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Identifying the Factors Causing Delay of Shop Drawings Process in Construction Projects: A Case Study

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Abstract

Adhering to the project timeline without delays is a major challenge that demonstrates the efficiency of construction projects. Delays can be controlled if their real causes have been evaluated properly. Delay in submitting/ approving engineering shop drawings is more often encountered in projects. Therefore, it is important to investigate the reasons of the shop drawings delay. This study aims to identify and evaluate the factors causing delays in the process of implementing engineering shop drawings in the Iraqi construction market. To achieve this aim, a comprehensive review of previous literatures was conducted to identify the reasons of project delays, analyze its findings, and highlight its relevance to this study. Based on the literature review findings, twenty specific causes of work delays related to project schedule, cost, and stakeholder performance were identified and investigated through a structured survey conducted by 49 Iraqi engineers. This research is quantitative relies on the statistical approach to analyze the data. The results were presented and analyzed using a Pareto chart. The calculations were performed sequentially as follows: calculating the importance index (IMP.I) for each item, sorting them in descending order to obtain the cumulative frequency percentage, and then importing the results into a Pareto chart. Based on the chart's output, the 20 factors have the same degree of influence on the preparation of working shop drawings and should receive the same degree of attention while trying to minimize their impact on project performance. Therefore, the project team will need to overcome the impact of the first 10 causes to solve 52% of the delay problem, the first 15 factors to solve the 77%, and so on until 100% is solved. The findings from this study can be used to develop strategic plans for preventing and eliminating delay factors. However, the project's budget and site conditions primarily determine the priority of these methods and techniques.

Keywords: Delay, Shop drawings, Literature review, Structured questionnaire, Importance Index, Pareto Chart.

I. Introduction

In general, construction work environments are experiencing rapid and continuous changes, which prompts construction companies to search for the latest methods and technologies to keep pace with market complexities. However, companies have realized that one of the challenges lies in dealing with the many stakeholders involved in a project, such as consultants, contractors, suppliers…etc [1].

Rasheed et al. 2022 [2] Declared that the construction projects are successfully implemented when the relevant stakeholders are able to receive uninterrupted orders and provide clear documentation throughout the project schedule without restrictions or delays.

To control the information flow in construction projects, various types and sizes of documents are typically used for coordination and communication among the project stakeholders, such as design drawings, shop drawings, invoices, reports, and schedules. These documents are playing a key role in exchanging the information; for example, the shop drawings are presenting a deeper level of engineering details than what is provided in design drawings; therefore, it is recommended to produce them prior to commencing the construction work [2].

Shop drawings are a set of detailed drawings prepared by contractors and suppliers, including additional details and descriptions based on specifications and design drawings. They are typically prepared after the necessary coordination between the design drawings and specifications of various engineering disciplines, and are then sent to the site for implementation after obtaining consultant approval [3]. In this case, contractors must gather information from various project design documents. This means that the process of submitting the shop drawings directly linked to project schedule and any delay in project activities will delay the shop drawings approvals. Migahed et al. 2019 [4] noted that shop drawings have a significant impact on the project cost, and it is recommended to consider this impact while estimating the project costs in the early stages. Therefore, it is important to investigate the factors that delay the preparations and submission of shop drawings.

The aim of this study is to investigate and evaluate the factors causing delay for the shop drawings submittal/approval process. This study will focus on the causes of delays in the Iraqi construction market based on the author's practical experience and interests. According to what was reported to [5] from construction sources, there are many factors affecting the performance of contractors in Iraq and cause delays in their work.

Two objectives were considered and will be achieved in the study methodology: the first is to identify the causes of delays by reviewing previous studies, and the second is to verify the impact of these causes on project efficiency by collecting data from Iraqi engineers via a structured questionnaire and then using a quantitative approach to calculate the collected data.

Some limitations are expected during the survey, as engineers are usually busy and do not have enough time to answer the questionnaire. Moreover, some engineers may not be familiar with engineering drawings and have not used them before. Therefore, this study will highlight the importance of using such drawings in projects and explain ways to avoid delays in their delivery.

The following sections will be discussed as parts of the structure of this study:

- Literature review.
- Research Methodology.
- Data analysis and discussion.
- Conclusion and recommendations.

