
Multi-criteria modelling to support the candidate selection process using ELECTRE TRI-nC method: The case of Robert Walters

Bernardo Teixeira Dias de Sousa Monteiro

ABSTRACT

The industry of specialized Human Resources consultancy has lived through times of deep transformation, both by traditional methods of work and by deep development of technological techniques. The recruitment and selection, due to its vastness, has been the target of an investment for task automation through Artificial Intelligence, Machine Learning or Chabot's, in order to increase the service level, customers and client's satisfaction.

In this work, in order to support the entire selection process of Robert Walters consultancy company, a multi-criteria decision aiding method (MCDA) is used, each allows to evaluate and categorize candidates, streamlining the process by increasing efficiency with decreasing time analysis and effectiveness by reducing human failures.

Recruitment is done without the aid of a decision support method, but the selection is made using an MCDA method developed for situations involving ordinal classification problems, called ELECTRE TRI-nC. This method allows us to evaluate candidates from different points of view and to consider Decision Maker preferences. Two models were built, one for Logistics Manager and another for Technical Manager, the selection process was built from a family of criteria and the candidates were assigned to categories.

The results obtained are close to Decision Maker's expectations, allowing 33% of candidates for Logistics Manager to be selected and 20% of candidates for Technical Manager to be included in the shortlist of candidates to be presented to Robert Walters clients.

KEYWORDS: Multi-Criteria Decision Aiding, ELECTRE TRI-nC, Outsourcing, Recruitment and Selection.

1. Introduction

The world has undergone several changes with a high intensity and at a great speed. In recent years there have been economical, technological, social, cultural, legal, political, demographic or ecological changes, which operate in the world in a joint and systematic way and, consequently, we can consider that unexpected results will be produced and with greater uncertainty for organizations. One of the areas that has undergone the greatest changes is the Human Resources (HR) [1].

There are several ways to describe the importance of people within organizations. There are different terms used to describe HR: human capital, intellectual assets and talent management, and imply that it is all people belonging to the structure, who lead to a better performance of their organizations (along with other resources such as financial, material and information). The most successful organizations are adapting to be able to include different types of people within their structure in order to achieve a common purpose. HR management involves a variety of activities, including a structured analysis of the competitive market environment and job design in order to ensure that the company's strategy is implemented with the greatest success [2]. Nowadays, companies must understand that people are a competitive differential that holds and promotes organizational success. They are also the main competitive advantage in a globalized, unstable, changing and fierce competitive world. Within HR management, the idea of centralizing and concentrating the provision of services in various departments of companies has always been well established.

This way, several companies around the world began to outsource the various areas that once belonged to the HR department, activities such as: integration, training and development, processing salaries and remuneration, management of benefits, hygiene and safety at work, evaluation performance and, finally, recruitment and selection.

Generally, when making decisions, a balance is required between several factors (sometimes explicit or, at other times, without conscious thoughts), so that, in a certain way, in Multi-criteria decisions all decisions must be conscious and aware of their impact. One of the principles of Multi-criteria Decision Aiding, MCDA is to help the DM - Decision Maker(s) to organize and synthesize all the information in order to make the informed decisions, considering several factors or criteria's [3]. A good HR management plays a decisive role in companies. Thus, the recruitment and selection process has to be done in a sustainable way to meet the success of companies (hence the need for companies be specialized in this activity). The purpose of recruitment and selection is then to find the best professionals in the market for a given position. Bearing in mind the importance of this activity within companies, an effort is made to find the best forms, processes, techniques and technological alternatives for carrying out recruitment and selection [4].

This work aims to improve the candidate selection process for consultancy companies specialized in HR, through a study based on the construction of a Multi-criteria model for decision analysis. The model is applied to the recruitment and selection process of Robert Walters, a consultancy company specialized in HR. We are here facing a problem of multi-

criteria nature, where it will be intended to choose a candidate or a shortlist of candidates, indicating the categories, which will be ranked from the worst to the best candidate, to be hired by the client.

The purpose is to build a decision model with the DM using the MCDA-ULaval software to obtain the candidates' assignment. Therefore, the goals of this work are: understand how the specialized HR industry is distributed, define the recruitment and selection process, understand and describe the concepts of MCDA and the ELECTRE TRI-nC method, develop a decision model to support the candidate selection process by classifying them in pre-defined categories, obtain results and perform sensitivity analysis with MCDA-ULaval software, and finally discuss the final results.

2. Case Study

Recruitment and selection has undergone several changes over time. Initially, the recruitment process was done internally by the companies that placed advertisements in the newspapers, if they wanted to recruit a person to fill in a vacancy. After the 1990s, major changes occurred in the definition of HR: managing people started to be related with search and acquiring talents. With improvements in Technology, there was also an innovation in the HR working model.

Nowadays, companies that want to be innovative and ahead of this market are driven to maximize efficiency of their daily processes. Recruitment companies have made investments in Artificial Intelligence (AI) and automation of their day-to-day activities. The recruitment and selection consultancies have used several tools for the recruitment of professionals, for example using the usual online publishing tools (such as Sapó Jobs, Expresso, Indeed, among others), internet page of the company, talent search through LinkedIn, Facebook, Instagram, Twitter and Glassdoor in order to advertise the vacancy. AI will increase the level of satisfaction from the candidate and client and obtain greater productivity, since AI will remove a lot of heavy work inside the recruitment process. It is possible to see in the market many tools like M Recruit to pre-screen and grade candidates according to their skill levels or DaXtra Search, an innovative and robust form of research that can be linked with multiple online sources like our CRM (Customer relationship management), it is possible to filter the best candidates based on context and relevance and we can search by keywords which make it more powerful.

In 2019 and 2020, recruitment companies started to give greater importance to AI, such as Machine Learning and Chabot's focused on candidates' experience. With Chatbot candidate's answers can be replied immediately and gives more time for the recruiter to focus on other functions. One of the most used tools employ as database is Profile, where we can introduce all information about candidates and clients and it's visible for everyone inside the company which leads to less misunderstood around the organization.

