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The factors that affect constructability in Iraq

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Abstract: Applying the constructability concept in the construction industry has proven many benefits in different projects; however, this concept still lacks usage in Iraq. Therefore, it is important to encourage usage of the constructability concept in the construction industry in Iraq. The main purpose of this study is to investigate the factors that affect constructability in Iraq and then classify them according to their importance. A total of 37 factors were collected from an intensive literature review, and they were classified under the sub and main categories. A survey was undertaken in two sessions with open questionnaire and close questionnaire. The results were analysed and the mean, standard deviation and Cronbach's Alpha were obtained. Also, the developed weight was calculated for each alternative factor. The goal of this paper is to define the main factors that have an effect on Iraqi's constructability project in order to avoid issues in future Iraqi projects. The outcome showed that 34 factors had a major effect on increasing the constructability percentage in construction projects in Iraq. The top-ranking factors were structural frame types, high-strength concrete usage, adjacent infrastructures and adjacent site.

Keywords: constructability, effected factors, construction projects, constructability benefits, constructability definition, factors categories, Iraq

1 Introduction

The success of a construction project depends on commitment with its specified cost, time, quality, safety and resources (Abbas and Burhan 2022). The construction projects in Iraq are subjected to many problems which gives rise to the need to introduce the concept of constructability in the industry. The problems facing the industry are poor communication between the designer and builder (Khan 2019; Thirion 2019; Højbjerg et al. 2021), increase in project complexity, clashes between the building's components (Yang et al. 2013; Høqjbjerg et al. 2021), difficulty in controlling project time and budget (Rashed and Mahjoob 2014; Ahmed and Altaie 2021; Qi et al. 2022), and increased change orders and redesign in projects which lead to failed projects (Rezouki and Alhilli 2022). The essential responsibility of constructability is to convert plans and specifications into finished products (Khan 2019; Nolan and Gibson 2022). According to Zhang et al. (2016), applying constructability in project design would save 1%–14% of the capital cost, while Al Hamadani et al. (2022) mention that applying constructability saved 10%–20% of the total cost of the project. According to the Construction Industry Institute (CII) (2019), constructability improved to 7.1% from schedule performance and 6.1% from cost performance during project implementation and development. However, applying constructability still lacks around the world, and specifically in Iraq. Al-Fadhli (2022) made a model that used to assess value engineering and constructability in infrastructure projects in Iraq; however, the model lacked to mention the factors that impact constructability. Zolfagharian and Irizarry (2017) studied the constructability of designs in commercial buildings in the United States, where different factors affecting constructability were discussed, but the study was limited to a specific type of building, that is, commercial buildings. Also, while it discussed some building components, it excluded others such as mechanical, electrical and plumbing. Shash and Almufadhi (2021) revealed the constructability practices among stakeholders; their study remarked some factors that affect in constructability in Saudi Arabia, but it limited the implementation of constructability in industrial projects only. This study discusses all the factors that might affect constructability in Iraq, and it includes all building types.

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2 Review of literature

The main purpose of introducing Project management in the construction sector was to reach the project objectives. However, today many projects fail to reach their objectives due to a lack of communication between the design and construction teams (Kifokeris and Xenidis 2017; Høqjbjerg et al. 2021). Therefore, researchers started to find solutions for this phenomenon. In 1983, the Research and Information Association (CIRIA) of the construction industry started to use the concept of 'buildability' in order to find the best solutions for construction projects. CIRIA defined buildability as 'the extent to which the design of a building facilitates ease of construction, subject to the overall requirements for the completed building' (Tauriainen et al. 2012; Shash and Almufadhi 2021). Due to the efforts of the Business Roundtable, the CII was formatted and the term constructability was used for the first time in the construction industry in the U.S. in 1986 (Pocock et al. 2006). The CII defined constructability as 'the optimum use of construction knowledge and experience in planning, design, procurement, and field operations to achieve overall project objectives' (Tauriainen et al. 2012; Zolfagharian and Irizarry 2017; Khan 2019; Thirion 2019; Shash and Almufadhi 2021; Al Hamadani et al. 2022). From the above two definitions, it is obvious that the concept of constructability is more comprehensive than buildability, as it includes the management and design problems, while the buildability concept focuses mainly on design (Tauriainen et al. 2012; Khan 2019). However, in 2008 the Institution of Professional Engineers New Zealand Incorporated defined constructability as 'Constructability (or buildability) is a project management technique to review construction processes from start to finish during the pre-construction phase. It is to identify obstacles before a project is actually built to reduce or prevent errors, delays, and cost overruns' (Shash and Almufadhi 2021). While Gambatese et al. (2007) and Yang et al. (2013) described constructability as the quality reflection of the design documents, so if the design was difficult to understand it meant problems would accompany the project construction.

