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La juste allocation des ressources humaines pour une protection efficace contre le Covid-19

The right allocation of human resources for effective protection against Covid-19

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Résumé

« Nouveau corona virus 2019 » ou « COV-2019 », avec « CO » pour corona, « VI » pour virus et « D »pour maladie en anglais, comme l'indique son non, le virus de la COVID-19 est une nouvelle souche de la même famille que d'autres virus tels que le syndrome respiratoire aigu sévère (SRAS) et certains types de rhumes courants. D'après L'Organisation mondiale de la Santé (OMS), la maladie se propage rapidement depuis son apparition pour la première fois à Wuhan en chine, en décembre 2019, plus d'un quart de million de personnes tués ont été recensés partout dans le monde.

Dès le marquage du premier cas de coronavirus détecté sur le sol du Maroc le 4 mars 2020, et face à la pénurie des matériaux de protection, qui a engendré une demande grandissante notamment pour des masques de protection. Le secteur qui a répondu fortement présent à l'appel de la stratégie marocaine dans une situation d'urgence pour fabriquer et livrer au maximum de masques et à la chaine est l'industrie textile, comme il a été souligné par l'Amith. Cet engagement s'est traduit par un changement d'activité temporaire chez plusieurs entreprises. Dans ce sens que s'inscrit notre article qui traite le problème d'ordonnancnement des essources humaines, dont l'objectif est de la mise en place d'un outil d'aide à l'allocation de ces ressources aux différentes tâches et aux différentes opérations.

Mots clés : COV-2019, masques de protection, chaine logistique, industrie textile, Amith

Abstract

«The novel Corona Virus 2019» or «COV-2019», «CO» stands for corona, «VI» for virus, and «D» for disease. As its name indicates, the COVID-19 virus is a new strain of the same family as other viruses such as Severe Acute Respiratory Syndrome (SARS) and some common types of colds. According to the World Health Organization (WHO), the disease has been rapidly spreading since its first appearance in Wuhan, China, in December 2019. Over a quarter of a million deaths were registered worldwide.

After the confirmation of the first case of coronavirus in Morocco on March 4, 2020, the shortage of protective equipment, has led to a growing demand especially for protective masks, and particularly since the government has suggested to the public to wear a mask outdoor. The sector that has responded immediately to the emergency call of the Moroccan strategy to produce and deliver the maximum number of protective masks is the textile industry, as it was noted by the Amith. This commitment was reflected in a temporary change of activities in several companie. In this sense is part of our article which deals with the problem of scheduling human resources, the objective of which is to set up a tool to help allocate these resources to the different tasks and to the different operations.

Keywords :COV-2019, protective masks, Supply chain, textile industry, Amith.

Introduction

Casmade Service, a specialist in workwear, is a mid-size company based in Tangier, which was mobilized to convert its production line to provide a target of 700-800 masks per day (of woven fabric masks that can be reused five times), with full-time production, including nights and weekends.

Facing this challenge in a time of emergency, the company encountered a decision making problem concerning the allocation of engineers to manufacture and control the production of this necessary product. They would be in charge of managing teams throughout the production chain, While taking into account constraints of performance, quality, costs, and deadlines as well as the standards of Imanor (the Moroccan institute of standardization) Baayoud M. (2005). La gestion des RH au Maroc. In : YANAT, Z. et SCOUARNEC, A. (éd.), Perspectives sur la GRH au Maghreb, Algérie-Maroc-Tunisie. AGRH/Vuibert.

The present problem is the focus of our study which consists of the implementation of a support tool to help in the allocation of human resources to different tasks and different operations.

This mathematical modeling for decision-making assistance takes place in the phase of structural planning, where there is a breakdown of the chain into different links consisting of work packages. These links represent a workload for team leaders who must ensure the production of the best quality masks which meet the standards of Imanor, taking into account the cost which is fixed at 5dh/incl by the Moroccan government. Moreover, the masks must be delivered as quickly as possible. To face these constraints, the project manager must appoint the best engineers of the company to oversee these operations, under duress of their availability and the insurance of their health protection. This planning allows for a focus on the dependency between the different tasks (time constraints, logical structure, ...).

To produce protective masks made of woven fabric under the Protecmax brand and help Moroccans protect themselves effectively to reduce the spread of Covid-19.

The problem of human resource allocation in the supply chain processes refers to the appropriate allocation of available human resources to the tasks of the process.

Firstly, each process must be divided into tasks "activities, operations". Each task requires specific competencies, abilities, and previous experiences. Once the different tasks to be performed are defined, the appropriate candidates for each task must be selected according to the requirements related to the competencies "required competencies of each task".

Our article revolves around 5 main parts presented as follows: first an introduction which presents the problem treated. Then, we moved on to analyze and synthesize the work from a

thematic approach (the allocation of human resources). After we presented the methodology developed in our study. Followed by a presentation of the results. Finally, we discussed the results obtained in relation to other studies carried out.

1. Literature review

1.1. Tuple Linguistic Representation Model

[Herrera and Martinez, 2000] have proposed this model, which has proven to be the most appropriate one for solving real-life decision-making problems with linguistic information. The particularity of this model resides in its ability to represent linguistic information using two noted values (s_i , α) where s_i is a linguistic term and α is a numerical value of symbolic translation.

