ISSN 2347 - 3983
Volume 7, No. 9 September 2019
International Journal of Emerging Trends in Engineering Research
Available Online at http://www.warse.org/IJETER/static/pdf/file/ijeter17792019.pdf
https://doi.org/10.30534/ijeter/2019/17792019

An Analytic Hierarchy Process Approach in the Shortlisting of Job Candidates in Recruitment

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ABSTRACT

The analytical hierarchy process (AHP) is an intelligent and mathematical tool to improve the shortlisting process of organizations in recruiting skilled and competent employees. This reduces time-consuming recruiting activities by allowing it to rate, rank and shortlist candidates in a fair and objective manner especially from an applicant pool with various credentials.

Job candidates are measured on the identified criteria namely; education, work experience, position level and professional qualification that are methodically weighted according to their importance. Subsequently, comparison matrixes measure the characteristics of each individual by creating a functional hierarchy and receives a final decision score.

The contribution of this article was to provide a systematic and effective analysis on complex issues by specifying results by obtaining numerical decisions based on firm criteria preferences on the shortlisting process that is tunable to assist organizations to make better and proactive decisions in lesser time and cost in attracting and retaining quality employees.

Key words: Analytical Hierarchy Process, Human Resource, Management, Recruitment, Shortlisting

1. INTRODUCTION

Candidate sourcing is the first step in the recruitment process and followed by shortlisting. Screening and shortlisting may happen simultaneously by screening resumes and then shortlisting the best candidates to enable them to move forward for interviews and further assessment.

When shortlisting job candidates, both essential and desirable criteria must correlate to the job performance required for the position and the minimum level that the shortlisted candidate must possess for that role.

The said criteria must have established standards that are set high enough to identify quality candidates that can move forward to the next process and at the same time not too stringent to extremely screen out a number of qualified applicants. Therefore, the shortlist criteria should consider the qualities and traits of top performing employees currently in those positions and must be applied consistently across all candidates to avoid legal and discrimination issues.

Shortlisting is generally the most challenging and time-consuming step in the recruitment process. The challenge in recruitment is to find a fast and reliable way to recruit and retain talented employees and this is possible through the application of real-time [1, 2, 3, 4] intelligent approaches and mathematical tools in the shortlisting function of job candidates.

Currently. advanced technology allows organizations to equip themselves with the next generation of shortlisting tools. A popular Multi Criteria Decision Making (MCDM) method called analytical hierarchy process (AHP), assist organizations to solve problems [5, 6, 7, 8] related to candidate sourcing that involves a large degree of human judgment [9, 10].

Therefore, this reduces time-consuming recruiting activities by allowing it to rate, rank and shortlist candidates in a fair and objective manner especially from an applicant pool with various credentials.

2. PROBLEM STATEMENT

Presently, organizations are slowly embracing intelligent technologies to improve HR functions especially in recruitment to provide better insights to execute and operate effectively [11] people, process and technology. These mathematical approaches assist HR to automate many administrative tasks usually performed in most HR transactions.

However, organizations still rely on manual reviews and the shortcoming of this traditional method is that humans are known to be prone to bias [12, 13] in the shortlisting of candidates. If organizations desire to remain competitive in today's global economy, firms must incorporate innovative ways to improve HR decision-making processes.

The presence of various computer-aided decision making tools such as the MCDM will evaluate applicant performances based on various metrics that combines scores to analyze and predict effective results in the shortlisting of job candidates in the recruitment process.

The motivation of this article is to provide an alternative approach to derive real benefits and continuously improve the HR processes specially in the initial hiring and selection stage as indicated in Figure 1 that is likewise interdependent with the other HR functional stages.

Furthermore, these will provide consistent assessments to assure candidates that the selection process is not only fair and equitable but also considered applicant background and previous performances.

