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Main Delay Factors of Implementation EPC Construction Projects in Iraq

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ABSTRACT

This essay aims to highlight the most important issues and difficulties facing implementing large projects that follow the turn-key method, considered one of the types of contractual methods in Iraq, especially for large and complex projects requiring speedy completion. The projects implemented in this way face delays and delays in completion, which led to the lack of benefit from the projects for which they were implemented, especially those affecting the lives of citizens within the health sector. The case study dealt with the construction of hospitals with multi-bed capacities within multiple governorates in Iraq, With large financial allocations within the federal budget of the Government of Iraq over several years. After conducting a descriptive statistical analysis of the data obtained through a field survey and interviews with individuals working in the construction sector with experience in their field. The most important 10 factors were identified from a list of 51 delay factors (distributed according to the questionnaire forms) with a high RII. These factors were related to the delay in the payment of the contractor's dues, the delay in processing materials, the issuance of new instructions and regulations, the delay in obtaining official approvals from the relevant authorities, Errors in designs or contracting documents, lack of cooperation between the contracting parties, and multiple spare orders for reasons belonging to the employer. The article also included the most important suggestions that contribute to reducing the delay in completing projects.

Keywords: EPC, Delay, Construction, Projects, Obstacles.

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العوامل الرئيسية للتأخير في مشاريع تسليم المفتاح في العراق

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الخلاصة

يهدف هذا المقال إلى تسليط الضوء على أهم القضايا والصعوبات التي تواجه تنفيذ المشاريع الكبيرة التي تتبع أسلوب تسليم المفتاح والتي تعتبر من أنواع الأساليب التعاقدية في العراق ، خاصة للمشاريع الكبيرة والمعقدة التي تتطلب سرعة الإنجاز. وتواجه المشاريع التي تنفذ بهذه الطريقة تلكؤا وتأخيرا في الإنجاز ، مما أدى إلى عدم الاستفادة من المشاريع للغرض المراد انشاؤها من اجله ، خاصة تلك التي لها مساس مهم بحياة المواطنين ضمن القطاع الصحي. تناولت الحالة الدراسية بناء مستشفيات بسعات متعددة الأسرة ضمن محافظات متعددة في العراق ، التي تم رصد تخصيصات مالية كبيرة لها ضمن الميزانية الاتحادية للحكومة العراقية على مدى عدة سنوات. بعد إجراء التحليل الإحصائي الوصفي للبيانات التي تم الحصول عليها من خلال مسح ميداني وإجراء مقابلات مع الأفراد العاملين في قطاع البناء ممن لديهم خبرة في مجالهم. تم تحديد أهم 10 عوامل من قائمة من 51 عامل تأخير (موزعة وفقًا لنماذج الاستبيان) والتي كان لها معامل أهمية نسبية عالي. وتتعلق هذه العوامل بالتأخر في سداد مستحقات المقاول ، والتأخر في تجهيز المواد ، وإصدار تعليمات وأنظمة جديدة ، وتأخر الحصول على الموافقات الرسمية من الجهات المختصة ، وأخطاء في التصميمات أو مستندات التعاقد ، وعدم التعاون. بين الأطراف المتعاقدة ، وأوامر الغيار متعددة لأسباب تخص صاحب العمل. وكذلك تضمن المقال اهم الاقتراحات التي تساهم في تقليل تأخر انجاز المشاريع.

الكلمات المفتاحية : EPC ، تأخير ، إنشاءات ، مشاريع ، معوقات.