In the following, We recall some definitions to demonstrate the characteristics of the computation process of this model:

Definition 1: [Herrera et Martinez, 2000]

Let β be the result of an aggregation of the indices of a labels set assessed in linguistic terms set $S = \{s_0, s_1, ..., s_g\}$, i.e. the result of a symbolic aggregation operation, $\beta \in [0, g], g+1$ is the cardinality of S.

Let $i = round(\beta)$ and $\alpha = \beta - i$ be two values, such that, $i \in [0, g]$ and $\alpha \in [-0.5, 0.5]$, then α is called a symbolic translation.

The symbolic translation of a linguistic term s_i is a numerical value assessed in $[-0.5, 0.5]$, that marks «the difference of information» between a counting of information $\beta \in [0, g]$ obtained from the symbolic aggregation operation and the closest value in $\{0, ..., g\}$ which indicates the index of the closest linguistic term in S.

Definition 2: [Herrera & Martinez, 2000]

Let $S=\{s_0,s_1,...,s_g\}$ be a linguistic term set of the cardinality g+1 and let $\beta\in[0,g]$ be the numerical value representing the result of a symbolic aggregation operation of the indices of a labels set assessed in the set S, then the 2-tuple that expresses the equivalent information to β is obtained with the function:

$$\Delta:[0,g)\to S\times[-0,5,0,5)$$

$$\Delta(\beta)=(s_i,\alpha)\begin{cases} s_i, & i=round(\beta)\\ \alpha=\beta-i & \alpha\in[-0,5,0,5)\end{cases}$$

-where round is the usual round operation,

- S_i is the linguistic term that has the closest index label to β,

- α is the value of the symbolic translation.

Proposition 1 [Herrera & Martinez, 2000]

Let $S=\{s_0,s_1,...,s_g\}$ be a linguistic terms set and let (s_i,α) be a 2-tuple. There is always a function Δ^{-1} such that, from a 2-tuple, it returns its equivalent numerical value $\beta\in[0,g]$. It is defined as:

$$\Delta^{-1}:S\times[-0,5,0,5)\to[0,g],$$

$$\Delta^{-1}(s_i,\alpha)=i+\alpha=\beta$$

Remark:

From definition 2 and proposition 1, it is obvious that the transformation of the linguistic term inti 2-tuple consist of adding a value zero as a symbolic translation, such that $s_i\in S\to(s_i,0)$.

Based on the above-mentioned definition, it is possible to develop comparison and aggregation operators for the 2-tuple model [Herrera et Martinez, 2000].

Comparison of 2-tuples:

let (s_i,α_i) and (s_j,α_j) be two 2-tuples assessed in the same linguistic terms set:

(i) if i < j, then (s_i,α_i) is smaller than (s_j,α_j)

(ii) if i=j

a) if $\alpha_i=\alpha_j$ then (s_i,α_i) and (s_j,α_j) represent the same information

b) if $\alpha_i<\alpha_j$ then (s_i,α_i) is smaller than (s_j,α_j)

c) if $\alpha_i>\alpha_j$ then (s_i,α_i) is bigger than (s_j,α_j)

Aggregation of 2-tuples :

Definition 3 : [Herrera & Martinez, 2000]

let $a=\{(b_1,\alpha_1),(b_2,\alpha_2),...,(b_n,\alpha_n)\}$ be a set of linguistic 2-tuples, the 2-tuple arithmetic mean operator φ_1, is defined as :

$$\varphi_1[(b_1,\alpha_1),(b_2,\alpha_2),...,(b_n,\alpha_n)]=\Delta\left(\sum_{i=1}^{n}\frac{\Delta^{-1}(b_i,\alpha_i)}{n}\right)$$

Definition 4: [Herrera & Martinez, 2000]

let $a=\{(b_1,\alpha_1),(b_2,\alpha_2),...,(b_n,\alpha_n)\}$ be a set of linguistic 2-tuple and $\{w_1,w_2,...,w_n\}$ be their associated weights .the 2-tuple weighted averaging operator φ_2 is defined as:

$$\varphi_2[(b_1,\alpha_1),(b_2,\alpha_2),...,(b_n,\alpha_n)]=\Delta\left(\frac{\sum_{i=1}^{n}\Delta^{-1}(b_i,\alpha_i)w_l}{\sum_{i=1}^{n}w_i}\right)=\Delta\left(\frac{\sum_{i=1}^{n}\beta w_i}{\sum_{i=1}^{n}w_i}\right)$$

where $\beta=\Delta^{-1}(b_i,\alpha_i)$

Definition 5: [Herrera & Martinez, 2000]

let $a=\{(b_1,\alpha_1),(b_2,\alpha_2),...,(b_n,\alpha_n)\}$ be a set of linguistic 2-tuple and $W=\{(r_1,\alpha_1'),(r_2,\alpha_2'),...,(r_n,\alpha_n')\}$ their associated weights. The 2-tuple linguistic weighted averaging operator, φ_3, is defined as :

$$\varphi_3\left[\left((b_1,\alpha_1),(r_1,\alpha_1')\right),\left((b_2,\alpha_2),(r_2,\alpha_2')\right),...,\left((b_n,\alpha_n),(r_n,\alpha_n')\right)\right]=\Delta\left(\frac{\sum_{i=1}^{n}\Delta^{-1}(r_i,\alpha_i')\times\Delta^{-1}(b_i,\alpha_i)}{\sum_{i=1}^{n}\Delta^{-1}(r_i,\alpha_i')}\right)$$

