guide decision-making processes by using traditional financial analysis tools (optimization of an objective function). However, given the actual characteristics and conditions of a KM project, where knowledge is understood as an intangible asset that can be tacit or explicit (Nonaka and Takeuchi, 1995; Euroforum, 1998, Edvinsson and Malone, 1997; Well, 1998; Fernandez, Montes and Vásquez, 1997, 1998a, 1998b), decision-making processes cannot always express all the objectives or criteria in economic terms; reducing criteria to just one is not always possible. Therefore, the process of making investment decisions in a Knowledge Management project, needs to be analyzed in a context of multiple objectives or criteria, and in that sense, if required, it is more appropriate to use analytical models of multi-criteria decision-making models. In this sense, and according to Roy (1988), due to the fact that this is a multi-criteria decision-making process, it demands defining the following elements:

- The existence of multiple criteria (objectives)
- The conflict between the criteria (objectives)
- The complex and subjective nature of the assessment process
- The involvement of investment decision makers of the project in the process's assessment.

Among other subjects to be considered in multi-criteria decision-making, we can mention the following: if decision makers have various goals, how can they be represented on a single target? If several objectives are proposed, what are they? For a real case, in which you have several objectives, how are they prioritized? It is common to find conflicting criteria; e.g., implementing knowledge management projects seek for improving product or service quality, minimize production costs, eliminating nonstructural waste and non-quality costs associated with the process.

A key aspect of decision-making processes in KM projects, as stated by Riesco (2006), is that they emphasize the technical and technological aspects but neglect the human factor; people who will be the directly involved in the challenges of implementing a project of this nature. This suggests that these changes (structural, strategic and in organizational culture) that adopting a KM model may require are not taken into account. And therefore, adverse situations may occur within the organization affecting the achievement of project objectives. Due to this peculiarity of KM projects, where the human factor is central, decision-making is complex and therefore requires a broader view, a multi-criteria analysis, which allows the participation of every stakeholder.

4. The Paradigm of Multi Criteria Decision Making (Multicriteria Decision Paradigm)

In everyday life, we often face difficult situations when making decisions, especially if many aspects should be considered simultaneously. Still, the situations in which a decision maker (individual or collective) is confronted with a choice in the presence of multiple objectives or criteria are very numerous (this is the most common case). In a decision-making process, the decision maker usually faces selecting among several possibilities, rather than a single alternative. Somehow, complexity lies in this process, because if it were a single alternative, it would not configure a decision-making issue. According to Fernandez (2011), "this means that decisions are intrinsically linked to a plurality of views that can be defined as criteria. Contrary to this natural observation, for many years, the only possibility to formulate a decision problem was to do it under a mono-criterion optical which interrelated the multi-dimensional aspects of a decision situation with a single measurement scale". Therefore, according to Fernandez (2011), "nowadays, it is considered that a mono-criterion vision of a decision-making problem is very limited, and in some sense, forced or unnatural". Consequently, during the last thirty years, a new formulation and conceptualization of multi-criteria decision-making problems has increasingly attracted the attention of researchers and decision-makers. According to that, in 1976, Bernard Roy proposed the need for de-optimizing operative research.

Multi-criteria decision-making (MCDM), also known as Multi-Criteria Decision Analysis, or Multi-Objective Analysis, is an activity that helps managers making decisions, especially in terms of choice, sorting and ranking of alternatives. As an area of knowledge, since 1960 it has been individualized, adopting its own methodology, gaining importance in the decision theory; the most important part of Decision Theory.

MCDM offers great advantages over the mono-criterion model; the decision maker has more freedom to express his preferences; it is therefore much more realistic than mono-criterion's approach. In this sense, it supports modeling preferences by mathematical structures that can be: pseudo criterion, semi-criteria, pre-criteria and/or interval criteria. In addition, this modeling is less rigid than multi mono-criterion because it allows active participation of the decision maker. Hence, it is more realistic.

In short, since it is more realism and more readable, at the end the Multi-criteria Analysis represents an important asset in organizations.

