

# Multicriteria approach for selecting human resources for projects: an application in Kaizen Institute Portugal

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**Abstract:** An adequate selection of which human resources should be part of a project is not always an easy task. There are many criteria involved and several stakeholders. Although the complexity of decision-making process is recognized, there are few models and tools that support it, and the method most widely used in companies is based on the intuitive analysis of the decision-maker, resorting to his/her professional experience, interest and personal knowledge of available resources. This unsubstantiated method may result in an inefficient selection of employees to projects, causing discontent and unsatisfactory performance that impairs all people involved in the process. Kaizen Institute Portugal (KIP) is a consulting company specializing in continuous improvement, which has precisely this problem.

This paper aims to develop a solution to assist in KIP's human resources selection process for projects. A comprehensive literature review was undertaken in order to find existing approaches to solve these type of problems. However, it was concluded that solutions for similar problems are scarce and none of them fitted KIP's requirements. Thus, a new set of tools based on multicriteria decision analysis models were developed to assist in KIP's process. These tools evaluate the employee's suitability for the projects and identify who should be selected considering the company's strategic objectives and the employee's availability.

**Keywords:** *Project management; Project-based organizations; Selection of Human resources; Multicriteria analysis*

## 1 Introduction

Continuous Improvement is an increasingly popular concept in the business world, which has been changing the paradigm that for an institution to be more profitable it must necessarily evolve through the acquisition of new markets, resources or strategies. Driven by the crisis, companies look for ways to be more profitable internally, reshaping and optimizing their internal processes before looking for external solutions [1]. In this context, consultant companies that promote cultural change for a continuous improvement approach emerge. The Kaizen Institute is one of these consultant companies and has been growing exponentially in recent years, becoming a worldwide reference in the support of organizations subject to this change [2]. The consultant's structure has been resized according to its increasing demand and its internal management policies have evolved. However, as in many other companies, there is a lack of tools that support the process of selecting the most adequate human resources to develop the projects, which has become a critical problem since Kaizen is a project-oriented company (PBO).

Although most resource selection processes are conducted empirically and based on the professional experience of their decision-makers [3], intuition suggests that one of the major obstacles to the success of the organization is to proceed in a non-systematic method and without explicit formal models to assist the recommendation and allocation of human resources to the projects. The complexity associated with the selection process does not allow an efficient choice of resources [4] and impairs all stakeholders. It increases the likelihood of customer dissatisfaction if the company's performance is precarious, leads to unmotivated employees who are not integrated into projects that they consider challenging, and does not allow an efficient use of the company's resources. These aspects can be improved if there is a holistic system to support the selection of the most adequate human resources to develop the projects.

## 2 Contextualization on Kaizen Institute

Kaizen Institute Portugal (KIP) is a multinational company that provides consulting and training services to the business community. It has been suffering from a substantial growth of its demand for the past few years. As a result, KIP has been hiring more people and consequently extending its structure, being currently composed of more than 120 employees. In the past 10 years, it has shown an average

growth of 30%, both in revenue and in the number of employees, and there is no prospect of slowing down this growth as the company intends to continue to evolve both in its client portfolio and in its areas of expertise. It is possible to differentiate the company's employees according to their function regarding the development of projects. The group of Directors is formed by the top hierarchical level and their function is to manage the EMs (engagement manager). These, in turn, are the project leaders and coordinate Consultants who are responsible for implementing the projects.

Being a PBO, KIP generates knowledge for its employees by exposing them to a variety of different problems that require different skills and that allow them to evolve through their application [5]. Unlike many other companies, KIP has its own tools developed from the Lean methodology. These are Kaizen tools of Q.C.D (Quality, Cost and Delivery) and Growth, which have different impacts on companies. The technical skills of the KIP consultants are dependent on the projects that are assigned to them, and they are evaluated according to their capacity to implement the company's tools. Thus, sometimes conflicts of interest arise between consultants and the decision-maker (who allocate human resources to projects) because the latter may not take into account that the consultant intends to acquire or explore skills beyond those he already has.

KIP differentiates between two tips of projects: *Strategic* and *Normal*. This distinction is made according to the dimension of the client the project is destined for; the market in which the client positions himself; and the market-share percentage KIP has. The EMs and Consultants selected for each project depend on its classification as *Normal* or *Strategic*. If the project is *Strategic*, the best and most experienced employees and are assigned to that project, in order to ensure a high performance, whereas, if the project is *Normal*, less experienced employees may be selected, representing good opportunities to grow.

The projects to which a KIP employee is assigned also influences the number of weekly trips that he/she has to do since the KIP consultants work directly with the clients in their workplace. A collaborator may have more than 4 projects occurring simultaneously in different locations, therefore the number of trips a consultant has to make is a sensitive issue in KIP since it is difficult to maintain good work-life balance. A separation between the Lisbon and Porto offices during the project allocation process is desirable to minimize inter-agency travel.

As it was possible to conclude, there is a great variety of topics that must be considered during the process of

selecting the most suitable employees for the development of projects. These factors range from the professional goals of KIP employees to the number and distance of travels, preferences of sectors, domain of the Kaizen's tools and interpersonal skills. Currently, the process of choosing and training the teams that should be responsible for the execution of the projects considers all these issues in an empirical way and without any support tool.

## 2.1 Definition of the problem

By proceeding without a tool to support allocation decisions, there are sometimes situations of workload imbalance between the various consultants and EMs, with some being overworked. Also, by not using a standardized database, decision-makers do not have all the information related to the alternatives and make the assignment without considering the preferences of the Consultants and EMs, creating situations such as unwanted specialization and excessive travel, which results in unnecessary costs and the demotivation of the employees. The problem is even more pressing because KIP is a project-based organization (PBO). If the allocation of resources to projects is inadequate, employees may be unmotivated and may not perform adequately their tasks, damaging the final results of the projects [6].

