Research Article

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Time overruns in the construction projects in Iraq: Case study on investigating and analyzing the root causes

https://doi.org/10.1515/eng-2022-0351
received March 01, 2022; accepted June 26, 2022

Abstract: In the construction industry, time overrun in construction projects has become a global phenomenon. In Iraq, this problem is very considerable where a high percentage of projects are completed behind schedule, causing a large negative impact on society on the one side and the economic impact on the other side of the country. This study aims to define the major factors that cause construction project's time overrun by studying delay causes of projects and performing a number of interviews with a group of specialists in project construction. Next, a questionnaire is used to obtain responses from 115 participants in the city of Najaf. In addition, agreement analysis is performed to ensure that the arranged rankings by all involved respondents' categories are not ordered by coincidence, and the Chi-squared test is put to use as well to mark the agreement or disagreement context among the respondent category rankings. The target respondents of the study included: clients, consultants, project managers, contractors, and engineers who have an experience in project management and construction. The findings of the study revealed that the top five most essential factors causing delay in public construction projects are global and local economic crises, bureaucracy and corruption, public holidays, delay in getting governmental permits, and issuing numerous change orders by owners. Moreover, eight components are extracted from the 45 questionnaire items put to use for factor analysis. Among the extracted factors are the inaccuracy of tendering process, technical performance management, and government interferences.

Keywords: construction projects, project management, delay causes, factor analysis, Iraq

1 Introduction

Construction projects, delay has been defined in various ways by different authors. Barmble and Callahan [1] defined construction delay as the time period through which some construction project parts have not been performed or extended due to expected situations. Aibinu and Jagboro [2] defined the delay as a circumstance where the project client and contractor separately or jointly share the noncompletion state of the project within the agreed, stipulated, or original contract time period. Construction delay was defined by Assaf and Al-Hejji [3] as the construction time overrun either beyond the specified completion date or beyond the agreed date by the project parties for the project delivery. Bekr [4] defined construction delay as exceeding or extension of the time period that is already agreed upon between the project owner and contractor to complete and deliver the project. In other words, construction delay may be defined as a failure to deliver the project within the agreed deadline between the project client and contractor because of defined and undefined causes. Construction delay is one of the large events in the construction industry that could occur simultaneously with the other delays, influencing directly the completion time of projects. In fact, numerous construction projects experience delays exceeding the initial time estimates. These delays rise an adverse impact on the project's success in terms of time, cost, and quality. Construction delays cause troublesome for all involved parties in project construction where they could result in all of the claims, desertion, construction sector with slow growth, disputes, availability reduction of economic resources, and competition decrease [5]. Thus, it became important to eliminate the time overrun phenomenon by obtaining a clear idea regarding factors that cause delay for construction projects

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and oppose project's success to failure. Depending on that, this study is conducted to fill the gap by developing a framework for identifying, analyzing, and grouping the causes of time overruns in construction projects in Iraq after considering different points of view of clients, consultants, project managers, contractors, and engineers. Classification of time overrun factors is carried out by using factor analysis where a casually established structure is made by underlying delay factors. Hence, insight into the major delay causes of construction projects from all engaged parties in project management and construction is provided. Moreover, the existent statements and affirmations that indicate an adjustment or opinion relative to the concept of delay causes of projects are tested and validated. In addition, the main goal of this study is to identify the critical factors that impact the Ira construction project's performance and cause delay, group the defined factors into a cluster by using factor analysis, and then test the degree of agreement of the project delay factor rankings.

2 Literature review

2.1 A brief overview of Iraq construction industry

In the last few decades, Iraq has exposed into nationwide wars, causing a complete destruction in its economy and infrastructure, motivating Iraq government to pay more attention to the construction industry. Since 2008, Iraq witnessed a considerable growth in infrastructure construction and reconstruction projects. Iraq's economy continued to grow as a result of the occurring growth in the oil sector where oil revenue contributes to the largest portion of revenue for the Iraqi government, resulting in booming all of urbanization and infrastructure development [6]. Then, the Iraqi government kept financing infrastructure projects till 2014 when big parts of Iraq were invaded by Islamic state of Iraq and Syria (ISIS), causing chaos in both economical and political situations of the country. So, ISIS was the first reason for slowing Iraq's infrastructure. The other reason for infrastructure construction and reconstruction deceleration is the Iraqi government's dependence mainly upon oil revenue for the country's economy, therefore construction industry does not impact impressively on its economy [7]. Hence, coronavirus disease (COVID-19) and ISIS caused a decrease in oil revenue; that is why the Iraq government revealed an austerity policy and transferred large amounts of money predestined to finance infrastructure projects to cover medical and war expenses. These exceptionally developed situations created highly negative influences on the Iraq construction industry where many construction projects were suspended due to the shortage of funds [8]. After defeating ISIS, the Iraq government started again funding a number of infrastructure projects. As a consequence, the necessity of this study comes here to overwhelm the main delay causes of Iraq's public projects and to stop wasting more time.