According to Roy (1996), the decisions made in MCDM contexts can face diverse problems: (1) Choosing an alternative, (2) Sorting the alternatives into homogeneous groups defined according to an order of preference, (3) Assessing the alternatives from best to worst (4) Describing the impact of alternative solutions in terms of performance, according to criteria.

Making the decision to select an alternative investment in KM projects represents a typical example of decision- making which could identify the problem a).

A very interesting referring the MCDA is the following which enriches the degree of conformity and coherence between the evolution of decision-making processes, the value and objective systems of those involved in this process. Thus, this approach to decision-making processes is very close to the demand for a knowledge management implementation project in which the human factor is essential for both the process of choosing the most viable alternative, and for implementing it (Fernandez, 2011). In this sense, the purpose of MCDA is helping to show guidelines despite ambiguity, uncertainty and the abundance of alternatives to facilitate human actions in situations of complexity.

4.1 Elements of Multi Criteria Decision Making

For Multi-criteria Decision Analysis fairly simple basic elements are required (even with the diversity of approaches, methods and techniques): (1) A set of finite or infinite actions (alternatives, solutions, courses of action to achieve the criteria or objectives); (2) At least two criteria or goals (if you have one goal it would be the paradigm of mono criterion), and, (3) A central decision maker (which may be an individual or a group of individuals). Figure 1 illustrates the schematic paradigm of Multi criteria Decision (MCDM).

According to Fernandez (2011), in the process of multi-criteria decision making the decision maker is willing to choose among several possibilities (alternatives), called *the choice set*. In choosing this set of alternatives, the decision maker has several points of view, called *criteria*. These criteria could be at least partially contradictory, in the sense that if the decision maker adopts one of these views, he/she will not choose the same alternative that if based on other criteria. The central decision maker assigns different weights to the criteria or objectives by his/her preference structure.

	Criteria or Objectives						
Alternatives	C_1	C_2	C_3	...	C_j	...	C_n
A_1	r_{11}	r_{12}	r_{13}	...	r_{1j}	...	r_{1n}
A_2							
A_3	Decision Matrix or Payoff Matrix						
...							
A_i	r_{i1}	r_{i2}	r_{i3}	...	r_{ij}	...	r_{in}
...							
A_m							
Weights	w_1	w_2	w_3	...	w_j	...	w_n

Figure 1 Multicriteria Decision Problem Paradigm (MCDM)

Note: rij: Represents the evaluation of the effect of alternative i on achieving criterion or objective j;
wj: Vector of weights assigned by the decision maker to each of the criteria or objectives j,
according to his/her preference structure. Source: Barba-Romero, 1987.

5. Methodology for Decision Making in Knowledge Management Projects

Considering the decision-making process proposed by Anderson, Sweeney, and some contributions from Multicriteria Decision Making, a methodology is presented to guide the implementation of knowledge management projects in companies. The methodology includes the following steps: (1) Identification and problem definition, (2) selection of central agent or decision maker, (3) identification of the set of alternatives solutions, (4) selection criteria for evaluating alternatives, (5) evaluation of alternatives solutions, and, (6) selection of the best alternative based on multiple criteria or objectives.

(1) **Identification and problem definition**. This step requires identifying the situation that is expected to solve, improve, or maintain by implementing the knowledge management project. At the same time, it defines the project's scope within the company. The scope identifies the objectives to be achieved (economic, social, environmental, financial, technical, market, process, etc).

(2) **Selection of central agent or decision maker**. This step requires identifying the people in the company that will be part of decision-making process and of implementing the knowledge management project. Since the

project involves achieving various objectives, as far as possible, the decision-making group members should form an interdisciplinary group so it can provide a broader look at the decision-making process from a multidisciplinary approach. Involving the project implementation participants will first, transcend the tendency to neglect human factors and emphasize the technical aspects of the project. Second, it will reduce the occurrence of risk events associated to human mistakes in the *adoption* phase of the KM model. Third, the process of implementation and adjustment required for the organization, according to project requirements is legitimized. Finally, it creates cultural, strategic and structural spots which support the change process, feedback, continuous improvement and achievement of the objectives.

