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#### Article

### Decision making to manage the optimal selection of personnel in the hotel company applying the hungarian algorithm

The International Journal of Management Science and Information Technology (IJMSIT)

#### **Provided in Cooperation with:**

North American Institute of Science and Information Technology (NAISIT), Toronto

*Suggested Citation:* Gil-Lafuente, Anna María; Oh, Young Kyun (2012) : Decision making to manage the optimal selection of personnel in the hotel company applying the hungarian algorithm, The International Journal of Management Science and Information Technology (IJMSIT), ISSN 1923-0273, NAISIT Publishers, Toronto, Iss. 6-(Oct-Dec), pp. 27-42

This Version is available at: https://hdl.handle.net/10419/97849

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# **INTERNATIONAL JOURNAL OF**

# Management Science and Information Technology





#### The International Journal of Management Science and Information Technology (IJMSIT)

NAISIT Publishers

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#### The International Journal of Management Science and Information Technology (IJMSIT)

#### NAISIT Publishers

Issue 6 - (Oct-Dec 2012)

#### **Table of Contents**

#### 1 **OUALITATIVE AND OUANTITATIVE METHODOLOGICAL APPROACH FOR EVALUATING PUBLIC R**

DR NIKOLAS GEORGIADIS, Head of Research and Documentation Department, Hellenic Quality Assurance and Accreditation Agency (HQA) in Higher Education, Greece DR DIMITRA ILIOPOULOU, School of Electrical and Computer Engineering Division of Information Transmission Systems and Material Technology, National Technical University of Athens. Greece PROFESSOR VICKY MANTHOU, Department of Applied Informatics, University of

Macedonia, Thessaloniki, Greece PROFESSOR DIMITRIS KOUTSOURIS, School of Electrical, Greece

#### 27 DECISION MAKING TO MANAGE THE OPTIMAL SELECTION OF PERSONNEL IN THE HOTEL COMPANY APPLYING THE HUNGARIAN ALGORITHM

ANNA MARÍA GIL-LAFUENTE, Department of Economics and Business Organization, University of Barcelona, Spain YOUNG KYUN OH, Department of Economics and Business Organization, University of Barcelona, Spain

IMPACT OF INFORMATION SHARING AND BUYER DEPENDENCE AMONG 43 SUPPLY CHAIN MEMBERS ON TRUST AND STRATEGIC FLEXIBILITY SHI KUI-RAN, College of Economics and Management, Nanjing University of Technology, China WANG JI-NING, College of Economics and Management, Nanjing University of Technology, China WANG PING, College of Economics and Management, Nanjing University of Technology, China

This is one paper of The International Journal of Management Science and Information Technology (IJMSIT) Issue 6 - (Oct-Dec 2012)



#### Decision making to manage the optimal selection of personnel in the hotel company applying the Hungarian algorithm

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#### Abstract

In a context of globalization and permanent change, we present a process for the administration and the management of human resource in the field of the organization of the hotel environment. The classic systems used for the optimal selection of personnel among the proposed candidates are often ineffective due to the existence of variables (characteristics, peculiarities or singularities) not only objective but also mostly subjective.

We have proposed the application of a model based on the treatment of uncertainty, the Hungarian Algorithm (also known as König's Algorithm), in order to show a process for optimal selection of personnel. This work allows for a company, in hotel business, can choose those candidates who will be best fit for the offered jobs, but at the same time optimizing the candidates' aptitude in the set of hotel atmosphere. The objective is to see how candidates are as efficient as possible to the company, and not only analyzing the individual efficiency of each jobs.

Keywords: decision making, Hungarian Algorithm, human resources, selection of personnel, hospitality

#### 1. Introduction

Throughout the history of humanity, our ancestors were seeking for food and better living conditions. We know that the hospitality is an attitude that begins to manifest at the time of the ancient Greeks and the Roman Empire. According to Casson (1974), the word *hotel* it appeared after the "Feathers Hotel" in England in 17th century. The concept of hotel appears in French in



the middle of the 19th century, this concept evolves towards modern hospitality by César Ritz (Gonzaléz and Talón, 2003). Despite the bankruptcy of hotels due to the Great Depression of 1930 and the global economic recession, the hotel industry has been growing rapidly due the development of the road and air transport through increasing of leisure time, and the expansion of the market expansion and the development of the tourism sector during the economic recovery. Today there are hospitalities and travel agencies which give greater role in the tourism industry. The organizational role and the function of this sector will be developed through greater complexity of the business management system.