On the other hand, employee skills are a key element for an efficient project delivery (that is, respecting project planning, cost and quality objectives) [5]. It is essential that the right resources are assigned to each project in order to maximize the best possible result, contributing to the customer's satisfaction and the company's success. Knowing that an inefficient selection of resources harms all stakeholders involved and influenced by the project, it may be concluded that the current KIP process has to be aided by decision support tools [7].

## 3 Literature review

### 3.1 Project management tools

According to one of the most recognized guides in the field – PMBOK – defines project management as the application of knowledge, skills, tools and techniques to project activities in order to meet their requirements [7]. To manage a project, it is necessary to cover several areas: scope, time, costs, quality, human resources, risks, communications and acquisitions [7]. The problem to be addressed in this paper is in the area of human resources, and it is important to distinguish between the various approaches used to manage them. Project management is often used to allocate resources and level resources. Human resource allocation is understood as the technique of ensuring that for every project activity to be executed, there is a responsible resource. Levelling human resources refers to the proper work distribution among the people in the project. On the other hand, and not so explored, the human resource recommendation approach intends to determine the most appropriate resource to be allocated for a project, having a direct influence on the project's final performance [8].

According to [7], to recommend human resources for projects, the following characteristics should be considered: (i) previous work experience: whether individuals have done similar or project related work before; (ii) personal interests: if individuals are interested in working on the project; (iii) personal characteristics: whether individuals work well together; (iv) availability: whether individuals will be available in the required time periods; (v) skills and proficiency: whether individuals possess the necessary skills.

Based on a research carried out over the existing project management tools, it was possible to conclude that although there are softwares that covers the great majority of the project management needs, none of the most used programs has the capacity to recommend adequate resources staffing.

### 3.2 Methodologies to Recommend Human Resources

Few strategy scholars would question that an adequate selection of resources is critical for good project management [9]. This process is crucial for the generation of productive teams and can also help in the systematic development of skills in the long term. Despite the importance of identifying the right people to perform specific functions, little is known about how to do this correctly [3]. Most managers normally base the decision-making process on their experience, heuristic knowledge, subjective perception and intuition, and there is little literature on this topic [9]. The following paragraphs present some of the methodologies identified to recommend resources for projects.

In [3] it is proposed an allocation model that evaluates the skills of human resources based on their profile and promotes an affectation of the same for the projects with greater compatibility. Through tools like the 16PF (questionnaire that evaluates the personality of the collaborator), a parallelism between the characteristics of the personality of the resources and the skills that these are likely to possess is drawn. This model considers that all skills have the same weight in the allocation decision.

It was also suggested a tool that uses the RBC (case-based reasoning) technique, which uses historical data from previous experiences to recommend the resources for new projects. The tool uses the algorithm of the nearest neighbour to return a list of recommended resources [8].

Assuming that the time spent to develop new skills is directly related to the level of knowledge that a resource already has of other skills, in [10] the Best-Fitted Resource methodology is used to define the most adequate resources to be assigned to a project. For this purpose, weights are assigned to the skills needed to perform the projects. Subsequently, an overall value of the resource adequacy for the project is obtained.

In [11] a voluntary allocation process was proposed, in which the project teams are made up of employees who propose themselves to carry out the projects. This promotes the motivation and commitment of the workers, having limitations related to the number of people who volunteer for the projects and their skills.

None of the referred methodologies presents a solution for KIP's problem since they do not consider all the necessary dimensions. Some only take into account technical skills [3; 8; 9] while others only account for the subjects will [10]. Also, the identified methodologies incur on some of the well-known mistakes reported in the decision analysis literature, weighting criteria solely on the basis of the intuitive notion of importance [9], using linear functions to measure performance [8] and ad-hoc criteria weighting [3].

Thus, it was concluded that a new approach was necessary to evaluate how compatible human resources are for the projects, in order to better establish the method of recommendation of KIP resources. This evaluation should consider the multiple objectives of the company, motivation and the development of the employees and, at the same time, be theoretically sustained, without committing the typical technical errors reported. It is also intended that the development of this new approach involves the stakeholders of the problem, in order to consider all viewpoints.

Concerning the intended specifications, the multicriteria decision analysis stands out as a methodology with the potential to evaluate the KIP's collaborators suitability.

### 3.3 Multicriteria decision analysis

Decision analysis is a branch of Operational Research that has undergone a progressive growth in the last decades [12]. There are many approaches that have emerged in the context of decision analysis, including multicriteria decision analysis (MCDA), since it has become imperative to weigh risks and to break down the problems into multiple objectives to make responsible and conscious corporate decisions [12].

We can describe "MCDA as an umbrella term to describe a collection of formal approaches which seek to take explicit account of multiple criteria in helping individuals or groups explore decisions that matter" (in Belton&Stuart, 2002, p. 17). Despite the natural inclination to rely on the human mind's ability to make good judgments decisions, numerous scientific studies have shown that the non-oriented decision-making process is subject to several forms of inconsistency [13].

In order to engage in a multicriteria decision-making process, three key stages [14] must be respected:

(i) identification and structuring of the problem, meaning "unfolding" the problem under analysis, identifying its scope, the main areas of interest, the entities that are involved and recognizing the importance of its resolution;

(ii) construction and use of the model: extracting the essence of the problem and translating it into a language that allows supporting a decision analysis, in order to move from "complexity to simplicity" (in Belton&Stuart, 2002, p. 21). In this stage the alternatives to be considered in the decision and the criteria that should differentiate them are defined, a multicriteria model is developed, the alternatives are evaluated and the results are questioned;

(iii) action plan outline: conclusions of the decision support process are withdrawn and the alternatives that best solve the problem are recommended [14].

Although all methods in the multicriteria analysis have in common the requirement to assign some measure of relative importance to the different criteria, they differ regarding the information they need and in the way their models analyse the alternatives [14]. The three main methods in this context are: Value Measurement Methods, Outranking Methods and Goal Programming Methods [14].