Applying constructability added many benefits to the project and to its participants. The implementation of constructability would enable structural engineers to notice the construction cost, framework safety and stability of structure, elements dimension, properties of materials, joint categories and connection design, regulation of construction, and conditions of construction position and logistics (Tauriainen et al. 2012). While for the designer it would help to enhance the relationship with the contractor and the owner, reduce claims, and better reputation; for the contractor it would help to reach stable progress for the construction with the specified cost (Khan 2019; Thirion 2019). Garcia (2009), cleared the benefits of applying constructability to the owners, as it had a medium effect on schedule reduction and had a low-to-medium impact on cost savings. However, till today many owners have resisted to use constructability as it needed extra budget (Thirion 2019). According to Khan (2019), Shash and Almufadhi (2021), and Thirion (2019), there are two types of constructability benefits: qualitative and quantitative; the qualitative benefits are more safety, better communication, enhanced location accessibility, improved construction flexibility, less maintenance cost, enhanced attention on the common goal and so on; while the quantitative benefits involve improve construction cost by reducing labour, material and equipment cost, a compact time table and less engineering cost. Othman (2011), Al-Fadhli (2022) and Al Hamadani et al. (2022) noticed that implementing the constructability concept in the earlier stage of the project had a good influence on the entire building process. It was clear that applying constructability through different stages of the project's life cycle had a great impact on the project cost and schedule; it would decrease the projects' duration and cost and keep them within the budget.

There are several elements that affect constructability and its performance; as a result, many researchers have started to define these factors. According to Shash and Almufadhi (2021), there are 12 principles to apply in constructability: integration, understanding of construction, objectives of corporate, resources availability, team expertise, external issues, method of construction, programmer, conductivity, qualifications, feedback and improvement in construction. The mentioned factors were used to measure the level of application of constructability (constructability assessment factors) and divided into six groups: economic impact, space, standardisation, utility availability, installation and site impacts. It was stated that constructability assessment and improvement are affected by 16 factors, which are prefabrication, grid layout, standard dimension, component flexibility, resources availability, labour availability, construction sequence, time underground, building envelope, weather effect, safety, material access, personnel access, equipment access, adjacent foundation and infrastructure; however, three factors are added, which are labour skills, roads useability and government facilities. Finally, 16 critical parameters of constructability were identified; these parameters are coordination, the process of bidding, integration, schedule for driving and construction, elements standardisation, weather, design simplification, prefabrication, site accessibility, adverse circumstances, technical qualifications, enhanced innovations, learned from past reviews and exercise, resources accessibility, recycling and management of waste and use of progressive information technology. To achieve successful implementation of constructability, the following must be applied: continuous maintenance of a sensible plan, persistence, upfront preparation and positive hands-on leadership. Yoon et al. (2018) mentioned the factors used to assess constructability as the following: building envelope, weather effect, safety, economic impact, coordination, bidding process, structural frames types, roof types, slab types, external wall types, internal wall types, structural reinforcement scope, prefabricated MEP and high-strength concrete application. The stated factors to evaluate constructability are standardisation and repetition, site conditions and planning resources, document control, ease of construction and planning. Accordingly, the current research will combine all the previous factors and study their effect on constructability for the first time in the Iraqi construction industry through several practical steps to ensure the selection of suitable factors and their associated weights.

3 Methodology

The aim of this study is to identify the factors that impact on constructability in Iraqi's construction projects and enhance the usage of this concept in the country. In order to get a comprehensive knowledge of the factors that affect constructability in the Iraqi construction industry, data were collected from different books, researches, papers, journals, articles and websites; 37 factors were found from the intensive literature that had the possibility of impacting on constructability. To study and analyse these factors, they were classified into three levels as follow:

– Level one includes all factors that affect constructability (umbrella that includes all factors). It consisted of three main categories: design attributes category, construction attributes category and external impacts category. The design attributes category included the sub-categories and factors that affect constructability through the design process, while the sub-categories and factors that affect constructability through the construction process would go under the construction attributes category. Finally, the external impacts category that represents the external factors and sub-categories that have the impact on constructability behaviour of the project.
– Level two presents nine sub-categories which were as follows: standardisation and repetition, economic, structure system, space, installation, document control, utility availability, site impact and other. Each sub-category contained its factors.
– Level three included 37 factors that were weighted in order to rate their effect on constructability.

