

Personnel selection system based on the selection algorithm

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Abstract

The evolution of personnel selection systems has been driven by technological advances and changes in the needs of organizations, referring to the set of processes and tools used by an organization to evaluate and select the most suitable applicants to fill a position within the company, in order to ensure that people with the skills, knowledge and competencies necessary to perform the responsibilities and functions associated with the position are hired. It is therefore proposed to implement a personnel selection system, which will help optimize the recruitment and selection process using the competency model and the selection algorithm to choose the best candidates according to the selection criteria established for each job position, resulting in the best candidates for the position with the qualities for which they were chosen.

Keywords: selection system; selection process; applicants; competency model; selection algorithm.

Sistema de selección de personal basado en el algoritmo de selección

Resumen

La evolución de los sistemas de selección de personal ha sido impulsada por los avances tecnológicos y los cambios en las necesidades y expectativas de las organizaciones y se refiere al conjunto de procesos y herramientas utilizados por una organización para identificar, evaluar y seleccionar a los postulantes más adecuados para ocupar una posición laboral dentro de la empresa, con el fin de garantizar que se contrate a personas que tengan las habilidades, conocimientos, competencias y características necesarias para desempeñar eficazmente las responsabilidades y funciones asociadas al puesto. Es por ello que se propone implementar un sistema de selección de personal, que ayudará a optimizar el proceso de reclutamiento y selección utilizando el modelo de competencias y el algoritmo de selección para así elegir a los mejores candidatos de acuerdo a los criterios de selección establecidos para cada puesto de trabajo, dando como resultado a dos de los mejores candidatos para el puesto con las cualidades por las cuales fueron elegidos.

Palabras clave: sistema de selección; proceso de selección; postulantes; modelo de competencias; algoritmo de selección.

1. Introduction

Personnel selection is an important issue for organizations because the success of their activities depends on it [1], which must be performed by suitable people, a good result in personnel selection not only directly affects the quality of work, but also indirectly influences competitiveness [2]. Personnel selection systems are an evolution of traditional selection methods [3], which use

technologies such as machine learning, natural language processing and data mining to evaluate and rank candidates more efficiently and objectively [4].

Personnel selection processes can be affected by the lack of complete information about candidates, which can make it difficult to assess their suitability for the position [3] furthermore they are carried out under time pressure, which can limit the ability of the selectors to properly evaluate the candidates [5].

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In this context, the implementation of a personnel selection system is proposed, which will allow transforming the input data sent to the company in order to choose the best candidates according to the selection criteria established for each job position, using the competency model, with which it will be possible to identify the key competencies based on two competencies which are specific and transversal, the applicants will be evaluated according to these competencies through specific tests and performance evaluations. Subsequently, the system will perform calculations with the input data stored in the database in order to perform the ranking of the best candidates by means of ranking scores using the selection algorithm.

Finally, by running the personnel selection system, it was possible to visualize the suitable candidates and clearly show the qualities for which they were chosen, which allows optimizing the recruitment process and ensuring that the best candidates were selected for the position.

The structure of this article is as follows: State of the art, proposed personnel selection system adequacy to the problem, execution, results, implementation of the system, conclusions, recommendations and references.

2. State of the Art

2.1 *The problem of personnel selection*

Personnel selection is a fundamental process for organizations, as it involves identifying, evaluating and choosing the most suitable candidates to fill jobs, this selection of candidates can present several problems and challenges that can hinder the proper recruitment process [4].

One of the most significant problems in personnel selection is the presence of bias and discrimination [6]. Recruiters may be influenced by biases based on age, gender, race, ethnicity, or other personal characteristics, which can lead to unfair and inequitable hiring decisions [7].

In addition, the tests and assessments used in the selection process may not be adequate to accurately measure the skills, competencies, and aptitudes required for the position [8]. This can lead to poor candidate selection and a mismatch between the skills of those selected and the needs of the position [9].

If proper selection is not performed, there may be a high rate of employee turnover or hiring errors [10]. This implies an additional cost to the organization in terms of time, resources, and productivity, and can negatively affect the overall performance of the company [11], as recruitment and selection processes can become lengthy and costly, especially when handling large volumes of candidates, which can lead to a delay in hiring and increase operational costs for the organization [12].

2.2 *Personnel selection systems*

Personnel selection is a fundamental process for organizations, as it involves identifying, evaluating, and

choosing the most suitable candidates to fill jobs. In recent years, the advancement of technology has significantly influenced this field, leading to more efficient and accurate personnel selection systems [13].

