



IMPLEMENTATION OF PARTS OF THE INTEGRATED MANAGEMENT SYSTEM
IN THE IMPLEMENTATION OF THE STRUCTURE OF CONSTRUCTION
PROJECTS

Davood Goudarzi
Department of Civil Engineering
Arak Branch, Islamic Azad University ,Arak, Iran
Amirpasha348@yahoo.com

Fereydown Shirvani
Faculty of Engineering, Islamic Azad University of Shoushtar ,Shoushtar, Iran
Fred.shirvani@gmail.com

Fateme Jazebi
Faculty of Payame Noor University, Ahwaz, Iran
Fa.jazebi@gmail.com

Asghar Ghorbani Chegini
Faculty of Engineering, Islamic Azad University of Boroojerd, Boroojerd, Iran
Asgharghorbanichegini@yahoo.com

Abstract

The present study aims at analyzing the contractors' chosen preliminary evaluation scope within the IMS limit of project management's knowledge modules. One of the scales in the primary mechanism of implementing the projects is reaching a high level of productivity in the goals and selection of the most qualified contractors in line with the best accomplishment of these goals. Based on the past statistics, the various fields' outsourcing in the PLC projects' construction cycle has undergone a considerable growth in contrast to the past in the implementation of the civil reconstruction projects and this has caused an increase in the transferring of the risks and responsibilities from the employer team to the contractors and, considering the absence of a precise and well-controlling mechanism and system based on the recommended evaluation indices for the selection of the contractors, a lot of claims and challenges have been created and many projects have been left unfinished and the employers as well as the society have been incurred with a large deal of irreparable life and financial losses. Therefore, according to the important standards of the evaluation fields, the present study analyzes the contractor's selection in two areas of contractor selection based on the old countrywide bidding method in six identified domains and the new contractor selection method in ten identified domains. Use was made of fuzzy logic for analyzing these indices in several sample volumes of the contractors. Fuzzy logic is the strongest and most flexible instrument for



the evaluation of this index for it is capable of even mathematically configuring and finally evaluating the uncertain and inexact parameters. Following the completion of this research and putting its results into effect, it is expected that the selection of the most qualified contractor can to a large extent heighten the scope of expectations and claims and lower the challenges in the project's time, cost, quality and productivity.

IndexTerms – claims, projects' lifecycle, IMS, contractor evaluation indices

I. INTRODUCTION

During the recent years, we have witnessed considerable growth in the changes of the procedures and systems of bid-holding and the employers have applied methods like free bidding, limited bidding and desertion of the bids' formalities. Determination of the contractors' qualifications which is done by the employer (pre-appraisal stage) usually serves the lowering of the risks like low-quality implementation, extra costs and so forth. Besides its long process, this method imposes a lot of costs on the project factors and this can per se cause an increase in the overhead expenses to the employer, advisor and contractor[1]. Moreover, considering the severe price competition, some contractors are ready to suggest very low prices in the bids and this may be followed by future problems like the contractor's filing of lawsuits and so forth which is occasionally accompanied by the deposing of the contractor with the costs of such ways of treating being completely clear in the projects. Furthermore, according to the fact that only one scale (suggested price) is utilized in the common procedures, there would be no guarantee for the selection of the best contractor [2]. Considering the flaws observed in the above-described system and such other flaws like unjustified long delays and lack of keeping pace with the scheduled timetable, unexpected increase of the costs in comparison to the preliminary estimations and/or even in respect to the contractor's suggested price, weak and low-quality implementation of the project, occurrence of safety incidents and filing of lawsuits between the three apices of a project's triangle, to wit employer, advisor and contractor, have made the employers think of utilization of selection systems based on several scales instead of using systems of contractors' selection based on the bid price. During the recent years, we have witnessed a growing trend in this ground [3-4].