Table 1 shows these three levels with a brief explanation for each factor. The next step was the field survey, which consisted of open and closed questionnaires. The purpose of the survey was to select the factors that affect the constructability and rate them according to their importance. The responses were analysed using the SPSS program to find the mean and standard deviation for each factor, Cronbach's alpha for each factor and the total Cronbach's alpha. From the means the developed weight was calculated for each factor.

4.1 Field survey and data analysis

4.1.1 Open questionnaire

The 37 chosen factors were presented on specialists and experts in order to get their opinions, evaluations and recommendations in these factors. Then the factors that affect constructability in the construction industry in Iraq were collected.

Interviews were held with many experts in variety of specialisations from different Iraqi ministries and institutes. These ministries were the Ministry of Higher Education and Scientific Research, Mayoralty of Baghdad, Ministry of Construction, Housing, Municipalities, and Public Works; and the new Central Bank of Iraq project. Table 2 presents a summary of the expert samples in the open questionnaire: 34 factors were chosen from the open questionnaire Figure 1 represents the chosen factors and their classification.

4.1.2 Closed questionnaire

After the open questionnaire the closed questionnaire was prepared by using a Google form in order to rate the collected factors using the 5-point Likert scale. The questionnaire consisted of 5 sections and 19 questions. The first section was about personal information and general questions. The second section was about the effects of the main and sub-categories. The third, fourth and fifth sections included the effects of the factors. However, the fifth

Tab. 1: The three levels of the collected data.

Main categories	Sub-category	Factors	Description	Reference
Design attributes	Standardisation and repetition	Prefabrication	Precast concrete, prefabricated utility products, prefabricated MEP, etc.	Boton (2018), Hijazi et al. (2009), Zhang et al. (2016), and Khan (2019)
		Grid layout	(Horizontal/vertical/radial) grid dimensions, a repeated grid layout will lead to faster construction sequences	Boton (2018), Hijazi et al. (2009), and Zhang et al. (2016)
		Standard dimensions	Dimensions for door, windows, partitions, tiles, etc.	Boton (2018), Hijazi et al. (2009), and Zhang et al. (2016)
	Economic	Component flexibility	Flexibility of movement of internal partitions (fixed/mobile)	Boton (2018), Hijazi et al. (2009), and Zhang et al. (2016)
		Resources availability	Various resources such as building material, labour, and equipment can be approached, hired, and put to work for the execution of the project	Boton (2018), Hijazi et al. (2009), Zhang et al. (2016), and Shash and Almufadhi (2021)
		Labour skills	Availability of special labour skills	Boton (2018), Hijazi et al. (2009), and Zhang et al. (2016)
		Team expertise	The project team must be selected based on their experience knowledge and skills requirement for the project	Shash and Almufadhi (2021)
		Application of advance information technology	Adoption of latest and modern computerised means of technology for the project	Khan (2019)
		Coordination or communication	Coordination and communication among team members (builder and designer, site staff)	Khan (2019) and Yoon et al. (2018)
		Simplification of Design	Designs considered efficient construction	Khan (2019), Shash and Almufadhi (2021)
		Construction methodology	Major construction method options, in the project's design phase	Shash and Almufadhi (2021)
	Structure system	Structural frame types	Steel frame, concrete frame, wood frame	Yoon et al. (2018)
		Roof types	Gable, hip, Dutch, etc.	Yoon et al. (2018)
		Slab types	Conventional, flat, waffle slabs	Yoon et al. (2018)
		Structural reinforcement scope	The design and type of reinforcement	Yoon et al. (2018)
		High-strength concrete application	The usage of high-strength concrete	Yoon et al. (2018)
Construction attributes	Space	Material access	Space for material storage and transportation on site	Boton (2018), Hijazi et al. (2009), and Zhang et al. (2016)
		Personnel access	Accessibility of personnel for different site locations	Boton (2018), Hijazi et al. (2009), and Zhang et al. (2016)
		Equipment access	Accessibility of equipment and tools for and from different site locations	Boton (2018), Hijazi et al. (2009), and Zhang et al. (2016)

(*Continued*)

Tab. 1. Continued.