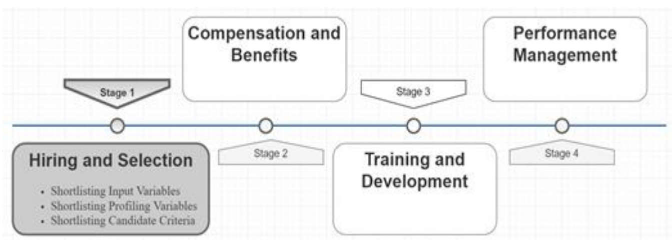

Figure 1: HR Analytics Functional Area Framework

3. METHODOLOGY

This section provides a comprehensive background on the methodology when shortlisting job candidates in the recruitment process.

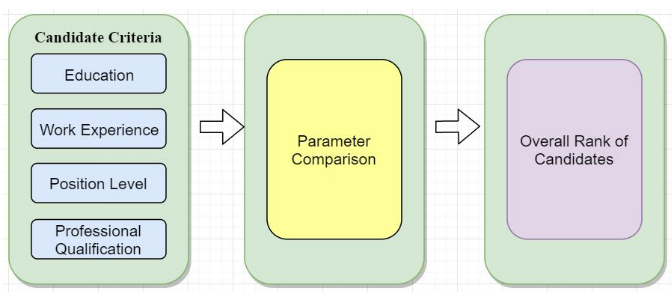

Figure 2: Overview of the Proposed Candidate Criteria Shortlisting System

Job candidates are measured on the identified criteria namely; education, work experience, position level and professional qualification that are methodically weighted according to their importance. Subsequently, comparison matrixes measure the characteristics of each individual by creating a functional hierarchy and receives a final decision score.

This shortlisting system resemble the thought process of human beings during evaluation of each attribute in the recruitment process. Also, this system further streamlines work processes that enables HR to focus on crucial strategic planning and align itself with the overall goals of the organization.

4. DISCUSSION OF RESULTS

The Analytic Hierarchy Process (AHP) was used to solve shortlisting problems of job candidates in organizations. Five employee profiles were used to demonstrate the strength of AHP to eliminate subjective biases that occurs when deciding on the best candidate that is fit for a job position. Table 1 illustrates the qualifications of the 5 individual applicants.

Table 1: Applicant Qualifications Used in the Shortlisting Process

Applicant	Highest Educational Background	Number of years of work Experience	Last Job Position Held	Professional Qualification
A	Doctoral degree	10 years	Senior level for 7 years	With Professional License
B	Bachelor degree	20 years	Director for 2 years, (senior for 7 years)	With 2 Certifications
C	Master's degree	5 years	Entry level for 3 years	With certification
D	Post-Doctoral degree	21 years	Executive for 2 years, (director for 5 years, senior for 5 years)	No license or certification
E	Bachelor Degree	18 years	Junior Level for 3 years	No license or certification

Table 1 exhibits the qualifications of 5 applicants that will be shortlisted for a particular job. This data will serve as a basis for constructing the AHP to choose the best fit candidate for this job vacancy.

4.1 One to one comparison for criteria under education

The educational background of the five candidates were compared amongst themselves that was reflected in Table 2 below. The numerical values of the integers will indicate the educational background each applicant as follows: integer 3 means that the applicant has an educational background that one level higher compared with the other candidates, integer

5 having two levels higher from the others, integer 7 indicated that the applicant is three levels higher and an integer 9 is four levels higher from the other candidates.

Likewise, 1/3 means that another applicant is one level higher as compared to him while 1/5 will indicate that the other candidate is two levels higher than him. Additionally, 1/7 will imply that someone else is three levels higher than himself while 1/9 will connote another candidate is four levels higher. Finally, integer 1 was used to compare the applicant to itself.