1. INTRODUCTION

A thorough set of search criteria was used to find the literature reviewed in this study from wide sources connected to all scientific journals. Nearly all projects face delays, whether completely or generally. Numerous studies have been conducted globally to reduce delays, risks, and extra expenses. For this type of project, the contractor bears 100% responsibility for the material and human capabilities to prepare its plans and schedules of quantities accurately. Timely completion is an important goal all project parties seek **(Ahuja et al., 1994)**. The study aimed to identify all the reported reasons for delays in EPC projects in the construction sector. One of the main objectives of any EPC construction project is to complete it promptly according to the schedule **(Back and Moreau, 2000).** Engineering is the first stage of an EPC project. It is the method by which an idea into reality with experience and understanding of the whole of the structure to specialize on how well operations and maintenance are carried out from the conceptual stage through basic engineering and detail engineering, the construction phase is the action of setting up or building installations as effectively as feasible based on everything that was chosen in the engineering phase (**Yeo and Ning, 2002).** Studies from other countries provide a more comprehensive view of the construction delay issue. Because of this, reviewing previous

research in this field published in countries other than Iraq is also considered essential. Recent publications research on delays have been briefly mentioned in several countries summarized in this section **(Enshass and Al-Najjar, 2009)**.

There are various research studies to identify and evaluate the factors that cause delays and are considered essential in helping the project management department to complete the project **(Olawale, 2010)**. The activities of purchasing products and services for the requirements of the project and its support are included in the procurement phase. It covers the planning phases of the purchasing process, contract planning, the planning contract, accepting the vendor's offer, evaluating bids and selecting the winning bid, contract management, and contract closing PMBOK. Typical construction operations include constructing temporary structures, clearing the site, putting up the infrastructure, establishing a fabrication facility, building, installing various pieces of equipment, plumbing, electrical wiring, and testing. Various disciplines make up the categories of the construction phase itself, which is designed to adhere to a system to make planning, implementing, monitoring, and regulating during the building phase easier **(Sears et al., 2014)**. It is also necessary to document all the problems and obstacles that the current project is going through to benefit from them for future projects and avoid their recurrence or reduce their impact on the construction project's success **(Lundkvist et al., 2014)**.

Other factors mentioned in previous literature that cause delays in EPC projects, such as project scope adjustments **(Sustaita, 2016),** the project's out-of-date budget **(Akal, 2016),** intergovernmental agreements that delay the bidding process **(Tippee, 2017)**, and pending governmental decisions **(Alhajri et al., 2018)**. **(Kumaraswamy and Chan, 2019)** studied numerous factors that were significant to the project: the client, the designers, the contractors, the material, the manpower, the equipment, and the technology, as well as outside factors. When at least two independent delays happen simultaneously, it is referred to as concurrent. Any unplanned, payable, and/or ethically acceptable delays occur for circumstances beyond the contractor's control. All of these delays impact the management of projects. While internal factors for delays are brought on by project stakeholders (such as providers, governmental agencies, contractors, etc.), external delays are brought on by outside parties involved in the project delivery process **(Durdyev and Hosseini, 2019)**. The respondents highly agreed upon the factors that may lead to delays and cost overruns **(Rashed and Al-Dhaheri, 2019)**. Delay factors have been investigated and ranked by **(Ali, 2021)**, who showed that the primary causes of the delay were poor design and owner incompetence, change orders, weather, site conditions, shipping delays, economic factors, and changes in quantities. The delays in the implementation of EPC construction projects are considered one of the obstacles to the successful and effective completion of these projects within all sectors in general and within the building and construction sector in particular **(Sanni et al., 2022)**. Based on a review and review of previous literature and similar research articles that dealt with the most important factors that lead to delaying the implementation of EPC projects and by looking at relevant sources, a table was organized that includes the factors causing these projects' delays, as shown in **Table 1.**

The main objective of this essay is to identify the main factors that cause delays within large EPC projects and focus on developing a list of recommendations related to reducing delays within EPC projects to achieve the successful completion of these projects. This list of recommendations includes probable solutions for the problems encountered while analyzing the study's data collection and serves as the thesis's deliverable. The suggested list will assist in reducing delays and preventing schedule overruns.

Table 1. The various construction project delays cause.