Main categories	Sub-category	Factors	Description	Reference
	Installation	Construction sequence	Sequence of installation of components	Boton (2018), Hijazi et al. (2009), and Zhang et al. (2016)
		Time under ground	Construction time under ground level	Boton (2018), Hijazi et al. (2009), and Zhang et al. (2016)
		Building envelope	Construction of the whole building envelope	Boton (2018), Hijazi et al. (2009), Zhang et al. (2016), and Yoon et al. (2018)
		Weather effect	Effect of climate conditions on construction work	Boton (2018), Hijazi et al. (2009), Zhang et al. (2016), Khan (2019), and Yoon et al. (2018)
		Safety	Effect of construction sequence of workers' safety	Boton (2018), Hijazi et al. (2009), Zhang et al. (2016), and Yoon et al. (2018)
		Waste management and appraisal recycling	Organise and regulate the waste and convert waste into reusable products	Khan (2019)
		Encouragement to innovations	Promotion of new ideas, the projects constructability can be enhanced using innovation ideas during the construction stage	Khan (2019)
	Document control	Specifications	The projects constructability can be enhanced by developing transparent specifications	Khan (2019)
		Simplification of technical specifications	Detailed description of technical requirement in terms of suitability for design development of an item	Khan (2019)
		Qualifications, feedback and improvement in construction	The projects constructability can be enhanced by utilising the lesson-learned databases and best-practices for other projects	Shash and Almufadhi (2021)
		Inspections and site meetings	Quality of inspections and site meetings, level of knowledge sharing and capturing project objectives in accordance with client objectives	Kotze and Wium (2019)
External impacts	Utility availability	Government facilities	Availability of governmental facilities like electrical and infrastructure services	Boton (2018), Hijazi et al. (2009), and Zhang et al. (2016)
		Road-use ability	Applicability of public roads for transportation	Boton (2018), Hijazi et al. (2009), and Zhang et al. (2016)
	Site impact	Adjacent site	Effect of current construction on adjacent constructions	Boton (2018), Hijazi et al. (2009), and Zhang et al. (2016)
		Infrastructures	Effect of current construction on adjacent or nearby infrastructure constructions	Boton (2018), Hijazi et al. (2009), and Zhang et al. (2016)
	Other	Corporate objectives	Understand the project objectives as well as the client's objectives	Shash and Almufadhi (2021)
		Bidding process	The type of bid (design–build/design–bid–build)	Khan (2019) and Yoon et al. (2018)
		Construction-driven schedule	The schedules are prepared in the construction projects to keep a check on the various design and construction activities	Khan (2019) and Shash and Almufadhi (2021)

section contained some questions about suggestions and adjustments. The questionnaire was sent to professionals and experts by email and social media. Forty responses were received from different work fields.

5 Data analysis

From the 40 responses, 36 responses were chosen to be analysed and according to Unite for Sight (2021) 'sample size >30 and <500 are appropriate for most research'; however, all the responders were experts and have good knowledge in this field. The academic qualifications of the responders were as follows: 15 bachelor's degree, 16 master's degree and 5 PhD, as shown in Figure 2. While the practical experience years were nine responses >20 years, six answers between 15 years and 20 years, nine replies from 10 to 15, six responses between 5 years and 10 years and six answer <5 years, as presented in Figure 3.

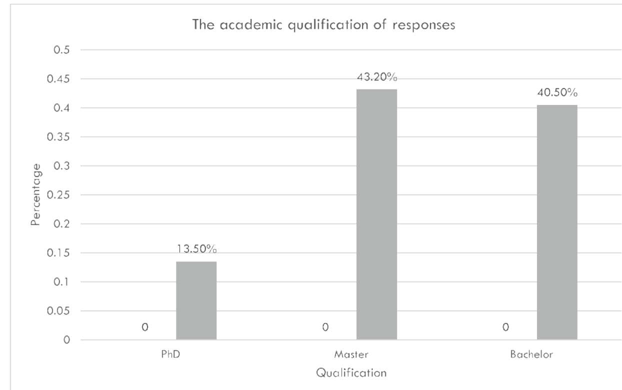

Fig. 2: The academic qualification of responses.

