Abstract-- By implementing Fuzzy Simple Additive Weighting (SAW) method for selecting project manager in MAPNA Company a multi criteria decision making (MCDM) method was conducted in this paper as part of an extensive research. Project manager selection is another tough and complex issue among decision making problems. In order to use a systematic method, a framework is demonstrated in this paper to assist a group of decision makers to use linguistic variables for rating candidates. Identifying the best candidate among participants for project manager selection is the goal of this study. To achieve this objective, a fuzzy SAW method has been used. The validation of these models were inspected by using a case study of project manager selection in order to choose a right PM for project manager position in a project based company. The feedbacks reveal that this model is quite reliable in selecting project managers and can ameliorate the efficiency of decision making process.

Index Terms-- Fuzzy SAW, Linguistic variables, Project manager selection, Project based organization, Project management.

I. INTRODUCTION

PROJECT manager selection is the key role in project based companies; hence, success of each project depends on the skills and aptitude of a PM. The role of an effective project manager is similar to a sharp sword. In one edge, controlling and managing the main and rudimentary of information communication is shined. On the other side of this sword (PM) demands of projects’ owners are the key players in making the role of project manager more significance. An appropriate PM has a vital and critical role in running projects. This level of importance makes the process of selecting a suitable project manager difficult and tough [1].

In this paper it is tried to exploit a systematic methodology in order to determine hierarchical structure of hiring criteria and sub criteria in multi criteria decision making model for project manager selection. For the purpose of identifying criteria which are used, qualitative approach is conducted in this study for selecting PM in project based companies. The rest of this paper is arranged as follow: In section 2 a brief review is allocated to project manager selection. Then, methodology is discussed in section 3. Finally, in order to illustrate our method a case study of selection PM is demonstrated in section 4. The paper concludes with suggestions for future research.

II. LITERATURE REVIEW

Multi criteria decision making (MCDM) has been used in selecting project manager. For example Chen and Cheng [2] developed a fuzzy MCDM method for information system project manager selection. Bi and Zhang [3] analyzed the significance of choosing an eligible project manager in their study. They tried to quantitatively assess the ability and quality of a project manager by implementing fuzzy analytical hierarchy process which was based on triangular fuzzy numbers. Whatever they did is considered as a reliable and scientific method in terms of selecting the right person for project manager. Hui et al. [4] tried to demonstrate a suitable competency based framework. The rationality of this paper is examined in methodology section which was constructed principle component analysis. All these efforts make this study prominently valuable and referential in project manager selection. By implementing principles of fuzzy mathematics an extensive assessment model of project manager candidates has been established by Liqin et al. [1]. Zavadskas et al. [5] developed a multi criteria methodology for project manager selection based on grey criteria. Zhao et al. [6] adopted a fuzzy comprehensive evaluation methods in the selection of a project manager. Rashidi et al. [7] combined fuzzy systems, ANNs, and Genetic algorithm for choosing a qualified project manager.

III. METHODOLOGY

In this study we developed a hybrid model for project manager selection by using a new systematic model consists...
of Delphi method, fuzzy linguistic evaluation and fuzzy SAW method:

A. Delphi method

The Delphi technique [8] is a set of procedures for eliciting and refining the opinions of a group of people without their being required to hold face to face meetings. The necessary steps for this section are:
1. Selecting experts for criteria selection
2. Investigate previous studies pertaining to criteria for personnel selection problem.
3. Generate Ideas (criteria for project manager selection)
4. Feedback to experts
5. Developing criteria hierarchy

Delphi, which is considered by many similar researches, is the method that has been exploited in this research paper in order to evaluate and weigh the data. A number of questionnaires have been used for this study. After five steps, the hierarchical structure for project manager selection criteria will determine like this that shown in the Figure 1.