Personnel selection systems are decision support systems that generate a result showing a ranking for each potential employee, so that management decision makers can see the capability of each potential employee based on the ranking [5,6,14]. Generally speaking, it can be stated that personnel selection systems are among the most complex organizational and intellectual processes and of necessary precision [15,16]. There are organizations that already apply personnel selection systems in order to optimize this activity [9]; something that as a result of the pandemic contingency has forced other organizations to use and implement this type of systems [17], in this way the use of personnel selection systems is beginning to become widespread around the world.

There are several types of personnel selection systems used by organizations to identify and hire the most suitable candidates, such as filtering systems which can perform an initial filtering of candidates based on the criteria established by the company [6]. Analytics systems that can scan and analyze a large number of resumes quickly and automatically and virtual interviews using chatbots or virtual assistants [18], these systems can ask predefined questions and analyze candidate responses in real time, evaluating factors such as consistency, language used and communication skills [16,17].

Recruitment systems are taking advantage of advances in algorithms and machine learning techniques to improve the efficiency of their processes [11]. These algorithms can analyze large volumes of data and patterns to identify the most suitable candidates [19]. In addition, machine learning allows systems to improve over time as they are provided with more information [20].

There are several algorithms to build a personnel selection system, these are mathematical tools and models designed to assist in the selection and recruitment process [20], using predefined data and criteria to evaluate candidates and make decisions based on the information collected, some of them are the Decision Tree Algorithm, which creates a tree-like model [7], where each internal node represents a characteristic or attribute, each branch represents a decision based on that attribute, and each leaf represents the result or final decision [7,18], the Selection Algorithm, which establishes the criteria and requirements necessary for the vacant position, such as technical skills, competencies, work experience, educational level, in order to choose the most optimal applicant [12,21]. The Sentiment Analysis Algorithm, this algorithm evaluates and analyzes the comments and opinions of candidates, as well as interactions with the organization on digital platforms [22].

Recruitment systems are harnessing the power of data and predictive analytics to make more informed decisions [23]. By analyzing data from past candidates and their performance in the organization, these systems can identify patterns and success factors that help predict future candidate performance. This allows for more informed and objective decision making [21,24].

Table 1.
Input data.

Factors	Weight Factors	Dimension	Dimensional Weight	Definition	Abbreviation
Specific competencies	0.5	Behavioral	0.10	V1	CO
		Ability to learn			
		Adapting to change			
		Creativity			
		Innovation			
Transversal competences	0.5	Instrumental	0.40	V2	IN
		Teamwork			
		Vision of the future			
		Personal			
		Analytical capacity			
		Synthesis capacity			
		Organizational capacity			
		Oral and written communication			
		Knowledge of a foreign language			
		Computer skills			
Transversal competences	0.5	Personal	0.20	V3	PE
		Information management capability			
		Troubleshooting			
		Decision making			
		Systemic			
		Working in an international context			
		Skills in interpersonal relationships			
		Recognition of diversity and multiculturalism			
		Critical reasoning			
		Ethical commitment			
Transversal competences	0.5	Systemic	0.40	V4	SI
		Autonomous learning			
		Leadership			
		Knowledge of other cultures and customs			
		Motivation for quality			
		Sensitivity to environmental issues			
		The ability to adapt to the company's philosophy			
		Customer orientation			
		Controlling emotions			
		Negotiation skills			

Source: Own elaboration.

3. Proposed personnel selection system

The proposal is to implement a personnel selection system, which will help to optimize the recruitment and selection process, saving time and resources, while ensuring the recruitment of the most suitable candidates for the vacancies.

For the construction of the personnel selection system the selection algorithm will be used where relevant data will be collected about the candidates, such as their work experience, skills, educational level, achievements. This data set and selected variables will be used to make the selection algorithm with similarity weights for each variable that organizes the decisions based on the characteristics of the candidates, resulting in the most optimal candidate for the position.

The input variables used to perform the recommendation of applicants are detailed in Table 1 where they are divided into factors, each factor has its corresponding dimensions, the factors and dimensions have their respective weights that are used to convert from qualitative to quantitative data these data will be taken using the competency-based method.

The weights only influence the rating of the factors or dimensions shown, and do not influence the recommendation of the personnel directly; furthermore, the values proposed

for the model are tentative, these can be modified or updated later for greater precision.

After having identified the input variables, we proceed to adapt the algorithm to the case study and develop the algorithm operating model. For the elaboration of the model it will be possible to make use of the input variables which are defined in Table 1 and the variables of the position in Table 2, in order to be able to calculate the similarity distance as shown in the following tables:

Based on the above, we use the selection algorithm, which calculates the distances between the knowledge data and the applicant's entry data, using the Euclidean distance,

Table 2.
Job variables.