Tab. 2: Summary of the open questionnaire (expert samples).

Institutes	No. of interviews	Job tittle
Mayoralty of Baghdad	5	2 Senior chief engineer, senior associate engineers, chief engineer, senior engineer
Ministry of Higher Education and Scientific Research	1	Senior university lecturer
Ministry of Construction, Housing, Municipalities, and Public Works	4	Senior chief engineer, chief engineer, senior chief engineer, senior associate engineers
The new Central Bank of Iraq project	4	Project manager, consultant, chief engineer, site engineer

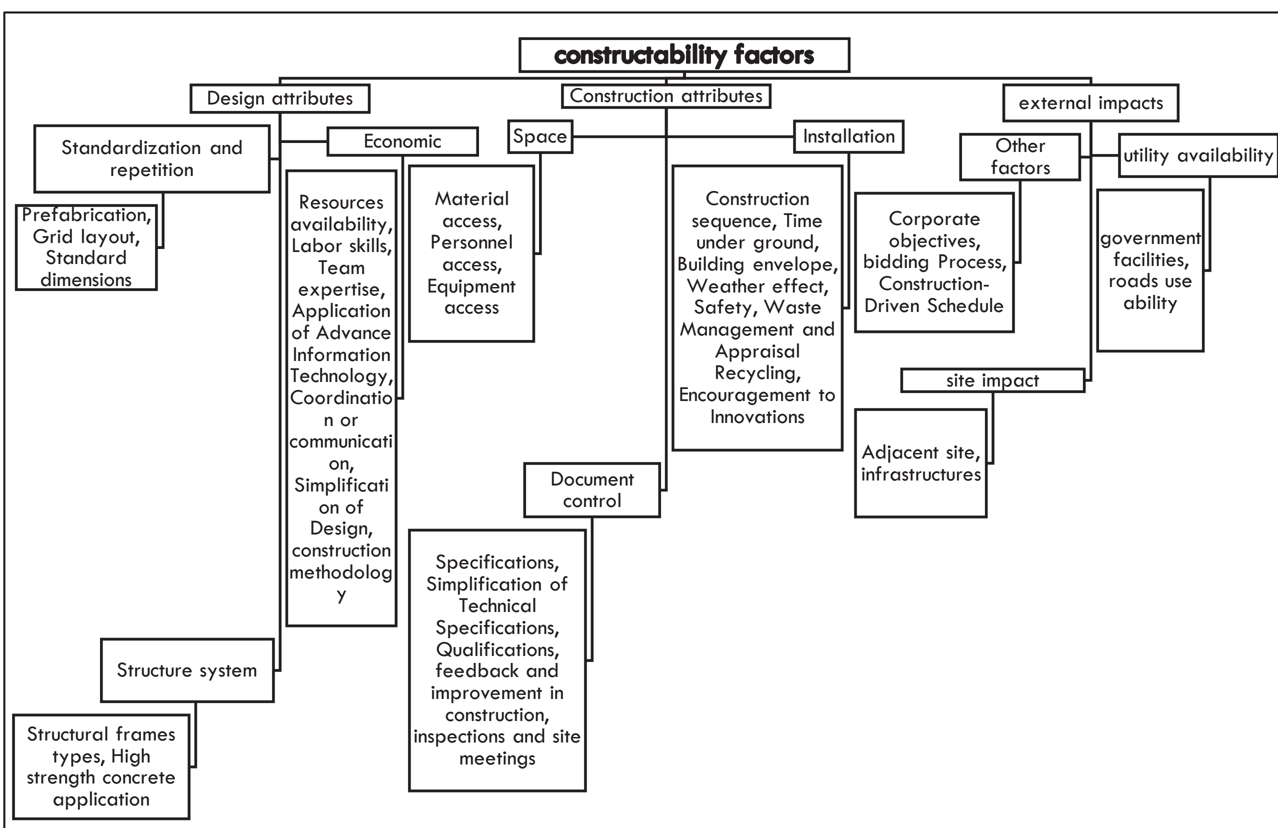

Fig. 1: The chosen factors and their classification.