There are several authors who have made an emphasis on the conceptualization of the process of management and the administration of human resources (De la Calle Durán et al., 2004, Gómez-Mejía, Balkin and Cardy, 1999; Labrado, 2000; Manuela Pardo, 2006; Martha Alles, 2000; Montes Alonso and Rodriguez, 2006; Rojo and Cabrera, 1999; Valle Cabrera, 1995; Wayne Mondy, 2010). The human resources management occupies an important position both in the various sizes in hotels for administration jobs in order to fix the objectives and correct the deviations. It should serve to provide better services and more adapted to the diversity of customers and thus generate competitive advantage. In this sense, the director of each department should consider the importance of human resources processing to select workers who are more appropriate or adequate in order to facilitate and improve the quality of the activities of accompany whom they are in responsible for. According to Gómez-Mejía (1999), the effective management of human resources is a fundamental element of the work of any director. For Labrado (2000), the mission of all members of the area of human resources department of the company is to ensure that the company has a team of highly prepared, motivated and committed to the objectives. However, employee should also consider that their task is satisfy while importance for quality of work.

The process for the selection of staff consists of choosing a person for a job with a particular profile, susceptible to be defined through a few methods and mathematical models that will be allowed candidate to be compared under equal qualities (Kaufmann and Gil Aluja, 1986).

In this context we manifest the decision making in the management of personnel selection applying the Hungarian algorithm (D. König, 1916) in order to perform an efficient and optimal assignment between different candidates through jobs offered by the establishment hotel.

#### 2. Direction, organization and human resources in hotel companies

It must be borne in mind that in the hospitality industry are converging of three general characteristics: services, seasonality and temporality. Hotels, hostels and apart-hotels are companies that are oriented to the service and generate performance depending on the season and the duration of reservations (Javier Cerra at al., 2001). The hotels must provide both tangible goods



(furniture, rooms, meeting and exhibition rooms, food menu, etc.) and intangible (services employees, maintenance services, warranty, etc.) additional to the clients or guests. For this reason, it is important that the manager and the directors of each department have knowledgeable about their field at a high level of skill to handle well in order to control the organization and to manage simultaneously the direction, as well as resolve the problems and conflicts that may arise.

We present in the *Table 1*, the general functions of the hotel's department of management. In general, the role of the director is to manage and direct to meet the objectives based on these four functions:

Department	Functions				
	Planning				
	<ul> <li>Fixing of the general objectives of the hotel</li> </ul>				
	• Determination of policies plans and budgets to achieve of the proposed				
	objectives				
	Organization				
	• Definition of the organizational and hierarchical structure and of the hotel				
	• Establishment of the functions, tasks and responsibilities of the various				
Direction	departments				
	Management				
	• Proper development of tasks and assigned responsibilities through the				
	motivation and the leadership				
	Control				
	• Comparison of the results obtained with the initial estimates				
	• Correction of the diversions detected				

Table 1. Functions of the hotel's department of management

source: adapted from González and Talón (2003).

Montejano (2000) refers to an organization specified of hotels by its organizational structure in levels of functions may have several forms that are expressed graphically through their corresponding organization chart.

One of the main goals of human resources management would be comply correctly the missions of his position following the role and the planning of the company in order to achieve the objectives to make the company is more competitive in the market. For this reason, the companies are giving increasingly more importance to the investment in the quality of human resources in the direction of the company. For Chon and Sparrowe (2001), the trend today in the hotel industries is changing the recruitment and the benefit systems in order to attract and/or retain workers well qualified and talented, as well as reduce the turnover rate of employees in the industry.