The Value Measurement Theory is based on the fundamental principle that the comparison of alternatives may be achieved through their association with a real value that allows obtaining an order of preference of the same, consistent with judgments of a decision maker [14]. The most widely used methods to construct and implement models based on this Theory are the Multiattribute Value Theory (MAVT). These are among the most applied and explored methods multiple criteria methods [14]. To aggregate the value of alternatives and allow their comparison, the MAVT methods often resort to the Additive Model due to its simplicity, transparency and easy application [15].

The following explanation of the characteristics of the additive evaluation model refers to the symbols and terminology adopted in [16].

The additive model allows obtaining the overall value  $v$  of an alternative  $x$ , by summing the products of the partial value  $v_i$  of the alternative in the evaluation criterion  $i$  ( $i = 1, \dots, n$ ) with the criterion's assigned weight  $w_i$ . To obtain these partial values  $v_i$  in each criterion, we resort to value functions that designate a value to the different levels of performance  $x_i$  of the descriptors of performance of each criterion.

$$v(x) = \sum_{i=1}^n w_i v_i(x_i) \quad (1)$$

The criterion's weight must be positive and normalized according to equation 2.

$$\sum_{i=1}^n w_i = 1, \quad w_i > 0 \quad \forall i \in [1, n] \quad (2)$$

The global value  $v(x)$  provides quantitative information on the extent to which each alternative contributes to the satisfaction of the previously defined objectives, according to the preferences of the decision-maker. Thus, if the overall value of an alternative A is greater than the overall value of alternative B, it is concluded that the former is preferable [17].

In order to establish the value functions and to perform the criterion weighting, several techniques may be used within the MAVT methods, such as those shown in Table 2.

Table 1: Techniques used to define value functions and weigh criteria

Techniques to establish value functions	Techniques for criteria weighting
Bisection Method (Quantitative)	Swing Weighting (Quantitative)
Direct Rating (Quantitative)	Trade-off (Quantitative)
MACBETH (Qualitative)	MACBETH (Qualitative)

Quantitative methods such as Direct Rating, the Bisection Method, the Swing Weighting and Trade-Off require the decision maker to express numerical judgments about the attractiveness of a given performance level to define value functions and weigh criteria [14]. However, providing numerical estimations can be a difficult task for the decision maker, since it is counterintuitive to use numbers to express personal preferences in an abstract context.

On the other hand, MACBETH is a qualitative method that uses the decision-makers' judgments about differences in attractiveness, thus avoiding the difficulty previously mentioned [18]. In the context of KIP's problem, since it is intended to provide subjective judgements concerning humans, this approach represents additional value.

MACBETH, developed by Bana and Costa and Vansnick (1994) [19], is an interactive multicriteria decision-making approach used to construct qualitative judgments of comparisons between two elements [16]. This approach is used both to structure a multicriteria model as to evaluate and test it. It has a strong sociotechnical component, as it resorts to the judgments and opinions of the problem's decision-makers, throughout the structure and construction of the decision support model. This interaction can be performed through decision conferences and interviews, always with a professional in multicriteria decision analyses performing the role of a facilitator who guides the group to define the model and obtain results. To apply the MACBETH approach in decision analysis it is possible to resort to the M-MACBETH software [20]. This allows the structuring of the model while detecting inconsistencies in the introduction of the decision-maker's judgments. Finally, it also provides the possibility of performing sensitivity and robustness analyses on the intrinsic and relative value of the alternatives to be evaluated by the model [21].

Unlike the value measurement methods, Outranking methods do not involve a value function to estimate an aggregated value of each alternative. The final result does not correspond to an overall classification of each alternative, but rather an outranking relationship between the various alternatives. An alternative A is said to overcome another alternative B if, taking into account all the information concerning the problem and the preferences of the decision maker, there is a solid argument that supports the conclusion

that A is as good or better than B and that there are no strong arguments otherwise [14]. Thus, the general principle of these methods is based on the concept of dominance [17]. Methodologies based on the Outranking model require the specification of some subjective parameters in addition to the definition of weights, such as concordance and discordance thresholds. The implications of this choice are difficult to assess, which is a disadvantage of this approach regarding the KIP' problem.

Goal programming methods are a variant of linear programming focused on the achievement of objectives [22]. Thus, they resort to an objective function defined according to the desired goals, so that the deviations from the goals penalize that function. Goal programming methods are intuitive and appropriate tools for problems that are familiar to the decision-maker and where the notion of satisfactory performance is clear. However, these methods are more complex than methods based on the additive model because they involve a greater number of constraints in the definition of the global value of each alternative, and there are no additional benefits of applying them to evaluate human resources.

In conclusion, using a MACBETH approach to construct an additive aggregation model is the best option for the KIP's problem. The possibility of using structured software and defining the functions of value of the criteria only on the basis of qualitative judgments represents added value. Furthermore, the sociotechnical component of this approach provides transparency in the structuring and modelling process, which contributes to a greater confidence in the evaluation results of the alternatives. Having been proven through existing examples in literacy its applicability in human resources assessment [23], the MACBETH approach was chosen to build the decision support tools for the case study under analysis.

## 4 Methodological Framework

### 4.1 Proposed methodology

Considering the collected information throughout the literature review, it is intended to create a multicriteria approach that supports the recommendation of human resources to KIP's projects by evaluating the collaborators' suitability for the project.

This approach will consist on supplying tools based on multicriteria models for each resource selecting stage of a project, providing a structured support system to situations where the assignment of employees is not clear.

As for each KIP's projects, there is the need to select an EM for the project's planning phase (Planning EM), an EM for the implementation phase (Implementation EM) and Consultants also for the implementation phase. The developed approach needs to consider three distinct tools - Tool 1, Tool 2 and Tool 3 - to support during the various selection stages of the initial life cycle of KIP's projects (steps 2 and 4 of Figure 1).

The multicriteria models of these tools intend to evaluate each Consultant and EM assigning them into categories of attractiveness according to their suitability for taking on each project. As KIP decided that to differentiate in three categories its collaborators would be enough to consider all the company's objectives, these categories will be represented by the colours - green, yellow and red - corresponding, respectively, to the levels 'Very Adequate', 'Adequate' and 'Poorly Adequate'.