Table 2: Reciprocal Matrix for Education Criteria

Comparison According to Education					
Applicant	**A**	**B**	**C**	**D**	**E**
A	1	5	3	1/3	5
B	1/5	1	1/3	1/7	1
C	1/3	3	1	1/5	3
D	3	7	5	1	7
E	1/5	1	1/3	1/7	1
SUM	4 3/4	17	9 2/3	1 5/6	17

Table 3: Paired Comparison Matrix for Education

Comparison According to Education						
Applicant	**A**	**B**	**C**	**D**	**E**	**Composite Value**
A	0.21	0.29	0.31	0.18	0.29	0.26
B	0.04	0.06	0.03	0.08	0.06	0.05
C	0.07	0.18	0.10	0.11	0.18	0.13
D	0.63	0.41	0.52	0.55	0.41	0.50
E	0.04	0.06	0.03	0.08	0.06	0.05
SUM	1	1	1	1	1	1.00

Table 3 illustrated the paired comparison matrix for education. The elements from Table 1 are normalized by dividing each of them by the sum of the column which they belong. The composite value is computed by getting the average value of each row. The composite value gives a clear measure in ranking of candidates according to their educational background.

4.2 One to One Comparison for Criteria under Length of Work Experience

Table 4 revealed comparisons between the background and length of work experiences of the 5 job candidates. The numerical values of the integers will describe the length of service of the applicants as follows: integer 2 depicts a 1-2 year work experience, integer 3 will describe a 3-4 year work experience, integer 4 will indicate a 5-6 year work experience, integer 5 will mean a 7-8 year work experience, integer 6 indicates a 9-10 year work experience and integer 7 with an 11-12 year work experience, integer 8 reveals a 13-14 years work experience and integer 9 having more than 15 years work experience. Finally, integer 1 was used to compare the applicant to itself. The lower triangle of Table 5 is the reciprocal of the elements of its upper triangle.

Table 4: Reciprocal Matrix for Work Experience Criteria

Comparison According to Work experience					
Applicant	**A**	**B**	**C**	**D**	**E**
A	1	1/6	4	1/7	1/5
B	6	1	9	1/2	1/2
C	¼	1/9	1	1/9	1/8
D	7	2	9	1	3
E	5	2	8	1/3	1
SUM	19 ¼	5 2/7	31	2	4 5/6

Table 5: Paired Comparison Matrix for Work Experience

Comparison According to Work Experience						
Applicant	**A**	**B**	**C**	**D**	**E**	**Composite Value**
A	0.05	0.03	0.13	0.07	0.04	0.06
B	0.31	0.19	0.29	0.24	0.10	0.23
C	0.01	0.02	0.03	0.05	0.03	0.03
D	0.36	0.38	0.29	0.48	0.62	0.43
E	0.26	0.38	0.26	0.16	0.21	0.25
SUM	1	1	1	1	1	1.00

Table 5 classified the paired comparison matrix for work experience. The elements from Table 4 were normalized by dividing each of them by the sum of the column which they belong. The composite value is computed by getting the average value of each row. The composite value gives a clear measure in ranking applicants according to their length of work experience.

4.3 One to One Comparison for Criteria under the Position level handled

The position level handled by 5 applicants were compared to each other. The numerical values of the integers will indicate the acquired position level of each individual as follows: integer 3 means that the applicant have one position level higher, integer 5 means having two positions levels higher, integer 7 is three position levels higher and integer 9 is four position levels higher than the others. Additionally, integer 1 was used to compare the applicant to itself. Also, the lower triangle of Table 6 is the reciprocal of its upper triangle.

Table 6: Reciprocal Matrix for Work Experience Alignment Criteria

According to Work Experience Alignment Relevance					
	A	B	C	D	E
A	1	1/3	5	1/3	3
B	3	1	7	1/3	5
C	1/5	1/7	1	1/9	1/3
D	3	3	9	1	7
E	1/3	1/5	3	1/7	1
SUM	7 1/2	4 2/3	25	2	16 1/3

Table 7: Paired Comparison Matrix for Work Experience Alignment

According to Work Experience Alignment						
	A	B	C	D	E	
A	0.13	0.07	0.20	0.17	0.18	0.15
B	0.40	0.21	0.28	0.17	0.31	0.27
C	0.03	0.03	0.04	0.06	0.02	0.04
D	0.40	0.64	0.36	0.52	0.43	0.47
E	0.04	0.04	0.12	0.07	0.06	0.07
SUM	1	1	1	1	1	1.00

Table 7 described the paired comparison matrix for the last position levels handled by the applicants in their previous companies. The elements from Table 6 were normalized by dividing each of them by the sum of the column which they belong. The composite value is computed by getting the average value of each row. The composite value gives a clear measure in ranking applicants according to their last position levels handled.