On the other hand, Pardo (2006) manifest the importance of human resources in the tourism sector due to two elements: the presence in the field of intangible services, and by personnel costs, which are higher than in other sectors. The human resources in the hotel companies is constituted as a fundamental asset in its provision by which are converted into the basis of the competitive advantage that the company can achieve through the satisfaction of their customers, as well as a personnel qualified, who will be the reason for the success of a business based on intangible and expectations related with work experiences (Blasco et al., 2006; Gonzaléz y Talón, 2003). Finally, the selection of appropriate personnel is the mechanism that determines the overall quality of human resources (Gómez-Mejía et al., 1999).

#### 3. Methodology

In general, the methodology of the Hungarian Algorithm which can use and apply to optimize the decision making on the selection of personnel with differences between little appreciable candidates. The objective is to analyze the remoteness or approach of the individuals' preferences respect of the characteristics of the candidates in the selection of personnel for each job, looking for the overall efficiency for the company.

#### **3.1.** The concept of the Assignment

The Assignment is one of the four basic elements (Relation, Assignment, Grouping and Ordering) that constitute the process of decision making in uncertainty.

"We understand by assignment process through which each element of a set of objects is attached to another item belonging to another set of objects of different nature, based on certain characteristics, required a certain level" (Gil Aluja, 1999).

In order to obtain relations, start the process for the allocation. You can use some of indexes capable of expressing "*distancing or nearness*" in appropriated placement, the range is between the objects to affect and the objects to which must be involvement. Among the best known include those that arise from the notion of distance and which are based on from the notion of adequacy. The task of correctly assigning one object to another object has in itself a combinatorial nature, and thus, the complexity in will achieve optimal results (Gil Aluja, 1999).

#### **3.2.** The Hungarian Algorithm<sup>1</sup>

<sup>&</sup>lt;sup>1</sup>GIL ALUJA, J. (1995). "*Modelos no numéricos de asignación en la gestión de personal*". Proceedings of the 2nd Congress of International Association for Fuzzy-Set Management and Economy (SIGEF). Santiago de Compostela, Spain. 15-17 November.



One of the processes traditionally used for optimal allocation takes its roots in a famous work of D. König<sup>2</sup> in 1916. The denomination of the methodology is the nationality of the mathematician. The Hungarian algorithm is an assignment model based on the treatment data matrix allows, through a sequential process, effecting the best possible allocation of process on elements.

*Definition:* If accepted optimize an array for the principle of minimization will be necessary from a matrix based on distances, which will name  $\left[\overline{\underline{Q}}\right]$  or complementary matrix of adjustment  $\overline{\underline{R}}$ .

Bear in mind that not always the number of rows of these fuzzy relations equals the number of columns, so that we are dealing with a rectangular matrix. To render the algorithm more practical, we will transform the rectangular matrix in a square matrix always adding rows or columns needs by considering physical objects or fictitious.

To simplify the algorithm, denoted by  $P_{ii}$  elements of the matrix that we consider whether it is the

ratio  $\begin{bmatrix} \overline{Q} \\ \widetilde{Q} \end{bmatrix}$  and the  $\begin{bmatrix} \overline{R} \\ \widetilde{R} \end{bmatrix}$ . The algorithm consists of the following steps:

Step 1. Subtract all the elements in each row or column as you add a column or row, the smallest value of the same. Will  $u_i = \min_i P_{ij}$  in the case of rows, from which results in each box,  $P_{ij} - u_i = P_{ij} - \min_i P_{ij}$ , or  $u_j = \min_i P_{ij}$  if we refer to the columns with what you have in each box  $P_{ij} - u_i = u_i = P_{ij} - \min_i P_{ij}$ .

The same shall apply in each column  $v_j = \min(P_{ij} - u_i)$  or row  $v_i = \min(P_{ij} - u_j)$ . Thus there is at least one zero in every column and every row in a matrix whose elements are  $P_{ij}$  which will, in turn, values:

$$P_{ij} - (u_i + v_j)$$
, or:  $P_{ij} - (u_j + v_i)$ 

*Step 2*. It will be seen as a possible assignment, in which the values of the solution are all zero. If so we will have an optimum. Otherwise proceed to the repeat the process. To do this:

- a) It is considered one by the rows that contain fewer zeros.
- b) Fit one of the zeros of each row and the other zeros are blacked out of the row and column that belongs to the zero framed.
- c) Repeat the process with the rows that containing zeros growing until we are zeros for framing.