Given the distinct nature of the criteria needed to select EMs and Consultants, based on the theoretical foundations of multicriteria analysis, two multicriteria models were constructed. Tools 1 and 2 are composed of the same model

that will consider criteria for evaluating EMs - Model A - and Tool 3 resorts to a model to evaluate Consultants - Model B.

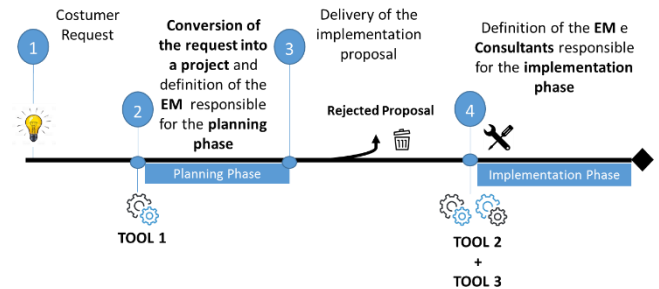


Figure 1: Proposed approach

In addition to these multicriteria models, Tools 1, 2 and 3 are also composed of *eligibility rules* for screening EMs and Consultants at an initial stage, defining which ones should be evaluated by the multicriteria models, and *selection rules* that intend to guide the selection process after the models evaluation of the alternatives, defining who should be the selected employee(s) for the project.

Figure 2 shows a general outline of the sequence of activities that compose each of the Tools 1, 2 and 3.



Figure 2: General outline of Tools 1, 2 and 3

The development of the tools is carried out through a sociotechnical approach using the decision-conference process, existing face-to-face interaction between stakeholders who play the role of decision-makers and an impartial facilitator, expert in decision analysis.

The selected decision-makers of this approach were a KIP Senior Partner and a Project Leader, due to their degree of influence, knowledge of the strategic interests of the company and availability.

The construction of the multicriteria models - Model A and B - was done resorting to the MACBETH approach where the differences in attractiveness between the alternatives were established through qualitative judgments. From these, the weights of the criteria and the scores of the alternatives in each evaluation criterion are obtained. Figure 3 presents the methodology employed for the construction of the multicriteria models and it is composed of several activities correlated and developed between the facilitator and the group of decision-makers.

### 4.2 Methodology for building the multicriteria models

According to Figure 3, during the model structuring screening criteria are defined. These intend to restrict the alternatives that should be considered in the models, defining mandatory requirements related to the projects. The evaluation criteria, in turn, are integrated in the multicriteria models and represent the dimensions on which the alternatives are evaluated. To ensure that they are properly defined, they must meet certain requirements such as being consensual, independent, exhaustive, measurable, non-redundant, operational and concise, so that performance descriptors can be constructed [24]. A value tree format is used to represent the evaluation criteria, allowing decision-makers to visualize and validate the structure of the model. The evaluation criteria are then operationalized through descriptors performance. According to Bana and Costa, this descriptor consists of an ordered set of plausible levels that allow decision-makers to measure how much a given



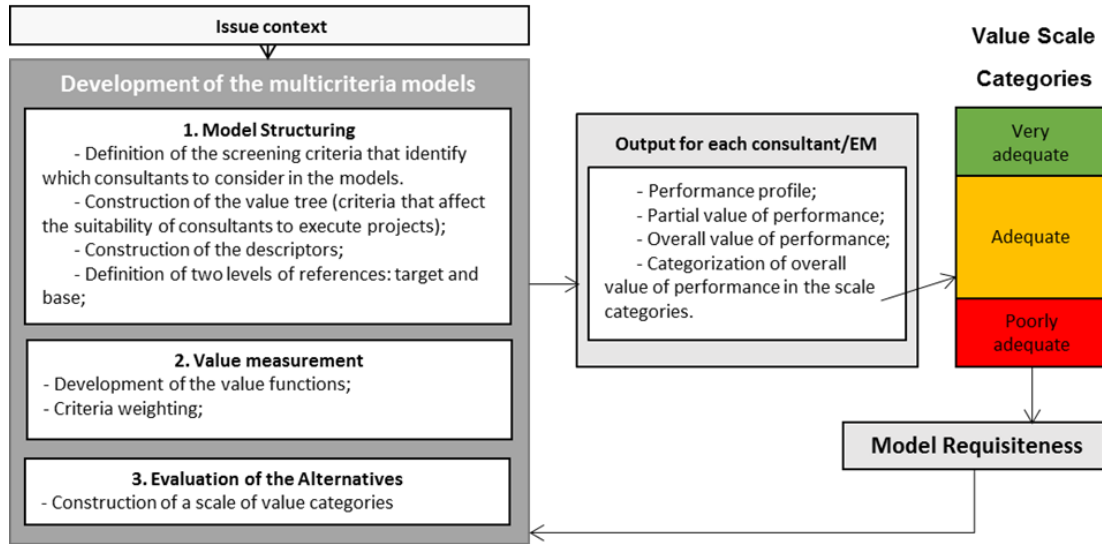


Figure 3. Methodology used to build Model A and B

alternative contributes to achieving the defined objectives [25]. Defining an upper and lower reference level for each descriptor, typically referred to as *Good* and *Neutral*, also contributes to the intelligibility of a criterion, because it allows you to identify a threshold from which the levels of the performance criteria are attractive and, on the other hand, a limit of indifference that identifies levels less attractive. These reference levels are normally associated with the values of 0 and 100, respectively.

After building the structure of the model, the definition of the value functions for each evaluation criterion and the determination of their weights takes place, in order to construct an additive model and obtain the overall benefit of each alternative. Constructing a value function for each evaluation criterion requires the determination of the function –  $v_i(x_i)$  in equation 2 – that assigns a score value to each performance level  $x_i$  contained in the descriptor of performance  $X_i$ . These functions should translate the preferences of the decision-makers and allow the assessment of the local impact of the alternatives.