(3) **Identification of the set of alternative solutions**. Once you having identified the central decision maker, we proceed to the selection phase for a set of feasible solutions for achieving the project's objectives. This phase should involve all stakeholders in the project, which could support the identification of solutions to the problem defined in the first step; employees, managers, external consultants, experts in KM, etc.

It is possible to find the project's objectives somewhat contradictory. What the multi-criteria analysis intends is to face this type of real business situations in which the solution for a decision-making problem deserves a broader, diverse, and therefore, complex approach. Even with this, the pattern that will guide the selection of alternatives is primarily the achievement of the objectives identified in the first step. To do so, and Figure 1:

List the alternatives (or solutions or projects or candidates), A_i (i = 1, … m), such alternatives must be different and accurate. There cannot be any intermediate alternatives. In short, $\{A_i\}$ set is discrete and universal.

(4) **Selection criteria for evaluating alternatives**. The group integrating the central decision maker (based on the objectives the project seeks to achieve) defines the criteria to be used to assess the contribution of each alternative solution to the achievement of each of the various project's objectives. The criteria (attributes, or characteristics) on which to base the decision, form a discrete set $\{C_j\}$, (j = 1, … n).

(5) **Evaluation of alternative solutions**. In this step, r_{ij} evaluations of each alternative i with respect to each criterion or objective j, describes the effect that each alternative considered may have on achieving individual objectives or criteria. All the r_{ij} are the so-called *decision matrix or payoff matrix*. The decision maker members build the matrix according to their abilities and expertise. Finally, to evaluate the alternatives, the decision matrix is used as follows:

Each member of the central decision maker (according to his/her preferences) assigns relative weights W to each project's objective j**;** they constitute a weight vector **{**W_j**}.** In this sense each member has full autonomy to assign weight according to his/her experience, education, and closeness to the problem.

(6) **Selection of the best alternative solution.** This step consists of selecting the alternative (according to its contribution to achieving the multiple objectives or criteria) which best satisfies the central decision maker preferences, in terms of solving the issue. To do this, the decision matrix (built during the phase of evaluating the alternatives) is used along with the weights assigned to criteria by the decision maker agent.

6. A Case Study: A Service Provider Company in Medellin (Colombia)

A company providing television, telephone and internet services in Medellin faces the challenge of adapting to technological, structural, human and knowledge requirements of mass media (updating processes): "super" broad band, interfaces multisensory, access to web data- storage clouds, virtual and real information exchange, context modeling, wireless internet connection, 3D technology, DIY, hacking, communication without people,

semantics infrastructure, energy sustainability, inter-operability and extensibility needed for the convergence of devices and information surrounding people lives.

For this, the company decided to start a knowledge management project in order to obtain and ensure competitiveness and sustainability.

Establishing the KM Project, the company seeks for achieving the following objectives:

(1) Access the expertise required to become competitive in the short term.

(2) Ensure that contracted or developed expertise remains within the company in the mid-term.

(3) Generate sustainable competitive advantages in the mid and long term.

(4) Maximize profitability in the short, medium and long term.

(5) Diversify the company's portfolio in the short, mid and long term.

(6) Improve the quality of goods and services offered by the company in the short, mid and long term.

To achieve the multiple objectives or criteria, the following alternatives were proposed:

(1) To hire experts in the field needed by the company.

(2) To train employees on the specific areas required.

(3) To implement communities for the dissemination and knowledge transfer required.

(4) To set up technology platforms to store and use knowledge.

(5) To implement knowledge transfer strategies to ensure it will remain within the company.

(6) To create new products and/or services to meet the existing market or new markets.

(7) To improve the products and/or existing services to support the existing customers and potential customers search.

(8) To create an R & D Department to develop new products and services.

(9) To implement innovation management strategies for adapting the company to new technologies.

(10) To adjust the structure, strategies and corporate culture to implement the project.

(11) To encourage better working environments those facilitate the adoption or implementation of the proposed KM project.

