Research Article

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Identifying the selection criteria of design consultant for Iraqi construction projects

Abstract: The quality and cost of constructed buildings are heavily influenced by the performance of design/auditing consultants. Thus, selecting the right design consultant and design auditing consultants is of utmost importance and not an easy task for any construction client. so, the client should specify the efficiency criteria and assess the performance levels of the design and design auditing consultant firm. The study aims to identify the selection criteria of the design consultant in construction projects and also identify the selection criteria of the design auditing consultant for the construction projects by using the Delphi survey with applying the principal components analysis (PCA). The results of the present study showed that there are 13 key criteria for selecting the design consultant, where the criterion of "Efficiency and experience of the company/consultant in previous work" was of the highest importance. While there are Ten key criteria for selecting the design auditing consultant for the construction project, where the criterion of "Credibility and professional integrity (transparency, professional conduct, and ethics)" was of the highest importance in the decision-making process. Moreover, the results of applying PCA on the Delphi survey outcomes showed that all the resulting selection criteria are most valuable and suitable for the selection process in construction projects.

Keywords: design, consultant, criteria, Delphi, PCA

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1 Introduction

The professional service contract is designed for use where professional, expert, or specialized services are required and no actual construction work is to be performed. Professional services may be for consulting work, engineering agreements, soil investigations, aerial surveys, and the like [1]. The efficiency and expense of constructed buildings are heavily influenced by the skills, commitment, and perspectives of professional service consultants. Nevertheless, it can be challenging to establish and evaluate non-price factors for both companies and individual consultants when selecting consultants. As a result, clients have generally relied on long-term relationships or other client or colleague recommendations [2]. The client seeking counsel's goal and objective is to engage a consultant who is rated top at delivering advice, assessing the design, and collaborating with the company's staff members [3]. In 2002, Kubr [4] emphasized the importance of consultants in giving knowledge and information, making decisions, and decreasing risk while working for the client. In the private sector, forming a client-consultant relationship typically begins with a suggestion from a friend or other clients, and then progresses as trust deepens. Relationships are also based on personalities rather than businesses. However, procurement restrictions in the public sector limit the use of such informal selection criteria [2]. Since choosing a consultant based on the lowest bid sometimes does not ensure the lowest overall cost of the project after delivery of the project [5], it also may not give excellent quality or very good client satisfaction [6]. According to ref. [3], there are three categories of uncertainties when it comes to choosing consultants:

- Performance uncertainty: the consultancy industry's low institutional leads to a reduced entry-level, which is perceived as a severe information asymmetry between consultants and clients.
- Relational uncertainty: according to several researchers, clients are unsure whether consultants put their clients' benefits first or if they are working mainly for their own benefits.

- Behavioral uncertainty: this is a result of the client's and coworkers' reactions to making an agreement with the consultant.

Tokár-Szadai in 2013 [7] stated that for a successful collaboration, the consultants will require the following skills in the construction projects: innovative idea and convincing presentation; ability to create an appropriate atmosphere; future-oriented approach; cooperative skills; experience; and consultant prestige.

Although the important role of the consultant in the construction projects is making decision, giving information, providing and assessing the design, preparing the bid documents, *etc.*, there are few studies that outlined the selection criteria of the consultants in the construction projects. So, the present study aims to identify the selection criteria of the design consultant and design auditing consultant in order to facilitate the selection process by the construction projects' clients. This study will be reviewing the relevant literature and conducting the Delphi survey and applying the Principal Components Analysis (PCA) to achieve the study aims.

2 Literature review

2.1 The selection criteria of engineering services consultant

It is vital to analyze and assess various relevant criteria in order to select the best consultant [8]. Most construction projects choose architectural and engineering services based on the most economically beneficial bid (many factors) instead of the least cost, and reviewers are more concerned with individual issues than features of project design and execution. Due to several considerations such as the intangible nature of the activities, the asymmetry of information between the client and possible consultants, and the clients' incompetence in selecting consultant services is so often characterized as complicated and difficult [2]. According to a study conducted by Volker in the Dutch in 2010, architect selection can be viewed from two perspectives: legal and psychological. A review of relevant literature on the selection of architectural and engineering consultants shows that there are a number of factors/criteria that affect the selection decision. Table 1 shows these selection factors/criteria.

3 The research objective

In many previous studies, the authors in their works outlined the selection methods and tools but did not focus on how to identify the selection criteria for design consultants and design auditing consultants in construction projects, The present study aims to facilitate the selection process for clients by:
1. Identifying the main criteria for selecting the design consultant for the construction projects.
2. Identifying the main criteria for selecting the design auditing consultant for the construction projects.