No.	Identified causes of construction project delay	Reference
1	Delays in advance payment, late material deliveries, late progress payments, and delays in design document approval can all affect how a project is financed.	**(Muhwezi et al., 2014)**
2	Factors relating to the contractor and the client or owner.	**(Yasamis and Arditi,2002)**
3	Internal organizational difficulties, payment delays, a lack of coordination between the construction parties, and decision-making delays.	**(Abd El-Razek et al., 2008)**
4	The major reason for the delay was the land acquisition component.	**(Sambasivan and Soon, 2007)**
5	Lack of experience among contractors, poor planning, low labor productivity, additional work, and overtime.	**(Doloi et al., 2012)**
6	Low worker productivity, rework, delays, and poor site management are all factors that contribute to bids being chosen based on the lowest price.	**(Mpofu et al., 2017)**
7	The client's decision-making process may bring delays, modification to control procedures, design flaws (such as unclear or inconsistent information and requirements), labor skill levels, client- or consultant-made design adjustments, and problems with permissions from other stakeholders.	**(Alajmi and Ahmed, 2022)**

2. METHODOLOGY OF THIS WORK

An Illustration of the present work methodology is shown in **Fig. 1.**

3. STRUCTURED INTERVIEWS AND PILOT STUDY

Table 1. which included the delay factors in the implementation of projects, was presented by reviewing the literature, sources, and articles related to the subject by several experts and specialists working in the field of building and construction in general and who have specialized experience in turnkey contracts in particular. Interviews were organized with them, and they discussed the most significant factors that led to the delay in implementing hospitals with different bed capacities in several Iraqi governorates. The issue of lagging hospitals, in which the turn-key method was adopted in its implementation, has occupied a great deal of attention from the Iraqi government, and these projects have allocated huge sums of money within the federal plan for Iraq within the allocations of many years since the health sector is considered one of the most chief sectors for which sums are allocated It

has a financial impact because of its direct impact on the lives of citizens. The percentage of experts by work sector is shown in **Fig. 2**.