<sup>&</sup>lt;sup>2</sup> KÖNIG, D. (1916). "*Théorie der endlichen und unendlichen graphen*", reprinted later by Chelsea Publ. C. No. New York, 1950. This work was introduced by Kuhn, H. W. in his article "*The hungarian method for the assignment problem*." Naval Research Quarterly. Vol 2, nº: 1-2., p. 83-98 (1995).

It will be noted that is possible an assignment, in which the  $P_{ij}$  values of the solution are all zero. In positive case will have an optimum. Otherwise the process will continue. To do this:

Step 3. Obtention the lower number of rows and columns that containing all zeros. To do this:

- a) An arrow is drawn  $\leftarrow$  to the rows in which there is *no zero-framed*.
- b) Is drawn with an arrow  $\uparrow$  in the column that is a zero strikeout *in a row indicated with arro w*.
- c) An arrow is drawn ← to those rows in which there is indeed a zero framed *in a column ma rked with arrow.*
- d) Repeat *b* and *c* until they cannot draw more rows or columns.
- e) A line in the rows marked by arrows and a line in each column marked by arrows. These ro ws and columns represent the smallest number of them that have zeros or badly framed.

Step 4. Eventual displacement of some zeros. To this end, we choose among the array elements that have not been scratched, the smallest value. This figure is subtracted from the elements in the unshaded columns and joins the elements of the rows it scratches. A matrix with the elements is obtained  $P_{ii}$ .

*Step 5*. With the new matrix whose elements are  $P_{ij}$ , will return to step 2, following the same procedure used for the matrix with the elements  $P_{ij}$ . In the case of finding an optimal solution we will stop and reach the end of the process. Otherwise, continue with step 3 and 4. If necessary we will return to 2.

We show that we find a solution even though it need not be unique and can therefore be other. In this sense it is necessary to show that the solution found is emerging as the best possible under the existing alternatives and the different combinations planteables. Any other allocation will be less satisfactory as a whole, although individually might get better assignments consider one by one. Additionally, there are other models that allow an optimization for general level such as the *OWA (Ordered Weighted Averaging) Operators* and *Branch and Bound algorithm*.

## 4. Application of algorithm model in the process of personnel selection of a hotel department

In this part, we describe the process of the applications with the above mentioned studies. The general manager of a hotel has to evaluate the characteristics of the candidates in relation to the profile of the jobs.



We suppose the existence of five departments D vacancies and six candidates C already evaluated in eight requirements R. The evaluation of the requirements is represented as the degree of belonging in a fuzzy set by assigning a value in the characteristic function of membership in the interval [0, 1]. In this case, the requirements represent the personal characteristics that require jobs.

We express the following set R:

$$R = \{R_1, R_2, R_3, R_4, R_5, R_6, R_7, R_8\}$$

Describe as:

 $R_1$  = Level of education

 $R_2 =$  Knowledge of languages

 $R_3$  = Knowledge of the hospitality industry

 $R_4$  = Work experience

 $R_5$  = Ability to make decisions

 $R_6$  = Personnel character extroverted and empathetic

 $R_7$  = Leadership capacity

 $R_8$  = Capacity to guide the customer

In the *Matrix 1* we present the descriptors of the candidates according to the degree of compliance with the established requirements:

$$C = \{C_1, C_2, C_3, C_4, C_5, C_6\}$$

	$R_1$	$R_2$	$R_3$	$R_4$	$R_5$	<i>R</i> <sub>6</sub>	$R_7$	<i>R</i> <sub>8</sub>
$C_1$	0.7	0.6	0.7	0.5	0.7	<mark>0.9</mark>	0.8	<mark>0.9</mark>
<i>C</i> <sub>2</sub>	0.8	0.7	0.5	0.6	0.8	0.7	0.7	0.6
<i>C</i> <sub>3</sub>	0.9	0.6	0.8	0.7	0.6	0.7	0.8	0.8
C_4 ~	0.8	0.7	<mark>0.9</mark>	0.6	0.8	0.6	0.5	0.8
C <sub>5</sub>	0.6	0.8	0.6	0.9	0.7	0.6	0.9	0.7
C <sub>6</sub>	<mark>0.9</mark>	<mark>0.9</mark>	<mark>0.8</mark>	0.7	0.6	<mark>0.9</mark>	0.7	<b>0.</b> 9

Matrix 1.