A qualitative approach was adopted in this study. A literature review and the Delphi survey with PCA were used to fulfill the aims of this study. In addition, the XLSTAT software (Version 2015) was used for statistical analysis.

Table 1: The common selection criteria of engineering consultant from the relevant literature

No.	Source	Selection criteria of engineering service consultant
1.	Bergmann, 2003 [9]	1) Problem-solving abilities; 2) Expertise; 3) Coaching, assisting, and leading skill; 4) Integrity and trust; 5) Authenticity and reliability; 6) Highly vital and change-oriented; 7) Sensitivity; 8) Strong proficiency; 9) Technical competence; and 10) Branch knowledge.
2.	Volker, 2010 [10]	1) Expertise; 2) Intuition; 3) System; 4) Time; 5) Trust; and 6) Uncertainty.
3.	Sporrong, 2011 [2]	1) Experience with a consultant in the past; 2) The consultant's past experience; 3) The reputation of the consultants; 4) The recommendations inside and outside the organization; 5) Personal contact with the consultant; and 6) The service fee.
4.	World Bank, 2011 [11]	1) Consulting firm history; 2) Approaches; 3) The project's main consultant; 4) Information flow; and 5) National professionals' participation.
5.	Tokár-Szadai, 2018 [8]	1) Deadline; 2) Consultant's personality; 3) Company image; 4) Commitment fee; 5) Professional content of the offer, and 6) Company reference and Trust.

4 Results and discussions

4.1 Conducting the Delphi rounds

The Delphi survey is an appropriate research approach for solving complicated challenges in the Engineering and construction industry without concern of collusion, even when the participants are familiar with one another [12]. A Delphi panel might include as few as three members or as many as 80 members, and studies of Delphi with less than 10 participants are uncommon [13,14]. So, a suitable participants sample in the Delphi survey is 12, which is generally considered to be sufficient to enable consensus to be achieved [1,15]. Welding in 2013 [16] stated that the Delphi study usually involves 3 or 4 rounds. After reviewing the relevant literature, the research also visited the related directorates in the Baghdad government such as Al-Mansour General Engineering Company, Housing Directorate, Buildings Directorate, *etc.*, to collect more information about the selection criteria for design consultant and design auditing consultant for the construction projects. Then, this study conducted the Delphi survey with a group of expert engineers who were having experience for more than 15 years in design and project management in the Iraq construction industry, to identify the key selection criteria of the design consultants and the key selection criteria of the design auditing consultants for the construction projects. The Delphi process depends on developing the questionnaire form for each round. Like, ref. [17] the research sent invitations to a number of experts to ask them to participate in the Delphi rounds with a description of the purpose of this survey. Twelve experts responded and agreed to participate, the personal information of the selected experts are given in Table 2.

4.1.1 Delphi first round

In this round, the questionnaire form includes the questions about the selection criteria of the design consultant, and furthermore, it also includes questions about the selection criteria of the design auditing consultant. These questions which were formulated according to the literature review and field visits, similar to that in ref. [18], used five-scale rating for answers with using the weight value as shown in Table 3. Then the selected experts were asked face to face to identifying the important degree for each criterion in the questionnaire form with the possibility to add other criteria by the participants if they considered it necessary.

Table 2: Personal information of experts' sample in the Delphi survey

Expert name	Institution name	Work sector	Academic degree	Field	Current position	Experience in years
A.J.	Buildings directorate	Public sector	MSc.	Civil	Planning engineer	From 15 to 20
S.J.	Al-Mansour general engineering company	Public sector	BSc.	Civil	Division manager	From 15 to 20
H.M.J.	Al-Arabia company for engineering technologies and contracting	Private sector	BSc.	Mechanical	Project manager	More than 20
A.M.J.	The general company for Iraqi railways	Public sector	BSc.	Civil	Project manager	More than 20
A.A.A.	National center for engineering consultancy	Public sector	MSc.	Architectural	Depart. Manager	From 15 to 20
M.W.	Buildings directorate	Public sector	BSc.	Civil	Planning engineer	From 15 to 20
K.W.	Debajeh engineering consulting office	Private sector	BSc.	Civil	Project manager	From 15 to 20
H.S.	Buildings directorate	Public sector	BSc.	Civil	Division manager	More than 20
A.M.	Al-Khwarizmi engineering consulting office	Private sector	BSc.	Civil	Project manager	More than 20
H.H.	X-Line engineering office	Private sector	MSc.	Civil	Project manager	From 15 to 20
A.S.	Office of externally funded projects	Public sector	High Diploma	Mechanical	Division manager	From 15 to 20
S.Y.	Buildings directorate	Public sector	BSc.	Civil	Division manager	More than 20