Definition 6 : [Herrera & Martinez, 2000]

let $a=\{(b_1,\alpha_1),(b_2,\alpha_2),...,(b_n,\alpha_n)\}$ and let $b=\{(c_1,\beta_1),(c_2,\beta_2),...,(c_n,\beta_n)\}$ be two vectors associated with the linguistic 2-tuple of the set S and let $W=\{(r_1,\varepsilon_1),(r_2,\varepsilon_2),...,(r_n,\varepsilon_n)\}$ be their associated 2-tuple weights. The linguistic 2-tuple weighted Euclidean distance between a and b, $d(a,b)$ is defined as :

$$d(a,b)=\sqrt{\sum_{j=1}^{n}\frac{\Delta^{-1}(r_i,\varepsilon_j)[\Delta^{-1}(b_j,\alpha_j)-\Delta^{-1}(c_j,\beta_j)]^2}{\sum_{j=1}^{n}\Delta^{-1}(r_i,\varepsilon_j)}}$$

1.2. TOPSIS method [Hwang et Yoon, 1981]

TOPSIS (Technique for Order Preference by Similarly Ideal Solution) is a multi-criteria decision-making method, it is based on the principle that the chosen alternative should be the closest to the positive ideal solution and the farthest from the negative ideal solution. The objective is to select the « best» alternatives.

The TOPSIS method comprises the following steps:

1. Calculate the normalized decision matrix;
2. Calculate the weighted normalized decision matrix;
3. Determine the ideal positive solutions and the ideal negative solutions;
4. The n-dimensional Euclidean distance between the alternatives and the ideal and non-ideal solutions, where n is the number of criteria;
5. Calculate the closeness of each alternative to the ideal solution

Such that:

1.2.1. The normalized value is defined as:

$$n_{ij} = \frac{x_{ij}}{\sqrt{\sum_{j=1}^{m} x_{ij}^2}} \quad , \qquad j = 1,...,m \text{ and } i = 1,...,n$$

Where: x_{ij} is the evaluation of the alternative A_j for the criterion C_i.

1.2.2. The weighted normalized value v_{ij} is defined as :

$$v_{ij} = w_i n_{ij} \quad , \qquad j = 1,...,m \text{ and } i = 1,...,n$$

where w_i is the weight of i criterion, and $\sum_{i=1}^{n} w_i = 1$

1.2.3. Ideal and non-ideal solutions

$$A^+ = \{v_1^+,...,v_n^+\} = \left\{\left(Maxv_{ij} \setminus i \in I\right), \left(Minv_{ij} \setminus i \in J\right)\right\}$$

$$A^- = \{v_1^-,...,v_n^-\} = \left\{\left(Minv_{ij} \setminus i \in I\right), \left(Maxv_{ij} \setminus i \in J\right)\right\}$$

Where I is the set of benefit criteria (the higher the evaluation the better), and J is the set of cost criteria (the lower the evaluation the better).

1.2.4. The distance between each alternative and the ideal solution is defined as:

$$d_j^+ = \left\{\sum_{i=1}^{n} \left(v_{ij} - v_i^+\right)^2\right\}, \qquad j = 1,...,m$$

$$d_j^- = \left\{\sum_{i=1}^{n} \left(v_{ij} - v_i^-\right)^2\right\}^{1/2}, \qquad j = 1,...,m$$

1.2.5. The relative closeness of the alternative A_j to A^+ is defined as :

$$R_j = d_j^- \left(d_j^+ + d_j^-\right), \qquad j = 1,...,m$$

Since $d_j^- \geq 0$ and $d_j^+ \geq 0$, then it is obvious that $R_j \in [0,1]$, rank the alternative in a decreasing order from R_j .

2. Methodology : Proposed Approach

One of the greatest challenging facing experts, managers, and team leaders in the logistic field is the challenge of allocating the right candidate for the right operation, given the benefits that it brings to the company. First, they must determine the acquired skills of the candidates and the required skills of the operations, then they must use this information to make the right decision.

- Identification of the acquired skills of the candidates and the required skills of the operations, using this information to make the right decision.
- Systematic estimation of the personnel work capacity and performance is imperative to assess the satisfaction of the personnel in the execution of the assigned operation.
- The linguistic 2-tuple representation model can be used as one of the most objective and effective evaluation methods.
- Implementation of the TOPSIS decision-making method based on the previous results.

Our approach consists of different steps that were inspired by the decision analysis scheme proposed by [Elli Rapti, 2015]. Then, we move to a detailed description of procedures, while depicting the steps one by one. Moreover, we will implement the approach to a real case to demonstrate its pertinence.

2.1. Step 1: Identification of the acquired and required competencies

Competence is a professional qualification. It consists of knowledge (knowledge-based skills), know-how (practical skills), and know-whom (interpersonal skills). The acquired and required competencies are divided into the three categories proposed by (Harzallah & Vernadat, 2002) as follow:

1. Knowledge: refers to everything that has been learned in school or acquired in training, it is mainly composed of:
   - Theoretical knowledge: includes theorems, concepts, functions, laws, ...
   - Knowledge of the existing: this covers specific knowledge of the field, the operations, and the environment in which the competence is performed.

- Procedural Knowledge: it is related to the need to deal with procedures, methods...