Using the MACBETH approach implemented in the M-MACBETH software, it is possible, through qualitative judgments, to define the differences of attractiveness between the various performance levels of the criteria, by filling a matrix of judgments with the following semantic scale: Extreme, Very Strong, Strong, Moderate, Weak, Very Weak, Null. Afterwards, the software automatically generates a quantitative scale assigning values to each one of the performance levels, and allowing to associate a score to the alternatives in each criterion. Subsequently, based on this score, and on the criterion weights the additive model aggregates these scores and calculates a global value of the alternatives.

For the determination of the weighting coefficients of each criterion within the MACBETH approach, the facilitator questions the decision makers as to the differences in attractiveness of pairs of fictitious alternatives. These fictitious alternatives represent extreme profiles in which they only present the classification of *Good* in 1 of the criteria and *Neutral* in the rest. Besides these, another fictitious alternative is also considered that, unlike the others, has *Neutral* classification in all the criteria [26]. Decision-makers should then make comparisons between alternatives and introduce in each cell of the matrix of judgments the intensity by which they prefer a fictitious alternative with *Good* level in a given criterion relative to another alternative with only *Good* level in another criterion. In the last column of the matrix, the judgments evaluate the attractiveness of going from the

*Neutral* to *Good* level in each criterion. After the validation of the consistency of the judgment matrix, the weights of each criterion are proposed by the program and can be adjusted by the decision makers within the range of values indicated by M-MACBETH.

After the construction of the models, the alternatives must be classified according to three categories: Green, Yellow and Red - corresponding, respectively, to 'Very Adequate' collaborators for the project, 'Adequate' and 'Poorly Adequate'. For that purpose, a range of global values should be assigned to each category, limiting it to the value of separation profiles that split adjacent categories. The definition of these separation profiles should be done with the decision makers of the problem.

Since in the case of KIP's problem it is only necessary to define two separation profiles (once they only require three categories), the *Good* and *Neutral* reference profiles were used to do this separation. Thus, establishing the following rules (4.1) according to [23], the value ranges of the categories are defined.

$$\text{Categories: } \begin{cases} \text{'VeryAdequate'}, & V > 100 \\ \text{'Adequate'}, & 100 \geq V > 0 \\ \text{'Poorly Adequate'}, & V \leq 0 \end{cases} \quad (3)$$

In the former equation,  $V$  represents the global value of the alternatives. Alternatives with an overall value greater than 100 (*Good* reference profile value) should be associated with the Green category; alternatives with a global value between 0 and 100 should be associated with the Yellow category; and finally, alternatives with an overall value less than or equal to 0 should be classified as Red. The use of these profiles of reference to make the separation of categories is only possible if it is clear to the decision-makers the profile (performance level in each criteria) that a *Good* and *Neutral* collaborator should have.

#### 4.3 Methodology for defining the eligibility and selection rules

Currently, the human resource selection process resorts to a set of rules that are intuitively used to filter and select the employees that should be allocated to the projects. For the construction of the tools, it is intended to decipher the intrinsic logic of the selection process through an iterative process in which several scenarios are explored together with the decision makers of the problem.

The definition of eligibility rules aims to define which employees meet the requirements necessary to be considered in the multicriteria analysis.

On the other hand, the selection rules aim to provide KIP's decision makers with a structured way of identifying the employee they should recommend for the project, after categorizing the alternatives through the multicriteria analysis.

The next section presents the building of the tools adopted by KIP.

## 5 Applying the Proposed Methodology

### 5.1 Building the multicriteria models

#### 5.1.1 Model A

As defined in the previous chapter, the Tools 1 and 2 intend to allocate the EMs respectively for the planning and implementation phases of the project, by resourcing to Model A in order to evaluate and categorize the eligible employees.

To build this model, three decision conferences took place between the facilitator and the model decision makers. The first sought to generate ideas and clarify the most relevant issues in the process of selecting EMs. With the information obtained, the screening and evaluation criteria of the models were defined, as well as its respective descriptors of performance. In the second decision conference, the decision-makers approved this first model structure and the definition of the value functions took place. Finally, at the last conference of this model, the weights of criteria were defined.

Trough discussions the following screening criterion were established:

1. The EM must have implemented all the KIP tools required by the new project at least 1 time in past projects (each project may require up to 3 of the 7 KIP tools);
2. The EM must have run at least 1 project;
3. If the project is international, the EM must be available for travelling to a foreign country;
4. The sum of km travelled per week by the EM, in case he is selected for the project, must be less than 500kms.

Considering the requirements evaluation criteria have to meet (already previously mentioned), the evaluation criterion which captures all of the fundamental aspects for evaluating the EMs suitability for projects were introduced in the M-MACBETH software as presented in Figure 4.

When observing Figure 4 it is possible to the 5 assessment criteria represented in red – *Project management skills, technical skills, Human Skills, Motivation and Trips* – and the ramifications to yellow intend to indicate the various components that these criteria include and which will be considered in their operationalization.

To make the criterion operational for the evaluation of alternatives, descriptors of performance were built as presented in Table 2.

For criterion *Technical implementation skills*, as well as for *Project management skills*, it was considered that the level of skill depended on the number of projects executed by the collaborates. The descriptor of *Technical implementation skills* is made of three ranges of knowledge regarding KIP's tools: having applied the tool in 1 or 2 projects; have already applied the tool in 3 to 5 projects; and, finally, having applied the tool in more than 5 projects. From this last degree on decision-makers consider that knowledge stabilizes. Each project undertaken in the KIP can require up to three of the seven KIP tools made available by the company. To define a qualitative descriptor for this criterion it was necessary to

create combinations of the different degrees of knowledge in the various tools required.