2.2 Previous studies regarding delay factors of construction projects

Many studies have defined different causes for delay of construction projects, which is reviewed and outlined in this section to constitute a theoretical framework where questionnaire items can be established. Danso et al. [9] investigated the influencing factors on time overruns in telecom tower projects in Ghana. They found that the main impacting factors for delay in telecom tower projects are delay of issuing payment certificates by clients, unrealistic requirements of clients, shortage of tower materials in markets, delay in providing design information and modifications of contract, inferior workmanship, inferior site management, contractor's unethical behavior for gaining high profit, inflexible attitudes among the involved parties, construction engineers with inadequate experience, main dispute on project site, changes in design scope, shortage of quality control, poor managerial skills, and inferior management for the contract by consultants. Doloi et al. [10] executed a study for defining the key causes influencing time overruns in Indian construction projects. The most crucial factors of the Indian construction industry were defined as follows: a shortage of commitment, poor management of the site, inferior project site conditions, inefficient planning, clarity shortage in project scope, inadequate communication, and below-standard contracts. Gündüz et al. [11] explored causes of delays in construction projects in Turkey. They investigated the impact of 83 various delay causes in their study. The highly most influencing factors for delays were found as follows: inadequate experience of contractors, ineffective planning and scheduling of construction projects, inferior management for site and supervision, design changes, material late delivery, undependable subcontractors, late inspection and testing performance, poor skill workers, change orders, late site delivery, late approval of design documents, late payments, late decision making, inferior coordination and communication among the parties of projects, and unforeseen of surface and subsurface soil conditions. Marzouk et al. [12] investigated delay causes in Egyptian Civil Engineering projects. The specified top ten delay causes of projects are: not efficient planning and scheduling, inferior management of site and supervision, change orders, problems in projects financing by contractors, project awarding to the lowest bidder, low productivity of labors, impacts of subsurface conditions, late work delivery by subcontractors, lack of materials, and less-qualified workers. Khoshgoftar et al. [13] searched for causes of delays in construction projects in Iran. The key causes for delays defined in their study included: difficulties in financing the completed work, poor planning, management of site, management of contract, and shortage of communication between the project parties. Lindhard et al. [14] explored the causes of delays in the construction industry. In their conducted study, they revealed the six often most happening reasons to delay, which are connecting work, variation in the work plans, manpower, external conditions, construction design, and materials. Enshassi et al. [15] explored the most impacting factors on delays in construction projects in Gaza Strip. The revealed highly critical factors of delay in construction projects are as follows: strikes, closures of borders, materials shortage in markets and on sites, late delivery of materials to the construction sites, problems of cash flow, and inferior site management. Bajjou et al. [16] executed a study to specify the crucial factors of project delays in Moroccan construction study. The determined top ten factors causing for delays are late progress payments, employees with inadequate training, waste management without a strategy, unrealistic project duration set by clients, rework construction due to errors, extreme subcontracting, slowness in getting permits from governmental institutes, poor planning and scheduling, a shortage of collective planning, and workforce with no skills. Mahdi and Soliman [17] investigated the most significant causes of delay in all Arabic Gulf countries. The carried out analysis by them showed that there are 14 causes of delay in the gulf area, and the majority of delay factors comprises lack of resources, poor team management, inferior site management, unavailability of workforce and construction materials, difficulties in getting approvals from government institutions, and financial problems. Rachid et al. [18] searched the time overrun causes of construction projects in Algeria. They defined 59 delay causes in their study. The most important five causes of delay are slowness of change orders, unrealistic duration of the contract, slow variation orders of the additional quantities, slow progress payments, and inferior planning and scheduling. Mohamad et al. [19] investigated the time extension of projects in Malaysia. In their study, 16 causes of delay were defined. The most impacting causes are unavailability of skilled workers, a shortage of resources and manpower, change orders, drawing amendments, and slowness in making decisions. Indhu and Yogeswari [20] carried out a study to specify the inappropriate delay factors of construction equipment and their influence on the progress of construction projects in India. The main key factors that are defined in their study comprised incorrect management of inventory, equipment non-replacement, and unsound selection of equipment. These factors caused the firm to loss its reputation. As it is obvious from the previous review that factors causing the delay in different types of construction projects in the worldwide are available and discussed in numerous studies. A high percentage of the published studies have adopted the approach of questionnaire to get data from respondents. Anyhow, the substantial factors are extensively perceived to be the causes of construction projects delay. In addition, what was more observed is that there is a less coverage regarding time overrun factors in Iraq construction projects. Therefore, this study is intended to participate in this consideration by identifying the noticed knowledge gap.

3 Methodology

The used data for this study were gathered from various categories like contractors, project managers, engineers, consultants, and clients. Project managers (PMs), contractors, and engineers were chosen after checking their profiles and reviewing their experience in executing projects in Iraq by using LinkedIn and by going to the websites of the target audience. To assure that the obtained data are valid and reliable, only members of active companies were targeted. The targeted consultants for this study were selected from the engineering staff of the University of Kufa where they are members of the Engineering Consultant Bureau in the College of Engineering. Clients were chosen from ministries, agencies, and departments that are engaged in construction projects. The collection process of data was managed by adopting three phases sequential approach: literature review, interview, and questionnaire (Figure 1). A preliminary review was executed to define the delay causes of projects. This stage was followed by an interview with a number of clients, consultants, contractors, PMs, and engineers. The exact number of respondents needed for the interview was not specified at the start of the study, but then it was arrived when the obtained data have been optimized where no new information come out