2. Know-how: this category includes operational knowledge, the practical application of procedures. It consists of:
   - Procedural know-how: every candidate must know how to apply a procedure or method.
   - Empirical know-how: it is based on the individual abilities to analyze a current situation, extract relevant information and then organize his/her work.
3. Know-whom: this category is related to the individual's behaviors while he/she is performing tasks in a changing environment, it consists of:
   - Relationship aspects: it is related to the individual's relationships within the work context.
   - Cognitive abilities: it refers to the ability to react and make the right decision when facing unexpected events.
   - Behaviors: such as curiosity, motivation, ...

Table N° 1: Types of competence

knowledge			Know-how		Know-whom		
Theoretical knowledge	Knowledge of the existing	Procedural knowledge	Procedural know-how	Empirical know-how	Relationship aspects	Cognitive capacities	Behaviors

Source: authors

2.2. Step 2: Evaluation of competences

In this phase, the experts have to evaluate the competencies levels (knowledge, know-how, know-whom) of each candidate with regards to each operation. To make the right judgment, the evaluators need a scale to help them express their opinions. The linguistic scale selection must be adapted to the context. This refers to the choice of the appropriate linguistic terms set and their semantic.

The proposed linguistic terms set may be defined in an arbitrary discourse universe. The semantic of the linguistic information can be assigned to five, seven, or nine terms.

To avoid any subjective evaluation, we suggest the aggregation of all evaluators' opinions based on the linguistic 2-tuple model.

2.3. Step 3: Aggregation of the experts' opinions

In every evaluation problem, each expert must express his/her opinion about the different tasks. Since we attempt to propose a generic evaluation method, we presuppose that the experts' opinions do not have the same importance.

Therefore, the resources aggregated level of acquired competencies is defined as:

$$(\eth a_{ikj}, \alpha_{ikj}) = \Delta\left(\sum_{l=1}^{L} \Delta^{-1}\left(\eth a_{ikj}, \alpha_{ikj}\right) w_l \Big/ \sum_{l=1}^{L} w_l\right)$$
$$\forall j = 1,2,...,J; \forall k = 1,2,...,K; \forall i = 1,2,...,I$$

In fact, each expert has to express his/her opinion on the level of each required competence resource in each task. The aggregated required level of each competence resource is given as:

$$\left(\eth \Upsilon_{\underset{\sim}{kj}}, \alpha_{kj}\right) = \Delta\left(\sum_{l=1}^{L} \Delta^{-1}\left(\eth \Upsilon_{kjl}, \alpha_{kjl}\right) w_l \Big/ \sum_{l=1}^{L} w_l\right)$$
$$\forall j = 1,2,...,J; \forall k = 1,2,...,K; \forall i = 1,2,...,I$$

The resulting aggregated levels of acquired and required competencies resources are identified as the input of the evaluation problem. The objective is to ensure an effective and efficient execution of tasks depending on the suitability of the acquired and required competencies levels.

2.4. Identification

The competencies considered in this study case take into account some new skills that were seen as trivial until recent times, yet, the pandemic made them imperative. They include the spirit of solidarity, the management of complexity, the ability to work under stress, the sense of responsibility, and the ability to work remotely and adapt to change, as noted by Nabila Bakkas. (Nabila Bakkas, le matin , 11 Mai 2020)

These new criteria have shifted radically the management practices of human resources in companies around the world. In this study, we have reflected on the central position of the human capital within companies, and its key role in enriching every organism. This study can serve as a prototype for other investigations.

The categorization of competencies in this study is based on the work of [Harzallah and Vernadat], who proposed a generic model that includes categories and sub-categories of competencies as follow:

Table N° 2: Categories of competences

Categories of competences							
knowledge (K)			Know-how (K-H)		Know-whom (K-W)		
Theoretical knowledge (TK)	Knowledge of the existing (KE)	Procedural knowledge (KP)	Procedural know-how (PK-H)	Empirical know-how (EK-H)	Relationship aspects (R.)	Cognitive capacities (CC)	Behaviors (B)

Source: authors

After defining the competencies that will be analyzed according to each candidate, we start the evaluation phase.

2.5. Evaluation

Due to the current circumstances, we have opted for a remote meeting with the project manager instead of a face-to-face session. Following the meeting, we have identified 7 operations to be carried out respecting the project scope statement and the product characteristics (protection masks) as required by Imanor. The following table contains the list of tasks:

Table N° 3: List of tasks

Operations	Title
Operation 1	Ensure the set up of manufacturing machines
Operation 2	Supply of necessary raw materials
Operation 3	Manage the stock and the sterilization of raw materials
Operation 4	Monitor the manufacturing process (requirements)
Operation 5	Guarantee the mask performance
Operation 6	Supervise the masks testings
Operation 7	Packaging, marking, and labeling

Source: authors

After the identification of the seven operations starting from the set up of manufacturing machines to the packaging and labeling of the protection masks, we will break down each operation into a set of tasks to have a better evaluation, as follows:

Table N° 4: Tasks in each operation

Operations	Types of Skills	Tasks in each operation
Op 1	(TK)	Characteristics of the used material
	(KE)	Machine manipulation process
	(KP)	Understand the instructions
	(PK-H)	Ability to explain the instructions
	(EK-H)	Ability to easily adapt the machine to new characteristics
	(R.)	Delegation of modifications to the project manager and operators
	(CC)	Suggest optimal adaptations
	(B)	Ability to adapt to change
Op 2	(TK)	Advanced and updated knowledge concerning the characteristics of the necessary materials for masks production
	(KE)	Market expertise and mastery of the local, regional and national competitions
	(KP)	Mastery of purchasing and supplying techniques
	(PK-H)	Determine the company purchasing policy
	(EK-H)	Write reports and submit them to the project manager
	(R.)	Mastery of negotiation techniques
	(CC)	Manage any problem related to the product
	(B)	Technical and business competencies
Op 3	(TK)	Allocate the stocking space for raw materials and products
	(KE)	Entry, exit, and placements of products
	(KP)	Minimize the stock level without risking stock shortage
	(PK-H)	Manage activities in the stock sites