Table 3: Weight value (WV) of descriptive frequencies [18]

Descriptive frequency	Class interval (CI)	WV
V. low	$1 \le CI \le 1.8$	1
Low	$1.8 < CI \le 2.6$	2
Medium	$2.6 < CI \le 3.4$	3
High	$3.4 < CI \le 4.2$	4
V. high	$4.2 < CI \le 5$	5

Similar to ref. [19], the research used the arithmetic mean value, standard deviation (SD), and Cronbach alpha (α) for the statistical analysis by using XLSTAT software (Version 2015). In this round, the criteria that got arithmetic mean value of less than 3.4 were removed from the form in the second Delphi round. The analysis results showed that the average value of Cronbach alpha (α) for all criteria was more than (0.7) which indicates good reliability and consistency for the experts' answers. Also, some of the selected experts recommended merging some criteria and adding other criteria. So, the new list of fifteen selection criteria was prepared, and this list of criteria will be used in the second round of the Delphi survey.

4.1.2 Delphi second round

The relative importance for the selection criteria has been requested to indicate by the selected sample in this round for both the design consultant and auditing design consultant. The statistical analysis results showed that there

are 13 selection criteria for the design consultant having arithmetic mean value of more than 3.4 that resulted from this round and will be used in the third Delphi round, and the average value of α for these resulted criteria was 0.919, indicating that the experts' answers have high reliability and consistency, while there were only 2 criteria that got arithmetic mean value of less than 3.4, which will be removed from the third Delphi round, as shown in Table 4. Also, the statistical analysis results showed that there are 10 selection criteria for the design auditing consultant in the construction projects having arithmetic mean value of more than 3.4 that resulted from this round and will be used in the third Delphi round. The average value of α for these selection criteria was 0.923, also indicating that the experts' answers have high reliability and consistency, while there are 5 criteria that got arithmetic mean value of less than 3.4, which will be removed from the third Delphi round, as shown in Table 4.

4.1.3 Delphi third round

In this round, the same experts were asked to re-evaluate the relative importance of the selection criteria that resulted from the second Delphi round, the purpose of this round is to find the key selection criteria that affect the decision-making process for both the design consultant and design auditing consultant in Iraq construction projects. The results of the statistical analysis of this round showed that there are 13 selection criteria for the design

Table 4: The list of selection criteria for design consultant and design auditing consultant from the second Delphi round

No.	Selection criteria	Design con.		Design auditing con.	
		Mean	SD	Mean	SD
1.	Respect the time	4.6667	0.49237	4.6667	0.49237
2.	Credibility and professional integrity (transparency, professional conduct, and ethics)	4.5833	0.66856	4.5833	0.66856
3.	Quality in previous designs	4.5833	0.51493	4.5000	0.52223
4.	Efficiency and experience of the company/consultant in previous work	4.5833	0.51493	4.6667	0.49237
5.	The reputation of the consultant in business and professional fields	4.5000	0.67420	4.4167	0.79296
6.	Organizing, communication, and negotiation skills	4.2500	0.75378	4.2500	0.75378
7.	Availability of resources	4.2500	0.86603	4.3333	0.65134
8.	Consulting service fees	4.0000	0.60302	3.8333	0.57735
9.	Participatory approach and work plan	4.0000	0.95346	3.3333	0.77850
10.	History of past disputes	3.7500	0.75378	3.6667	0.98473
11.	Harmony with the consultant from previous work with him and social media	3.7500	0.86603	3.1667	0.71774
12.	Understanding the country and its culture	3.7500	0.75378	4.0000	0.73855
13.	Fantasy	3.5833	0.99620	3.2500	0.96531
14.	Communication within and outside the profession	3.250	0.75378	3.333	1.02986
15.	Knowledge of the construction industry	3.1667	0.57735	3.0833	0.28868

consultant having the value of arithmetic mean more than 3.4 and the calculated value of α for these selection criteria was 0.908, While there are 10 selection criteria for the design auditing consultant in the construction projects having an arithmetic mean value of more than 3.4 and the calculated value of α for these selection criteria was 0.939. Because the results of the third Delphi round are similar to the results of the second Delphi round, there is no need to go to the fourth Delphi round and these results refer to a high consistency in experts' answers between the second and third Delphi round and reaching to the consensus in this survey. Table 5 illustrated the final selection criteria for both the design consultant and design auditing consultant in Iraq construction projects, these criteria ranked from the highest importance to the lowest importance.