Next, we present the set of jobs vacant D:



$$D = \{D_1, D_2, D_3, D_4, D_5\}$$

Describe as:

 $\begin{array}{l} D_1 = \text{Department of Accommodation} \\ \widetilde{D_2} = \text{Department of Maintenance, technical services and safety} \\ \widetilde{D_3} = \text{Department of Commercial} \\ \widetilde{D_4} = \text{Department of Finance} \\ \widetilde{D_5} = \text{Department of Human Resources} \end{array}$ 

Thus, in the *Matrix 2* we show the result of the corresponding descriptors:

	$R_1$	$R_2$	$R_3$	$R_4$	$R_5$	<i>R</i> <sub>6</sub>	$R_7$	$R_8$
$D_1$	0.7	1	0.9	0.7	0.7	1	0.6	1
$D_2$	0.7	<mark>0.9</mark>	0.9	0.6	0.9	1	0.7	1
D <sub>3</sub>	0.8	0.8	0.8	0.7	0.7	0.7	0.8	0.7
$D_4$	0.8	0.8	0.8	0.8	0.9	0.6	0.8	0.6
D <sub>5</sub>	0.8	0.7	0.8	0.6	0.8	0.7	0.7	0.8

#### Matrix 2.

Calculates the relative distances of Hamming:

$$(C_1, D_1) = \frac{1}{8}(|0.7 - 0.7| + |0.6 - 1| + |0.7 - 0.9| + |0.5 - 0.7| + |0.7 - 0.7| + |0.9 - 1| + |0.8 - 0.6| + |0.9 - 1|) = \frac{1}{8}(|0.7 - 0.7| + |0.6 - 1| + |0.7 - 0.9| + |0.5 - 0.7| + |0.7 - 0.7| + |0.9 - 1| + |0.8 - 0.6| + |0.9 - 1|) = \frac{1}{8}(|0.7 - 0.7| + |0.6 - 1| + |0.7 - 0.9| + |0.5 - 0.7| + |0.7 - 0.7| + |0.9 - 1| + |0.8 - 0.6| + |0.9 - 1|) = \frac{1}{8}(|0.7 - 0.7| + |0.6 - 1| + |0.7 - 0.9| + |0.5 - 0.7| + |0.7 - 0.7| + |0.9 - 1| + |0.8 - 0.6| + |0.9 - 1|) = \frac{1}{8}(|0.7 - 0.7| + |0.8 - 0.6| + |0.9 - 1|) = \frac{1}{8}(|0.7 - 0.7| + |0.8 - 0.6| + |0.9 - 1|) = \frac{1}{8}(|0.7 - 0.7| + |0.8 - 0.6| + |0.9 - 1|) = \frac{1}{8}(|0.7 - 0.7| + |0.8 - 0.6| + |0.9 - 1|) = \frac{1}{8}(|0.7 - 0.7| + |0.8 - 0.6| + |0.9 - 1|) = \frac{1}{8}(|0.7 - 0.7| + |0.8 - 0.6| + |0.9 - 1|) = \frac{1}{8}(|0.7 - 0.7| + |0.8 - 0.6| + |0.9 - 1|) = \frac{1}{8}(|0.7 - 0.7| + |0.8 - 0.6| + |0.9 - 1|) = \frac{1}{8}(|0.7 - 0.7| + |0.8 - 0.6| + |0.9 - 1|) = \frac{1}{8}(|0.7 - 0.7| + |0.8 - 0.6| + |0.9 - 1|) = \frac{1}{8}(|0.7 - 0.7| + |0.8 - 0.6| + |0.9 - 1|) = \frac{1}{8}(|0.7 - 0.7| + |0.8 - 0.6| + |0.9 - 1|) = \frac{1}{8}(|0.7 - 0.7| + |0.8 - 0.6| + |0.9 - 1|) = \frac{1}{8}(|0.7 - 0.7| + |0.8 - 0.6| + |0.9 - 1|) = \frac{1}{8}(|0.7 - 0.7| + |0.8 - 0.6| + |0.9 - 1|) = \frac{1}{8}(|0.7 - 0.7| + |0.8 - 0.6| + |0.9 - 1|) = \frac{1}{8}(|0.7 - 0.7| + |0.8 - 0.6| + |0.9 - 1|) = \frac{1}{8}(|0.7 - 0.7| + |0.8 - 0.6| + |0.9 - 1|) = \frac{1}{8}(|0.7 - 0.7| + |0.8 - 0.6| + |0.9 - 1|) = \frac{1}{8}(|0.7 - 0.7| + |0.7 - 0.7| + |0.7 - 0.7| + |0.7 - 0.7|) = \frac{1}{8}(|0.7 - 0.7| + |0.7 - 0.7| + |0.7 - 0.7|) = \frac{1}{8}(|0.7 - 0.7| + |0.7 - 0.7| + |0.7 - 0.7|) = \frac{1}{8}(|0.7 - 0.7| + |0.7 - 0.7| + |0.7 - 0.7|) = \frac{1}{8}(|0.7 - 0.7|) = \frac{1}{8}(|0.7 - 0.7| + |0.7 - 0.7|) = \frac{1}{8}(|0.7 - 0.7| + |0.7 - 0.7|) = \frac{1}{8}(|0.7 - 0.7|) = \frac{1}{8}$$