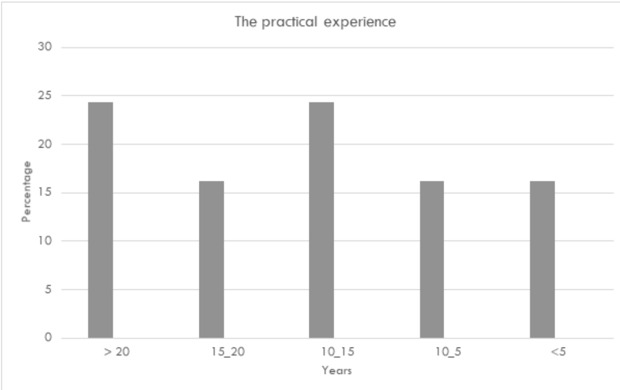

Fig. 3: The practical experience.

However, the major responses of the specialisation were civil engineers. In addition, the percentage of the answer about the usage of constructability in previous projects was only 44.4%. It was a good indicator that the concept of constructability had been introduced in the construction industry of Iraq. However, there was still a high percentage (more than half) that ignored the benefit of this concept.

The collected data were analysed using the SPSS program; the mean, standard deviation and Cronbach's alpha were calculated for each of the main categories, sub-categories and factors. Formulas (1) and (2) were used to measure the mean and standard deviation for the collected data (Science Buddies 2022):

Mean equation

$$\mu = \frac{\sum_{i=1}^{N} Xi}{N} \tag{1}$$

Standard deviation

$$\sigma = \sqrt{\frac{\sum (X-\mu)^2}{N}} \tag{2}$$

The reliability/internal consistency of the survey data was measured by the Cronbach's alpha coefficient. Its value should be >0.7 to consider it as a reliable survey, the formula below was used to find it (Frost 2022):

$$\alpha = \frac{N * \overline{c}}{\overline{v} + (N-1) * \overline{c}} \tag{3}$$

The total value of Cronbach's alpha for the survey responses was 0.963, which means a high level of response reliability. Table 3 represents the values of mean, standard deviation and Cronbach's alpha for all the responses.

Then the relative weight was calculated for all the main categories, all the sub-categories and all the factors located under the same sub-category; for example, the relative weight of the design attribute was found by dividing its mean on the summation means of design attribute, construction attribute and external impacts, and the same procedure was used to find the other relative weights. The last step found the level of importance of each factor to constructability by computing the decomposed weight for each factor. According to Zhang et al. (2016), it was calculated by multiplying the relative weight of the factor by the relative weight of the up level (sub-category) and by the relative wight of the main category that the sub-category located under it. For example, the decomposed weight of the prefabrication factor equal to 0.040, was computed by multiplying 0.338 × 0.317 × 0.370; which was the relative weight of the factor (prefabrication) by the relative weight of the sub-category (standardisation and repetition) and by the relative weight of the main category (design attributes). The same process was adopted for the remaining factors. Table 4 represents the relative weights and the decomposed weights of the factors.

6 Results and discussion

From Table 4 it is obvious that the main category that had the highest affect percentage on constructability was design attributes with a value of 0.370. This approved that applying constructability in the early stage of the project (early design phase) would reflect more benefits than applying it in the advanced stages. The highest weight of the sub-categories under this main category was found in the economic with value equal to 0.356 and the lowest was found in standardisation and repetition with a value of 0.317. Structural frame types had the maximum decomposed weight with a rate equal to 0.063, and component flexibility had the minimum percentage with a value of 0.015; it also got the lowest relative weight value.

Construction attribute got the second effectiveness percentage on constructability with a rate of 0.322. Instillation was considered as the maximum sub-category with 0.341 and document control had the minimum percentage, which was 0.326. The factor that got the highest effectiveness under this main category was equipment access with a percentage of 0.038, while the lowest percentage was found in Encouragement to Innovations with 0.15; it also got the lowest relative weight value.

External impacts had the lowest effectiveness on constructability with a value of 0.299. Its highest sub-category was found in its impact with a value of 0.364 and the lowest one was found in other factors with a percentage of

Tab. 3: The values of mean, standard deviation and Cronbach's alpha.