II. A GLANCE AT THE PROCESS OF CONTRACTORS' PRE-APPRAISAL AND SELECTION

In Iran, the method of the contractors' pre-appraisal and selection has been commenced since 1965. The governmental transactions' procedures, passed in 1965, has the following stipulation about the selection of the contractors: if there is offered no suggestion and/or when the suggested price is not normal, the commission can arrange a minute and rule the performance of the transaction via price quotation according to a previously obtained fair price[5]. In 1970, the method of inviting the contractors to bid their prices has been asserted by the commission as follows: a company's invitation for limited bidding is sent to some individuals whose qualification for participation in the transaction has been previously verified and their names



have been inserted in the list of the qualified contractors. In the continuation and in 1973, the method of determining the winner of the bid has been stated in the following words: the method of contractor selection is based on the unit prices, estimation of the total project cost and available on-site masonry expenditures which are calculated by the advising engineers and the bidders offer their prices based on the total costs. This marked the initiation of the pricelist system. Considering the abovementioned materials, the summary of the bidding process is presented below within three stages as applied during the recent years[6-8]:

1. Verification of the contractors' qualification
2. Inviting the qualified contractors for bidding
3. Holding the bidding and determination of the winner

It is worth mentioning that the ministry of power and the ministry of oil also have a series of useful experiences in the area of the contractor selection. In the ministry of oil, the method of the contractors' pre-appraisal and selection is in such a way that the contractors seminally deliver three packets to the employer, including the company's warrant of participation in the bidding, all the documents given to the contractor to be filled and the documents related to the bidders' facilities, implementation competencies and engineering capabilities for implementing the project within the specified timetable as inserted in the bid documents and, finally, the price suggestion paper. Then, the employer ratifies the contractors and selects the most superior one based on its abilities and suggested price. In the new procedures, the delegation of task to the contractor and the method of the contractors' selection include the following stages as stipulated the enactment in 2002:

1. Initial call
2. Inviting the contractors capable of accomplishing the task and preparing a list of the superior contractors to be invited to the bidding
3. Holding the bid and selecting the most superior contractor

III. SCALES OF CONTRACTORS' SELECTION

Identification of the scales effective in the evaluation and quality determination of the contractors that take part in civil reconstruction projects are amongst the important stages of the contractors' selection. Many scales can be considered for the selection of the contractors like time, cost, security and quality, technology, managers and personnel's experience, machinery and capital. Of course, besides the aforementioned scales, there are also many other criteria that can be mentioned such as the relationship between the contractor and the previous employers, the relationship between the contractor and the subcontractors and personnel and some others the importance of which is lower as compared to the primary scales.

The contractors can be evaluated and their qualifications can be assessed according to the abovementioned scales and criteria for various construction projects. The main goals of the contractors' pre-qualification appraisal include the followings:

1. Elimination of the disqualified contractors from the competition round
2. Ensuring the existence of a healthy competition between the contractors



3. Elimination or minimization of the contractors' failure risk or improving the employer's security
4. Optimization of the contractor selection in line with the achievement of a higher balance between the price and the ability parameters of the contractor.

IV. PRIMARY SCALES OF THE PRESIDENTIAL MANAGEMENT AND PLANNING ORGANIZATION FOR BID-BASED CONTRACTOR SELECTION

1. Cost as a Scale

As it has also been posited in the procedures of the countrywide bids, the scale for the final selection is the amount of price suggested by the contractors. Most of the problems of the bidding system also stems from this section. Sufficing to this same scale is one of the significant disadvantages of the bidding systems. Declaration of very low prices by some contractors causes the emergence of claims during the project implementation and/or even deposing of the contractor and annulment of the contract.

2. Time as a Scale

The bidding system used in our country orders a limited time for the project accomplishment in such a way that the time of project completion is mentioned at the same time with holding the bid and also signing the contract and the contractor has to finish whole the project within the specified time and deliver it to the employer. However, there are many problems on finishing a project within the set time that make the project completion time exceed the considered period and the contractor has to be capable of compensating the delays and getting the project done on the due date in case of the occurrence of such unpredictable delaying problems. This depends on the contractor's executive power and its recognition of the work factors and machineries and the contractor should allocate more force and exercise stronger management in such cases to make up for the delays.

3. Security Plan and Quality (HSEQ-Plan) as a Scale

One of the important scales showcasing the method of the contractor's performance is security and quality. Based on the standards, the amount of damages, incidents, accidents and others of the like account for the degree to which this scale has been observed. In advanced and industrial countries, having international security and quality certificate like ISO series of the standards plays a notable role in the decisions for selecting the contractors and the employers try choosing the contractors who have performed their prior tasks with a very high quality and observance of all the security matters.