2.1 Robert Walters

Robert Walters (RW) is a world-leading specialist professional recruitment consultancy, operates in 31 countries around the world and born in 1985. RW has three

main brands: Robert Walters (focused on positions from middle to top management), Walters people (junior positions and temporary work) and Resource solutions (Recruitment Process Outsourcing and manage services). RW Portugal started in 2016 and it is mainly focused in 4 specialization areas: Engineering & Operations, IT (Information and Technology), Finance & Accountability and Marketing & Sales.

2.2 Recruitment and selection process in RW

The recruitment and selection process has 12 activities and 6 entities decisions. The recruitment and selection process in RW starts with a call for a client in order to understand if they are recruiting and try to schedule a meeting. After meeting with the client then they will start looking for candidates and after searching, the selection process will start with many stages between the candidate, RW consultants and with the client. Including many interviews, supposedly one with RW and between one and three with the client. For this study it will be focused in the selection process and it starts with the candidate call after screening the candidates in Figure 1.

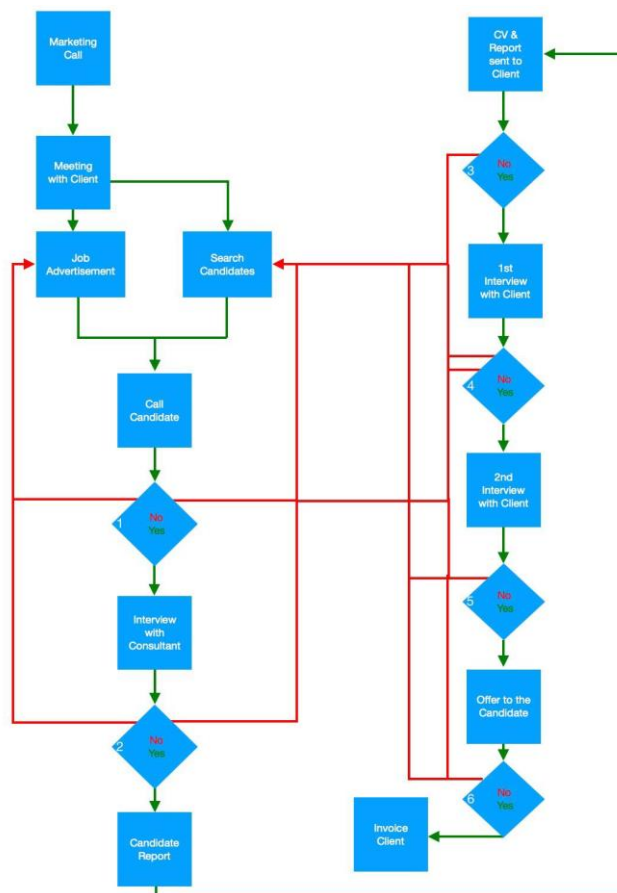


Figure 1 Robert Walters recruitment and selection process

3. Literature Review

3.1 Industry of consultancy specialized in Human Resources

With the change in the HR paradigm, different ways to support the types of activities that are carried out in an HR department have emerged, such as strategic planning, the development of company employees, their retention and the

hiring of the most appropriate professionals. Hiring people in the current competitive market is quite challenging, mainly due to the demand for the best professionals being greater than the existing offer, which is the reason for the same professionals generally compete between each other. The recruitment activity is a time consuming task, hence the need for specialized HR consultants and also another type of executive search for candidates to fulfil critical positions. Its purpose is to find the best professionals that meet the needs of companies. As we can see in Figure 2, the growth of the recruitment market from 2008 to 2019 is quite high, in 2008 with revenues of 350 to reach 481.2 billion US dollars in 2019. This market has almost always been increasing, except in 2009, due to the crisis that arose in the previous year with the bankruptcy of one of the largest investment banks (Lehman Brothers), having even triggered one of the biggest financial crises, since the crisis of 1929, as well as a big increase in the unemployment rate. In 2015 and 2019 there was a small decrease, and it is also expected that there will be a major decrease in the year of 2020 due to Covid-19, as many companies are not able to produce or maintain their activity for some months.

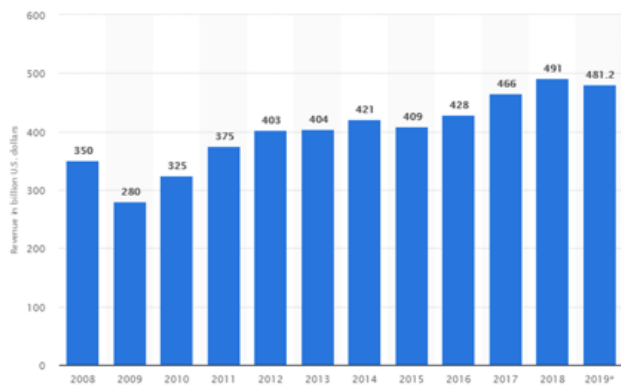


Figure 2 The global revenue figures for the recruitment industry from 2008 to 2019 in billions of US dollars [5]

We can see in Table 1 that this specialized HR consulting market has made the economy of several countries grow considerably due to the revenues recorded in the top 5 brands with the highest revenues in this market, totaling almost 100 billion US dollars.

Table 1 Top 5 revenues from HR Specialized Consultants (Adapted from the Staffing Industry Website) [6]

Company	2018 Revenue in Billion U.S. dollars	Headquarters country
Randstad	25.8	Netherlands
The Adecco Group	25.1	Switzerland
Manpower Group	21.6	United States
Recruit	13.5	Japan
Alegis Group	11.9	United States

The increase in global competition, coupled with customer expectations, leads the company to growth, or, contrarily, to eventual survival in a competitive market. Nowadays it is no longer enough to be effective in selling a specific product or service, or to be guided by the reputation of the players. Organizations need to have a quick response to deal with the changing global professional environment. Continued success therefore depends on attracting and retaining high

quality individuals who can respond quickly to these changes [7].

Lawrance Bossidy stated “I am convinced that our most important task is to hire and develop people. In reality, the bet is made on people and not on strategies.”

Recruitment is the process of defining and attracting a group of candidates, from which some will be chosen later for possible hiring for employment. The challenge will be to be able to recruit highly qualified candidates from an abundance of less qualified people who are also looking for the company. Even high-level positions like top management or administration are vacant due to a lack of good candidates [8].

3.2 Recruitment Process

The recruitment goal is to provide organizations with an effective workforce. Therefore, recruitment is considered as a means of achieving effectiveness and efficiency for organizations, through people (allowing favourable conditions for them to reach their personal goals).