4.2 PCA

PCA has been widely employed by researchers in a variety of fields for dimensionality reduction [20]. The PCA extracts those features that are most valuable and have a value of factor pattern coefficient more than 0.3 [21]. Prior to performing the PCA, it is required to run the Kaiser–Meyer–Olkin (KMO) test. KMO can determine whether the data are acceptable for doing the PCA. If the value of KMO is below 0.5, the PCA should not be done [22]. Kaiser in 1974 [23] developed the KMO calculation equation as illustrated in Equation (1). The present study calculated the PCA and KMO from the data of the third Delphi round by using XLSTAT software to find if there is the possibility of reducing the final selection criteria that resulted from the Delphi survey for the selection of both the design consultant and the design auditing consultant for the construction projects. The results showed that the values of KMO for the selection criteria for the design consultant was 0.616 as shown in Table 6, this refers to suitable data to run PCA. After applying the PCA, the results showed that there are 3 components that have eigenvalue of more than 1, as shown in Figure 1 and all the values of factor pattern are more than 0.3 as shown in Table 6, so these results referring to the selection criteria for the design consultant are most valuable and there is no possibility to reduce. In addition, the results showed that the value of KMO of the selection criteria for the design auditing consultant was 0.528, this value refers to acceptable data to run the PCA. After applying the PCA, the results showed that there are 2 components that have eigenvalue of more than 1,
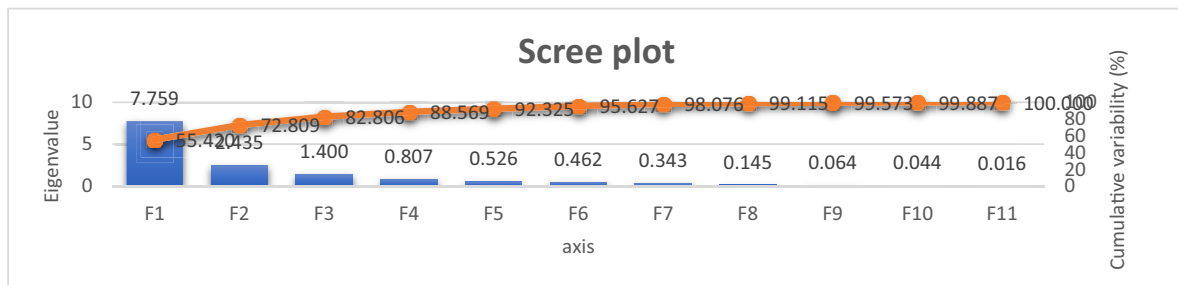
Table 5: The final selection criteria for design consultant and design auditing consultant from the Delphi survey

Rank	Selection criteria for the design consultant	Analysis results		Selection criteria for the design auditing consultant	Analysis results	
		Mean	SD		Mean	SD
C1.	Efficiency and experience of the consultant in previous work	4.583	0.900	Credibility and professional integrity	4.500	0.674
C2.	Credibility and professional integrity	4.500	0.904	Quality in the previous designs audit process	4.416	0.900
C3.	Respect the time	4.416	0.900	The reputation of the consultant in business and professional fields	4.333	0.651
C4.	The reputation of the consultant in business and professional fields	4.333	0.887	Respect the time	4.333	0.887
C5.	Quality in previous designs	4.333	0.887	Efficiency and experience of the company/consultant in previous work	4.333	0.887
C6.	Organizing, communication, and negotiation skills	4.083	0.514	Organizing, communication, and negotiation skills	4.083	0.514
C7.	Availability of resources	4.083	0.792	History of past disputes	4.000	0.603
C8.	Harmony with the consultant from previous work	4.083	0.792	Consulting service fees	4.000	0.738
C9.	Understanding the country and its culture	4.000	0.953	Availability of resources	4.000	0.738
C10.	Consulting service fees	3.833	0.717	Understanding the country and its culture	3.833	0.937
C11.	Fantasy	3.833	0.834			
C12.	History of past disputes	3.750	0.753			
C13.	Participatory approach and work plan	3.666	0.492			

Table 6: The KMO and PCA factor pattern values of the selection criteria for the design consultant and the design auditing consultant