Job variables			
CO	IN	PE	SI
CO1	IN1	PE1	SI1
CO2	IN2	PE2	SI2
CO3	IN3	PE3	SI3
...
CO _n	IN _n	PE _n	SI _n

Source: Own elaboration.

generating recommendations from the candidates who are closest to the published job.

```

Selection procedure(arr):
  n <- longitude(arr)
  For i from 0 until n-1 do:
    min_idx <- i
    For j from i+1 until n do:
      If arr[j] < arr[min_idx] then:
        min_idx <- j
    If min_idx != i then:
      exchange(arr[i], arr[min_idx])
  Here is the results that most closely match the requested preferences.
  for(i<k){
  print(arrayResult[i]);
  i++; }
    
```

In order to execute the solution, you must have the data that will be used for the selection calculation, which must be converted from qualitative to quantitative data, for this the values shown in Table 3 are used.

Table 3. Quantitative data.

Factors	Dimension	Value	
Specific competences	Behavioral		
	• Ability to learn	1	
	• Adapting to change	2	
	• Creativity	3	
	• Innovation	4	
	• Teamwork	5	
	• Vision of the future	6	
Transversal competences	Instrumental		
	• Analytical capacity	1	
	• Synthesis capacity	2	
	• Organizational capacity	3	
	• Oral and written communication	4	
	• Knowledge of a foreign language	5	
	• Computer skills	6	
	• Information management capability	7	
	• Troubleshooting	8	
	• Decision making	9	
		Personal	
		• Working in an international context	1
		• Skills in interpersonal relationships	2
		• Recognition of diversity and multiculturalism	3
		• Critical reasoning	4
	• Ethical commitment	5	
	Systemic		
	• Autonomous learning	1	
	• Leadership	2	
	• Knowledge of other cultures and customs	3	
	• Motivation for quality	4	
	• Sensitivity to environmental issues	5	
	• The ability to adapt to the company's philosophy	6	
	• Customer orientation	7	
	• Controlling emotions	8	
	• Negotiation skills	9	

Source: Own elaboration.

Table 4. Data entered by five users(applicants).

Factors	Variables	Candidate 1	Candidate 2	Candidate 3	Candidate 4	Candidate 5
Specific Competences	V1	1	1	2	4	1
	V2	3	2	1	3	3
	V3	4	3	2	1	1
	V4	5	4	3	3	1
	V5	2	4	5	1	4
Transversal Competences	V6	3	2	1	3	5
	V1	2	2	1	4	3
	V2	2	3	2	1	2
	V3	1	1	1	3	1
	V4	3	2	4	3	5
	V5	5	2	3	5	4
	V6	1	2	1	3	1
V7	4	3	4	2	3	

Source: Own elaboration.

The input data is obtained at the time of registration of the applicant when answering the questionnaire, these data will be used for the calculation of distances in the selection algorithm. Table 4 shows the data entered by 5 candidates for the position of administrator along with their numerical values.

After obtaining the data of both the knowledge, the applicant's entry data and the conversion of those data to quantitative values, the selection algorithm is executed. Next, the execution is done in 4 steps:

Step 1

Having the variables established, we proceed to store the input data in the variables V1, V2, V3, V4, V5, V6, V7. The entered variables transformed into quantitative data perform a procedure called selection that takes as input an arr array. The procedure implements the selection algorithm to sort the array in ascending order. A Para loop is used to iterate through the array indices, from 0 to n-1, where n is the length of the array.

Step 2

The loop is used to find the index of the smallest element in the unordered portion of the array. It starts with i+1 and compares each element with the element in min_idx. If a smaller item is found, it is updated min_idx.

```
array = [V1, V2, V3, V4, V5, V6, V7]
```

Iteration over the unordered portion of the array

```
for i in range(len(array)-1):
  min_idx = i
```

Index of the smallest element, we assume it is the current element.

Comparison of each element after the current one with the element in min_idx.

```
for j in range(i+1, len(array)):
    if array[j] < array[min_idx]:
        min_idx = j
```

We update min_idx if we find a smaller item.

Exchange of the current item with the smallest item found.

```
array[i], array[min_idx] = array[min_idx], array[i]

print(array)
```

Step 3

After the second loop is completed, it is checked if min_idx is different from the current index i. If so, the elements are exchanged at positions i and min_idx, ensuring that the smaller element is placed in the correct position.

At the end of the procedure, the array will be sorted in ascending order, as shown in the following pseudocode.

After obtaining the user's input data and converting that data to quantitative values, the selection algorithm is performed using the selection algorithm. Next, the execution is performed:

```
Function selectPersonal(Candidates,
competencesRequired):
    bestCandidates = []
    For each candidate in candidates:
        score = 0
        For each competition in competencesRequired:
            If candidate.hasCompetence(competence):
                score = score + 1
            If score == longitude(competencesRequired):
                bestCandidates.add(candidate)
    Return bestCandidates
End of function
```

After having executed the algorithm, the results obtained from this calculation are shown and the results are ordered in ascending order as follows:

```
arrayResult= [[idbestcandidates][1idcandidates],...,[^i][N]}
```

Step 4

The Table 5 shows the loop execution for each iteration:

Table 5. Element array results.