	(EK-H)	Capacity to optimize stock management: products referencing, space organization……
	(R.)	Negotiate replacement solutions with the suppliers
	(CC)	Organization and prioritization
	(B)	Trust
Op 4	(TK)	The production process of new product
	(KE)	Coordinate the production demands
	(KP)	The industrial policy set by the administration
	(PK-H)	Contribute to the design of new models
	(EK-H)	Monitor the daily production in terms of the previsions
	(R.)	Notify and train for technical evolutions
	(CC)	Anticipate evolutions
	(B)	Curiosity and flexibility
Op 5	(TK)	Performance indices
	(KE)	The required quality criteria of the protection masks
	(KP)	Plan predictive activities
	(PK-H)	Develop a predictive action plan for production
	(EK-H)	Advise the company about development strategies
	(R.)	Carry out actions related to internal communication
	(CC)	Decision-making in case of solution choice
	(B)	Ability to suggest new performance indices
Op 6	(TK)	testing requirements
	(KE)	Specifications of measuring devices
	(KP)	testing methods
	(PK-H)	Mastery of testing methods
	(EK-H)	Monitor the testing results
	(R.)	Report the testing methods and results
	(CC)	Ability to carry out testings with the available laboratory devices in absence of specifications concerning special measuring devices
	(B)	Check the compliance of tests with the technical specifications of Imanor
Op 7	(TK)	The packaging, marking, and labeling processes
	(KE)	Difference between medical masks and other masks
	(KP)	Specifications packaging, marking, and labeling
	(PK-H)	Monitor the phases of each process
	(EK-H)	Check the compliance of the processes with the specifications of Imanor
	(R.)	Group work
	(CC)	Supply the necessary materials for The packaging, marking, and labeling of masks
	(B)	Write reports about the packed, marked, and labeled products.

Source: authors

3. Competencies categories

The competencies considered in this study case take into account some new skills that were seen as trivial until recent times. Yet, the pandemic has made them imperative. They include the spirit of solidarity, the complexity management, the ability to work under stress, the sense of responsibility, and the ability to work remotely and adapt to change.

3.1. Candidates

The study case includes eight candidates, who are the only available engineers in the company in this critical period.

Like all the staff in this company, the engineers in charge of the operation have received training concerning the causes and consequences of the virus, in addition to the protective measure that should be respected to keep everyone safe and maintain a clean and healthy environment inside the company.

3.2. Valuators

The evaluators are highly qualified members, who work at the mentioned company, and who are familiar with the candidates. They can evaluate the acquired competencies of the candidates as well as the required competencies of the operations.

The company is equipped with software that covers the levels of each staff member in terms of competencies (knowledge, know-how, know-whom). The data was recently updated on 01.01.2020, (two-yearly updates). The evaluators were able to provide the most reliable evaluations. However, there might be an estimated error rate related to the evaluations. To deal with this issue, we will determine an importance weight associated with each evaluator, which represents the level of his/her implication with the evaluated engineers.

The project manager has assigned three managers who will be in charge of the evaluation.

3.3. Linguistic evaluation scale of granularity 7

For the experts to start the evaluation of the candidates, they need a practical tool to help them with this task. It involves the determination of a linguistic evaluation scale, with a granularity (number of linguistic terms) that is neither too small (to provide a good distinction interval for the evaluations) nor too big (to avoid useless precisions.

In our study, we will use a linguistic evaluation scale of granularity 7, defined as:

Table N° 5: linguistic evaluation scale

Linguistic variable	Semantics
S0= Null (N)	(0, 0,0.17)
S1= Very low (VL)	(0,0.17, 0.33)
S2= Low (L)	(0.17, 0.33, 0.5)
S3= Medium (M)	(0.33, 0.5, 0.67)
S4= High (H)	(0.5, 0.67, 0.83)
S5= Very high (VH)	(0.67, 0.83, 1)
S6= Perfect (P)	(0.83,1,1)

Source: Herrera, 2004

Using the linguistic terms (Null (N); Very low (VL); Low (L): Medium (M); High (H); Very high (VH); Perfect(P)), the evaluators can easily fill the competencies matrix and respectively precise the acquired level of each candidate and the required level of each competence resource related to each operation. The following table displays the evaluations (Herrera, 2004):