(12) To adjust the organizational structure to the requirements demanded by the KM project

7. Solution and Case Study

In order to select the best alternative for implementing the Project in the company, two methods for decision-making analysis will be used: The first, from the perspective of a single criterion or objective, using a linear optimization model. The second is the use of a multi-criteria methodology proposed in this article, which uses the Weighted Average multi criteria decision technique.

(1) Using the linear optimization technique: Mathematically, a linear optimization problem is posed as follows:

Maximize	$Z = CX$
Subject to	$AX <= b$
	$X_1, X_2, \ldots, X_n \geq 0$

Where:
Z: is the target function (the project's general objective)
AX: are the problem's restrictions to achieve the objective (a mathematical equation system).
X: is a matrix of m x n containing the restriction variables subjecting the target function.

In this case, for selecting the best alternative, a linear optimization model aimed at maximizing the profits of the company by implementing a KM project.

Using the optimization model requires the following steps:

- To define the target function (t.f.): It means to express in economic terms the objective to be achieved. This requires building a mathematical equation that represents the goal to be achieved by the project.
- To define the problem (objective function and constraints to achieve the target): It is to express in a system of mathematical equations, the objective of the project and the technical limitations or restrictions or resources (availability) to achieve this objective.
- To solve the problem. This step identifies the best alternative to achieve the project's objective; i.e. an alternative to be taken to maximize (in the case of profits) or collapse (if it relates to costs) the target function's objective.

This process requires to initially express in economic terms the project's objective (also represented by a system of mathematical equations); both the objective and the constraints to achieve the objective of the project. One way to represent these through mathematical equations consists of expressing both in technical terms, productive capacity, economic profit, economic costs, profitability, availability of resources, production methods, etc.

In this case, the decision making process for implementing the KM project using an optimization model, requires first of all, expressing the objectives and alternatives (expected to achieve the objectives) in technical and/or economic terms. Secondly (and perhaps more upsetting), representing in a single mathematical expression or equation (target function, Z) all targets. The latest (a meta-goal) is called the central or main goal.

Thus, the objective of the project shall be expressed in terms of profitability so the main purpose of the project will be the maximization of profitability. With that, the function Z (CX) in the optimization model represents the company's profitability generated by implementing a KM strategy.

For this case, the application of a linear optimization technique to select the most appropriate alternative to implement the KM project produced the following results:

Assuming positive economic effects expected thanks to the improvement in knowledge management in the company (achieving higher levels of goods production and/or services), the most suitable alternative seems to be this: selecting technology platforms and infrastructure in general, to achieve production levels that maximize profitability. This implies having technological means to support the implementation of KM projects, and an improved production capacity, which is expected to be achieved through the employees' appropriation of knowledge in the organization.

This alternative selected for implementing the KM project in the company, leads necessarily to prioritizing aspects such as technology and production of goods and/or services rather than giving priority to human, cultural or management aspects. The latter usually are assumed to be static; they are assumed to automatically respond to the proposed changes; they are set aside or forgotten. These initial assumptions made on important issues in the implementation of a KM project (the human, cultural, and management structure issues), usually lead to mistakes, as it is recognized by Riesco (2006).

(2) Alternative selection using a multi criteria approach. According to the proposed methodology, once posed the problem to solve, selecting the best alternative based on multiple criteria (objectives) requires the following sequence:

(a) To identify the criteria or objectives of the project.

(b) To identify alternatives to achieve the multiple objectives.

(c) To select a group of experts to support decision making.

(d) To create a payoff matrix of alternatives and criteria.

(e) To define the weights assigned to each of the objectives according to their importance.

(f) To find the weight average obtained by applying the set of weights to the matrix.

(g) To select the most appropriate alternative for project implementation.

For the case under consideration, there it is the sequence described above:

(a) Identification of criteria for the project and alternatives. It refers to the KM project's objectives and alternatives described above.

(b) Selection of the experts. In order to support decision-making in implementing the project, a group of KM experts (external) was selected.