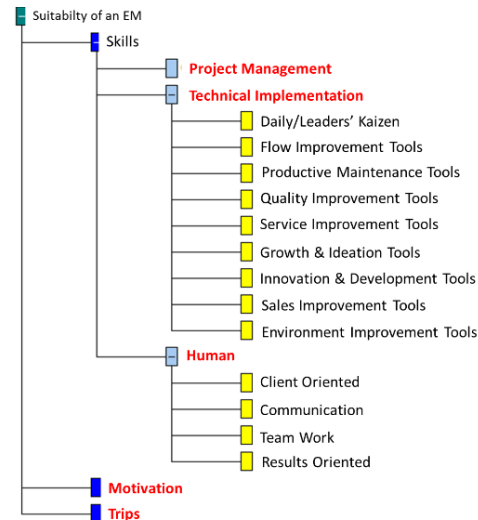


Figure 4. Model A Value Tree

For the *Human skills* criterion, a qualitative descriptor of performance was built only considering what KIP defines as the most valued human competencies. For the *Motivation* criterion, only three levels representing the will of a collaborator for the project execution were defined as a qualitative descriptor. Finally, for descriptor of the *Trips* criteria, it was considered the number of weekly kilometres undertaken by the employ.

Two reference levels were defined for each criterion, the *Good* level (performance unquestionably attractive) and *Neutral* (neither attractive nor repulsive performance) identified by the very clear notion of the decision-makers of what was the performance a 'Very Adequate' employee and 'Poorly Adequate', should have. The correct definition of these reference level usually assumes a substantial importance during model building, because it affects the process of weighting criteria. Furthermore, since these are also going to be the performance levels of the reference profiles used to separate the categories of the models, their correct definition is even more important.

To build the value functions it was requested that the decision-makers filled-in the judgement matrix of each criterion in M-MACBETH by classifying qualitatively the difference of attractiveness between levels of performance using the seven semantics categories. For this purpose, the facilitator made questions like: "In the *Project management skills* criterion what is the difference in attractiveness between selecting an EM who has already managed 1 project and one who has managed 5 (knowing that the two EMs have the same performance in all other criteria)?" As the Decision-makers ranked this difference in *Extreme* attractiveness, the respective matrix entry was filled with this judgement (Figure 5 entry 5-1).

This procedure was repeated to compare all levels of performance in all evaluation criteria.

	5	4	3	2	1
5	nula	weak-mod	strg-vstr	extreme	extreme
4		nula	moderate	v. strong	strg-vstr
3			nula	mod-strg	strg-vstr
2				nula	strong
1					nula

Figure 5. M-MACBETH Judgment Matrix for Criterion Project Management skills

Table 2. Model A

Weight	Criterion	Descriptor of Performance	Performance Levels		Value
33%	Project Management Skills	Nº of autonomously managed projects.	1		-66.67
			[NEUTRAL] 2		0
			3		50
			[GOOD] 4		100
			5		133.33
28%	Technical Implementation Skills	Combination of the number of projects implemented in each one of the KIP tools required by the new project.	1-2	1-2 implemented projects in all the necessary KIP tools	-41
			(1-2)*2;3-5	1-2 projects carried out in two of the required tools and 3-5 projects implemented on a third required tool	-33
			(1-2)*2;>5	1-2 projects carried out in two of the required tools and >5 projects implemented on a third required tool	-12
			[NEUTRAL] 1-2;3-5	1-2 projects carried out in one of the required KIP tools and 3-5 on the second tool	0
			1-2;(3.5)*2	1-2 projects carried out in one of the required KIP tools and on the other two tools 3-5 projects	33
			1-2;>5	1-2 projects carried out in one of the required KIP tools and > 5 on the other	37
			1-2;3-5;>5	1-2 projects carried out in one of the tools; 3-5 projects carried out on a second tool; > 5 in a third	42
			1-2;(>5)*2	1-2 projects carried out in one of the required KIP tools and on the other two > 5 projects	83
			3-5	3-5 projects carried out in all of the KIP tools you needed	87
			(3-5)*2;>5	3-5 projects carried out in two of the KIP tools required and on the third > 5 projects	96
			[GOOD] 3-5;>5	3-5 projects carried out in one of the required KIP tools and > 5 on the second	100
			3-5;(>5)*2	3-5 projects carried out in one of the required KIP tools and in the remaining two tools > 5 projects	104
>5	>5 projects carried out in all the KIP tools needed	121			
23%	Human Skills	Employee's level of competence in the inter-human and intra-human relationship attributes more valued by KIP.	[NEUTRAL] Week	The consultant does not have strong human skills, being more suited to perform more technical papers – Works in accordance with the established goals; Correctly interprets his customers' needs; Communicates effectively his views but is resistant to third parties' feedback; Respects his colleagues, however, prefers individual work.	0
			[GOOD] Median	The consultant has appropriate expertise for a good project execution but does not stand out from other colleagues – Finds effective ways to achieve the objectives taking into account the cost-benefit ratio; Investigates about his clients' problems proactively; Transmits information with clarity and expresses himself with coherence, using feedback in order to facilitate interaction; Respects his colleagues and is positive in the collaboration with others.	100
			Complete	The consultant is distinguished by his excellence in all human skills valued by KIP - He develops actions to surpass his objectives and to obtain results superior to the committed; Anticipates customer expectations and strives to overcome; He is persuasive and leads with empathy and assertiveness the discussions in which he is involved; Promotes team development and promotes skills education.	200
11%	Motivation	Level of interest that the developer has to have in order to be selected for the new project.	Against	The employee does not want to execute the project.	-300
			[NEUTRAL] Neutral	The employee doesn't mind executing the project	0
			[GOOD] Motivated	The employee wants to execute the project since it is in line with his goals of career progression.	100
5%	Trips	Nº kms that the employee will weekly do, if allocated to the new project.	500		-66
			[NEUTRAL] 400		0
			300		55
			200		80
			[GOOD] 100		100
			0		143

While inserting the qualitative judgments in the M-MACBETH matrixes, sometimes the software pointed out inconsistencies in them and proposed other judgments. In each case, the suggestion was discussed among decision-makers until a consensus was reached.

Once assured the consistency of the judgements, the software built a quantitative scale that assigned a score to each level of performance of the criteria. These scales were subsequently validated by the decision-makers, who could

changed them if they disagreed with the values of the scores without disregarding the previously defined judgments, since within the limits of the range of values defined by the software.

Note: All data regarding Model A is presented in Table 2.