Table N° 6: Simulation of Herrera study

		S1								S2								S3							
		Req	C1	C2	C3	C4	C5	C6	C7	Req	C1	C2	C3	C4	C5	C6	C7	Req	C1	C2	C3	C4	C5	C6	C7
Op1	(Tk)	VH	H	H	VH	VH	H	M	VH	H	VH	H	H	M	H	H	M	VH	H	VH	H	M	M	H	VH
	(KE)	H	VH	H	H	P	H	L	H	VH	H	H	H	M	P	H	M	VH	H	H	H	L	H	H	VH
	(KP)	P	M	VH	H	P	H	M	H	VH	H	H	M	H	H	M	L	P	VH	VH	VH	L	H	VH	P
	(PK-H)	H	M	M	VH	H	M	L	H	P	H	VH	M	M	P	H	M	H	VH	VH	VH	M	VH	H	P
	(EK-H)	H	H	H	M	VH	H	L	VH	VH	HM	VH	H	M	VH	VH	H	VH	H	H	H	H	VH	H	VH
	(R.)	VH	M	VH	M	H	VH	H	VH	VH	H	H	M	H	VH	H	H	VH	VH	VH	H	L	M	M	VH
	(CC)	H	H	M	MH	VH	H	H	VH	P	VH	M	M	H	H	VH	H	H	M	H	H	M	M	M	P
	(B)	P	H	H	H	H	H	M	P	P	VH	H	H	M	VH	H	H	VH	M	H	H	L	L	L	P
Op2	(Tk)	M	H	L	P	VH	M	L	P	H	M	H	M	M	M	VH	M	H	H	VH	H	VL	VL	L	VH
	(KE)	VH	M	VL	P	H	H	H	H	H	M	VH	M	H	H	H	M	VH	H	VH	M	M	M	H	H
	(KP)	H	VH	M	VH	H	VH	H	H	VH	M	H	L	H	H	H	M	VH	VH	VH	M	M	L	M	VH
	(PK-H)	H	H	M	H	VH	M	M	P	VH	H	H	L	L	M	H	M	P	VH	M	M	M	L	L	P
	(EK-H)	M	H	M	VH	H	M	M	P	P	L	M	M	M	H	M	M	P	VH	M	H	H	L	L	P
	(R.)	VH	L	H	M	VH	H	M	VH	H	L	H	M	M	H	M	M	VH	VH	H	M	VH	M	M	VH
	(CC)	H	M	M	H	H	H	M	VH	P	H	M	L	H	VH	H	M	VH	H	H	L	M	H	M	H
	(B)	H	M	H	H	H	M	M	P	VH	L	M	M	M	VH	VH	M	VH	H	H	M	M	M	M	VH
Op3	(Tk)	M	H	H	H	M	H	H	H	VH	M	P	M	M	H	H	H	P	VH	H	M	M	M	H	H
	(KE)	H	VH	VH	H	H	VH	H	P	H	M	H	H	H	H	VH	VH	P	VH	P	L	H	M	H	H
	(KP)	H	M	VH	H	M	M	H	VH	M	VH	M	H	H	VH	H	VH	H	VH	H	M	VH	H	VH	H
	(PK-H)	VH	H	VH	VH	M	H	H	VH	H	H	H	H	M	H	VH	M	VH	VH	H	VL	VH	M	VH	H
	(EK-H)	M	VH	H	VH	L	M	VH	M	H	H	M	M	H	M	H	H	VH	VH	M	M	H	M	VH	VH
	(R.)	VH	H	H	M	M	VH	L	H	VH	P	H	M	H	H	H	M	P	H	H	L	VH	M	VH	H
	(CC)	H	H	H	M	L	H	VH	H	VH	VH	VH	M	VH	H	VH	M	VH	H	H	M	M	H	P	VH