Categories, sub-categories and factors	Mean	Standard deviation	Cronbach's alpha
Design attributes	4.0556	0.71492	0.963
Construction attributes	3.6389	0.76168	0.962
External impacts	3.2778	0.88192	0.963
Standardisation and repetition	3.5556	0.84327	0.963
Economic	4	0.86189	0.963
Structure system	3.6667	0.79282	0.962
Space	3.5556	0.93944	0.962
Installation	3.6389	0.86694	0.962
Document control	3.4722	0.90982	0.963
Utility availability	3.5	0.87831	0.962
Site impact	3.7222	1.00317	0.962
Other factors	3	0.92582	0.962
Prefabrication	3.5556	0.84327	0.963
Grid layout	3.6111	0.72812	0.963
Standard dimensions	3.3611	0.83333	0.963
Component flexibility	3.4167	0.60356	0.963
Resources availability	3.9444	0.75383	0.963
Labour skills	4.0556	0.75383	0.962
Team expertise	4.1111	0.85449	0.962
Application of advance information technology	3.6111	0.80277	0.963
Coordination or communication	3.9167	0.90633	0.962
Simplification of design	3.9444	0.82616	0.962
construction methodology	3.8333	0.87831	0.963
High strength concrete application	3.3333	0.79282	0.962
Structural frames types	3.6944	0.85589	0.962
Material access	3.5833	0.76997	0.961
Personnel access	3.6389	0.99003	0.961
Equipment access	3.7222	0.88192	0.962
Construction sequence	3.6667	1.01419	0.962
Time under ground	3.5556	0.90851	0.962
Building envelope	3.25	0.87423	0.962
Weather effect	3.3611	1.07312	0.962
Safety	3.75	0.99642	0.962
Waste management and appraisal recycling	3.25	1.10518	0.962
Encouragement to innovations	3.2222	1.09834	0.962
Specifications	3.8889	0.78478	0.961
Simplification of technical specifications	3.8056	0.85589	0.961
Qualifications, feedback and improvement in construction	3.5556	0.77254	0.962
Inspections and site meetings	3.5278	0.90982	0.962
Government facilities	3.8611	0.86694	0.962
Road-use ability	3.7222	0.88192	0.962
Adjacent site	3.4444	0.73463	0.962
Infrastructures	3.5556	0.77254	0.962
Corporate objectives	3.6111	0.83761	0.962
Bidding process	3.6389	0.89929	0.962
Construction-driven schedule	3.7222	0.8489	0.962

Tab. 4: The relative weights and developed weights.

Main categories	Relative weight	Sub-category	Relative weight	Factors	Relative weight	Decomposed weight
Design attributes	0.370	Standardisation and repetition	0.317	Prefabrication	0.338	0.040
				Grid layout	0.343	0.040
				Standard dimensions	0.319	0.037
		Economic	0.356	Component flexibility	0.111	0.015
				Resources availability	0.128	0.017
				Labour skills	0.132	0.017
				Team expertise	0.133	0.018
				Application of advance Information Technology	0.117	0.015
				Coordination or communication	0.127	0.017
				Simplification of Design	0.128	0.017
				Construction methodology	0.124	0.0 16
		Structure system	0.327	Structural frames types	0.526	0.063
				High-strength concrete application	0.474	0.057
Construction attributes	0.332	Space	0.333	Material access	0.327	0.036
				Personnel access	0.332	0.037
				Equipment access	0.340	0.038
		Installation	0.341	Construction sequence	0.152	0.017
				Time under ground	0.148	0.017
				Building envelope	0.135	0.015
				Weather effect	0.140	0.016
				Safety	0.156	0.018
				Waste management and appraisal recycling	0.135	0.015
				Encouragement to innovations	0.134	0.015
		Document control	0.326	Specifications	0.263	0.028
				Simplification of technical specifications	0.258	0.028
				Qualifications, feedback and improvement in construction	0.241	0.026
				Inspections and site meetings	0.239	0.026
External impacts	0.299	Utility availability	0.342	Government facilities	0.509	0.052
				Road-use ability	0.491	0.050
		Site impact	0.364	Adjacent site	0.492	0.054
				Infrastructures	0.508	0.055
		Other factors	0.293	Corporate objectives	0.329	0.029
				Bidding process	0.332	0.029
				Construction-driven schedule	0.339	0.030

0.293. Infrastructures got the highest effect on constructability with a value of 0.055 and corporate objectives got the minimum impact on constructability with a value of 0.029; it also got the lowest relative weight value. Figure 4 presents the factors effectiveness percentage on constructability in Iraq.

In addition, in order to increase the constructability and to achieve the project objective by commitment to its specified schedule, cost and quality. The new construction project in Iraq needed to focus on applying the factors that had a high percentage of affection on constructability to reach all the benefits that can be offered by it. This could be achieved by using a checklist that includes all these factors and tick the factor that had been applied in the project.