Ii. Literature Review

Many studies have been conducted to investigate and assess the factors affecting the time and cost of construction projects. One of these factors was the accuracy and timely delivery of construction workshop drawings. The studies had different objectives but were similar in their approach to data collection and analysis of results. The aim for the study [4] was to assess the effect of work shop drawings in meeting the project budget. Based on the literature review and gathering opinions of industry expert's, 30 factors that would impact project cost were identified. The research was quantitative relaying on conducting a questionnaire of 50 engineers working in Egypt and the Gulf states. Statistical analysis of the collected data was used to calculate the Impotence Index. By using Pareto analysis chart, 8 factors with an importance index higher than or equal to 85% was nominated as the most impactful factors on project cost. In general, the top 8 delaying factors were related to the delay of preparing drawings, changes, size and location of project, and tender documents. Another study regarding the impact of shop drawings was conducted by Kamal et al. 2022 [3] but focused on the causes of delays during submittal/ approval process of shop drawings. A structured questionnaire with 4 sections was created after obtaining opinions from experts' engineers and review previous literatures. First section was consisting of questions related to engineers' experience, second (24 question) is consist of ranking questions for factors of delay in projects, third section (43 question) was dealing with factors affecting the submission and approvals of shop drawings while the fourth section (24 question) is focusing on selecting solutions to overcome the delay. All sections include ranking selections and quantitative approach was used to analyze data. The survey was conducted by 82 respondents working in Egypt. Accordingly, the collected data used to calculate the Frequency Index, Severity Index, and Importance Index. These factors were the indicator to identify the top 5 causes of delay for the submission of workshop drawings. The top factors are related to rework errors in the site, changes, lack in coordination, unrealistic schedules, delay in subcontractor work. A framework was created to obtain effective solution for the submittal of shop drawings delay. This framework designed based on professionals' experience, literature review outputs, and the top factors obtained from analysis.

Some studies encourage the use of new technology to solve the problem of projects delay, Mohite and Salunkhe 2019 [6] adopted such idea. The study aimed to identify the factors causing changes in shop drawings and thus their impact on project time and budget. The methodology to achieve this aim consists of two steps; the first is to review of previous literature and discover the factors causing delays in submitting the shop drawings, and the second is to conduct field visits to several projects to discover the reasons for changes in the shop drawings. A qualitative approach was used to collect information during the field interviews. 9 factors were identified as the most effective factors that cause changes in the shop drawings during construction stage. The analysis of factors effectiveness conducted by using Minitab software. The factors were ranked as per the mean values obtained from the software. The factors were ranked from highest mean value to lowest value to examine their degree of effect on drawings changes. it has been discovered that there is always some or other factors causing changes and this would increase time and cost of projects. Therefore, this study recommended to use 3D drawings in construction projects. It has been discovered that if the shop drawings were drawn with the proper coordination by providing 3D building models, this would reduce changes, avoid delays in the construction process and control the project budget.

As a review for studies conducted in Iraqi construction field, Abidali and Ali 2018 [5] investigated the factors affecting the contracting companies' performance in Baghdad/Iraq. The methodology of research was based on identifying the effective factors through extensive review for previous literatures. Accordingly, the structure of the questionnaire has been designed in two parts. The first part consists of personal questions for engineers' experience and the second is consist of five main sections with 10 to 5 questions. The five sections were related to contractor performance, cost factors, time factors, quality factors and external conditions factors. The questionnaire conducted by 45 engineers working in contracting companies in Baghdad/ Iraq. The Relative Importance Index (RII) have been calculated for the responses of the 5 sections and then select the factors with higher value of RII. Based on this analysis there were 5 major factors influencing the contracting companies' performance; project cash flow, average delay in regular payments, contractor experience, design team experience, and site preparation time. Abidali and Ali 2018 [5] discussed the negative effect of the five factors on contractors' performance and recommend solution to eliminate this effect.

Based on the review of the four previous studies, Table 1 shows the similarities and differences between the reviewed studies and the present study.

Table 1. The similarities and differences between the reviewed studies and the present study

Study Ref.	Present Study	
	Similarities	**Differences**

[3]	• Related to submittal of shop drawings process delay. • Conducting Literature review to design the questionnaire. • Using quantitative approach in collecting data. • Calculate IMP.I.	• Calculating Frequency Index, and Severity Index, • Assign the top factors and • Create formula to solve the problem • The questionnaire conducted in Egypt for 82 respondents
[4]	• Related to submittal of shop drawings process. • Conducting Literature review to design the questionnaire. • Using quantitative approach in collecting data. • Calculate IMP.I and use Pareto Chart to analyse data	• The aim was related to project budget. • The questionnaire conducted in Egypt and Gulf state for 50 respondents
[5]	• Conducting Literature review to design the questionnaire. • Using quantitative approach in collecting data. • Calculate IMP.I • The questionnaire conducted in Iraq.	• The aim was related contracting companies' performance • The questionnaire conducted for 45 respondents.
[6]	• . Related to submittal of shop drawings process. • Conducting Literature review to design the questionnaire.	• The aim was related to project time and budget. • Use the qualitative approach to collect data. • analysis of factors effectiveness conducted by using Minitab software • The questionnaire conducted in India.