After the having defined the evaluation criteria, the descriptors of performance and built their value functions, the definition of the criteria weights took place.

To this end, a similar procedure as the one used to build the value functions was undertaken. It was requested that the decision-makers considered a hypothetical profile with a *Neutral* performance in all criteria. Afterwards, the following question was made: "If you could alter (swing) from *Neutral* to *Good* the level of performance of only one criterion, which criteria would you choose?". Having answered the criteria of *Project Management Skills*, the Decision-makers defined it to be the most important swing. This same process was repeated until all the swings were ordered according to their importance. After ordering the swings of the criteria, a judgment matrix was filled with the decision-makers, representing the comparisons of the attractiveness of swings between the criteria with questions such as: "if in all the criteria the performance level were *Neutral*, how attractive would be *Neutral* level for *Good* only the criteria *Project Management Skills*?"

### 5.1.2 Model B

After building Model A, the focus turned to Model B which aims to assess the suitability of the alternative Consultants which can be dedicated to the projects during their implementation phase. To develop this model, only one decision conference was required, once it was concluded that there are many similarities between it and Model A.

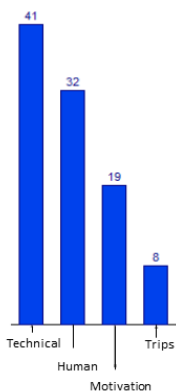


Figure 6. Model B criteria and criteria weights

When structuring Model B it was found nearly all points of view valued in choosing an EM were also applicable to the selection of Consultant. This is because, apart from the management dimension (present in the role played by the EM in the project), the day-to-day life of a Consultant is quite similar to the EMs'. Both have to apply the KIP tools, do trips, deal with people and be motivated.

It was also adopted as a working hypothesis to consider the same descriptors of performance and value functions of the criteria used in the Model A. After validation, it was defined that for the construction of the Model B it would only be necessary to define new weights for the criteria. The final results are presented in Figure 6.

The building of the models was then concluded. To validate them, a sensitivity and robustness analyses of their alternatives' evaluation and categorization took place in section 6, through the application of the models to assist on the selection of employees for a hypothetical project.

## 5.2 Defining the Eligibility and Selection Rules

As already mentioned, the eligibility rules aim to define which of the total set of EMs and KIP Consultants are eligible to be selected for the project execution. These rules allow the tools to consider in any selection process: (1) the form of which the costumers' contact was made with KIP; (2) the planning phase EM's availability to do the implementation phase; (3) the creation of project teams in which the EMs and

Consultants belong to the same KIP sub-team; and (4) the screening criteria of the multicriteria models.

Note: The eligibility rules complement the model's screening criteria. The decision to differentiate these two dimensions was made because, although the screening criteria are the same regardless of the alternatives, the eligibility rules consider different scenarios and it would be very confusing for the reader if both were merged.

On the other hand, the selection rules, aim to identify which EM or Consultant should be recommended for the projects' executions, based on: (1) the evaluation and categorization of the multicriteria models; (2) the strategic importance of the projects (*Normal* or *Strategic*); and (3) the employees' availability. These rules allow the tools to consider the development of professional skills of employees KIP during the selection process.

In Figure 7 Tool 1 is presented, with all its components – eligibility rules, multicriteria Model A and selection rules. In order to interpret the tool and its' rules, a detailed description is made:

### 1<sup>o</sup> Eligibility Rules

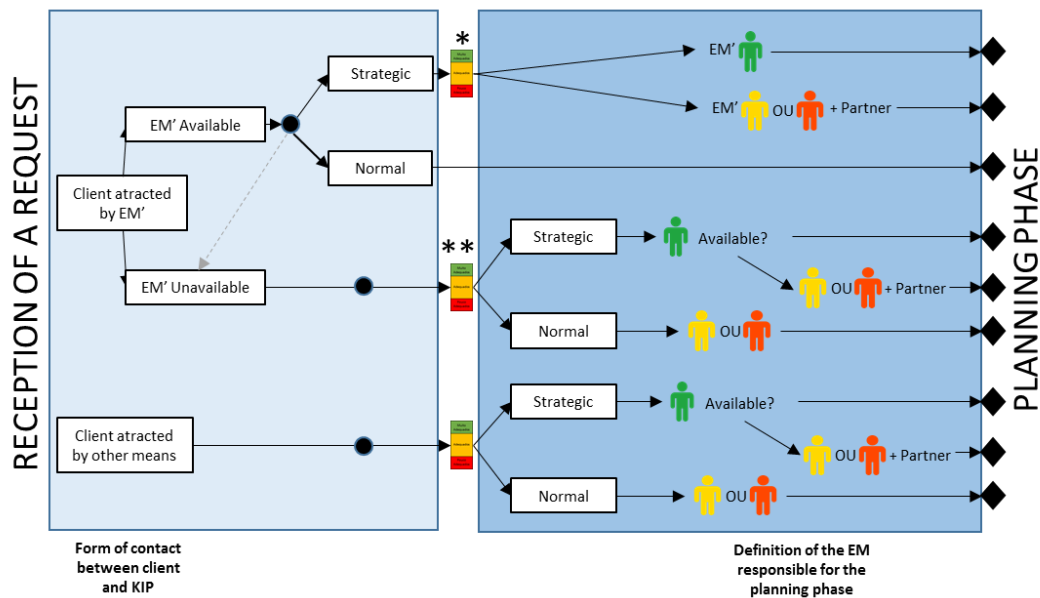
- i. If the client contacts KIP through an EM (represented as EM' in the scheme in order to differentiate him from the remaining other KIP EMs) his availability for being responsible for the planning phase of the project should be checked:
  - a. If he is available, it should be analyzed if he respects Model A's screening criteria:
    1. If he doesn't, it should be as if no EM' was ever available (following rule *i.b*);
    2. If he does, the projects' strategic classification should be analyzed:
      - If it is *Normal*, EM' should be directly recommended as the EM responsible for the project's planning phase.
      - If it is *Strategic* there is the need for evaluating and categorizing EM' by resorting to Model A;
  - b. If EM' isn't available, all KIP EMs (except EM') should be subject to Model A's screening criteria, and the eligible alternatives should be evaluated and categorized in Model A.
- ii. Situations where the client addresses directly the company or the contact is established with an employee that does not correspond hierarchy to an EM, Model A's the screening criteria should be applied to all KIP EMs. The valid alternatives should be evaluated by the Model A.