4. Experience as a Scale

In order to assess the contractor's sophistication according to the necessities of the task offered by him, the employer can evaluate and determine a score for the experience of the contractor based on his previously accomplished projects as well as via asking his prior employers about their satisfaction or dissatisfaction of him.



5. Managers and Personnel as a Scale

In this parameter, the contractor's managerial-executive pyramid is evaluated from its peak to its lowest point and the company managers appraise the simple workshop personnel and give a score to this scale which is one of the important parameters of the contractor's company.

6. Machinery as a Scale

Like the management and personnel, this scale, as well, is amongst the criteria related to the main texture of the contracting company. Machinery is a parameter of a great important and possibly one of the greatest and most significant parameters in the large civil reconstruction works.

7. Contractor's Capital as a Scale

In most of the civil reconstruction projects, there is a very long process for paying the contractors' debts. The major concern here is that the contractor has to get the project reached a stage before getting paid and this needs him to have an initial financial affordability in terms of the use of equipment and machinery so the contractor should have preliminary sufficient capital for equipping his workshop.

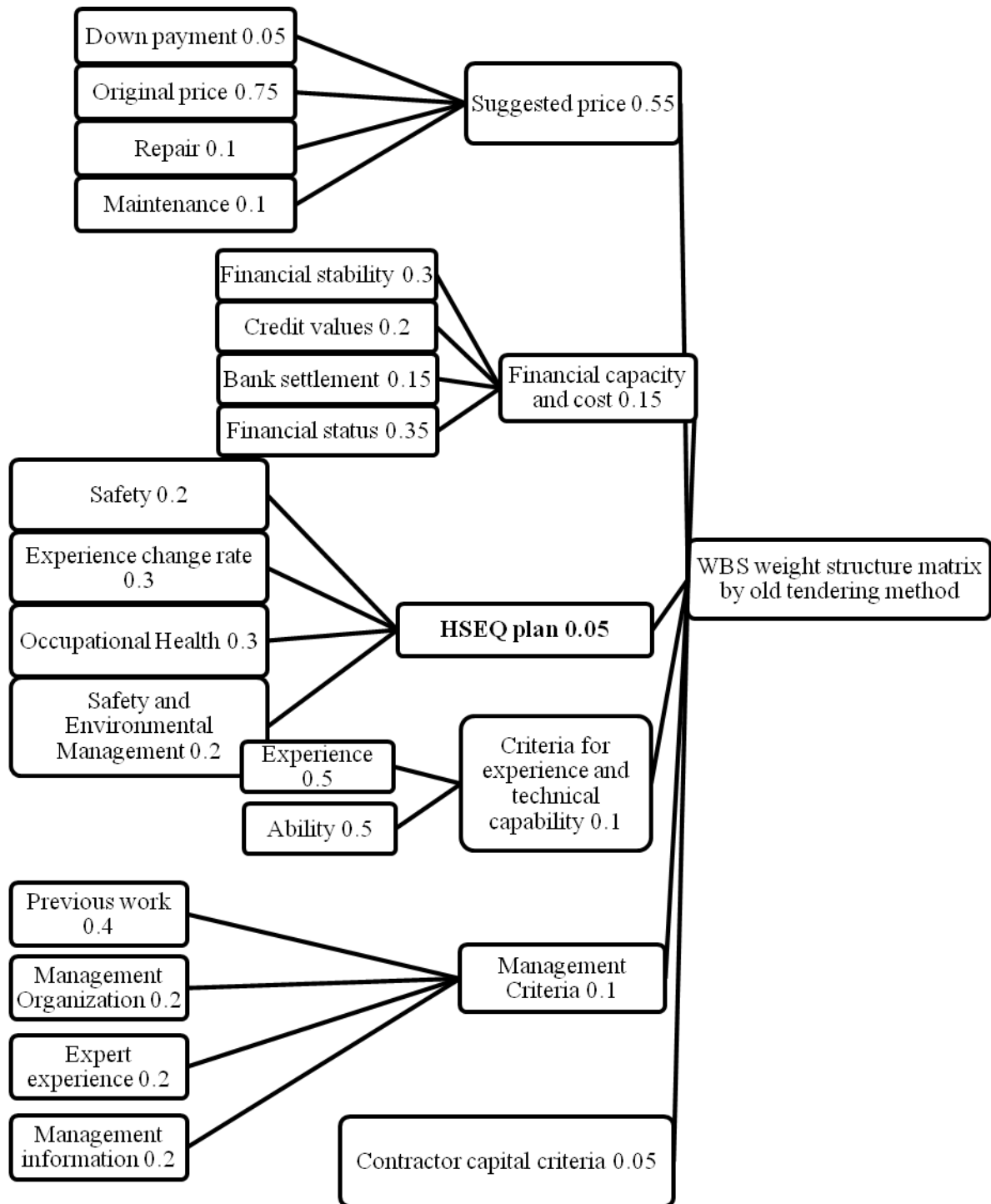


Fig 1. Weighting six tender evaluation indices using the old method as work-breakdown structure (WBS).



V. INDICES' EVALUATION AND SELECTION SYSTEM BASED ON FUZZY LOGIC

Fuzzy logic is a powerful tool for solving the issues related to complicated systems the perception of which is rather difficult and/or the issues pertinent to reasoning, decision-making and human inference. As for the contractors' selection based on this method, since many of the existent decision-making scales are based on the decision-makers' judgments and considering the uncertainties extant in such method, fuzzy logic can be a proper method for contractor selection. The prior works performed globally in this regard are very limited but they are also proper grounds for this research.

The simple weighted fuzzy logic is one of the multiscale compensatory decision-making methods wherein the most important choice is computed assuming a W vector (weights of the indices' importance) as shown beneath:

$$A_0 = A_i \max_i \left(\frac{x_{ij}}{x_i} \right) \quad (1)$$

Where, W is the weight vector and r is the score of the indices.

VI. CONTRACTOR SELECTION ANALYSIS USING FUZZY LOGIC FOR THE TEN IDENTIFIED INDEX FIELDS