7 Conclusion and recommendations

The objective of this study was to review the concept of constructability and to define the main factors that have an effect on it in the Iraq industry. Also, it mentions the benefits of applying it and encourages all construction participants to implement this concept as fa as possible in all project phases. Questionnaires were conducted to rate the effect of the chosen factors on constructability by founding the decomposed weight for each factor. In addition, the factors with a high ratio of effecting must be focused on to apply them in construction projects. They had a major role in reducing the problems that company project construction has, such as clashes between components, change order, design errors, misunderstanding, etc. Moreover, adopting this concept would ease the construction process, as all the problems would be discovered in the early stages and fixed, which would be easier than discovering them in the advanced stage of construction.

In the future, the Iraqi government needs to put new specifications and rules in project constructions, that force all project participants to follow the instructions to apply the constructability concept in projects through these factors' implementation. Also, in future studies, the methods of applying these factors need to be studied and be more accurate by supporting it in an advanced way to assess the constructability and find the quantity value for it.

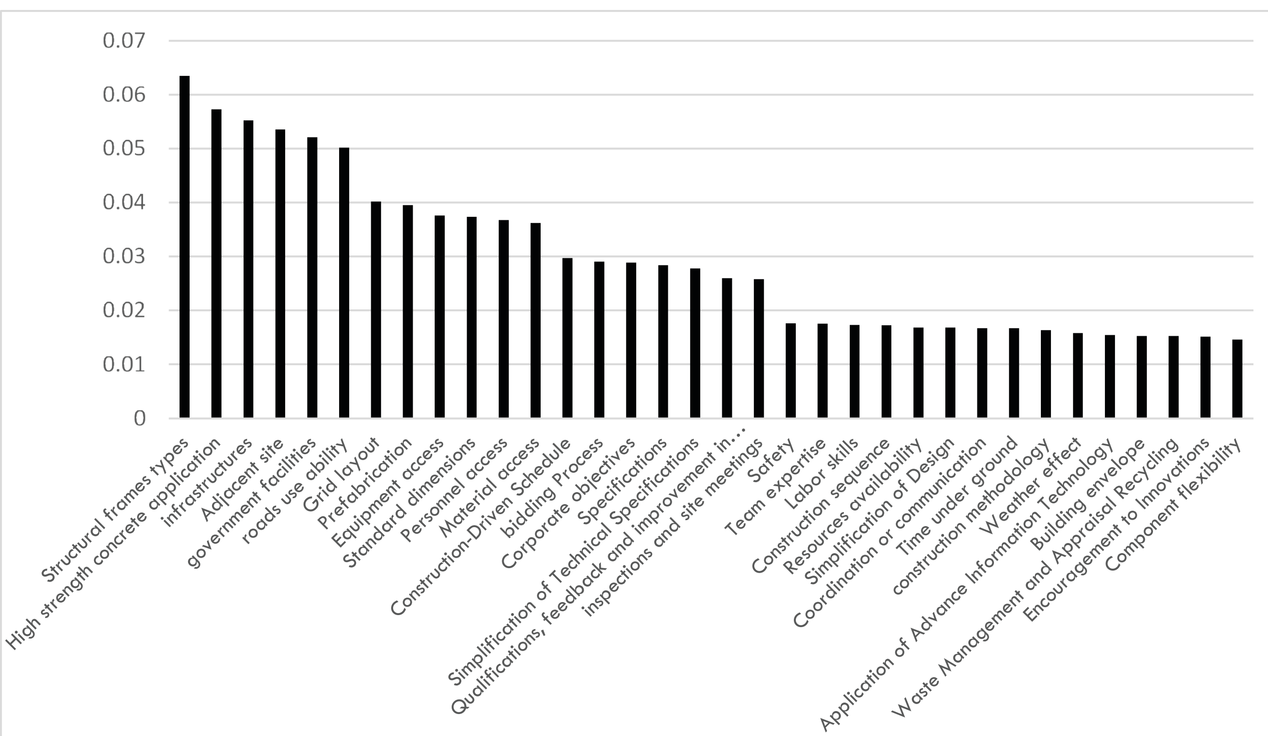

Fig. 4: The factors and their affection percentage on constructability.

Conflict of interest

On the behalf of all authors the corresponding author declared that there is no conflict of interest.

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