The basic objective of the recruitment process is considered the creation of a set of candidates that make up a list, candidates that are properly qualified, allowing the subsequent selection of the best candidates for the company, attracting more and more employees. In turn, the basic objective of the selection process will be to choose the right candidates, from the list, making a shortlist for the client to fill the position or the various positions of the company [9].

Regarding the selection criteria, today, companies should not be concerned only with the characteristics of the position, but with the evaluation parameter should be the comparison between the individual and the company, should comprehend if the candidate has their values, their rites, its myths, understands their history, idiosyncrasies, its culture [10]. The selection process should be based on three questions, whether the candidate is ideal for the organization, whether his profile meets the company's mission and their values [10].

Headhunting companies use different ways of approaching the market, depending also on the position they intend to close, from direct approach instead of ads, having the function of identifying the intended professional and captivating him to accept a new challenge, since these top professionals are usually not available in the job market or don't respond directly to advertisements [11].

There are several ways of recruitment, external recruitment takes place when we want to fill a position, with candidates externally from the organization, who are attracted by the recruitment techniques or we can do it internally with candidates inside our company or in both ways, with external and with internal candidates. The methods by which the organization approaches and discloses the existence of a job opportunity with the most appropriate HR sources that provide candidates for the selection process, which are [1]:

- The search for candidates in the company's database or who present themselves through spontaneous application;
- The suggestion of candidates from the company employees;

- Publishing through advertisements in newspapers or magazines or websites; Contact with consulting companies specialized in HR;
- Search posters or advertisements in the organizations' lobby; Research in trade unions and associations;
- Searches at conferences and lectures at universities and schools;
- Contacts from other companies;
- Online recruitment;
- Trainee programs.

In RW the recruitment process starts the search inside Profile (which is a database where all the information about the candidates is placed, the interview notes, CVs, clients contacts, Jobs with the information of the ads, the clients descriptions and the contract signed between RW and the companies. In a second phase, job vacancy announcements are placed on various internet platforms such as the company's website, LinkedIn, Sapo Empregos, expresso or Indeed. Sometimes the search is also done with other LinkedIn tools, looking for people directly from the functions they have (using keywords) or from companies that participate in the same type of market and have certain profiles. A very common good practice is references from other candidates and in this market it is important to have a good name as it keeps the good name of the company by spreading the word through mouth, the type of advertising that RW has and seeks to maintain.

3.3 Selection Process

The selection refers to "the choice of the right man for the right position, or, more broadly, among the recruited candidates, the most suitable for the position" [4].

The entire selection process is based on two fields: job requirements (which are the characteristics that the position requires for the candidate), their knowledge, attitudes and skills, so that they can perform the position in the best way. It is essential to have the necessary information and data for each candidate, based on the use of two instruments: the selection interviews and various assessment tests [10].

There are several ways of selecting or screening candidates:

- **Curriculum vitae (CV) analysis:**

Are usually the first form of contact that the applicant has with the employer or the recruitment company. With this tool it is allowed to evaluate the biographical data, assuming that past behaviours and experiences are good indicators for the performance of the future function. That help to predict other variables, such as job satisfaction, turnover and career progression [12].

- **Assessment centres:**

Are considered a form of traditional sequential selection. This technique started at the time of World War II for the selection of officers. This technique aims to reproduce professional situations, which allow to recreate analogies of specific situations in which candidates are confronted with the performance of the function. This process is based on observing and evaluating the candidates' performance within several components, in order to reach a final decision [23].

- **Practical group exercises – focus:**

There is now an extensive methodological literature on the detailed practices of conducting focus groups, for recruiting and selecting participants, where they are, the development of a 'guide' question, the group's specific focus, role and technique of the moderator, "basic rules" for the conduct of the group, the structure and dynamics of the discussion, the practical aspects and notes by the "judges" [13].

- **Graphology:**

Graphological tests used by HR are complementary and sometimes even more useful than interviews. They allow to map some writing resources to a personality profile, combining the candidate's congruence with the ideal psychological profile for the position. Graphology can show the interviewer some hidden aspects of the candidate's personality and allows us to find any type of desired skill that the job requires, such as leadership, teamwork or organizational skills. A graphological analysis requires a complex process of interpretation, following the graphological premise that handwriting is personal and unique, there are many handwriting characteristics that psychologists analyse for a personal assessment. Examples of resources and related interpretation, according to characteristics, emotional expression, optimism and energy, traits related to aggressiveness, shape of individual letters (position of the bar t or i point are related to self-esteem), pressure during writing, signs of stress [14].

- **Interview with candidates:**

Is an interpersonal interaction with one or more interviewers and a candidate with a limited duration where it is intended to identify knowledge, skills, abilities, attitudes and behaviours in order to understand if the candidate has what is intended for the job. The interview should not only be to check if the candidate has the minimum requirements for the job, but also to understand if the candidate is the "prototype of a good candidate" for the interviewer.

Other aspects are verified at the time of the interview, such as the candidate's physical appearance, the presentation and the empathy that is made between the candidate and the interviewer, which may not even be directly related to the function, but which influence the HR technician's decision. Ways can be defined to characterize the interview, as being structured (it can be done face-to-face or by videoconference), or unstructured (it can be done by phone or in groups to save time and see the social interaction between the candidates) [12].

- **Professional References:**

Can be confirmed in different ways, sometimes to inquire about certain functions and positions performed by the candidate, it can be through contact with a former boss, or by letters of recommendation. There is also the possibility that a candidate will realize that he is not interested in the position, and may refer another candidate to the process.

- **Evaluation tests:**

Companies can request certain assessment tests that they intend the candidate to perform, such as Excel tests or other software in order to prove the candidate's proficiency, logical reasoning tests, and tests to assess specific skills and knowledge for the performance of the function. They can also request Case Studies, often used by consultancy companies to be able to evaluate all these types of knowledge, document the time that the candidate takes to perform the tasks and his

reasoning ability. Interviewers sometimes test candidates' fluency in languages to assess their level.