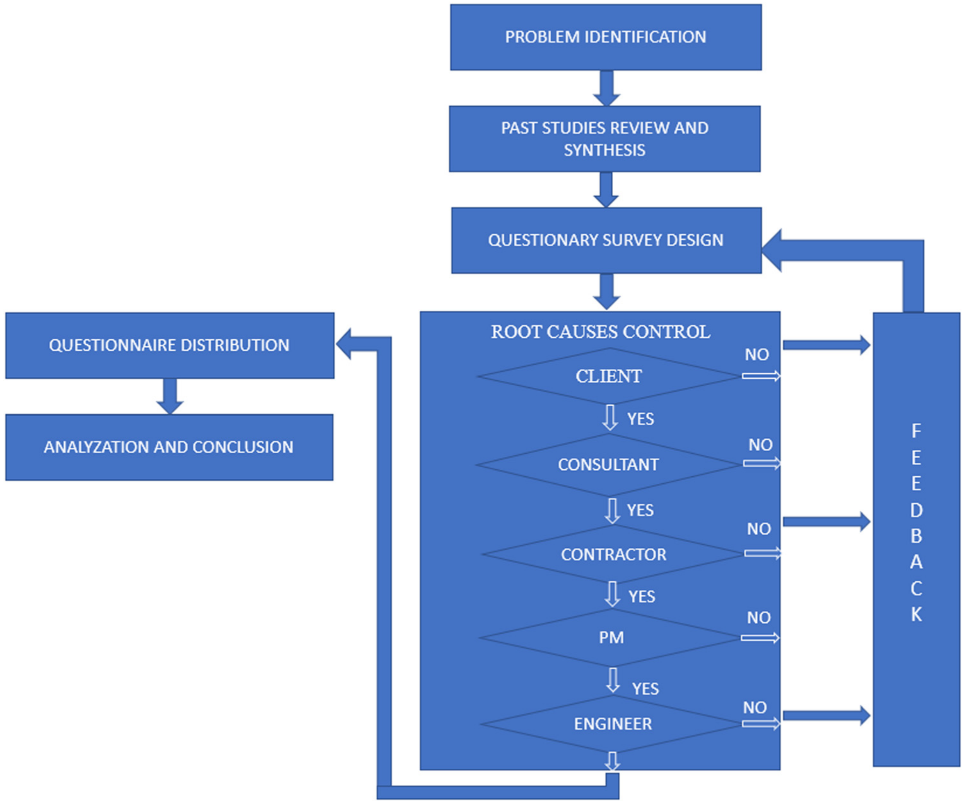

Figure 1: Methodology.

from participants [21]. The major purpose of conducting an interview was to recognize construction projects, delay causes within the Iraqi local context. This step was carried out depending on the reality that construction projects are unique [22], factors causing for delay of a project may differ from a project to another based on the settings of sociocultural [23], the geographical location of the project [24], the used criteria for assessing [22], and who is evaluating the construction project [25]. Therefore, it was assumed that factors that may cause delay to construction projects within the Iraq government construction projects may vary. The questionnaire included two main parts: the first part was formulated to obtain the personal characteristics of respondents like years of experience, academic qualification, and professional qualification. In the second part, the target respondents were asked to rate how the 45 variables have contributed in the past construction delays of projects in Iraq by using a five-point Likert scale, where 5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, and 1 = strongly disagree. The collected data were analyzed by using conclusive and descriptive statistical tools. The conclusive tools included using statistical package for the social sciences (SPSS) to calculate the relative importance index (RII), to rank the 45 delay causes of projects, and to carry out a factor analysis on the 45 causes of delay by utilizing rotation method, varimax with Kaiser normalization. The used descriptive tools comprise tables, standard deviation, mean, and percentages. Two approaches were applied to calculate the needed sample size for this study. The first approach comprised carrying out Yamane's formula to compute the required sample size of respondents [26]. By checking the number of active working and registered construction companies with the Companies' Register Authority in Najaf city, the number of active companies was found to be 992 companies ($N = 992$). At a 95% acceptable confidence level, the statistical value of z is equal to 1.96, and with a margin of error of 10%. Applying formula (1):

$$n = \frac{N}{1 + Ne^2}$$
$$n = \frac{992}{1 + 992(0.1)^2} \tag{1}$$
$$n = \frac{992}{10.92} = 91,$$

where n = responses required number, e^2 = error margin, and N = size of the sample. Researchers of this study received 115 responses, which are more than Yamane's required threshold of responses. To support the validity of the applied formula (1), another formula (2) was carried out [27] to specify the level of confidence and error margin for the actual gotten responses:

$$
\begin{aligned}
e^2 &= \frac{z^2 p(1-p)}{n1} - \frac{z^2 p(1-p)}{N}, \\
e^2 &= \frac{0.41}{115} - \frac{0.41}{992}, \\
e &= 5.61,
\end{aligned}
\tag{2}
$$

where p = actual responses as a percentage of population, e = error margin, $n1$ = actual gotten responses, and N = surveyed population. The findings illustrate that an 11% response rate of all the population of 992 at the level of confidence of 95% has an error margin of 5.61%. According to Yin [28], a level of confidence of 95% with an error margin of 10% is acceptable. Therefore, obtaining a lower error margin of 5.61% increases the validity of the received data.

4 Results

4.1 Respondent demographic survey

The personal characteristics of 115 respondents who sent back valid questionnaires are included in Table 1.

Table 1: Respondent demographic survey

Variable	Category	Frequency	Percentage
Category of respondents	Client	8	6.96
	Consultant	18	15.65
	PM	15	13
	Contractor	19	16.52
	Engineer	55	47.83
Total		115	100
Highest level of education	Doctorate	9	7.83
	Master	25	21.74
	Bachelor	78	67.83
	No degree	3	2.61
Total		115	100
Years of experience	Less than 5	16	13.91
	5–10	20	17.39
	10–20	41	35.65
	20–30	25	21.74
	30–40	8	6.96
	Above 40	5	4.35
Total		115	100

4.2 Preliminary examination

It is a necessity to check if the study construct provides the analysis required standards before proceeding with the other developed study calculations. Thus, three checks are carried out for the study, which are: reliability, validity, and normality. To investigate the reliability of the questionnaire items, Cronbach's alpha (α) is computed by applying formula (3) to check the internal consistency of the scales.

Cronbach's alpha formula:

$$
\alpha = \left(\frac{k}{k-1}\right)\left(1 - \left(\frac{\sum s_y^2}{s_x^2}\right)\right), \tag{3}
$$

where k is the number of items of the conducted survey, $\sum s_y^2$ is the summation of the items' variance, and s_x^2 is the total score variance.