	(B)	H	H	H	H	H	VH	VH	H	H	VH	H	M	H	M	H	H	VH	VH	VH	H	H	H	P	VH
Op4	(Tk)	VH	M	H	H	M	M	H	L	M	H	L	H	H	M	P	H	H	H	H	M	P	VH	P	H
	(KE)	M	H	H	VH	H	H	M	M	H	H	VL	H	H	L	P	M	VH	H	M	L	P	VH	H	VH
	(KP)	H	H	M	H	M	L	M	M	H	H	M	M	VH	VL	H	H	VH	VH	M	H	P	M	H	H
	(PK-H)	VH	VH	M	H	H	M	H	L	M	H	M	H	M	L	VH	VH	P	VH	H	VH	VH	L	VH	VH
	(EK-H)	VH	VH	H	M	M	L	H	M	VH	P	L	VH	M	M	H	M	H	VH	H	H	VH	L	H	H
	(R.)	H	H	H	M	H	H	M	M	P	VH	M	M	H	M	VH	H	P	VH	H	M	VH	M	H	H
	(CC)	M	H	VH	H	H	M	M	H	H	H	L	M	H	H	VH	H	VH	H	H	M	H	L	VH	VH
	(B)	M	H	H	VH	H	L	H	H	H	M	M	M	M	L	VH	H	VH	M	VH	M	VH	M	VH	VH
Op5	(Tk)	H	VH	M	H	H	H	H	L	P	M	H	H	H	VH	VH	H	P	M	H	M	VH	VL	H	H
	(KE)	VH	H	P	H	H	H	M	L	H	H	VH	H	VH	H	M	M	H	L	H	H	M	L	H	H
	(KP)	M	M	H	H	VH	VH	M	H	VH	H	H	H	H	H	H	H	VH	M	VH	H	M	L	VH	M
	(PK-H)	H	M	VH	M	H	H	M	H	VH	M	VH	H	H	H	M	H	VH	L	VH	M	H	M	H	M
	(EK-H)	VH	M	VH	M	M	M	H	H	H	H	H	H	P	H	M	VH	VH	M	H	L	H	L	H	M
	(R.)	VH	H	H	M	H	H	H	H	P	M	H	M	H	H	H	H	VH	M	M	M	H	L	H	VL
	(CC)	M	H	VH	H	H	M	M	M	H	H	M	H	H	M	H	VH	VH	H	P	M	VH	M	VH	L
	(B)	M	VH	P	H	H	H	M	L	VH	VH	M	M	VH	M	H	VH	VH	M	P	L	H	H	H	M
Op6	(Tk)	VH	H	H	VH	M	L	H	L	H	H	M	L	H	H	H	H	H	H	H	VH	H	M	VH	H
	(KE)	H	VH	H	H	H	VL	H	H	VH	H	M	M	H	H	L	VH	H	M	VH	P	VH	VH	H	VH
	(KP)	M	M	VH	H	H	M	H	H	VH	VH	M	M	M	H	L	P	VH	M	VH	P	VH	P	H	P
	(PK-H)	M	H	VH	M	VH	M	H	H	VHP	VH	LVL	L	M	H	M	P	VH	H	H	H	M	P	VH	P
	(EK-H)	VH	M	M	H	M	L	M	L	H	M	M	M	M	M	L	H	H	VH	H	VH	H	P	VH	VH
	(R.)	VH	M	M	M	H	H	M	L	M	M	L	L	H	M	M	P	VH	H	VH	VH	M	H	H	M
	(CC)	H	VH	M	H	H	M	M	M	H	H	L	VH	H	H	M	H	VH	H	H	H	M	H	P	P
	(B)	H	H	H	H	VH	M	M	M	H	H	M	VH	H	M	M	VH	VH	H	H	H	H	VH	P	P
Op7	(Tk)	H	M	M	M	L	H	M	H	H	H	H	H	VH	H	H	H	VH	H	H	H	H	VH	P	P
	(KE)	H	M	M	H	M	VH	H	M	M	M	H	VH	H	H	H	H	VH	M	VH	VH	VH	VH	H	VH
	(KP)	VH	H	H	VH	M	H	H	H	H	H	VH	VH	H	VH	M	VH	VH	M	H	VH	VH	M	H	H
	(PK-H)	M	VH	VH	H	N	H	VH	H	M	P	H	VH	H	H	M	H	H	H	H	H	H	L	VH	VH
	(EK-H)	H	H	VH	M	M	H	M	VH	VH	VH	H	H	M	H	H	H	H	H	H	P	H	M	VH	H
	(R.)	M	M	H	H	M	H	L	M	VH	H	VH	H	M	M	M	VH	VH	H	VH	P	VH	H	VH	H
	(CC)	M	M	M	H	N	M	VL	H	M	M	H	H	H	H	M	H	P	VH	VH	VH	H	H	VH	VH
	(B)	VH	L	M	VH	M	M	M	M	M	H	H	VH	H	M	M	VH	P	H	H	VH	H	H	VH	H

Source: Herrera, 2004

To tackle the first step, we will introduce the first line of evaluations➔ evaluation related to theoretical knowledge (TK) with regards to Operation 1

Table N° 7: Theoretical knowledge evaluation

	S1								S2								S3							
OP1	Req	C1	C2	C3	C4	C5	C6	C7	Req	C1	C2	C3	C4	C5	C6	C7	Req	C1	C2	C3	C4	C5	C6	C7
(Tk)	VH	H	H	VH	VH	H	M	VH	H	VH	H	H	M	H	H	M	VH	H	VH	H	M	M	H	VH

Source: authors

The application of the following equation allows the expression of the aggregated level of acquired and required competencies resources respectively with the equation….. and the equation …..

$$(\eth a_{ikj}, \alpha_{ikj}) = \Delta\left(\sum_{l=1}^{L} \Delta^{-1}\left(\eth a_{ikj}, \alpha_{ikj}\right) w_l \Big/ \sum_{l=1}^{L} w_l\right)$$

$$\forall j = 1,2,...,J; \forall k = 1,2,...,K; \forall i = 1,2,...,I$$

$$\left(\eth \Upsilon_{kj}, \alpha_{kj}\right) = \Delta\left(\sum_{l=1}^{L} \Delta^{-1}\left(\eth \Upsilon_{kjl}, \alpha_{kjl}\right) w_l \Big/ \sum_{l=1}^{L} w_l\right)$$

$$\forall j = 1,2,...,J; \forall k = 1,2,...,K; \forall i = 1,2,...,I$$

where:

E_l Expert $l (l = 1,2,...,L)$

$\eth_i$ Candidate $i (i = 1,2,...,I)$

T_j Task $j (j = 1,2,...,J)$

k Competence resource $k (k = 1,2,...,K)$

$\eth a_{ikjl}$ Evaluation of competence resource k of candidate i for the task j expressed by expert l

$\eth \Upsilon_{kjl}$ Evaluation of competence resource k required by task j expressed by expert l

w_l Importance weight of expert l

3.4. Transformation of linguistic evaluations:

In this phase, our work consists of transforming the linguistic terms (evaluations) into p(si, 0) 2-tuple, according to the following transformation function:

$: S \rightarrow S \times [-0.5, 0.5), \theta\ (si) = (si, 0), si \in S.$

After applying the mentioned function, we obtain the following results, which are related to the transformation of the evaluations of theoretical knowledge (TK) related to operation 1 :

Operation1: the evaluations of the 7 candidates/ theoretical knowledge (TK)

Tableau N° 8: the evaluations of the 7 candidates

	Req	C1	C2	C3	C4	C5	C6	C7
S1	(VH, 0)	(H, 0)	(H, 0)	(VH, 0)	(VH, 0)	(H,0)	(H,0)	(VH, 0)
S2	(H,0)	(VH, 0)	(H, 0)	(H,0)	(M,0)	(H,0)	(H,0)	(M, 0)
S3	(VH, 0)	(H, 0)	(VH, 0)	(H,0)	(M,0)	(M, 0)	(H, 0)	(VH, 0)