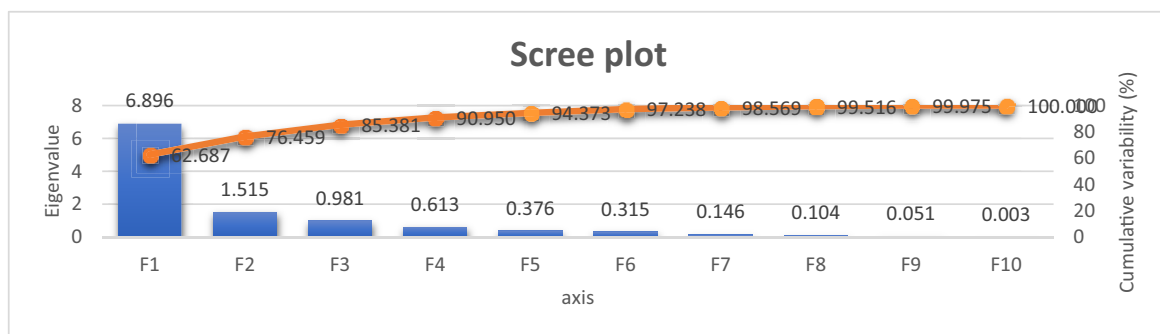|		PCA results of the selection criteria						
Design consultant	KMO	Factor pattern			Design auditing consultant	KMO	Factor pattern	
		F1	F2	F3			F1	F2
C1.	0.74	**0.820**	−0.350	0.210	C1.	0.73	**0.843**	0.158
C2.	0.56	0.497	0.144	**−0.723**	C2.	0.81	0.139	**−0.923**
C3.	0.77	**0.927**	0.014	−0.265	C3.	0.42	**0.845**	−0.200
C4.	0.48	0.415	**0.777**	0.076	C4.	0.41	**0.784**	−0.491
C5.	0.66	**0.709**	−0.424	−0.381	C5.	0.41	**0.842**	−0.229
C6.	0.66	**0.927**	−0.059	0.151	C6.	0.47	**0.781**	0.380
C7.	0.69	**0.850**	−0.321	−0.074	C7.	0.79	**0.871**	0.302
C8.	0.35	0.347	**0.871**	−0.057	C8.	0.41	**0.868**	0.064
C9.	0.49	0.500	0.167	**0.721**	C9.	0.29	**0.630**	0.089
C10.	0.50	0.634	**0.648**	−0.120	C10.	0.42	**0.895**	−0.125
C11.	0.76	**0.842**	−0.425	0.145	KMO	0.516		
C12.	0.54	**0.886**	0.096	0.138				
C13.	0.49	**0.766**	−0.063	0.017				
KMO	0.616							

Values in bold for each variable correspond is the largest.

Figure 1: The eigenvalue of the selection criteria for the design consultant.

as shown in Figure 2 and all the values of factor pattern are more than 0.3 as shown in Table 6, so these results referring to the selection criteria for the design auditing consultant are most valuable and there is no possibility to reduce.

$$\text{KMO} = \frac{\sum_i \sum_{j \neq i} r_{ij}^2}{\sum_i \sum_{j \neq i} r_{ij}^2 + \sum_i \sum_{j \neq i} u_{ij}^2}, \tag{1}$$

where $R = r_{ij}$ is the correlation matrix; and $U = [u_{ij}]$ is the partial covariance matrix.

Figure 2: The eigenvalue of the selection criteria for the design auditing consultant.

5 Conclusion

According to the survey of the relevant literature and field visits, this study found that the previous studies which outlined the selection criteria of the engineering service consultant are few. Also in many Iraqi construction directorates, the consultant is selected directly according to the owner's opinion without competition with others in spite of the great role of the consultant in the construction project. So, the present study has studied this aspect by conducting three rounds of the Delphi survey and identified 13 key selection criteria for the design consultant, and 10 key selection criteria for the design auditing consultant in Iraq construction projects which facilitate the decision-making process for the owner or his representative. In addition, the results of applying PCA indicate there is no possibility for reducing the selection criteria that resulted from the Delphi survey and all the identified criteria are valuable and effective in the selection process; moreover, the answers of selected experts in the Delphi survey were adequate and effective. Finally, this study recommends using the selection criteria that resulted from this study with applying one of Multi-Criteria Decision-Making methods like AHP; ANP, TOPSIS, *etc.*, to ensure effective decisions on selecting the suitable design consultant and the design auditing consultant in the construction projects.