➤ **Personality tests:**

Several companies have chosen to carry out personality tests as a component in their recruitment processes to predict job performance, which from studies justify the effectiveness of this tool, by researchers. During World War II, personality tests resurfaced at the forefront due to military needs in recruiting pilots and soldiers [15]. Personality tests are generally psych diagnostic tests and require candidates to accurately describe their personality traits. The options for answering these questions are limited, for example, participants can ask true and false questions, or they can answer using a Likert scale. The 5 major personality factors are: extraversion, pleasantness, awareness, neurotic and openness to experience, directly related to genetic factors.

➤ **Psychotechnical tests:**

Can integrate the selection process, they are sets of exercises that aim to measure and assess whether the candidate has important aspects for the performance of the function, being able to assess mental development, abilities, skills and knowledge.

3.4 Outsourcing of Human Resources management and outsourcing activities

Increasingly, in today's world we can see that various activities within companies have been subcontracted, so that the company can be able to focus on its specialization and its "core business", developing its effectiveness, flexibility, innovation, quality and productivity and thus reducing fixed costs, freeing itself from HR management. With the increasing of globalization, outsourcing has become an important business approach and a competitive advantage that can be obtained as products or services are produced more effectively and efficiently by external suppliers [16].

Traditionally, outsourcing is a concept to illustrate the "usage of external resources". External demand means creating external value, and not within the company [16]. Strategically using external suppliers to perform service activities that have been traditionally internal functions [17]. Outsourcing can also involve the transfer of both people and physical assets to the supplier [18].

4. Methodology

In the business world, an important decision can be an organization's success or disaster. Deciding is sometimes not an easy task, especially when there are several criteria to consider. A bad decision can translate into the collapse of an organization, and in the current climate of turbulence and uncertainty, companies must know how to make the right decisions to become (and remain) competitive in an increasingly demanding market [20].

4.1 Multi-Criteria Decision Aiding

Multi-criteria Decision Aiding (MCDA) is a branch of operational research, which aims to help a DM to make decisions considering several criteria simultaneously.

The decision process that advises the resources that best suit the specifics of each project is extremely complex, as it

includes different perspectives and a high load of information for a DM. The use of a multi-criteria decision aiding model to support the process, together with an appropriate evaluation of employees will be the synonymous of a good strategy, with the objective of promoting informed decisions, since the process guides the DM considering multiple criteria and evaluation options [3].

4.2 ELECTRE TRI-nC Method

ELECTRE TRI-nC is an outranking method that belongs to the ELECTRE family developed for assigning actions to ordered categories considering multiple criteria [21].

Let $A = \{a_1, a_2, \dots, a_i, \dots\}$ denote the set of potential actions and g_j , a criterion. A coherent family of criteria, $F = \{g_1, g_2, \dots, g_i, \dots\}$, is defined to evaluate the actions. A set of completely ordered categories, $C = \{C_1, \dots, C_h, \dots, C_q\}$, is defined, in which C_1 is the worst category and C_q the best, with $q \geq 2$, considering $B = \{B_1, \dots, B_h, \dots, B_q\}$ a set of reference actions that define the categories and $B_h = \{b_{rh}, r = 1, \dots, m_h\}$, a set of reference actions that define the category C_h , such that $m_h \geq 1$ $e h = 1, \dots, q$ (at least m_h will be greater than 1). Note that if $m_h = 1$, for every h , then it would be the ELECTRE TRI-C method [19]. Generally, the ELECTRE TRI-nC method takes into account more than one action to characterize each category.

Each criterion, g_j , is considered a pseudo-criterion or criterion with thresholds, as it is associated with two thresholds:

- The preference threshold (p_j), between the performance of two actions that corresponds to the smallest difference in performance which, when exceeded, is considered the best performing action is strictly preferable;
- The indifference threshold $g_j(a)$, between the performance of two actions that corresponds to the biggest difference in performance considered compatible, with a situation of indifference between two actions, with different performances. Note that $p_j \geq q_j \geq 0$.

The introduction of these thresholds intends to take into account the imperfect character of the computation data of performances $g_j(a)$, for all $a \in A$, as well as the arbitrariness that affects the definition of the criteria.

When using thresholds, the following binary relations can be taken for each criterion:

- $|g_j(a) - g_j(a')| \leq q_j$, where a is indifferent to a' , according to g_j ($aP_j a'$);
- $g_j(a) - g_j(a') > p_j$, where a is strictly preferable to a' , according to criterion g_j ($aP_j a'$);
- $q_j < q_j(a) - q_j(a') \leq p_j$, where the judgment is ambiguous and there is not enough reasons to conclude a situation of indifference, nor a strict preference between two actions. There is a hesitation between indifference and strict preference, which means that a is weakly preferable to a' ($aQ_j a'$).

Within the concept of the outranking relation, $aS_j a'$, intends to convey the idea: "action a is at least as good as the action a' ", according to criterion g_j . It is necessary to consider three

concepts: concordance, non-discordance and credibility index:

- Concordance to the conformity between criteria that favour $aS_j a'$ to be accepted, that is, a sufficient majority of criteria must be in favour of this statement. Concordance is estimated by the global concordance index, $c(a, a')$, which associates each criterion with a weight w_j , so that $w_j > 0$, with $j = 1, \dots, n$, and $\sum_{j=1}^n w_j$ (assuming the sum of all weights is 1). By definition:

$$c(a, a') = \sum_{j \in c(aPa')} w_j + \sum_{j \in c(aQa')} w_j \quad (4.1)$$

$$+ \sum_{j \in c(aQa')} w_j \varphi_j, \quad (4.2)$$

$$\text{where } \varphi_j = \frac{p_j - (g_j(a') - g_j(a))}{p_j - q_j}$$

- Non-discordance: when none of the minority criteria is opposed to $aS_j a'$ exercises its veto power against this statement, in other words, refuting it. Non-discordance (or disagreement) is defined by the disagreement index, considering the veto threshold, v_j , so that $v_j > p_j$ can also be associated to the set of criteria. The veto effect is modelled using the partial disagreement index, $d_j(a, a')$, $j = 1, \dots, n$, and is defined as:

$$d_j(a, a') = \begin{cases} 1 & \text{if } g_j(a) - g_j(a') < -v_j \\ \frac{g_j(a) - g_j(a') + p_j}{p_j - v_j} & \text{if } -v_j \leq g_j(a) - g_j(a') \leq -p_j \\ 0 & \text{if } g_j(a) - g_j(a') \geq -p_j \end{cases} \quad (4.3)$$