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$$\begin{split} &(C_1, D_2) = \frac{1}{8} (|0.7 - 0.7| + |0.6 - 0.9| + |0.7 - 0.9| + |0.5 - 0.6| + |0.7 - 0.9| + |0.9 - 1| + |0.8 - 0.7| + |0.9 - 1|) \\ &= 0.13 \\ \hline &(C_1, D_3) = \frac{1}{8} (|0.7 - 0.8| + |0.6 - 0.8| + |0.7 - 0.8| + |0.5 - 0.7| + |0.7 - 0.7| + |0.9 - 0.7| + |0.8 - 0.8| + |0.9 - 0.7| + |0.8 - 0.8| + |0.9 - 0.7| + |0.9 - 0.7| + |0.8 - 0.8| + |0.9 - 0.7| + |0.9 - 0.6| + |0.8 - 0.8| + |0.9 - 0.6| + |0.8 - 0.8| + |0.9 - 0.6| + |0.9 - 0.6| + |0.8 - 0.8| + |0.9 - 0.6| + |0.8 - 0.8| + |0.9 - 0.6| + |0.8 - 0.8| + |0.9 - 0.6| + |0.8 - 0.8| + |0.9 - 0.6| + |0.9 - 0.6| + |0.8 - 0.8| + |0.9 - 0.6| + |0.8 - 0.8| + |0.9 - 0.6| + |0.8 - 0.8| + |0.9 - 0.6| + |0.8 - 0.8| + |0.9 - 0.6| + |0.8 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.7| + |0.8 - 0.7| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.7| + |0.8 - 0.7| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.7| + |0.8 - 0.7| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.7| + |0.8 - 0.7| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.7| + |0.8 - 0.7| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| + |0.9 - 0.8| +$$

In the following *Matrix 3* we present the results obtained in the matrix of distances *P*:

		Ι	Matrix	3.		
		$D_1$	$D_2$	$D_3$	$D_4$	$D_{5}$
	$C_1$	<b>0.1</b> 5	0.13	0.12	0.18	0.11
	$C_2$	0.22	0.18	0.10	0.11	0.06
[ <i>P</i> ] =	$C_3$	0.18	0. 20	0.06	0.12	0.07
	$C_4$	0.16	0.15	0.11	0.12	0.05
	$C_{5}$	0.22	0.23	0.10	0.11	0.16