In order to finish a civil reconstruction project, the primary scales of decision-making for selecting the contractors are as explained beneath (based on the management and planning organization's existent procedures):

1. Executive costs
2. Work history in the work field and major
3. Possession of the ready-to-work and available machinery and equipment
4. Effective management and proper managerial system for task accomplishment
5. Adequacy of the technical cadre and key elements in terms of knowledge and experience
6. Financial power and logistics
7. Task accomplishment's quality system (TQM, HSEQ Plan and IMS)
8. Contractor's nativity and sophistication
9. Good conduct history of the previous works' completion and absence of a bad professional conduct history
10. Creativities and innovations in the similar tasks

To determine the weights of the indices, the following process is taken: at first, the weight of the executive costs is determined according to the bids offered in this regard and the weights of the other indices are specified according to the Iranian management and planning organization's procedures. Considering the notions of the experts in this regard such as Sirs Hanush, Russel and Wang, the mean value of the proposed cost weight can be set at 55% and, assuming that the weights of the other scales are set at 45%, the weights of the other scales can be also specified according to the procedures of the country's management and planning organization as presented underneath:

If the weights of the indices one to ten are respectively denoted by W_1 to W_{10} , the weight vector of the indices will be of the following form:



$W = \{0/550/05850/05850/01170/03870/03870/01170/0270/03870/03870/0585\}$

Now, the number of the contractors who have attended the bidding and their acquired scores will be of the following form. The process of selecting the best contractor is as shown below. In this bidding, five contractors, namely A, B, C, D and E, have taken part and their acquired scores are as listed beneath. Table1 Of the contractors' scores in each of the scales based on fuzzy logic.

Table1.Of the contractors' scores in each of the scales based on fuzzy logic.

Index Contractor	1	2	3	4	5	6	7	8	9	10
A	97/5MS	5	6	7	8	9	6	6	7	5
B	98MS	7	7	7	8	8	4	5	8	5
C	986MS	4	8	7	8	7	7	7	7	6
D	99MS	8	7	8	9	9	8	6	6	7
E	103MS	9	8	9	8	8	9	4	4	8

At first, all of the above-presented values should be unscaled and this is done through the use of linear unscaling as shown below:

$$nv = I.$$

$$rI = \max rv$$

And, if the index is found having negative dimensions, then: $nv = I - I.$

The unscaled values of the above indices are as listed in the following table for the various contractors. Table 2 of unscaled values of the contractors' scores.