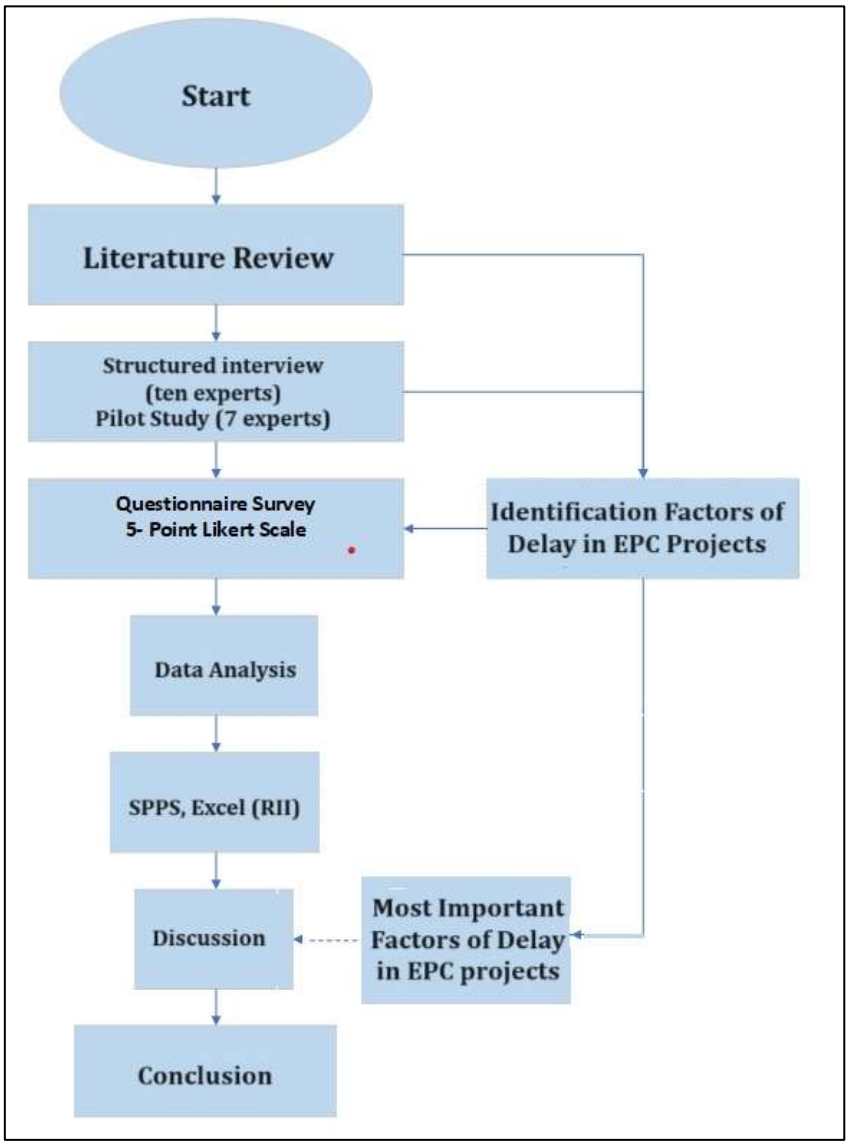

Figure 1. An Illustration of the methodology of the present work

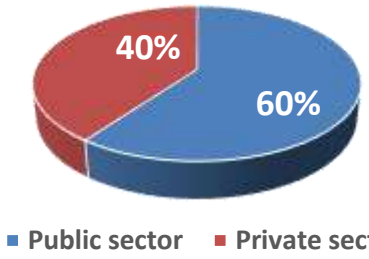

Figure 2. A diagram of the percentage of experts by work sector

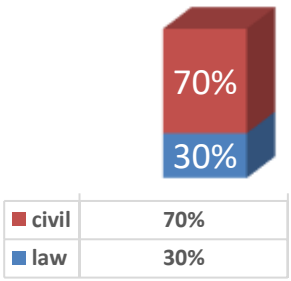

Figure.3 The specialization of experts

The specialization of experts is illustrated in **Figs. 3 and 4** illustrated the scientific qualifications of experts. The specialists who were interviewed had a general of more than 20 years of practical experience in building and construction and specialized experience of no less than 10 years in the field of Turnkey contracts. **Table 2.** contains profiles of these experts.

Table 2. Profile of experts

Specialists	Work Sector	Specialization	Years of Experience	Scientific Qualification
Number 1	Public	Civil	35	Ph.D.
Number 2	Private	Civil	30	M.Sc.
Number 3	Public	Law	23	M.Sc.
Number 4	Public	Civil	22	M.Sc.
Number 5	Public	Civil	21	B.Sc.
Number 6	Private	Civil	21	B.Sc.
Number 7	Private	Law	21	B.Sc.
Number 8	Public	Civil	18	M.Sc.
Number 9	Public	Law	16	B.Sc.
Number 10	Public	Civil	20	Ph.D.

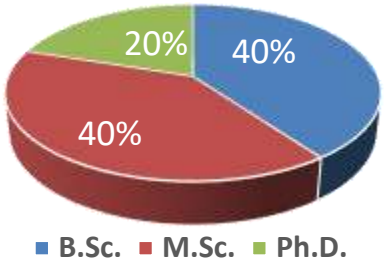

Figure 4. The scientific qualification of experts

A pilot survey was carried out to ensure that the research instrument is of sufficient quality regarding its dependability and credibility. This was accomplished by having a convenience sample of professionals with knowledge of construction projects assess the questionnaire independently. Before the questionnaires were sent, they were shown to two academics and a practical expert in construction to ensure that the phrases' content validity, clarity, and precision were checked. A preliminary questionnaire was designed that includes the factors that cause delays in turnkey projects based on what was obtained by reviewing the literature and previous articles related to the subject, as well as by looking at the reports of field visits to projects that were implemented in this manner and which witnessed a delay in implementation for several factors that have been proven. The research pertains to projects within the building and construction sector, especially lagging hospital projects, which are considered the case studies that have been dealt with by the researcher, and the reports of field visits were obtained through visits made by the researcher to the engineering follow-up departments in the Ministry of Health and the Iraqi Ministry of Planning. The initial questionnaire was presented to a group of experts and specialists who have general experience in the field of building and construction and have specialized experience in the field of turn-key contracts and within the engineering and legal specialties to express an