For the 45 items, Cronbach's alpha was computed and found equals to 0.97, which is above the recommended threshold of 0.7 [29]. Also, acquiring Cronbach's alpha of 0.97 means that excellent consistency is existing in the measurement. To make sure that the subject under examination is measured by the prepared questionnaire, a validity check is needed. This check is performed by conducting a review of the referring literature and through carrying out contents investigation by a number of clients, consultants, contractors, engineers, and project managers. The adjustments and comments of the target participants on the contents of the questionary survey assured the validity of the contents. The normality of the 45 items was investigated by performing Skewness and Kurtosis tests. Chan et al. [30] revealed that a distribution is normal when Skewness and Kurtosis values are zero; hence, the obtained Skewness and Kurtosis values are testified against the null hypothesis of zero. The values of z were within the range of −3.29 to +3.29. Thus, they are found to be rationally normally distributed. Values of Skewness and Kurtosis tests are included in Table 2. Abbreviations of variables are provided in Table 3.

4.3 Ranking of public project delay causes

The provided respondents' rankings on the delay causes of Iraq public construction projects are assessed in this section. The participants ranked the 45 delay causes of the questionnaire of construction projects by using a five-point Likert Scale. The utilized process is aimed at specifying the relative importance of various factors identified as being the major reasons for the delay in construction projects. The RII is computed by applying formula (4) [31,32]:

$$\mathrm{RII} = \frac{\sum_{i=1}^{5}(P_i U_i)}{N(n)}, \tag{4}$$

where RII is the relative importance index, P_i is the respondents rating of delay factors of public construction projects, U_i is the frequency of respondents choosing similar ranking of delay factors, N is the size of the sample, and n is the highest obtainable score on the delay factors of projects. The SPSS analysis findings, rankings of all categories of respondents, and the overall respondents' rankings are comprised in Table 4.

Table 2: Analysis outputs of delay causes of construction projects

Variables	Mean	SD	Skewness		Kurtosis	
			Statistic	Std. error	Statistic	Std. error
DPPC	3.23	1.39	−0.235	0.226	−1.25	0.447
DDCSC	2.75	1.337	0.273	0.226	−1.197	0.447
IMCOC	3.43	0.965	−0.318	0.226	−0.536	0.447
PCCCOP	2.95	1.375	0.013	0.226	−1.352	0.447
SMD	3.25	1.498	−0.314	0.226	−1.411	0.447
WSC	3.05	1.123	−0.066	0.226	−0.777	0.447
TPBA	3.38	1.387	−0.315	0.226	−1.237	0.447
PASD	2.67	1.09	0.361	0.226	−0.361	0.447
MIDD	3.1	1.489	−0.166	0.226	−1.435	0.447
DIDD	2.97	1.357	−0.022	0.226	−1.335	0.447
CSSPQ	3.02	1.481	−0.03	0.226	−1.491	0.447
ITPC	3.05	1.572	−0.115	0.226	−1.591	0.447
CPD	3.3	1.044	−0.594	0.226	−0.274	0.447
DPFC	3.28	1.478	−0.327	0.226	−1.343	0.447
REC	3.43	1.093	−0.875	0.226	−0.001	0.447
ISMSC	3	1.331	−0.068	0.226	−1.32	0.447
PPSPC	3.14	1.344	−0.104	0.226	−1.322	0.447
ICM	2.93	1.336	−0.028	0.226	−1.292	0.447
FCSIW	3.34	1.22	−0.532	0.226	−0.55	0.447
CTSIQ	2.94	1.434	−0.091	0.226	−1.468	0.447
DPFLTC	2.59	1.206	0.438	0.226	−0.77	0.447
MLSM	2.5	1.18	0.625	0.226	−0.362	0.447
LDM	2.7	1.251	0.242	0.226	−1.095	0.447
CTSMC	2.93	1.153	−0.107	0.226	−1.014	0.447
SFMSANTM	2.79	0.996	0.161	0.226	−0.642	0.447
CMP	3.2	1.179	−0.103	0.226	−0.744	0.447
DL	2.53	1.126	0.56	0.226	−0.476	0.447
UW	2.93	1.381	−0.016	0.226	−1.356	0.447
LPL	3.09	1.341	−0.228	0.226	−1.19	0.447
CLP	2.61	1.282	0.364	0.226	−0.875	0.447
DWWSSC	3.22	1.066	−0.093	0.226	−0.582	0.447
EB	2.57	1.068	0.397	0.226	−0.512	0.447
EOPS	2.32	1.031	0.638	0.226	−0.198	0.447
IEPE	2.47	1.02	0.26	0.226	−0.867	0.447
SE	2.54	1.062	0.209	0.226	−1.077	0.447
ISC	2.96	1.046	−0.052	0.226	−0.376	0.447
IWC	2.97	0.912	−0.089	0.226	−0.229	0.447
DGPM	3.5	1.334	−0.54	0.226	−0.939	0.447
TCRJS	2.98	1.108	0.114	0.226	−0.744	0.447
AC	2.82	1.048	0.095	0.226	−0.559	0.447
CGRL	3.18	1.189	−0.074	0.226	−1.032	0.447
PH	3.57	1.14	−0.547	0.226	−0.489	0.447
BC	3.68	1.536	−0.757	0.226	−0.981	0.447
GLED	3.7	1.061	−0.483	0.226	−0.454	0.447
DILTR	2.9	1.235	−0.071	0.226	−1.16	0.447