- Credibility index: denoted by $\sigma(a, a')$ measures the degree of credibility that leads to considering that "action a is at least as good as action a' ", taking into account the family of criteria defined by F . To estimate this index, the global agreement index and the partial disagreement index are considered, in the following expression:

$$\sigma(a, a') = c(a, a') \prod_{j=1}^n T_j(a, a'), \quad (4.4)$$

Where

$$T_j(a, a') = \begin{cases} \frac{1 - d_j(a, a')}{1 - c(a, a')} & \text{if } d_j(a, a') < c(a, a') \\ 1 & \text{Otherwise} \end{cases} \quad (4.5)$$

The ELECTRE TRI-nC method defines a level of credibility as the minimum degree of credibility denoted by λ , which is necessarily considered by the DM to validate, or not, the prevalence ratio, taking into account all F . The credibility level can be seen as a cut off level, as it contemplates a diffuse relationship in the outranking relation [22]. Normally λ , assumes a value within the range]0,5; 1]. The joint rules provide the assignment of each action to a category as follows:

- Descending rule: choose a level of credibility, λ ($0.5 \leq \lambda \leq 1,0$), decrease h from $q + 1$ until the first value of t , such that $\sigma(\{a\}, B_t) \geq \lambda$. If $t = q$, assign action a for category C_q . When $0 < t < q$, if $\rho(\{a\}, B_t) > \rho(\{a\}, B_{t+1})$ assign C_t and C_{t+1} , otherwise. For $t = 0$, select C_1 as an action a .

- Ascending rule: choose a level of credibility, λ ($0.5 \leq \lambda \leq 1.0$), increase h from 0 to the first k value, so that

$\sigma(\{a\}, B_t) \geq \lambda$. For $t = q$, select C_q as a possible category for action a . For $0 < t < q$ if $\rho(\{a\}, B_t) > \rho(\{a\}, B_{t+1})$ then select C_t as a possible category for a ; or select C_{t+1} ; For $t = 0$, select C_1 as action a for a possible category. [21].

5. Identification and structuring of the problem

Two models were built, for which is intended to find potential candidates for the position. In this case for the two different models, we constructed the criteria, chose a set of candidates (potential actions), and established the reference profiles to define the categories, which are illustrated in Table 2, from very good to bad. To construct the models, meetings were held with the DM, a Manager from Robert Walters that was chosen because he has some experience in this market of consultancy specialized in HR and in the areas of Engineering and Operations.

5.1 Strategies to structure the problem

In this study two models were built and a set of criteria were defined to assess the candidates in order to assign each one to a certain pre-defined category.

The Logistics Manager position belongs to Fast Moving Consumer Goods (FMCG), and is a tobacco company, the person should have knowledge in demand planning, forecast, using SAP and managing people.

The Technical Manager Company is a multinational that belongs to the real estate market, manages and holds its own assets and the person in question is intended to come from the area of mechanical, electrical or civil engineering. Generally speaking, this is the presentation that RW consultants make to candidates without being able to announce the name of the client in question about the two models/jobs, candidates will only be able to know this information if they are interviewed by the client. The client's name normally is not revealed but when it is a tobacco company, it has to be revealed.

For this study, the criteria considered are included in each of the following three points of view that are validated by the DM for the two models/jobs:

- Candidate skills;
- Linguistic competences;
- Performance in the interview.

Focusing on the Logistics Manager model, the criteria are the following: studies, skills, salary, experience, leadership, languages, psychological characteristics, tests/questionnaires and performance in the interview.

For the Technical Manager model, the criteria chosen to analyse were: studies, skills, salary expectation, experience, languages and performance in the interview. The established sub-criteria were: having a higher education course within 3 courses, civil engineering, electromechanical engineering, mechanics, for the skills criterion, budgeting, hard services, soft services, maintenance and risk analysis. For the experience criterion, account is taken of whether the candidate carries out maintenance contract management, people management and building management, for the languages, number of languages, etiquette and social skills criteria.

The candidates evaluated in this study were recruited by RW and interviewed by RW consultants between January and May 2020.

In table 2 are the categories chosen by the DM to categorize the candidates from C1 to C4.

Table 2 The categories that select candidates ranked by the highest probability of being hired for the least probability of being hired

C4	Very good
C3	Good
C2	Reasonable
C1	Bad

Here, we mainly focus on the Logistics Manager model, in Figure 3 shows the criteria tree for this model, where the points of view, criteria and sub-criteria are hierarchical. As established *a priori*, both have the same points of view, but in relation to the criteria, in Figure 3 we have 9 criteria and for the Technical Manager we have 6 criteria. Naturally, it was not possible to carry out a generic model in which it had the same number criteria since the clients are different from each other, as well as the candidate's position and profile are different with more or less similar requirements between them.

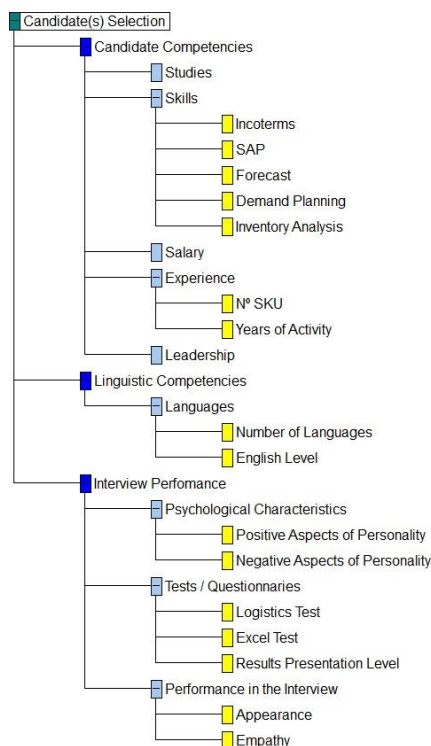


Figure 3 Value tree as a representation of the points of view, criteria and sub-criteria for the Logistics Manager

After the recruitment is carried out, an interview is made with the candidates and *a posteriori* the selection of the candidates and defined if the candidate will enter the shortlist to present to the client, and if it complies with the established requirements and constitutes at least a level of category C₃ therefore at least, then the candidate will constitute the shortlist to send to the client.