B. Fuzzy linguistic evaluation

Linguistic variable is a variable that contains values that are words. These amounts are expressed in the form of expressions. In other words, variables that are not numbers and its value are words and phrases. For example, “Height” is a linguistic variable that can include values such as very low, low, medium, high, very high, etc. Fuzzy numbers can be used to display linguistic variables. It is suitable to represent the degree of subjective judgment in qualitative aspect by using linguistic variables than in crisp value by using numbers. In conditions where decision problems are very complicated or not clearly explained to be described appropriately, the concept of a linguistic variable is very useful by using conventional quantitative expressions [9]. Once the hierarchy is structured, the next stage is to establish the importance of each criterion and also to evaluate candidates based on the hierarchy. The decision makers will make a judgment on the candidate’s status in each criterion, with respect to elements in the hierarchy using linguistic variables. Considering the fuzziness of project manager selection evaluation, this research adopt five linguistic variables to assess candidates [9]. In addition, the same linguistic terms are used to measure the importance of each criterion. For convenience in computation, a triangular membership function is used for transformation of fuzzy number. Triangular fuzzy numbers were chosen because of their simplicity and widespread use.

According to Siler and Buckley [10] Triangular Fuzzy Number (TFN) \( \tilde{r} \) are defined as \( \tilde{r} = (l, m, u) \), where \( l \leq m \leq u \) and \( l > 0 \), shown in figure 2. The parameters \( l, m \) and \( u \) indicate the smallest possible value, the most promising value, and the largest possible value.

![Fig. 2. Triangular Fuzzy Number](image)

The decision maker directly can be assigned the weight. A set of weights can be consisted of the numeric forms or linguistic forms. If a decision maker cannot assign weight in the numeric form, then the traditional crisp MCDM methods will be unable for decision making. In this study a fuzzy SAW by using linguistic input is presented. The mission of the weighting is to give relative weights to all evaluation criteria. In this step, each decision maker should assign criteria weights that mean the importance of each criterion based on the position to be filled. Decision makers only need to use linguistic variables to express their opinions, which is easier than giving an exact crisp number. Each decision maker use linguistic terms, reflecting to a specific fuzzy number, based on the requirements of job position. For example, “In my opinion for a project manager, ability in working with computer is very important”. In this sentence “ability in working with computer” is criterion and “very important” is criterion weight. Also using linguistic terms is more realistic rather than numerical values to express different extents of candidate’s rates. So this model provides a way in order to enable the decision-makers to make their decision in a linguistic framework. Therefore, it is necessary to a fuzzy linguistic rating scale be created.

C. Fuzzy SAW aggregation

The traditional MCDM method is based on the assumption of independence among the criteria. Thus, the subsequent decision making activities such as the application of the Simple Additive Weightings (SAW) method are performed additively. Applying the SAW method, the integrated
assessment of alternative can be undertaken through the following operation:

\[ u(p_i) = \sum_{j=1}^{n} r_{ij} w_j \]

Where \( w_j \) denotes the relative weight of criterion \( j \), for \( j \) equal 1 to 1, 2, \ldots, \( n \); and \( r_{ij} \) denotes the rating value of alternative \( i \) under criterion \( j \). The final ranking of the alternatives can be made according to the result of the SAW operations on all the alternatives.

IV. CASE STUDY

To validate the fuzzy integral model, a case study was conducted in an Iranian company. MAPNA is a project based organization and engaged in development and implementation of power, oil & gas, railway transportation and other industrial projects. It has 371 employees and located in Tehran. 14 persons in this company have been able to obtain international certificate in Professional Project Management (PMP). From 1992, MAPNA has been involved in more than 85 projects valuing over 17 billion euro.

When MAPNA Company wants to hire a project manager, the problem begins. A most appropriate candidate for the post of project manager must choose among a numbers of candidates. The decision was normally based on his/her experience. There are number of criteria that should be incorporated into the decision, to ensure that sound judgment can be made based on the criterion considerations. Based on this problem, the proposed system must have the capability to evaluate all the criteria that affect the selection of the project manager and stress the intuitive judgment in the decision making process. The next sections describes the development of the proposed methodology that can help MAPNA company to solving this problem.

A. Results of the Delphi

This section discusses the results, analysis and finding of the using Delphi method for developing selection criteria hierarchy for the project manager. A critical task for a project based organization is project managers’ selection. The selection criteria should specifically be defined to cover the decision maker’s requirements and corresponding to the specific job characteristics. For diverse job description varied criteria should be taken into consideration, e.g. for system analyst, project experts, etc. To specify the most suitable assessment criteria the modified Delphi method has been exploited. A list consists of selection criteria extracted from related literature and interviews with experts were designed and sent to some experts.