Table 3: Abbreviations list

Abbreviation	Variables
DPPC	Delay in progress payments by clients
DDCSC	Delay in delivering the construction sites to contractors
IMCOC	Issuing many change orders by clients
PCCCOP	Poor communication and coordination between clients and other parties
SMD	Slowness in making decisions
WSC	Work suspension by clients
TPBA	Type of project bidding and award
PASD	Project award with short duration
MIDD	Mistakes and inconsistencies in the design documents
DIDD	Delays in issuing design documents
CSSPQ	Clients' supervision staff with poor qualification
ITPC	Inaccuracy in tender preparation by clients
CPD	Changing in the project design
DPFC	Difficulties in projects financing by contractors
REC	Rework due to error during construction
ISMSC	Inferior site management and supervision by contractors
PPSPC	Poor planning and scheduling of projects by contractors
ICM	Inappropriate construction methods
FCSIW	Frequent changes for subcontractors due to their incompetent work
CTSIQ	Contractors technical staff with inferior qualification
DPFLTC	Delay in performing field and laboratory tests by contractors
MLSM	Materials lack on site or market
LDM	Late delivery of materials
CTSMC	Changes in the types and specifications of materials during construction
SFMSANTM	Slowness in finishing materials selection due to the availability of numerous types in markets
CMP	Changes in the materials prices
DL	Deficiency of labors
UW	Unqualified workforce
LPL	Low productivity of labor
CLP	Conflicts among labor personnel
DWWSSC	Difficulties of workforce to work in some sites due to security conditions
EB	Equipment breakdown
EOPS	Equipment operators with poor skills
IEPE	Inferior efficiency and productivity of equipment
SE	Shortage of equipment
ISC	Impacts of subsurface conditions
IWC	Influences of weather conditions
DGPM	Delays in getting permits from municipality
TCRJS	Traffic control and restriction at job site
AC	Accidents during construction
CGRL	Changes in governmental regulations and laws
PH	Public holidays
BC	Bureaucracy and Corruption
GLED	Global and local economic disaster
DILTR	Delay in Issuing laboratorial test results

As it is clear from Tables 2 and 4, the target participants ranked "global and local economic crisis" with a mean value of 3.70 as the most critical cause for delay in construction projects in Iraq. This is followed by "Bureaucracy and Corruption" with a mean value of 3.68 as the second highly severe delay cause, while "public holidays" with a mean of 3.57 was ranked third. The top ten rankings for time overrun causes according to the order of importance are as follows.

Global and local economic crises, Bureaucracy and corruption, public holidays, delays in getting permits from municipality, issuing many change orders by clients, rework due to errors during construction, type of project biding and award (the lowest bidder), frequent changes for subcontractors due to their incompetent work, changing in the project design, and difficulties in projects financing by contractors.

Moreover, the computed indexes are ranked for all target respondent categories. The main purpose of investigating all respondent rankings is to identify the highly crucial delay causes from various perspectives according to the respondent categories. Thus, as it is included in Table 4, clients ranked "bureaucracy and corruption" as the most severe time overrun cause, followed by "slowness in making decisions" (ranked second), while "poor communication and coordination between clients and other parties" and "delays in getting permits from municipality" are ranked third. Consultants ranked "type of project bidding and award (the lowest bidder)" as the highest delay cause, succeeded by "difficulties in projects financing by contractors" and "Frequent changes for subcontractors due to their incompetent work" ranked second, while "slowness in making decisions" and "bureaucracy and corruption" were ranked third. PMs ranked first all of "global and local economic disaster" and "bureaucracy and corruption," ranked second "public holidays," and ranked third all of "difficulties in projects financing by contractors" and "frequent changes for subcontractors due to their incompetent work." Contractors ranked "bureaucracy and corruption" as the most critical delay cause, ranked "global and local economic disaster" as the top second crucial delay cause, and "public holidays" was ranked third. Engineers ranked "global and local economic disaster" as the most severe delay cause, followed by "rework due to errors during construction" (ranked to No. 2), while "public holidays" was ranked third.

4.4 Agreement analysis

To confirm that the provided rankings by all involved respondents' categories: clients, consultants, project managers, contractors, and engineers are not ordered by