Table2. Of unscaled values of the contractors' scores

Index Contractor	1	2	3	4	5	6	7	8	9	10
A	0.984	0.555	0.75	0.777	0.888	1	0.666	0.851	0.777	0.625
B	0.979	0.777	0.785	0.777	0.888	0.888	0.444	0.714	0.888	0.625
C	1	0.444	1	0.777	0.888	0.777	0.777	1	0.777	0.75
D	0.969	0.888	0.875	0.888	2	2	0.888	0.851	0.888	0.875
E	0.941	1	1	1	0.888	1	1	0.751	1	1

Results of Contractors' Selection and Evaluation based on Bidding Method and Fuzzy Logic. The selection is made in fuzzy logic based on the following relation:

$$A_0 = A_i \max_i I \frac{x_{wj}}{x_v}$$

Where, A_0 is the most appropriate choice.

Table 3 considering the obtained weight vector, the score of each contractor is equal to $EA=0.7902$, $EB=0.7904$, $EC=0.8206$, $ED=0.8393$ and $EE=0.8359$.



Table 3. Contractors' Final Rating

Contractor	Order of the contractors using the common bidding procedures	Order of contractors using the proposed method
A	2	5
B	3	4
C	1	3
D	4	1
E	5	2

VII. CONCLUDING THE TWO METHODS OF CONTRACTORS' ASSESSMENT AND SELECTION

The summing of the results indicated that the unsuccessful experiences in price-based bidding method along with issues like projects' enlargement render it necessary to apply multiscale methods for selecting the contractors. As a method based on simple weighted multiscale decision-making, the proposed method is an example of multiscale decision-making methods for selecting the contractors. In designing the proposed model, efforts were maximally made for taking into account the existent criteria of the management and planning organization parallel to the selection of the contractors; furthermore, the well-experienced experts' ideas were also taken into consideration for doing so. In the studied example, the investigation of the obtained results showed that the order of the contractors selected using the proposed method is different from the order of the contractors appointed using the common bidding method even with the allocation of a considerable weight to the contractors' suggested price (0.55). Therefore, the future researchers are recommended to develop this model as a future work and try identifying the conditions appropriate for the application of this method of contractor selection.

REFERENCES

- [1] B. Zahraei, and M.Tavakkolan, "codification of a model for optimizing time, cost and resources using genetic algorithm", the first international conference on the strategic project management, Tehran, Sharif Industrial University, ShahidReza'ei Research Center, 2017.
- [2] M. Esmaeili, "concepts and techniques of data mining", Ketab-e-Sabz Publication Institute, 2019.
- [3] T. Corman, C. Lazerson, R. Diost, and C. Stein, "an introduction to the algorithms", tr. EynollahJa'afarnejadQomi, Computer Sciences Press, 2019.
- [4] V. Saber,SH. Ghobadi, and F. Barzinpour, "solving the cost-time balance problem of the projects considering the limited resources using multiscale genetic algorithm", third international conference on project management, Tehran, Aryana Research Group, 2017.



- [5] M.H. Kargarfard, A.S. Kheirkhah, "Using Genetic Algorithm and Heuristic Rules to Solve Multi-Project Scheduling with Problem Resource Constraint", 5th International Project Management Conference, Tehran, Ariana Research Group, 2009.
- [6] A.Sanaei Rad, V. Roustyi, "The Use of Time Management Based on PMBOK in Civil Engineering Projects and Presenting Strategies for Improving and Enhancing Them", 3rd National Conference on Civil Engineering, Khomeini Shahr, Islamic Azad University, Khomeini Shahr Branch, 2011.
- [7] A.A. Haeri, H.R. Navabpour, "An Introduction to Data Mining", 6th Iranian Statistics Conference, Tehran, TarbiatModares University, 2012.
- [8] F. Kamankesh, "Evaluation of Data Coding Methods in Genetic Algorithm", 4th National Conference on Data Envelopment Analysis, Mazandaran, Mazandaran University, 2011.
- [9]. P. Springer, "OpenACC - A Step Towards Heterogeneous Computing", German Research School for Simulation Sciences GmbH, Laboratory for Parallel Programming.