(c) Construction of the payoff matrix. Selected experts made the construction of the Alternative Payoff Matrix vs. the Criteria or Objectives. The matrix is constructed by evaluating the impact or effect that each of the alternatives generate in achieving individual goals. The evaluation of the matrix is the result of a consensus among the Project's participants. In this application, we used a numerical scale from 1 to 10; one being the lowest impact the alternative could generate on the objective or criterion, and 10 the highest impact. The payoff matrix is presented in Table 1.

Table 1 Payoff Matrix

Alternative	1	2	3	4	5	6	7	8	9	10	11	12
Criterion												
2	10	7	5	4	4	1	1	5	3	10	3	10
3	8	6	8	3	6	2	2	10	5	8	3	8
4	5	3	2	2	6	8	6	5	1	5	2	2
5	2	3	2	2	4	10	5	7	2	2	1	2
6	6	7	3	3	2	2	10	6	1	7	1	5

Source: Authors' own elaboration.

(d) Assignation of weights for each of the objectives. Two KM experts were selected. They used a scale of values from 1 to 10. They assigned the following sets of weights (by relevance) to each of the objectives of the project. See Table 2.

Table 2 Set of Weights Assigned by the Experts

Set of weights		
weight	Expert 1	Expert 2
Criterion 1	10	7
Criterion 2	8	10
Criterion 3	5	8
Criterion 4	4	6
Criterion 5	7	6
Criterion 6	6	7

Source: Authors' own elaboration.

(e) Estimation of weighted average. As a result of the application of the set of weights assigned by the experts, and usage of the payoff matrix the following weighted average for each of the alternatives was found. See Table 3.

Table 3 Index of Each Alternative According to Weight Assignation

Index / Alternative	Set 1	Set 2	Weighted Average
1	270	304	287
2	231	252	241.5
3	190	194	192
4	127	137	132
5	166	190	178
6	172	176	174
7	147	169	158
8	135	251	193
9	113	123	118
10	296	325	310.5
11	80	93	86.5
12	272	293	282.5

Source: Authors' own elaboration.

(f) Selecting the most suitable alternative for implementing the project. According to the weighted average of each assigned alternatives, it is considered that the best alternative considering the multiple targets is 10 (since its weighted average index has a value of 310.5). The alternative is to *adjust the structure, strategy and corporate culture to implement the project.*

The results of the methodology indicate that the sequence of alternatives to implement the KM project would be: 10, 1, 12, 2; it indicates a clear tendency to emphasize the human and administrative aspects in the organization; these aspects are more relevant for the project than technical aspects. This shows a clear difference from the technical and economic approach (which suggests the use of optimization models) leading to focus the project's decisions on technical or economic aspects.

8. Conclusions

The proposed methodology, compared with the optimization techniques, has a significant advantage leading the decision making process for implementing KM projects to a more adjusted context of the company since it allows considering all project's objectives and the alternatives possible.

Therefore, using this methodology supports the organizational and cultural changes required for implementing the project, which could reduce the possible occurrence of risk events at organizational, cultural or human level and subsequent failures in achieving the expected objectives.

The methodology supports considering objectives and alternatives for implementing the project which not necessarily need to be represented in economic and/or technical terms; it far exceeds the optimization techniques traditionally used in the process of making decisions.

Since the methodology demands the participation of an interdisciplinary group of the company, as well as knowledge management experts, we may consider that the process used for selecting alternatives (for the implementation of the project) would have a greater level of acceptance among the people in the organization (company).

Apparently, the orientation of the decision-making process for implementing KM projects in companies under optimization models (unicriteria or single target), promotes ignoring the human and organizational issues that a project of this nature require. Undoubtedly, this is due to the need of reducing the multiple objectives to a single goal to make it measurable in economic terms.

Finally, it could be accepted that the use of this methodology could lead to improve processes of cooperation from those people involved in the implementation of the KM alternative selected.

In addition, it could also lead to achieve legitimacy among participants, both in the process of decision making as well as in the adoption of the selected alternative one.

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