Nº	Variable	Formula	Candidate 1	Candidate2
1	V1	For j from i + 1 to n - 1: If array[j] < array[min_idx]	0.2	0.2
2	V2	For j from i + 1 to n - 1: If array[j] < array[min_idx]	0.03	0.01
3	V3	For j from i + 1 to n - 1: If array[j] < array[min_idx]	0.01	0.01
4	V4	For j from i + 1 to n - 1: If array[j] < array[min_idx]	0.2	0.1
5	V5	For j from i + 1 to n - 1: If array[j] < array[min_idx]	0.1	0.1
6	V6	For j from i + 1 to n - 1: If array[j] < array[min_idx]	0.3	0.2
7	V7	For j from i + 1 to n - 1: If array[j] < array[min_idx]	0.1	0.2
Score			0.98	0.82

Source: Own elaboration.

The Table 6 shows the results obtained from the top 3 candidates for the position:

Table 6. Results obtained and ordered from highest to lowest

	Applicants	Compatibility with the position
1	Candidate 1	98%
2	Candidate 2	82%

Source: Own elaboration.

4 System Implementation

For the implementation of the prototypes of the selection system was developed with the PHP programming language together with the MySQL database manager, the Visual Code programming environment was used with the MVC software architecture (Model, view, controller). Among the functional requirements of the system, we have the registration of applicants, the registration and publication of jobs, the generation of personnel selection, and the generation of reports.

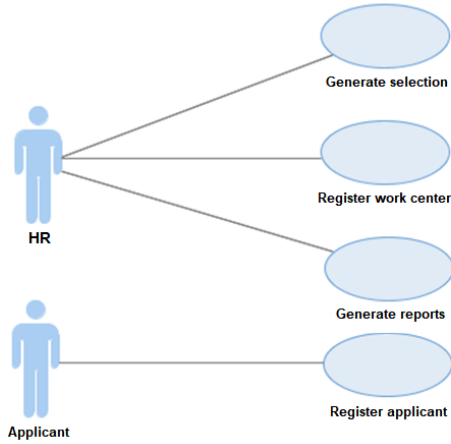


Figure 1. Basic system use cases.
Source: Own elaboration.

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02	15/06/2023	08065019	CUZCANO LUYO YDA DE MEDINA ANTONIA	antoniar@gmail.com	942815159	F	300	Candidato
03	15/06/2023	08065759	MEDINA CUZCANO CECILIA ANTONIA	ceciliamedina@gmail.com	914567893	F	100	

Figure 2. Results generated by the algorithm.
Source: Own elaboration.

Fig. 1 shows the main system use cases that were established in the information collection phase, as well as the system actors and the iteration it will have with each use case.

The following Fig. 2 shows the applicants selected by the selection algorithm, these candidates are shown after having made the questionnaire of the work to be applied in this way the most optimal candidates are selected.

Fig. 3 shows the answers of the applicants with the percentage of their score, showing the most outstanding qualities of the applicants.

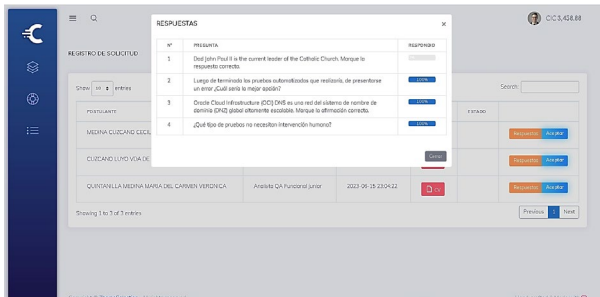


Figure 3. Applicants' answers with the percentage of their score.
Source: Own elaboration

5. Conclusions

The personnel selection system implemented with the selection algorithm has proven to be highly effective and efficient in the recruitment process. By using this algorithm, it was possible to significantly reduce the time required to review and evaluate resumes, as well as to conduct individual interviews. In addition, a substantial improvement in the quality of the selected candidates was observed, since the algorithm allowed to identify and prioritize the most relevant skills and competencies for each vacant position. This led to an increase in the success rate of hires, with highly qualified employees who better fit the requirements of the position and effectively contribute to the growth and development of the organization. In summary, the use of the selection algorithm in the personnel selection system has proven to be a valuable and powerful tool to optimize the hiring process and ensure the acquisition of suitable talent to achieve business objectives.

6. Recommendations

If the system is to be applied in a much larger area, it is recommended to increase the knowledge base considerably and condition the selection model so that it has an optimal functioning, infrastructure services must also be optimized and guaranteed.

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