opinion on the initial questionnaire before distributing it to the samples that were chosen, and after conducting the discussion and amendments to the questionnaire, it was Reaching the final version to distribute it to the participants in the questionnaire.

4. QUESTIONNAIRE SURVEY DISTRIBUTION

This article utilizes a questionnaire survey to investigate the significant factors impacting EPC construction project delays. Data and information from the study population were gathered quantitatively using field sources. There are 65 respondents in the target group, including 22 contractors, 13 consultants, 19 clients, and 11 other stakeholders in the construction sector. The samples for the investigation were selected using a simple method of random sampling. Structured questionnaires were adopted to collect the primary data in this research survey researcher to gain the initial answers from the respondents directly. According to their work experience and judgment, questionnaires were provided to the responders to acquire their ideas and level of knowledge on construction project delays. The questionnaire was designed so that the first part includes general information about the participants and the second part about factors that cause delays in EPC construction projects. Additionally, these factors were scored using the Likert Scale, which uses ordinal values from 1 to 5 **(Joshi et al., 2015).**

5. ANALYSIS OF GATHERING DATA

Despite the pilot survey being used to assess the validity or applicability of the construction sector survey questionnaire, it was also crucial to this study to use Cronbach's Alpha method to assess the validity of the data obtained **(Cronbach,1951)**. To do this, the following equation, Eq**.** (1), was used to determine Cronbach's Alpha **(Cronbach, 1951**):

$$\propto = \frac{n}{n-1}\left(1 - \frac{\sum_{i=1}^{n} \sigma_{yi}^2}{\sigma_x^2}\right) \quad (1)$$

The Cronbach's Alpha was calculated using SPSS Statistics Software, and the reliability coefficient was calculated to confirm the data's internal consistency. A Relative Importance Index (RII) was chosen as a viable analysis technique to help the study reach its goal **(Gebrehiwet and Luo, 2017)**. The ratings from the surveys were analyzed using this to determine a mean rating point, which indicates the rating for each factor that contributes to the delay of the EPC projects. Calculation of RII from Eq. (2):

$$Relative\ Importance\ Index\ , \mathrm{RII} = \frac{\sum W}{A \times N} \quad (2)$$

where:
W is the rating given to each factor by the respondents
A is the highest weight
N is the number of items

Before starting the surveys, respondents were informed of the objective of the research verbally and in writing, and an agreement was reached. The respondents were informed that they could participate in the research study and were free to decline. Additionally, they received a secrecy assurance.

6. ANALYSIS OF GATHERING DATA

a) From the randomly distributed 65 questionnaires to the intended respondents elected from the public and private construction sector, 55 have been returned, 10 could not provide information about the survey, three were marked as invalid, and 52 were judged acceptable. This means that 80% of the companies and professionals who participated in the survey responded. This proportion is acceptable for this study's analysis and reporting of its conclusions **(Miller and Salkind, 2002).**

b) Before analyzing the questionnaire survey findings, Cronbach's Alpha data reliability results were acquired to check the internal consistency of the respondents' Likert scale responses. The study's research objectives gathered the reliability test findings for the factors influencing project construction delays. Using **Table 3.** below and the Cronbach coefficient, the internal consistency of the delay is assessed **(Gliem and Gliem, 2003).**

Table 3. Cronbach's Alpha internal consistency.