Source: authors

The project managers evaluate each development activity according to the ability/ required competence using linguistic terms set S, the linguistic evaluation x_{ij} of an activity

x_i $(i = 1, 2,..., N)$ relative to the skill/ competence

c_j $(j = 1, 2,..., M)$ is transformed into a 2-tuple

3.5. Calculation of the difference between the levels and the ideal and non-ideal solutions

Table N° 9: Difference between the levels and the ideal and non-ideal solutions

		C1	C2	C3	C4	C5	C6	C7
Op1	d_{ij}^{+}	**0,33**	**1,14**	**0,39**	**0,89**	**0,7**	**1,08**	**0,65**
	d_{ij}^{-}	**0,56**	**0,71**	**0,11**	**1,52**	**1,01**	**0,4**	**0,47**
Op2	d_{ij}^{+}	**0,42**	**0,91**	**0,76**	**1,22**	**0,46**	**0,42**	**1,42**
	d_{ij}^{-}	**1,5**	**0,42**	**1,1**	**0,31**	**0,74**	**1,64**	**0,7**
Op3	d_{ij}^{+}	**0,33**	**2,02**	**0,42**	**1,71**	**1,11**	**0,14**	**0,72**
	d_{ij}^{-}	**0,56**	**0,7**	**0,03**	**0,45**	**0,44**	**1,71**	**0,91**
Op4	d_{ij}^{+}	**0,3**	**1,78**	**0,44**	**0,79**	**0,31**	**0,62**	**1,4**
	d_{ij}^{-}	**1,4**	**1,75**	**0,01**	**0,46**	**0,11**	**0,42**	**0,55**
Op5	d_{ij}^{+}	**2,01**	**1,21**	**0,07**	**0,75**	**0,36**	**0,44**	**0,03**
	d_{ij}^{-}	**1,2**	**0,73**	**0,06**	**0,42**	**0,41**	**0,14**	**0,46**
Op6	d_{ij}^{+}	**0,5**	**1,45**	**0,3**	**0,32**	**0,33**	**0,32**	**0,42**
	d_{ij}^{-}	**0,78**	**0,63**	**0,4**	**0,34**	**0,21**	**0,11**	**0,11**
Op7	d_{ij}^{+}	**0,12**	**0,74**	**1,5**	**2,73**	**1,05**	**0,69**	**0,4**
	d_{ij}^{-}	**0,18**	**0,24**	**1,56**	**0,4**	**0,63**	**0,76**	**0,79**

Source: authors

4. Final result

Table N° 10: Results

CC_{ij}	C1	C2	C3	C4	C5	C6	C7	FINAL RANKING
Op1	0,32	0,76	0,01	0,4	0,34	0,09	0,21	C2>C4>C5>C1>C7>C6>C3
Op2	0,15	0,67	0,22	0,75	0,36	0,41	0,3	C4>C2>C6>C5>C7>C3>C1
Op3	0,4	0,22	0,27	0,31	0,1	0,11	0,45	C7>C1>C4>C3>C2>C6>C5
Op4	0,21	0,35	0,4	0,25	0,59	0,07	0,13	C5>C3>C2>C4>C1>C7>C6
Op5	0,55	0,43	0,12	0,13	1,47	0,31	0,16	C1>C5>C2>C6>C7>C4>C3
Op6	0,33	0,89	0,65	0,76	0,42	0,5	0,43	C2>C4>C3>C7>C6>C5>C1
Op7	0,79	0,08	0,04	0,54	0,62	0,4	0,7	C1>C7>C5>C4>C6>C2>C3

Source: authors

Discussion

In this article, we have implemented an approach that allows the ranking of human resources for different tasks, while minimizing the gaps between the acquired and required competencies levels. For this purpose, it is imperative to provide a clear identification of the competence resources and to specify their levels objectively and accurately. The qualitative aspect of the chosen criteria has imposed the application of linguistic approach, namely the 2-tuple linguistic representation model to convey the evaluations provided by the different parties. The model offers the benefit of providing objective levels while avoiding any risk of ambiguity during the interpretation of the results. The obtained evaluations are the input data of the TOPSIS technique. This technique uses the calculation of the proximity factor between acquired and required levels to manage the multi-criteria aspect of the evaluation problem and to provide a ranking of the human resources for different tasks.

Conclusion

For modern systems of classification and management of information within companies, must take the information coming from human experts generally expressed qualitatively in natural language with linguistic labels. For this, we have considered in our article two models of linguistic representation used for classification purposes and efficient combination of qualitative information expressed in terms of qualitative beliefs, the 2-tuple and the TOPSIS model of Herrera-Martínez, Both models preserve accuracy and improve the efficiency of merging linguistic information expressing the global expert's opinion.

In in managerial involvement, the adopted method in our article does not only offer rankings of candidates to help select the best one but also provides an insight on the level of each candidate according to the task demands. This kind of information will guide the managers in terms of promotions and trainings….In this framework, the obtained ranking is a necessary step that aims to help in the allocation of human resources. From this study, we can open up on several horizons, by asking the questions "what is the link between the ranking and the rate of staff satisfaction, and what is the impact of this result on the managerial performance of the company?

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