4.4 One to One Comparison for Criteria under Professional Qualifications

Applicant professional qualifications are sometimes considered as an important requirement by some firms. Table 8 illustrates the reciprocal matrix for the professional qualifications and numerical values of the integers will describe each professional qualification as follows: an integer 7 classifies that an applicant has obtained a professional license compared as opposed to those without any professional license or certification, integer 5 will mean that an applicant has obtained professional license in contrast to another applicant with 1 certification, integer 3 depict an applicant has a professional license as compared to another applicant with 2 certifications and so forth. An integer 1 will indicate an applicant is compared to itself. The lower triangle of Table 8 is the reciprocal of its upper triangle elements.

Table 8: Reciprocal Matrix for Professional Qualification Criteria

According to Professional Qualification					
	A	B	C	D	E
A	1	3	5	7	7
B	1/3	1	3	5	5
C	1/5	1/3	1	3	3
D	1/7	1/5	1/3	1	1
E	1/7	1/5	1/3	1	1
SUM	1 5/6	4 3/4	9 2/3	17	17

Table 9: Paired Comparison Matrix for Professional Qualification

According to Professional Qualification						
	A	B	C	D	E	
A	0.55	0.63	0.52	0.41	0.41	0.50
B	0.18	0.21	0.31	0.29	0.29	0.26
C	0.11	0.07	0.10	0.18	0.18	0.13
D	0.08	0.04	0.03	0.06	0.06	0.05
E	0.08	0.04	0.03	0.06	0.06	0.05
SUM	1	1	1	1	1	1.00

Table 9 revealed the paired comparison matrix for professional qualifications. The elements in Table 8 were normalized by dividing each of them by the sum of the column which they belong. The composite value is computed by getting the average value of each row. The composite value gives a clear measure in ranking applicants according to their professional qualification.

4.5 Consistency Ratio

The consistency of the comparison is a very important factor in AHP. This was computed utilizing the following formulas below.

$$CI = \frac{\lambda_{max} - n}{n-1} \quad (1)$$

Where λ_{max} is the maximum eigenvalue
N is the number of sample being compared

The consistency ratio (CR) will also be computed to show the degree of inconsistency of the comparison. The formula below will be used as indicated below:

$$CR = \frac{\text{Consistency Index}}{\text{Random Consistency Index}} \quad (2)$$

Table 10 presented the consistency ratio of all comparisons done that are not greater than 10% that implies all comparisons made were consistent.

Table 10. Consistency Ratio for the Employee Qualifications

	Education	Work Experience	Work Experience Alignment	Professional Qualification
Largest Eigenvalue	5.229404	5 4/9	5 1/3	5 2/9
Consistency Index	0.057351	0.112766	0.082054	0.057351
Consistency ratio	0.051206	0.100684	0.073262	0.051206

4.6 Adjustment on the Priority

Depending on the priority and preference of HR and decision makers of the organization, the shortlisting process using AHP can be tuned or customized to conform to the actual workforce needs of the company.

As an example, when all the four criteria have equal weights during the shortlisting process, Table 11 will illustrate the reciprocal matrix for the Priority vector.

Table 11: Reciprocal Matrix for with Equal Priority

According to Priority				
	Education	Work Experience	Last Position Level Held	Professional Qualification
Education	1	1	1	1
Work Experience	1	1	1	1
Last Position Level Held	1	1	1	1
Professional Qualification	1	1	1	1
SUM	4	4	4	4

The elements in Table 11 are all received number values of 1 because they have all have equal weights. The paired comparison matrix for this scheme is reflected in Table 12. The parameter weight for each is 0.25 or 25%.