The present study is a study case for the factors affecting the work shop drawings submittal/approval process in Iraqi construction market. To design the questionnaire, the author combined factors identified as top factors in previous studies with those the author nominated based on personal experience. The results of this section will be used in next sections in case if the author will need to compare the outputs.

Iii.Research Methodology

Abbasbhai and Patel 2020 [1] stated that the data collection generally means a plan of action through which the research objectives can be questioned, and it can be classified into two types, namely the quantitative approach and the qualitative approach, The qualitative approach is typically used to obtain participants' opinions and understanding of the study objectives, and sometimes, it is used when a limited amount of knowledge about the topic is available, while the quantitative approach collects factual data to study the relationship between facts and their relationships in line with theories and findings of any previously conducted research. This study

utilized a quantitative research design, which involved administering a structured questionnaire and performing a statistical analysis of the data.

20 factors were identified as reasons for delaying the submission of shop drawings. These factors were obtained by reviewing previous literature studies and selecting those most relevant to the construction industry in Iraq. (Table 2) shows these factors with their references. To examine the actual impact of these factors, a survey questionnaire was conducted among nominated engineers working in governments and private companies located in Baghdad, Erbil, and other Iraqi cities was conducted.

The number of participants was calculated according to formula no (1), obtained from studies [4],[7]:

$$n = \left[\frac{Z^{\alpha}/_{2} * \sigma}{E}\right]^2 \quad (1)$$

Where:

$Z^{\alpha}/_{2}$ = the critical value =

σ = the population standard deviation = 6.95

n = number of participants

E = the margin of errors = 2

According to Migahed et al. 2019 [4], to obtain a 95% confidence level, the above-mentioned values should be used. Thus, the number of participants will be 46.39 = 47 participants. The participant count was sufficient, especially when contrasted with studies [3],[4] which were conducted in countries with greater population density than Iraq.

The questionnaire structure consists of two sections; Section (A) contains general questions such as specialization, years of experience, position, work location, company experience, and type of projects implemented by the respondents. Section (B) contains list of 20 factors that cause delay in the process of submitting/approving shop drawings. The ranking method was used to assess the degree of influence of the factors. This ranking process was conducted using a Likert scale. Based on this scale, respondents will choose one of the following five options: (1) Very low, (2) Low, (3) Moderate, (4) High, (5) Very high [1],[4],[5],[8]. The factor rating will be chosen based on the severity of its impact (Table 3).

Table 2. References for the factors causing delays in the production of shop drawings.

NO	FACTORS CAUSING DELAY	REFERENCES

•		
1	Changes in design drawings during the construction phase due to client requirements.	[3],[4],[6],[9], [10]
2	Delay in payments progress.	[3],[9],[11]- [13]
3	Inability to make timely decisions.	[3],[9],[10],[12]
4	Sudden stop of project work.	[3]
5	Failure to provide an appropriate communication system between all the project's stakeholders.	[1],[3],[4], [9],[10],[13]
6	Insufficient team experience.	[1],[3],[4], [12],[13]
7	Mistakes and discrepancies between the documents of the bidding-issued-for-construction tender and the Issued for Construction documents.	[4],[13]
8	Delay in reviewing and approving the submittals.	[3],[7],[12], [13]
9	Delay in issuing the revised drawings (changes during the construction phase).	[3],[12],[13]
10	The design drawings are not detailed or coordinated properly.	[3],[4],[13]
11	Conflicts, delays and mistakes by subcontractors.	[1],[3],[10], [13]
12	Preparing an ineffective project schedule and not being able to meet its deadlines.	[1],[4],[7], [8]
13	Delay in preparing submittals as per consultant comments, revised IFC drawings, and new orders.	[3], [9],[12], [13]
14	Inability to control material purchasing procedures that affect the production of workshop drawings for MEP work (mechanical, electrical, plumbing) and the architectural finishes.	[9],[12],[13]
15	Rework due to site construction errors.	[3], [9],[10],[12],[13]
16	Uncontrolled outsourcing shop drawing works.	[Suggested by experts]
17	Ignoring the new technology of producing drawings and doing coordination between different engineering disciplines, such as using BIM technology (3D models).	[Suggested by experts]
18	The shop drawings are not detailed or coordinated properly.	[3], [6]