5.2 Construction of the criteria

For the Logistics Manager we defined 9 criteria:

-g₁, Studies: it is a criterion built by an ordinal scale. In this case, having preference for a person who has completed the university so whether or not he has a university degree. It has only two levels, yes (2) and no (1), with preference for level 2, yes.

-g₂, Skills: it is a criterion built by an ordinal scale, it results from the integration of 5 sub-criteria: incoterms, SAP, forecast, demand planning and inventory analysis. With the levels established from level 1 to level 9, the criterion is to be maximized.

-g₃, Salary: it is a discrete and cardinal scale criterion. In this case, the sense of preference is to minimize since the client prefers that the candidate has a lower salary. Two limits have been established. Thus, the preferred limit is € 28,000 and the upper limit is € 45,000.

-g₄, Experience: it is an ordinal and discrete scale criterion built based on two sub-criteria. Starting with the number of SKU's, which depends on the type of business or industry in which we are involved, it demonstrates the responsibility we have and the number of years of experience performing these tasks. In this case it is intended that the candidate has at least 5 years to perform this type of work and it would be interesting if it has more than 7 years since they do not want a person too experienced and who has managed at least a thousand SKU's and without any maximum established being this value adjustable depending on the type of business.

-g₅, Leadership: it is a cardinal and discrete scale criterion representing the number of people the candidate manages or has managed. In this case it is intended a candidate who has already managed at least one person, with a maximum number of 20 people for the purpose, therefore a scale of 1 to 20 with preference to maximize.

-g₆, Languages: it is an ordinal scale criterion with two sub-criteria, number of languages and level of English with preference for level 9, therefore to maximize. For the sub-criterion number of languages the scale was divided only in two levels, taking into account that in this case English because he speaks so it is not included in the languages spoken by the candidate or his native language, the preference increases with the number of languages spoken such as Spanish, French, and German or among other languages. For the English level sub-criterion it is intended that the candidate has an English level of C1, although the candidate will not be discarded soon if he has a level of B2.

-g₇, Psychological characteristics: it is a discrete ordinal scale criterion, which contains two sub-criteria, the candidate can list 5 positive aspects of his personality and 5 negative aspects of his personality. The client will later decide whether he considers adequate the answers given by the candidates. It is to be maximized and it has a scale with 4 levels as shown in Table 3.

Table 3 Scale of psychological characteristics criteria for the Logistics Manager model

		5 Negative aspects of personality	
		No	Yes
5 aspects of personality	Positive	No	Level 1
	Negative	Yes	Level 2
		Yes	Level 3
		No	Level 4

- g_8 , Tests/ Questionnaires: in which various competences of the candidate are evaluated, take into account 3 sub-criteria, the execution of the logistic test sent and will be evaluated by the client, Excel Test and Presentation of the results. The Excel level sub-criterion that is evaluated by RW consultants with 3 different classifications with scores from 1 to 10. Finally, the presentation level sub-criterion where the level of presentation of the results obtained in the Excel test is also evaluated with scores from 1 to 10. Generally, the presentation made in PowerPoint or Prezi will not be sent without having done the Excel test, as this would not make sense the presentation that needs the results of the Excel test. An ordinal scale to maximize with 7 levels with preference for level 7.

- g_9 , Performance in the interview: where essentially two sub-criteria are evaluated: appearance, where the requirements of the DM intend to evaluate the candidate's attire with the possibility that a level of presentation may be inappropriate, satisfactory or have a good level of presentation in order to be able to be within the requirements of the DM; and empathy, where the candidate's etiquette and social skills are assessed, if he does not know how to carry on a conversation, if he answers questions in an open way or appears to be an interesting person and maintains a fluid and pleasant conversation. An ordinal scale is then presented with 5 levels to be maximized.

The model Technical Manager has other criteria.

5.3 Defining the weight of each criterion

ELECTRE TRI-nC allows considering different criteria weights. Using the SFR (Simos-Roy-Figueira) method in DecSpace, a web-based MCDA platform, we determined the normalized and non-normalized weights, as shown in Table 4 for the Logistics Manager model.

Table 4 Weights normalized and non-normalized for the Logistics Manager model

Criteria	Non-normalize weights	Normalized weights
Studies	1	5.56
Skills	3	16.66
Salary	1	5.56
Experience	2	11.11
Leadership	2	11.11
Languages	3	16.67
Psychological characteristics	2	11.11
Tests/ questionnaires	2	11.11
Interview performance	2	11.11

5.4 Determining thresholds

For the Logistics Manager model, we considered relevant within all criteria to define indifference, preference and veto thresholds, as follows: $q_j = 1$, $p_j = 1$, without a veto, for criteria g_2 , g_4 and g_6 $q_j = 1$, $p_j = 2$, $v_j = 6$, for criterion g_3 $q_3 = 1000$, $p_j = 2000$, $v_j = 5000$ and finally for the criteria g_5 , g_7 , g_8 and g_9 $q_j = 1$, $p_j = 2$, without veto.

Table 5 Indifference, preference, and veto thresholds for the Logistics Manager model

Thresholds	Criteria								
	g_1	g_2	g_3	g_4	g_5	g_6	g_7	g_8	g_9
q_j	1	1	1000	1	1	1	1	1	1
p_j	1	2	2000	2	2	2	2	2	2
v_j	-	6	5000	6	-	6	-	-	-

5.5 Defining reference actions

The reference actions/candidates were built together with the DM to characterize 4 categories: a candidate may be bad, reasonable, good or very good, as we can see in Table 5.

Table 6 Definition of reference actions for the Logistics Manager model

		Criteria family					
		g_1	g_2	g_3	g_4	g_5	g_6
C4	b_4^1	Level 4	Level 7	32.000	Level 5	Level 4	Level 5
C3	b_3^1	Level 3	Level 5	33.000	Level 4	Level 3	Level 4
C2	b_2^1	Level 1	Level 4	34.000	Level 3	Level 1	Level 3
C1	b_1^1	Level 1	Level 2	35.000	Level 1	Level 1	Level 1

6. Discussion of results and recommendations

The candidates' assignments according to the model were obtained from the software MCDA-ULaval.