Cronbach's alpha, α	Internal consistency
$\alpha \geq 0.8$	Excellent
$0.8 > \alpha \geq 0.7$	Good
$0.7 > \alpha \geq 0.5$	Satisfactory
$\alpha < 0.5$	Poor

The Cronbach's Alpha reliability test research findings for factors that cause delay are illustrated in **Table 4.**

Table 4. The Cronbach's Alpha reliability test findings

No. of Questions	Cronbach's alpha	Internal consistency
51	0.876	Excellent

Cronbach's Alpha reliability analysis of the 51 questions shows excellent internal consistency, with a Cronbach's Alpha of 0.876. This demonstrates that the respondents' answers to the 51 factors that cause EPC project construction delays have a high reliability of 87.6%.

c) Before analyzing the analysis's conclusions below, 51 factors that affect project delays in Iraqi construction projects have been identified and examined as the research goal. Based on Mean Values and the Relative Importance Index (RII), these elements are ordered according to their impact. Furthermore, according to the RII rankings shown in **Table 5.,** the RII rankings are categorized to identify the level of influence considering the various delay factors.

Table 5. The RII classification

Scale	Contribution level	RII
1	Very low	$0.0 \leq RII \leq 0.2$
2	Low	$0.2 < RII \leq 0.4$
3	Average	$0.4 < RII \leq 0.6$
4	High	$0.6 < RII \leq 0.8$
5	Very high	$0.8 < RII \leq 1.0$

In **Table 6**, the analysis of the questionnaires distributed to the participants and related to factors contributing to EPC project delays will be presented according to their points of view, opinions, and practical experience; for each factor, the RII was calculated for it. Then, the most important main factors are identified, which contributed to the delay, and arranged according to the degree of their relative importance from the highest to the least influential, depending on the RII for each of them.

7. RESULTS AND DISCUSSION

By ranking the top 10 factors that affect delays in EPC construction projects, In **Table 6.,** the factors that cause a delay in projects were arranged according to their RII value, as the 51 factors (High contribution level) were arranged according to the sequence of their RII and some factors had one rank of RII and some factors shared under the same rank of RII and therefore they took the same Ranking, for example, rank 2 with an RII value of 0.8 has 2 delay factors, rank 22 with an RII value of 0.708 has 3 factors, and rank 25 with an RII value of 0.696 has five delay factors. From the previous table, the factors that occupied the first ten ranks were taken as the most important and most important factors that lead to project delays, based on the respondent's opinion of the questionnaire, and they are organized in **Table 7.**

Table 6. The factors that cause delays in projects

No.	Factor causes delay	RII	RII ranking
1	Delay in paying companies' dues for the executed works	0.846	1
2	Delay in the approval of major work scope changes	0.800	2
3	New government laws, rules, and policies are introduced	0.800	2
4	design and specification mistakes	0.792	3
5	Errors and ambiguities in contract documents	0.792	3
6	Owner's change orders during construction	0.791	4
7	Challenges with project finance	0.783	5
8	Delays in the work of a subcontractor	0.779	6
9	An inability to coordinate and communicate with the contract's parties	0.767	7
10	Conflicts between the contracting parties of the project	0.765	8
11	Delayed obtaining of permissions	0.764	9
12	Delay in the material's delivery	0.763	10
13	Price increases or variations in materials	0.762	11
14	Purchasing challenges	0.762	11
15	shortage or lack of labor	0.762	11
16	Lack of materials available on the market	0.758	12
17	lack of considerable consulting experience	0.750	13
18	Continual personnel rotation for technical subcontractors	0.746	14
19	Contractor and other parties' disputes	0.746	14
20	insufficient number of skilled workers	0.742	15
21	Delay in the delivery or provision of the project site	0.742	15
22	Lack of or shortage of equipment	0.738	16
23	A change in the climate	0.733	17
24	Design document preparation delays	0.733	17
25	lateness in design document modification and approval	0.729	18