Table 12: Paired Comparison Matrix for Equal Priority

According to Priority					
	Education	Work Experience	Last Position Level Held	Professional Qualification	Parameter Weight
Education	0.25	0.25	0.25	0.25	0.25
Work Experience	0.25	0.25	0.25	0.25	0.25
Last Position Level Held	0.25	0.25	0.25	0.25	0.25
Professional Qualification	0.25	0.25	0.25	0.25	0.25
SUM	1	1	1	1	1

Using the parameter weights from Table 12 including the composite values derived from Table 3, 5, 7 and 9 respectively, the final ranking is illustrated in Table 13 below.

Table 13: Applicant Shortlist where Work Experience and Last Position Level Held are the Priorities

According to Priority						
	Education	Work Experience	Position Level	Professional Qualification	Composite Value	Rank
weight	0.25	0.25	0.25	0.25		
A	0.36	0.70	0.15	0.50	0.43	1st
B	0.06	0.29	0.27	0.26	0.22	4th
C	0.14	0.04	0.04	0.13	0.09	5th
D	0.38	0.37	0.47	0.05	0.32	2nd
E	0.06	0.23	0.07	0.05	0.10	3rd

There will be instances that the last position level handled and the professional qualification criteria are not all significant to the company. Most HR and organizational decision makers will place more value on the criteria of work experience then followed by the educational background. Below is an example of a shortlist process that places more importance on the work experience criteria and considers it as the highest priority followed by the educational background. Table 14 reveals the reciprocal matrix for the priority vector.

Table 14: Reciprocal Matrix with Educational Background and Work Experience as High Priorities

According to Priority				
	Education	**Work Experience**	**Position Level**	**Professional Qualification**
Education	1	1/5	5	1
Work Experience	5	1	7	5
Position Level	1/5	1/7	1	1/3
Professional Qualification	1	1/5	3	1
SUM	7 1/5	1 1/2	16	7 1/3

Table 15: Paired Comparison Matrix with Educational background and Work Experience as High Priorities

According to Priority					
	Education	**Work Experience**	**Position Level**	**Professional Qualification**	**Parameter Weight**
A	0.14	0.13	0.31	0.14	0.18
B	0.69	0.65	0.44	0.68	0.62
C	0.03	0.09	0.06	0.05	0.06
D	0.14	0.13	0.19	0.14	0.15
SUM	1	1	1	1	1

Table 16: Applicant Shortlist where Work Experience and Last Position Held are the Priorities

According to Priority						
	Education	**Work Experience**	**Relevance**	**Qualification**	**Composite Value**	**Rank**
weight	0.18	0.62	0.06	0.15		
A	0.36	0.70	0.15	0.50	0.58	1st
B	0.06	0.29	0.27	0.26	0.24	3rd
C	0.14	0.04	0.04	0.13	0.07	5th
D	0.38	0.37	0.47	0.05	0.33	2nd
E	0.06	0.23	0.07	0.05	0.16	4th

Table 15 identified the paired comparison matrix for the priority vector. The elements from Table 14 were normalized by dividing each of them by the sum of the column which they belong. The parameter weight is computed by getting the average value of each row.

Finally, the shortlist rank where the work experience and educational background were given higher priority is distinguished in Table 16.

5. CONCLUSION

Intelligent systems are emerging as one of the primary strategies of organizations to efficiently streamline business processes usually in talent sourcing and recruitment.

This article applied the analytical hierarchy process (AHP) according to the candidate criteria namely; education work experience, position level and professional qualification that is useful for organizations sourcing a small number of job candidates.

The mathematical application compared the candidate criteria into pairs to obtain weights to identify priorities in the applicant selection for a particular job position by consistently capturing composite values of each applicant. This proves to be a fairer and objective criteria evaluation as compared to the shortcoming of manual process that is impaired with biases, human errors [6] and differing perceptions [7] of evaluators.

The contribution of this article was to provide a systematic and effective [8] analysis on complex issues by specifying results by obtaining numerical decisions based on firm criteria preferences on the shortlisting process that is tunable to assist organizations to make better and proactive decisions in lesser time and cost in attracting and retaining quality employees.

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