To start the process we add one fictitious column F to obtain a square matrix. The values assigned to each element of the fictitious column is 1, the aim is to realize assignations from an optimization by minimal. In order to do that, we appear a "0" in each row and column, subtract



the smallest value in each row and each column. To begin with we opted for the smallest number in each row of the matrix. In this case, smaller values are  $(C_1, D_5)=0.11$ ,  $(C_2, D_5)=0.06$ ,  $(C_3, C_5)=0.06$ ,  $(C_5)=0.06$ , (

 $D_3$  )=0.06, ( $C_4$ ,  $D_5$ )=0.05, ( $C_5$ ,  $D_3$ )=0.10, ( $C_6$ ,  $D_3$ )=0.10. We show in the *Matrix 4*:

			Matr	·ix 4.			
	$D_1$	$D_2$	$D_3$	$D_4$	$D_{5}$	$F_{\sim}$	
$C_1$	0.15	0.13	0.12	0.18	0.11	1	0.11
C_2	0.22	0.18	0.10	0.11	0.06	1	0.06
C <sub>3</sub>	0.18	0.20	0.06	0.12	0.07	1	0.06
C_4 ~	0.16	0.15	0.11	0.12	0.05	1	0.05
C <sub>5</sub>	0.22	0.23	0.10	0.11	0.16	1	0.10
C <sub>6</sub>	0.10	0.11	0.10	0.16	0.11	1	0.10

We subtract the value chosen to row that belongs. The objective is to obtain a "0" in each row and each column. Performing the same operation on each column of the matrix obtained. We expose on the *Matrix 5*:

#### Matrix 5.



	$D_1$	$D_2$	$D_3$	$D_4$	$D_{5}$	$\mathop{F}\limits_{\sim}$
$C_1$	0.04	0.02	0.01	0.07	0	0.89
<i>C</i> <sub>2</sub>	0.16	0.12	0.04	0.05	0	0.94
$C_3$	0.12	0. 14	0	0.06	0.01	0.94
$C_4$	0.11	0.10	0.06	0.07	0	0.95
$C_{5}$	0.12	0.13	0	0.01	0.06	0.90
C <sub>6</sub>	0	0.11	0	0.16	0.11	0.90
	0	0.02	0	0.01	0	0.89

In the *Matrix 6*, we expose the obtaining of the matrix  $\overline{P}'$ :

Matrix 6.										
		$D_1$	$D_2$	$D_3$	$D_4$	$D_{5}$	$\mathop{F}\limits_{\sim}$			
	$C_1$	0.04	0	0.01	0.06	0	0			
	<i>C</i> <sub>2</sub>	0.16	0.10	0.04	0.04	0	0.05			
$\left[ \overline{P}' \right] =$	$C_3$	0.12	0. 12	0	0.05	0.01	0.05			
	$C_4$	0.11	0.08	0.06	0.06	0	0.06			
	$C_{5}$	0.12	0.11	0	0	0.06	0.01			
	C <sub>6</sub>	0	0.09	0	0.15	0.11	0.01			

Each "0" represents a possible allocation. To exist more than one "0" in each row and column must continue the process of König to find a matrix in which there is only one "0" in each row and column, which will represent the optimal and efficient allocation. Thus:

a) It is considered one by the rows that contain fewer zeros.

b) Fit one of the zeros of each row and the other zeros are blacked out of the row and column that belongs to the zero framed.

c) Repeat the process with the rows that containing zeros growing until we are zeros for framing.

The process starts framing the "0" of  $(C_6, D_1)$ , for example. We continue framing zeros and scratching those of the same row and column to eliminate possible duplications in the assignments (*Matrix 7*):

Matrix 7.										
	$D_1$	$D_2$	$D_3$	$D_4$	$D_{5}$	$\mathop{F}\limits_{\sim}$				
$C_1$	0.04	0	0.01	0.06	X	X				
<i>C</i> <sub>2</sub>	0.16	0.10	0.04	0.04	0	0.05				
C3 ~	0.12	0. 12	0	0.05	0.01	0.05				
$C_4$	0.11	0.08	0.06	0.06	×	0.06				
$C_{5}$	0.12	0.11	×	0	0.06	0.01				
C <sub>6</sub>	0	0.09	X	0.15	0.11	0.01				

The next step is to obtain the smallest number of rows and columns that containing zeros in the *Matrix 8*.