### 2<sup>o</sup> Evaluation and Categorization of the alternatives resorting to Model A

#### 3<sup>o</sup> Selection Rules

- iii. If the applied eligibility rules were *i.a.2.Strategic*, the EM' category attributed by Model A should be checked:
  - c. If EM' was categorized as Green, he should be selected for the project's planning phase;
  - d. If he was evaluated in a Yellow or Red category he should be recommended to plan the project, but an available Partner should also be selected to help him;
- iv. If the applied eligibility rules were *i.b*, or *ii*, the project classification should be analyzed:
  - e. If the project is *Strategic*:
    3. The most suitable (with greater overall value) and available Green EM should be selected to plan the project;
    4. If there is no Green EM available, the most suitable available Yellow EM and an available Partner should be selected;





**Legenda:**

- \* In this analysis EM' should be the only one considered
- \*\* In this analysis all KIP EMs should be considered, except EM'.
- ← If EM' does not comply with all Model A's screening criteria, he shouldn't be considered as an eligible employee for the project, and the process should be as if he was never available
- Application of Model A
- Analyzing whether the alternatives meet Model A's screening criteria requirements



Figure 7. Tool 1

5. If there is no Green or Yellow EMs available, the most suitable Red EM available and Partner should be selected;
- f. If the project is classified as Normal:
  6. The most suitable Yellow EM should be selected;
  7. If there is no Yellow EM available, you must suitable available Red EM should be selected for the projects' planning phase.

Tools 2 and 3 have a similar configuration to tool 1, but due to space limitations, they were not able to be presented in this paper.

**6 Test and Validation of the Created Tools**

In order to analyze and validate the created tools 1,2 and 3, it was necessary to select a KIP project and simulate the human resources selecting process. To do so only a representative sample of collaborators was taken into account, with diverse geographies, experiences, motivations and different personalities. This approach simplified the results interpretation without compromising the validation of tools, allowing to make the desired conclusions. The test intended to sequentially select the planning phase EM, the implementation phase EM and the Consultants. To do so, tool 1,2 and 3 were applied in each moment with their respective eligibility rules, models and selection rules.

When applying each multicriteria model, they evaluated the alternatives and their global values were associated with the previously defined categories. Figure 8 illustrates an

example of the final result obtained when resourcing to the models.

To validate Model A and B, during the teste, a sensitivity and robustness analyses were made to each. Both analyses intended to confirm if slight alterations in the model's parameters would change the EMs and Consultants assigned category. The analyses results were afterwards discussed with de decision-makers and based on their experience and personal knowledge of the alternative in question, the category of the employee was approved, or it was decided that the models required modifications, in order to become *requisite*.

In the end, the KIP's decision-makers were very satisfied with the result, considering that the tools suited the companies needs and constituted a good support for their decisions when selecting human resources for projects. The hypothetical application of the tools in the project demonstrated their validity, because, according to the decision-makers, the collaborators were categorized along categories corresponding to reality and the recommendations made by the tools could be applied in a real scenario.

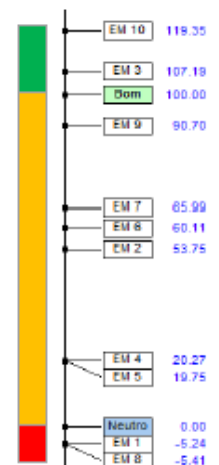


Figure 8. Categorization of the alternatives in each Model

## 7 Concluding Remarks

KIP suffered from the same problem many other companies do. The literature found revealed no method to recommend resources to projects that could satisfy it. Thus, an approach was developed to make use of multicriteria models that evaluated the collaborators' suitability to undertake projects, considering all relevant aspects of the problem. These models proved once again the potential of the multicriteria analysis MACBETH approach, since, through a simple process, it was possible to concentrate all the dimensions of a complex problem and solve an important issue for KIP. The developed approach also contributed to narrowing a gap identified in the literature of lack of structured methods to support the recommendation of resources to projects.

Although the decision-makers were very pleased with the created approach, naturally there is still some room for improvement. The definition of the *Human Skills* criterion only considered the core competencies valued by KIP, not exploring entirely the human component of a project, which represents a limitation in the built models. Also, it may be possible to improve the created tools by making them take into account other aspects, like, for example, synergies between elements. Despite the rules currently laid down for tools 1, 2 and 3 give preference for the choice of employees of the same KIP team, and the multicriteria models evaluate the suitability of the resources to meet the requirements of the project, it was not taken into account the interaction between EMs and the selected Consultants, which might represent a benefit for the project. Regarding the validation of the tools, it is also acknowledged that to fully validate the tools, it would be necessary to apply them in a real project, considering all the KIP collaborators. However, even if there is the need for changes, the tools are flexible and easy to alter.

Although the created tools represent a solution for KIP's problem, it is believed that the use of this type of methodology to select human resources will continue to face some disrepute, in particular by decision makers that benefit or are used to choose and define their teams. The proposed approach provides transparency in the structure of the tools and it is not intended to be used as a closed decision-making system, but rather a resource to support decisions. Notwithstanding, there is a natural resistance to change and a tendency to consider that it is not possible to shape a process that involves a large human subjectivity.

For future work, integrating the tools developed in this paper in a Decision Support System (DSS) would be a great asset for KIP, as it represents an automated process of selecting human resources for projects. Therefore, a step further would be to transform the tools created into digital language and by creating a database with all the required data (company's employee's availability, skills, motivations and trips). This way, it would be possible to achieve an automatic DSS to recommend resources for projects just by entering the data of the new projects in the system.

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