Table 4: RII and ranks of delay causes of construction projects

Variables	Client		Consultant		PM		Contractor		Engineer		OverallRank	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank	RII	Rank	RII	Rank
DPPC	0.775	4	0.733	5	0.64	15	0.747	5	0.564	17	0.645	12
DDCSC	0.575	11	0.589	15	0.627	16	0.568	18	0.505	28	0.55	35
IMCOC	0.725	6	0.689	9	0.72	9	0.768	4	0.644	5	0.687	5
PCCCOP	0.8	3	0.633	11	0.667	13	0.621	13	0.513	27	0.59	27
SMD	0.825	2	0.767	3	0.76	6	0.684	8	0.545	22	0.65	11
WSC	0.575	11	0.622	12	0.707	10	0.663	10	0.567	16	0.61	19
TPBA	0.625	9	0.844	1	0.773	5	0.632	12	0.618	8	0.677	7
PASD	0.525	13	0.556	18	0.613	17	0.589	16	0.487	31	0.534	37
MIDD	0.825	2	0.722	6	0.68	12	0.684	8	0.52	25	0.621	17
DIDD	0.775	4	0.567	17	0.707	10	0.674	9	0.516	26	0.593	25
CSSPQ	0.775	4	0.711	7	0.72	9	0.6	15	0.513	27	0.603	21
ITPC	0.775	4	0.689	9	0.68	12	0.684	8	0.516	26	0.61	19
CPD	0.7	7	0.7	8	0.72	9	0.705	6	0.611	9	0.661	9
DPFC	0.7	7	0.8	2	0.813	3	0.663	10	0.556	19	0.656	10
REC	0.55	12	0.722	6	0.773	5	0.621	13	0.691	2	0.685	6
ISMSC	0.6	10	0.711	7	0.76	6	0.537	20	0.545	22	0.6	22
PPSPC	0.625	9	0.756	4	0.747	7	0.611	14	0.56	18	0.628	16
ICM	0.6	10	0.7	8	0.733	8	0.526	21	0.527	23	0.586	29
FCSIW	0.725	6	0.8	2	0.813	3	0.589	16	0.604	10	0.668	8
CTSIQ	0.6	10	0.733	5	0.76	6	0.558	19	0.502	29	0.588	28
DPFLTC	0.475	15	0.611	13	0.6	18	0.505	22	0.476	33	0.518	39
MLSM	0.525	13	0.456	24	0.72	9	0.474	23	0.462	35	0.501	43
LDM	0.55	12	0.533	19	0.693	11	0.526	21	0.502	29	0.539	36
CTSMC	0.575	11	0.611	13	0.693	11	0.579	17	0.553	20	0.586	29
SFMSANTM	0.55	12	0.533	19	0.613	17	0.568	18	0.549	21	0.558	34
CMP	0.75	5	0.611	13	0.787	4	0.663	10	0.585	12	0.64	14
DL	0.675	8	0.478	22	0.587	19	0.558	19	0.451	36	0.506	42
UW	0.675	8	0.611	13	0.733	8	0.589	16	0.524	24	0.586	29
LPL	0.625	9	0.7	8	0.72	9	0.653	11	0.549	21	0.617	18
CLP	0.575	11	0.578	16	0.693	11	0.432	26	0.48	32	0.522	38
DWWSSC	0.6	10	0.644	10	0.76	6	0.558	19	0.647	4	0.643	13
EB	0.5	14	0.478	22	0.653	14	0.505	22	0.495	30	0.515	40
EOPS	0.525	13	0.467	23	0.6	18	0.442	25	0.425	37	0.464	45
IEPE	0.525	13	0.478	22	0.627	16	0.453	24	0.473	34	0.494	44
SE	0.525	13	0.522	20	0.64	15	0.474	23	0.476	33	0.508	41
ISC	0.6	10	0.644	10	0.613	17	0.568	18	0.575	15	0.591	26
IWC	0.625	9	0.567	17	0.613	17	0.579	17	0.6	11	0.595	24
DGPM	0.8	3	0.733	5	0.787	4	0.747	5	0.636	6	0.701	4
TCRJS	0.625	9	0.567	17	0.64	15	0.632	12	0.578	14	0.597	23
AC	0.525	13	0.511	21	0.573	20	0.568	18	0.582	13	0.563	33
CGRL	0.725	6	0.622	12	0.653	14	0.695	7	0.604	10	0.637	15
PH	0.775	4	0.689	9	0.84	2	0.779	3	0.658	3	0.715	3
BC	0.875	1	0.767	3	0.853	1	0.853	1	0.633	7	0.736	2
GLED	0.75	5	0.722	6	0.853	1	0.789	2	0.695	1	0.739	1
DILTR	0.625	9	0.6	14	0.6	18	0.611	14	0.553	20	0.581	32

coincidence or partiality, but these rankings represent the real and true causes of delay in construction projects in Iraq. For that purpose, two methods are carried out: Spearman rank correlation coefficient and Kendall's coefficient of concordance.

Spearman rank correlation coefficient can be computed by applying the following equation [33]:

$$p = 1 - \frac{6\sum_{i=1}^{n} d_i^2}{n(n^2 - 1)}, \tag{5}$$

where d represents the difference between the rankings of any two respondent categories for an individual delay factor, and n stands for the number of delay factors, which is 45 for this study. The computation outputs of the Spearman rank correlation coefficient are included in Table 5.

From the contents of Table 5, it is obvious that the calculated coefficients are strong and positive, which show a high harmonization between all respondent categories' ranks. The highest harmonization pairs are "consultant-PM," "client-PM," and "client-consultant." In case there is a necessity to constitute a level of agreement between the categories of respondents by adopting a single coefficient, then the significance of the second check of Kendall's coefficient of concordance (W) comes out. Legendre [34] stated that Kendall's coefficient is directly related to the Spearman rank correlation coefficient. Kendall's coefficient can be calculated by computing the mean of Spearman correlations pairwise by carrying out the following equation [35]:

$$W = \frac{(m-1)P+1}{m}, \tag{6}$$

where m is the number of categories of respondents, and P represents the mean of Spearman correlations pairwise, which equals 0.754 for this study.

The computation of Kendall's coefficient is 0.803; that means there is a harmonization in a high degree among the categories of all respondents on the time overruns causes of construction projects in Iraq.

4.5 Significance test

The Chi-squared test is put to use to mark the agreement or disagreement context among the respondent categories rankings is considerable statistically. Two hypotheses are put for the X^2 test, which are null hypothesis that means no agreement among the rankings of the respondent categories existed; hence, an alternate hypothesis that indicates an agreement among the respondent categories' rankings is established [27]. A relationship is found between Kendall's coefficient and Chi-squared value as explained in the following formula [36]:

$$X^2 = m(n-1)W, \tag{7}$$

where n = the number of delay factors, which equals 45, m is the number of categories of respondents, which equals 5, and W = Kendall's coefficient, which is 0.803 for this study.

The calculation output of Chi-squared test is 176.66. Then, by using the critical table for n = 45, 95% confidence interval, significance level ($\alpha = 0.05$), the X^2 critical ratio equals $X_{\alpha}^{2(n-1)} = X_{0.05}^{44} = 60.48$ [27]. Since, the calculated $X^2 = 176.66$ is more than $X^2_{\text{critical}} = 60.48$, the null hypothesis ($H_0$) is rejected, and an agreement of a high degree among the five categories of respondents on the 45 delay causes existed.