In such a way, we take the item with lower value "0.04" in which are not scratched rows or columns. This value is added to the striped rows and is subtracted from the non-striped columns. Wherewith, results in the *Matix 9*:

#### Matrix 9.

	$D_1$	$D_2$	$D_3$	$D_4$	$D_{5}$	$\mathop{F}\limits_{\sim}$
$\underset{\sim}{C_1}$	0.04	0	0.01	0.06	0.04	×
$C_2$	0.12	0.06	×	×	×	0.01
$C_{3}$	0.12	0.12	0	0.05	0.05	0.05
$C_4$	0.07	0.04	0.02	0.02	0	0.02
$C_{5}$	0.12	0.11	×	0	0.10	0.01
C_6	0	0.09	X	0.15	0.15	0.01

We repeat the process of framing and scratching "0" with the new matrix obtained, and to point the rows and columns, as has been done above. Thus, we show in the *Matrix 10*:



It is that the lowest value is "0.01" in which rows are not strikethrough or columns. Adds this value to the rows scratched and it is subtracted from the non-scratched columns. Thus, we obtain the following matrix of the *Matrix 11*:

#### Matrix 11.

#### Matrix 10.



	$D_1$	$D_2$	$D_3$	$D_4$	$D_{5}$	$\mathop{F}\limits_{\sim}$
$\underset{\sim}{C_1}$	0.04	0	0.02	0.07	0.05	0
C_2 ~	0.11	0.05	0	0	0	0
$C_3$	0.11	0.11	0	0.05	0.05	0.04
C_4 ~	0.06	0.03	0.02	0.02	0	0.01
$C_{5}$	0.11	0.10	0	0	0.10	0
C <sub>6</sub>	0	0.09	0.01	0.16	0.16	0.01

We continue the process and finally we obtain a final matrix (*Matrix 12*). There are 6 zeros framed one for each row and column.

	Matrix 12.										
	$D_1$	$D_2$	$D_3$	$D_4$	$D_{5}$	$\mathop{F}\limits_{\sim}$					
$C_1$	0.04	0	0.02	0.07	0.05	X					
$C_2$	0.11	0.05	×	0	×	X					
C <sub>3</sub>	0.11	0.11	0	0.05	0.05	0.04					
C_4	0.06	0.03	0.02	0.02	0	0.01					
<i>C</i> ₅	0.11	0.10	×	×	0.10	0					
C <sub>6</sub>	0	0.09	0.01	0.16	0.16	0.01					

The final matrix shows the result of the assignation of each candidate for each vacant department of the hotel. The results found were as follows:

- The candidate  $C_1$  has been assigned to  $D_2$  (Maintenance, security and technical services)
- $\circ$   $\;$  The candidate  $\,C_2^{}\;$  has been assigned to  $\,D_4^{}\;$  (Financial)
- The candidate  $C_3$  has been assigned to  $D_3$  (Commercial)
- The candidate  $C_4$  has been assigned to  $D_5$  (Human resources)

- The candidate  $C_5$  has been assigned to F (Fictional)
- The candidate  $C_6$  has been assigned to  $D_1$  (Accommodation)

We consider that in the case of the candidate  $C_5$  has been assigned to  $F_{\tilde{c}}$  (Fictional), that is, for the candidate  $C_5$  will not be mandated ready for the fictional job.

#### 5. Conclusions

In this paper we have presented the Hungarian Algorithm in order to be assigned optimally and efficiently a number of candidates for some departments of a hotel company. Manage the processing of the assignment is complex because of the variety of skills and qualities needed in each job and those inherent to each candidate that the company has to process correctly. In this sense, the work presented has allowed progress in the resolution of the techniques traditionally used, and thus offer a procedure that, in addition to obtain an optimal assignation of candidates for some jobs, also allows to optimize the efficiency of these assignations to level or to the organization as a whole.

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