Taking into account the results obtained in Table 6, we can conclude that according to RW standards, 5 candidates with good and very good levels would be presented to the client, a candidate with a very good level within the categories [C4, C4], other within the categories [C3, C4] a candidate with a level between good and very good and another 3 candidates are between the categories [C3, C3] with a level of good, so there are 5 candidates with a strong possibility of being hired. Bearing in mind the standards of RW, candidates or actions that fall within the categories [C2, C3] consequently won't be presented, therefore between the good and reasonable level, otherwise a shortlist of 7 candidates would be presented instead of 5 candidates which would be the number of candidates to present to the client. Thus, we can conclude that the remaining 10 candidates would not be presented to the client and we can find in Table 6 the 5 candidates sent to the Logistics Manager model, candidate 3, candidate 7, candidate 10, candidate 12 and candidate 14.

These results are very interesting because they represent what would happen in the reality, having in consideration this is a small representation of what actually happened. From the results obtained in Table 6 we can conclude that 33.34% of candidates would be presented to the client.

Even for the position Technical Manager the results were very similar to reality. In this model only 3 candidates would be presented. In the interval [C3, C4], 2 candidates with a level between good and very good and one candidate with a good level within the categories would be presented [C3, C3]. For the remaining 12 candidates, the highest percentage of candidates with 60% is between a reasonable and good level and the other 3 candidates between a reasonable and bad level. Therefore, only a shortlist of 3 candidates would be presented, only 20% of the 15 candidates interviewed would be presented to the client.

Table 7 Candidates perform for the Logistics Manager model

$\lambda = 0,7$												
Ações	g_1	g_2	g_3	g_4	g_5	g_6	g_7	g_8	g_9	Min	Max	Shortlisted?
Candidate 1	Level 2	Level 4	30.000	Level 4	4	Level 5	Level 3	Level 3	Level 3	C2	C3	No
Candidate 2	Level 2	Level 2	35.000	Level 6	5	Level 9	Level 2	Level 1	Level 4	C2	C2	No
Candidate 3	Level 2	Level 9	30.000	Level 10	10	Level 9	Level 4	Level 7	Level 5	C4	C4	Yes
Candidate 4	Level 2	Level 8	35.000	Level 6	2	Level 7	Level 4	Level 4	Level 4	C2	C2	No
Candidate 5	Level 2	Level 7	32.000	Level 6	3	Level 4	Level 4	Level 4	Level 3	C2	C2	No
Candidate 6	Level 2	Level 7	40.000	Level 7	4	Level 7	Level 3	Level 5	Level 4	C2	C3	No
Candidate 7	Level 2	Level 6	29.000	Level 7	3	Level 4	Level 4	Level 5	Level 5	C3	C3	Yes
Candidate 8	Level 1	Level 4	28.000	Level 1	3	Level 9	Level 4	Level 6	Level 3	C2	C2	No
Candidate 9	Level 2	Level 4	31.000	Level 5	1	Level 6	Level 3	Level 5	Level 3	C2	C2	No
Candidate 10	Level 1	Level 7	42.000	Level 10	2	Level 4	Level 4	Level 5	Level 4	C3	C3	Yes
Candidate 11	Level 2	Level 6	37.000	Level 5	5	Level 6	Level 3	Level 4	Level 3	C2	C2	No
Candidate 12	Level 2	Level 7	37.000	Level 10	12	Level 8	Level 3	Level 5	Level 5	C3	C4	Yes
Candidate 13	Level 2	Level 5	39.000	Level 4	2	Level 6	Level 4	Level 6	Level 5	C2	C2	No
Candidate 14	Level 1	Level 8	30.000	Level 7	1	Level 6	Level 3	Level 6	Level 4	C3	C3	Yes
Candidate 15	Level 2	Level 5	32.000	Level 5	5	Level 6	Level 2	Level 4	Level 4	C2	C2	No

6.1 Sensitivity analysis

For the Logistics Manager model, the sensitivity analysis was taken from the MCDA-ULaval software, where the upper and lower limits of each of the criteria and the level of credibility are established.

Table 7 shows the sensitivity analysis values for the weights of the Logistics Manager model with a credibility value of 0.7.

Table 8 Results obtained in the sensitivity analysis for the criteria weights and for the level of credibility for the Logistics Manager model

Criteria	Inferior limit	Superior limit
Studies	0.00	14.43
Skills	7.76	19.21
Salary	0.00	14.43
Experience	6.68	13.66
Leadership	6.68	13.65
Languages	7.73	19.21
Psychological characteristics	0.00	15.55
Tests/ questionnaires	6.68	13.66
Interview performance	0.00	19.98
Credibility level	0.67	0.72

From the sensitivity analysis, it was observed that the studies and salary criterion reach a difference of 14% between the upper and lower limits. The skills and languages criterion with identical values with an upper limit of 19% and a lower limit of 8%. The criterion, experience, leadership and tests / questionnaires also with the same percentages with an upper limit of 14% and a lower limit of 7%, the criteria psychological characteristics with a difference of 16 and the criteria performance in the interview with an upper limit of 20% and a lower limit of 0%. Regarding the level of credibility, we observed that it varied between 0.67 and 0.72.

6.2 Variation of credibility level

In order to perform the variation of credibility levels and to understand what would be the differences from the

credibility level of 0.7. It was performed and observed in MCDA-ULaval the new results from a credibility level of 0.65 and 0.75.

This time in Logistics Manager model with a credibility index of 0.65, 5 candidates will be presented, one candidate who is in a very good level and another candidate with a gap between good and very good and three candidates with a good level who will be inserted in the shortlist to be sent to the client. Previously when the level of credibility was 0.7, 5 candidates would also be sent to the client at the same intervals, so the level of credibility from 0.65 to 0.7 has not undergone major changes. While with a credibility level of 0.75, 4 candidates will be sent, but in this case 3 candidates with a good level and 1 with a very good level. So we can conclude for this model a trend that is likely to decrease the number of candidates to be sent to the client. While for the Technical Manager model we can see for a credibility index of 0.65, 3 candidates will be sent, 2 candidates with an interval between good and very good and another candidate with a level of good, but with a level of credibility 0.7, 3 candidates would be sent, 2 with a level between good and very good level and 1 with a good level, so the trend continues with the increase in the level of credibility, one more person would be sent to the client. If the credibility level had a value of 0.75, as expected, more candidates would be sent and in this case 5 would be sent, two more than the previous credibility level, 2 candidates with a level between good and very good and 3 with a good level. So we can see that in this model with the increase in the level of credibility, there will be a greater tendency to send more candidates.