26	The accident occurred while the building was proceeding	0.725	19
27	Equipment failure or breakdown	0.721	20
28	During a construction project, improper planning and preparation	0.721	20
29	inadequate site investigation and data gathering before design	0.713	21
30	Ineffective coordination and communication	0.708	22
31	Material type modifications during construction	0.708	22
32	unexpected site circumstances	0.708	22
33	Difficulties with equipment effectiveness and efficiency	0.704	23
34	underestimating the project's timeframe	0.700	24
35	inadequate site coordination and management	0.700	24
36	Services from utility companies are delivered slowly.	0.696	25
37	The low competence level of the equipment operator	0.696	25
38	construction error	0.696	25
39	Owner-imposed indefinite work suspension	0.696	25
40	Purchasing challenges	0.696	25
41	back-up consultant report	0.692	26
42	shortage or lack of labor	0.692	26
43	striking workers	0.688	27
44	Accessing credit facilities is difficult (E.g., Loans)	0.683	28
45	Personal disputes between workers	0.679	29
46	Schedule conflicts with subcontractors during project execution	0.675	30
47	instructions from consultants are delayed	0.671	31
48	decision-making takes too long	0.658	32
49	Materials that have been damaged but are urgently needed	0.650	33
50	Delays in the workers' mobilization	0.650	33
51	incomplete documentation before the project was implemented	0.642	34

Table 7. The top 10 major factors that cause delays in EPC construction projects

RII ranking	Delay factor	RII	No. of factors
1	Delay in paying companies' dues for the executed works	0.846	1
2	Delay in the approval of major work scope changes	0.800	2
	New government laws, rules, and policies are introduced	0.800	
3	design and specification mistakes	0.792	2
	Errors and ambiguities in contract documents	0.792	
4	Owner's change orders during construction	0.791	1
5	Challenges with project finance	0.783	1
6	Delays in the work of a subcontractor	0.779	1
7	An inability to coordinate and communicate with the contract's parties	0.767	1
8	Conflicts between the contracting parties of the project	0.765	1
9	Delayed obtaining of permissions	0.764	1
10	Delay in the material's delivery	0.763	1

10. CONCLUSIONS

The survey results show a substantial relationship between contractor, client, consultant, material, and equipment characteristics and construction project delays. However, neither general nor labor-related factors greatly affect project delay due to their value of RII. To avoid further delays, financial concerns should be prioritized first. The client should have a reliable system for prompt payments to contractors and from contractors to subcontractors, suppliers, and employees. Construction companies must also take good care of their customer relationships regarding timely project finance, design, and suspension of projects. Construction companies should take precautions to choose their consultants and maintain good communication with them. Materials used in construction projects need to be subject to quality monitoring. The building company should have enough supplies on hand and ensure continuous supply during the stage of the project's implementation. Construction companies should make major investments to acquire the most up-to-date equipment. In accordance with the study results and to ensure that delays in construction projects are effectively enhanced, the following suggestions are required:

a) Funding contractors with payments can prevent delays and increase the contractor's ability to complete projects on schedule.
b) The need to constantly review and benefit from the experiences of previous projects that have been implemented and similar to the current project to benefit from the solutions adopted to face previous problems and challenges.
c) The need not launch bids without obtaining the necessary approvals and licenses not to affect the workflow.
d) The a need to check the classification of contractors in terms of capital, the availability of mechanisms, and terms of manageability.
e) Contractors must efficiently apply the right techniques, project management concepts, and procedures to manage EPC construction projects to reduce delays and enhance their managerial abilities, adopting modern technologies in completing projects and using computers and modern means of communication to access the best investment of time and effort.
f) Coordinating with the relevant departments to avoid any problems associated with the project completion process.
g) The need to qualify the work team in supervising and implementing projects within the technical, administrative, and financial aspects, as well as conducting continuous training courses to assess their level of experience and the extent of their need for intensive training.

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