Table 5: Spearman rank correlation coefficients of overall categories of respondents

Respondent category	Values of Spearman rank correlation coefficient
Client-Consultant	0.891
Client-PM	0.918
Client-Contractor	0.849
Client-Engineer	0.359
Consultant-PM	0.932
Consultant-Contractor	0.882
Consultant-Engineer	0.593
PM-Contractor	0.849
PM-Engineer	0.527
Contractor-Engineer	0.739

4.6 Classification of delay factors

Factor analysis has been put to use to examine the relations among the 45 delay factors used for this study. The used extraction method for this analysis is principal component analysis to group causes of delay in Iraq construction projects into less number of groups. Before conducting factor analysis, a preparative check was performed by utilizing Kaiser–Meyer–Olkin (KMO) and Bartlett's tests to investigate the suitability of the gathered data for factor analysis. The main advantage of using Bartlett's test is to ensure the correlation matrix identity while the KMO test measures the sample adequacy where the data significance value should not be less than 0.5 to be satisfactory for factor analysis [37]. The findings of Bartlett and KMO tests are comprised in Table 6. The outputs of the performed tests included in Table 6 show that the adequacy of KMO measure of sampling is 0.917, which is above 0.5,

Table 6: KMO and Bartlett's tests for the study delay factors

Kaiser-Meyer-Olkin measure of sampling adequacy		0.917
Bartlett's test of sphericity	Approx. Chi-square	4743.502
	df	990
	Sig.	0

Table 7: Findings of overall variance illustrated for factors of project delay

Component	Initial eigenvalues			Rotation sums of square loadings		
	Total	% of variance	Cumulative	Total	% of variance	Cumulative
1	20.011	44.469	44.469	12.789	28.421	28.421
2	4.499	9.998	54.467	7.687	17.083	45.504
3	2.251	5.002	59.469	4.009	8.909	54.413
4	1.548	3.439	62.909	1.983	4.407	58.82
5	1.329	2.953	65.862	1.944	4.319	63.139
6	1.248	2.774	68.636	1.894	4.209	67.348
7	1.172	2.604	71.24	1.446	3.214	70.562
8	1.083	2.407	73.647	1.388	3.085	73.647

assuring the appropriateness of data for factor analysis. Moreover, a significance value of 0.000, which is below 0.5 where it indicates the excellence of the measure and confirms the identity of the correlation matrix [38]. An eight-component model was extracted from 45 items of time overruns in construction projects in Iraq for a sample of 115 respondents. The extracted components comprise 73.647% of the responses' variance. Results of the total variance for the delay factors of construction projects are included in Table 7. The component transformation matrix for the eight extracted components is comprised in Table 8. As it is obvious from Table 8 that most of the correlation coefficients are above the recommended level of 0.3 [39]. Furthermore, a rotated component matrix is included in Table 9 where all contained loading factors are more than 0.4.

The extracted time overrun factors are illustrated as follows: Factor 1: Inaccuracy of tendering process: This factor comprises failures occurring because of client's team deficiency in preparing an accurate tender estimation due to unskilled estimation team, not detailed project's drawings and specifications, unavailability of historical cost data, imports, etc. Factor 2: Technical performance management: This factor includes failures happening because of contractor deficiency the management of technical performance where he is not able to provide construction fleet of equipment on time with the needed number, horsepower, and productivity. Factor 3: Government interferences: It is composed of three sequent items, which are: government changes, political interferences, and changes in the regulations and laws as a result. In other words, government changes lead to political interferences in the projects and to changes in government policies. Factor 4: Weather conditions: This factor comprises all risk consequences from severe weather conditions that occur at projects' sites. Since, construction relies on weather conditions, planning and designing projects in Iraq are highly specified by the geography, landscape, and local weather conditions. Besides, building materials and strategies are changeable to fit a particular climate. Factor 5: Rework construction practices: It includes changes, errors, and/or omissions happening during construction stage and resulting in time overruns. The most encountered rework causes in Iraq projects are construction method changes, errors, and omissions that occurred during the construction stage. Factor 6: Material delays: This factor is composed of two items: numerous type availability of materials in markets and difficulty of getting governmental approvals. The Iraqi market

Table 8: Component transformation matrix for the eight excerpted components

Component	1	2	3	4	5	6	7	8
1	0.737	0.533	0.309	0.129	0.159	0.175	0.052	0.033
2	−0.641	0.523	0.36	0.34	0.145	0.091	−0.122	0.163
3	0.032	−0.465	0.737	0.27	−0.299	0.002	0.25	−0.122
4	−0.147	−0.102	−0.074	−0.054	0.453	0.629	0.449	−0.396
5	0.075	−0.223	−0.209	0.448	0.33	−0.141	0.415	0.632
6	0.021	−0.263	0.371	−0.339	0.705	−0.244	−0.341	0.07
7	0.131	−0.261	−0.188	0.629	0.11	0.232	−0.606	−0.224
8	−0.011	0.169	−0.095	0.283	0.202	−0.657	0.251	−0.589