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References

[1] Whitticks E. Construction contracts: how to manage contracts and control disputes in a volatile industry. Houston (TX), USA: Gulf Pub. Co.; 2005.

[2] Sporrong J. Criteria in consultant selection: public procurement of architectural and engineering services. Aust J Constr Econ Build. 2011;11(4):59–76.

[3] Pemer F, Werr A. The uncertain management consulting services client. Int Stud Manag Organ. 2013;43(3):22–40.

[4] Kubr M. Management consulting: A guide to the profession. 4th ed. Geneva: ILO; 2002.

[5] Wong CH, Holt GD, Harris P. Multi-criteria selection or lowest price? Investigation of UK construction clients' tender evaluation preferences. Eng Constr Arch Manag. 2001;8(4):257.

[6] Ling FYY. Consultancy fees: dichotomy between A/E's need to maximize profit and employers need to minimize cost. J Prof Issues Eng Educ Pract. 2004;130(2):120–23.

[7] Tokár-Szadai Á. Advisory roles. Compet Manag Sci. 2013;44(3):26–36.

[8] Tokár-Szadai A. Changes in the selection criteria of a management consultant in north-eastern hungary 2001–2016. J Contemp Econ Bus Issues. 2018;5(2):19–31.

[9] Bergmann T. ASCO CEO survey: Despite very satisfied customers, declining trend in the use of consultants. ASCO Study Facts Trends Manag Consulting Switz 2002/2003; 2003.

[10] Volker L. Deciding about design quality: Value judgements and decision making in the selection of architects by public clients under European tendering regulations [dissertation]. Delft: Delft University of Technology; 2010.

[11] World Bank Borrowers January. Guidelines: selection and employment of consultants under IBRD loans and IDS credits & grantsby; 2011. http://siteresources.worldbank.org/INTPROCUREMENT/.

[12] Ogbeifun E, Agwa-Ejon J, Mbohwa C, Pretorius JHC. The Delphi technique: A credible research methodology. Proceedings of the 2016 International Conference on Industrial Engineering and Operations Management Kuala Lumpur. Malaysia; 2016 March. p. 8–10.

[13] Wainwright P, Gallagher A, Tompsett H, Atkins C. The use of vignettes within a Delphi exercise: A useful approach in empirical ethics. J Med Ethics. 2010;36:656–60.

[14] Malone DC, Abarca J, Hansten PD, Grizzle AJ, Armstrong EP, Van Bergen RC, et al. Identification of serious drug-drug interactions: Results of the partnership to prevent drug-drug interactions. Am J Geriatr Pharmacother. 2005;3(2):65–76.

[15] Crane D, Henderson EJ, Chadwick DR. Exploring the acceptability of a 'limited patient consent procedure' for a proposed blood-borne virus screening programme: a Delphi consensus-building technique. BMJ Open. 2017;7:e015373. doi: 10.1136/bmjopen-2016-015373.

[16] Welding AK. Project evaluation: lessons learned vs Delphi method [dissertation]. Reykjavik: Reykjavik University; 2013.

[17] Al-Agele HKB, Al-Kaabi SAM. Identification of key factors affecting waste management in life cycle of the construction project by using Delphi technique. J Eng. 2016;22(7):19–34. https://joe.uobaghdad.edu.iq/index.php/main/article/view/187. Accessed: 23 November 2021.

[18] Mohammed SR, Jasim AJ. Examining the values and principles of agile construction management in Iraqi construction

projects. J Eng. 2018;24(7):114–33. doi: 10.31026/
j.eng.2018.07.08.

[19] Mohammed SR, Jasim AJ. Study and analysis of the delay
problems in Iraqi construction projects. Int J Sci Res.
2017;6(5):2331–6. doi: 10.21275/ART20173791.

[20] Preetha R, Vinila JS. Early diagnose breast cancer with
PCA-LDA-based FER and neuro-fuzzy classification system.
J Ambient Intell Humanized Comput. 2020;12:7195–204.
doi: 10.1007/s12652-020-02395-z.

[21] Lever J, Krzywinski M, Altman N. Points of significance:
principal component analysis. Nat Methods.
2017;14(7):641–2.

[22] Mahmoudi A, Deng X, Javed SA, Yuan J. Large-scale multiple
criteria decision-making with missing values: project selection
through TOPSIS.OPA. J Ambient Intell Humanized Comput.
2021;12(10). doi: 10.1007/s12652-020-02649-w.

[23] Kaiser HF. An index of factorial simplicity. Psychometrika.
1974;39(1):31–6.