7. Conclusions

The market for specialized HR consultancy has been growing over the last few years, and this trend is expected to continue. Due to the importance that companies have given to outsourcing non-core functions to their business, this market

is massive valuing 481.2 billion US dollars in revenue in the year of 2019.

Recruitment and selection will always be an activity with relevance in the business world, with traditionally medium and large companies having professionals dedicated to this function in their staff. This trend has been reversed because recruitment and selection has a specific need and requires technical expertise and knowledge of the area, giving rise to the replacement of these functions by specialized consultants who not only manage to reduce costs but also guarantee greater quality in the recruitment and selection process.

Many trends are being followed in the market investing in AI to make recruitment process much more efficient and effective by gaining significant time-saving, better hiring quality, increasing candidate's satisfaction, automation of the hiring process and cost-effective hiring.

Outsourcing this HR functions started to be a reality, recruitment and selection has a specific need and requires technical expertise and knowledge of the area, giving rise to the replacement of these functions by specialized consultants who not only manage to reduce costs but also guarantee greater quality in the recruitment and selection process.

Using ELECTRE TRI-nC method to build two models, the results obtained do not escape much from reality and reflects the process of selecting candidates from a consultant specialized in HR. It was possible to verify that in the Logistics Manager model only 33.34% of the evaluated candidates would constitute the shortlist of candidates to send to the client so only 5 of the 15 candidates evaluated would be presented to the client. In the Technical Manager model, 20% of candidates would be on the shortlist, so only 3 candidates would be displayed to the client.

We can consider that the models built reflect the reality well, since within a sample with 15 candidates, it would be difficult to find as many as find 5 candidates. Generally less than 5 candidates would be able to fulfill the requirements of RW consultants to integrate the shortlist to present to the client. Naturally that depends on the position in question, due to the number of candidates that exist in the market available for the position.

Using this kind of systems, it is possible to give more confidence to the client, so that the HR consultant can justify clearly with any doubts the shortlist of candidates sent and much more accurate in terms of the criteria and inside the range of criteria choose by the DM and the client. If a consultancy company wanted to use such program to find candidates, a search could be made in order to understand what types of software could do what was applied in MCDA-ULaval or even what programming languages exist that could easily recreate what was done in this study. So it could be simpler for other people to use this software and easier to parametrize exactly for other jobs and could be used as a database as well.

References

- [1] Chiavenato, I. (2010). *Gestão de pessoas*, 3º ed., Elsevier.
- [2] Snell, S. A., Bohlander, G., & Sherman, A. (2010). *Administração de Recursos Humanos*, 14º ed., Cengage Learning.
- [3] Belton, V., & Stewart, T. J. (2002). *Multiple Criteria Decision Analysis*, Springer-Science+Business Media, B.V.
- [4] Chiavenato, I. (2000). *Comportamento Organizacional*, 2º ed., MC GRAW HILL.
- [5] "Statista,"[Online]. Available:<https://www.statista.com/statistics/917984/search-firms-worldwide-by-revenue/>.
- [6] "StaffingIndustry,"[Online]. Available:<https://www2.staffingindustry.com/Editorial/Daily-News/Randstad-and-Adecco-rank-first-and-second-on-SIA-s-2019-Largest-Global-Staffing-Firms-List-52014>.
- [7] Bach, S. (2005). *Managing Human Resources*, 4º ed., John Wiley & Sons AND Sons LTD.
- [8] Boudreau, J. W., & Milkovich, G. T. (2010). *Administração de Recursos Humanos*, 1º ed., Atlas.
- [9] Gamage, A. (2014). "Recruitment and Selection Practices in Manufacturing SMEs in Japan: An analysis of the link with business performance," *Sri Lankan Journal of Human Resource Management*, vol. 1, pp. 49-57.
- [10] Marras, J. P. (2016). *Administração de Recursos Humanos - Do Operacional ao Estratégico*, Saraiva UNI.
- [11] Cardoso, A. Alves. (2010). *Recrutamento & Seleção de Pessoal*, Lidel.
- [12] Gomes, J. F. S., Campos e Cunha, Campos e Cunha, R., Cabral-Cardoso C. & Marques C. A. (2008). *Manual de gestão de pessoas e do capital humano*, Lisboa: Edições Sílabo.
- [13] Gareth, R. (1997). *Recruitment and selection: A competency approach*, Institute of Personnel and Development.
- [14] Wilkison, S. (1998). "Focus group methodology: a review," *International Journal of Social Research Methodology*, pp. 181-203.
- [15] Coll, R., Fornés, A., & Lladós, J. (2009). *Graphological Analysis*.
- [16] Neal, S. (2012). *The Oxford Handbook of Personnel Assessment and Selection*, 1º ed., Oxford University Press.
- [17] Prempeh, K. B., & Nsiah-Asare, E. (2017). *Evaluating the Impact of Outsourcing Strategy on Procurement Performance of Selected Technical Universities in Ghana*.
- [18] Makowenga, G. O. (2013). *OUTSOURCING AND CUSTOMER SATISFACTION IN KENYA POWER NAIROBI REGION*.
- [19] Mclvor, R. (2008). *What is the Right Outsourcing Strategy for Your Process?* *European Management Journal*, 26, 24-34.
- [20] Almeida-Dias, J., Figueira, J. R., & Roy, B. (2010). *ELECTRE TRI-C: A multiple criteria sorting method based on characteristic reference actions* *European Journal of Operational Research*, vol. 204, pp. 565-580.
- [21] Seixedo, C., & Tereso, A. P. (2010). *multicriteria decision aid software application for selecting MCDA software using AHP*.
- [22] Almeida-Dias, J., Figueira, J. R., & Roy, B. (2012). "A multiple criteria sorting method where each category is characterized by several reference actions: The Electre Tri-nC method," *European Journal of Operational Research*, vol. 217, pp. 567-579.
- [23] Figueira, J.R., Greco, S., & Ehrgott M. (2016). *Multiple Criteria Decision Analysis: State of the Art Surveys*, Springer.