Table 9: Factor analysis outputs of the factor loadings

Variables	Component							
	1	2	3	4	5	6	7	8
ITPC	0.887							
CSSPQ	0.846							
MIDD	0.834							
SMD	0.833							
DPFC	0.797							
DPPC	0.793							
PPSPC	0.759							
DIDD	0.732							
PCCCOP	0.725							
DDCSC	0.72							
BC	0.713							
ISMSC	0.701							
ICM	0.685							
DGPM	0.67							
TPBA	0.667							
CTSIQ	0.66							
WSC	0.646							
LPL	0.636							
CPD	0.591							
UW	0.51							
IEPE		0.879						
EOPS		0.827						
SE		0.821						
EB		0.751						
CLP		0.654						
DPFLTC		0.654						
LDM		0.641						
MLSM		0.636						
DILTR		0.511						
CGRL			0.717					
GLED			0.658					
AC			0.623					
CMP			0.614					
TCRJS			0.6					
PH			0.555					
IWC				0.818				
ISC				0.711				
REC					0.814			
CTSMC					0.524			
FCSIW					0.5			
SFMSANTM						0.668		
DL						0.622		
PASD							0.665	
DWWSSC								0.639
IMCOC								

comprises various types of materials from different sources, and getting an approval about usage of a specific material is very hard because of the outdated traditional governmental policies. Factor 7: Estimation challenges: It concludes the issues of risk management that could be ignored in the Iraq public project management. Risk challenges include poor processes of estimation due to unskilled estimators and incomplete drawings provided by clients. Factor 8: Exceptional challenges: Due to terrorist threats in Iraq, there are restrictions on delivering materials, equipment, and workers into some governmental sites where projects are constructed. Therefore, governmental permits are needed to deliver contractor supplies, but obtaining permits is complicated because of the impractical governmental regulations.

5 Output discussion

The top five highly ranked causes of time overruns of construction projects in Iraq are global and local economic disaster (mean = 3.7, RII = 0.739), bureaucracy and corruption (mean = 3.68, RII = 0.736), public holidays (mean = 3.57, RII = 0.715), delays in getting permits from the municipality (mean = 3.5, RII = 0.701), and issuing many change orders by clients (mean = 3.43, RII = 0.687). Global and local economic crisis is ranked as the highest impacting factor for delays in Iraq construction industry. The principal revenue of the Iraqi government is from export of oil products; therefore, the happening reduction in the world demand for oil because of ISIS and COVID-19 resulted in suspension of the construction activities in Iraq, causing delay in projects where no finance ability existed anymore. Bureaucracy and corruption are the second-ranked cause for delay of public projects. Corruption is penetrating almost all levels of the Iraqi government. In 2018, Iraq was ranked on average as 162 out of 180 by corruption perceptions index. Corruption and bureaucracy that are occurring as a result of corruption impacted directly the development of infrastructure in Iraq. Public holiday is the third delay cause of public projects. Iraq has numerous national and religious holidays; the matter that causes work suspension for many days where contractors cannot perform construction activities on holidays where the resident project representative office members are not present to supervise the contractor works at sites. Besides, contractors usually miscalculate the needed days of work to accomplish projects where they do not take into account of the number of holidays in Iraq. Delay in getting permits from municipality is the fourth-ranked cause of delay. Corruption, bureaucracy, and outdated governmental laws are the main cause of delay. Corrupt employees put a lot of obstacles in front of contractors to give such permits taking advantage of the elderly set laws where they claim that this is the best way to prevent frauds. Issuing many change orders by clients is the fifth highly causing factor for delay. Inaccuracy in tender preparation by clients, Iraqi governmental institutes, and projects awarding with incomplete drawings and specifications are the main problems, leading to work errors, work reconstruction, and project delay as a result.

6 Conclusion

A literature review, interview, and questionnaire are utilized in a consecutive research approach to build a framework for identifying and classifying delay factors of construction projects in Iraq. The study's participants comprised 115 respondents who have sufficient experience in the construction industry. Descriptive and conclusive statistical tools were used to analyze the collected data. The Spearman rank correlation coefficient was calculated to assure that supplied rankings by all respondent categories are not provided by chance, but instead they represent the actual delay causes. This study has defined 45 delay factors of projects that were observed to be the highly crucial factors for dissecting the public projects delay in Iraq. The highest top five ranked factors by the overall respondents are: global and local economic disaster, bureaucracy and corruption, public holidays, delays in getting permits from municipality, and issuing many change orders by clients. These findings are obtained by using a five-point Likert scale to satisfy the study objective and provide stakeholders of projects with a decision-making support by distinguishing what constitutes the major delay factors. Depending on factor analysis approach, the 45 delay factors were furthermore grouped into eight groups: inaccuracy of tendering process, technical performance management, government interferences, weather conditions, rework construction practices, material delays, estimation challenges, and exceptional challenges. The conducted agreement test illustrated that the calculated coefficients are strong and positive, exhibiting a high harmonization between the rankings of all respondent categories. The highest agreement pairs are "consultant-PM," "client-PM," and "client-consultant." Significance test was performed as well by utilizing the Chi-squared test to determine the disagreement or agreement context among the respondent categories rankings. The results showed that the null hypothesis is not accepted, and there is an agreement with a high degree among the five categories on the 45 delay causes. The gathered information from this study will serve in both practical and academic fields. Practically, the achieved information will help in the selection of public projects leaders and team members, in defining the possible points of delay where the standard measures will be taken in consideration, and in predicting the demands of the prophesied performance levels even before the commencement of projects. Academically, this study has provided some insights and concepts related to project management, particularly concepts of projects delay.

7 Recommendations

Based on the monitored causes of projects time overruns, future research will comprise investigating and framing the suitable plans to handle those causes. For example, wording an economic plan and program with a strategic dimension to be applied without any politic interferences, provide other funding sources for construction projects in Iraq by validating the other economic sectors, such as tourism, industry, and cultivation, eliminating the administrative and financial corruption by establishing supervisory programs, and issuing new rules and regulations to reduce the number of the public holidays.

Conflict of interest: Authors state no conflict of interest.

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