After the third round, the 14 criteria were structured into four main groups: Basic Requirements, Project Management Skills, Management Skills, and Interpersonal Skills. The final criteria structure for project manager selection in this study is shown in figure 3. The top level describes the main objective, which is project manager selection. To do that, four major criteria are considered, namely Basic Requirements, Project Management Skills, Management Skills, and Interpersonal Skills. These criteria are then divided into a total 14 sub criteria.

![Fig.3. The hierarchical structure for project manager selection](image)

B. Results of fuzzy linguistic evaluation

Linguistic variables consist of five linguistic terms for the importance of criteria is considered in the project selection case study. This terms with the forms that was shown in Table I, expressed in triangular fuzzy number. It is necessary that to define the importance for each criterion by each of decision makers. Weights are expressed by means of a linguistic variable whose values are “Very Unimportant”, “Unimportant”, “Fair”, “Important”, and “Very Important”. Then, candidates were assessed on the basis of the 14 criteria listed in criteria hierarchy. Candidate’s assessments on the criteria are expressed through a linguistic variable whose values are “Very Poor”, “Poor”, “Fair”, “Good”, and “Very Good”.

<table>
<thead>
<tr>
<th>TABLE I</th>
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<tbody>
<tr>
<td>Linguistic Term Used for Criteria Importance and Rating</td>
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<tr>
<td>Weight</td>
</tr>
<tr>
<td>Very Important (VI)</td>
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<tr>
<td>Important (I)</td>
</tr>
<tr>
<td>Fair (F)</td>
</tr>
<tr>
<td>Unimportant (U)</td>
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<tr>
<td>Very Unimportant (VU)</td>
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C. Results of Fuzzy SAW aggregation

The main goal of this stage is that help decision makers to reach a consensus on personnel selection for a specific job position. In this section, the key steps and calculations of the suggested aggregation method are described step by step. The input is the linguistic terms of weighting and rating by different decision makers. The fuzzy numbers are used and determine the aggregated fuzzy rating and fuzzy weight of all criteria and factors, as in Tables II and III. For example, fuzzy evaluation and weighting value of item C11 with respect to criterion C1 for candidate P1 are computed as:

\[ \tilde{X}_{11} = \frac{1}{3} \{ (0.75, 1.1) \oplus (0.25, 0.5, 0.75) \oplus (0.75, 1.1) \} = (0.58, 0.83, 0.92) \]

\[ \tilde{W}_{11} = \frac{1}{3} \{ (0.50, 0.75, 1.1) \oplus (0.5, 0.75, 1.1) \oplus (0.5, 0.75, 1.1) \} = (0.58, 0.83, 1) \]

<table>
<thead>
<tr>
<th>TABLE II</th>
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<tr>
<td>Aggregate Fuzzy Evaluation</td>
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414
The purpose of this section is to employ SAW formula and found the utility values for each candidate. The utility values of fuzzy SAW of all candidates are computed as shown in Table IV.

Finally, based on the results of the fuzzy SAW method that used to solve this project manager selection problem, when the closeness coefficient values of each candidate P1, P2 and P3 can are found to be 0.62, 0.77 and 0.71, respectively. The ranking order of the three alternatives is P2>P3>P1.

V. CONCLUSION

This study has clearly demonstrated that project manager selection can be improved in several ways by implementing the fuzzy MCDM model. As it is mentioned in this paper, this method has been implemented in one of the biggest companies in Iran and the usefulness of this method has been proved by the experts. According to popularity and the availability of the Internet, researchers must develop a decision support system (DSS) in order to solve the project manager selection problem in the Internet environment. The use of World Wide Web infrastructure is one part of this study, and a client/server computing architecture is another part of this model.

REFERENCES

and Management from the University of Iowa, USA. She obtained her PhD in Manufacturing Systems from the Faculty of Engineering, Universiti Putra Malaysia. Her research areas of interest are in work posture risk analysis (msds), occupational/industrial ergonomics, technology and operations management, supply chain management, benchmarking and designing for the elderly and schoolchildren. She has written and published papers in national and international journals and conferences. She is currently an executive council member of Pan Pacific Council on Occupational ergonomics, Executive committee member of the Human factors and Ergonomics society of Malaysia, a founding member of the Malaysian society of Engineering and Technology and was Head of Geron technology Laboratory with the Institute of Gerontology.

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