19	Unrealistic time schedule for project work.	[9],[12],[13]
20	Lack in the system of information flow and the documents control system	[1], [9],[12], [13]

The author used various types of tools while distributing the questionnaire to facilitate the response methods. The questionnaire structure was designed in both English and Arabic. The English and Arabic versions of the questionnaire were created in Google Docs and the shareable link was sent to respondents through email and WhatsApp. Some participants requested a telephone conversation or a face-to-face meeting to answer the survey. The survey document was sent to 72 participants, but only 53 participants responded; however, only 49 responses were accepted, as the responses were complete. The survey was conducted from July 2023 to February 2024. Through extensive professional relationships and the assistance of expert engineers, the author collected responses from engineers in Baghdad, Erbil, Muthanna, and Diyala. The author expects this survey to collect data that reflects the reality of the Iraqi construction sector, as this methodology has previously been studied in several countries. The methodology of conducting a questionnaire process to investigate the delay causes of construction projects was adopted in other countries such as Saudi Arabia, Kenya, Denmark, Jordan, Malaysia, Ghana, the U.S. state of Wisconsin, and Korea [3].

After collecting the data, an Importance Index (IMP.I) was calculated for each factor to rank its level of influence on the shop drawing submission/approval process. Formula (2) was used to calculate (IMP.I). this formula specified by the studies [1],[4],[5],[8]:

$$IMP.I = \Sigma W/A*N \qquad (2)$$

Where:

ΣW= Is the summation of the response for factors (from 1 to 5)

A= Highest rating (5)

N= Total respondents

Table 3. List of delaying factors and their impact level.

NO.	FACTORS CAUSING DELAY	IMPACT				
		1	2	3	4	5
1	Changes in design drawings during the construction phase due to client requirements.					
2	Delay in payments progress.					
3	Inability to make timely decisions.					
4	Sudden stop of project work.					
5	Failure to provide an appropriate communication system between all project's stakeholders.					
6	Insufficient team experience.					

7	Mistakes and discrepancies between documents of biding tender and the Issued for Construction documents.					
8	Delay in reviewing and approving the submittals.					
9	Delay in issuing the revised drawings (changes during construction phase).					
10	The design drawings are not detailed or coordinated properly.					
11	Conflicts, delay and mistakes by subcontractors.					
12	Preparing an ineffective project schedule and not being able to meet its deadlines.					
13	Delay in preparing submittals as per consultant comments, revised IFC drawings, and new orders.					
14	Inability to control material purchasing procedures that affect the production of workshop drawings for MEP work (mechanical, electrical, plumbing) and the Architectural finishes.					
15	Rework due to site construction errors.					
16	Uncontrolled outsourcing shop drawing works.					
17	Ignoring the new technology of producing drawings and doing coordination between different engineering disciplines, such as using BIM technology (3D models).					
18	The shop drawings are not detailed or coordinated properly.					
19	Unrealistic time schedule for project work.					
20	Lack in the system of information flow and the documents control system					

The results of (IMP.I) were applied to the Pareto chart after arranging them in descending order. According to Migahed et al. 2019 [4] and Asal 2014 [7], Pareto chart is often used to identify which items to focus on first in the improvement process. Furthermore, this chart will determine the cumulative impact value of each element, which will help in developing a plan for the measurements and actions to be taken to eliminate this impact. The chart consists of bars for descending values of (IMP.I) frequency and a line graph for cumulative total percentage frequency. Based on the output of the Pareto chart, the author identified the top factors that have the greatest influence on the process of preparing shop drawings.

Iv.Results Analysis And Discussion

The questionnaire has been distributed to 72 participants and the collected are 49 Responses which are 68% from what has been expected. The reason was that many engineers were busy or unfamiliar with using shop drawings. Therefore, this study will provide an opportunity to understand the necessity of using shop drawings in projects. Section A of the questionnaire contains general information about the participants, such as the types of companies

the participants worked for. As shown in Figure 1, 15 engineers working as owners' representatives, 8 as consultants, and 26 as contractors.

The results show that the participation of engineers working in contracting companies was higher than in other companies. This is an indication that they were more interested in this study even though the author tried to provide equal opportunities to all stakeholders working in the projects. This makes sense, according to Kamal et al. 2022 [3], the contracting companies are responsible for preparing the shop drawings, and any delay in doing so will directly impact their performance and interests.

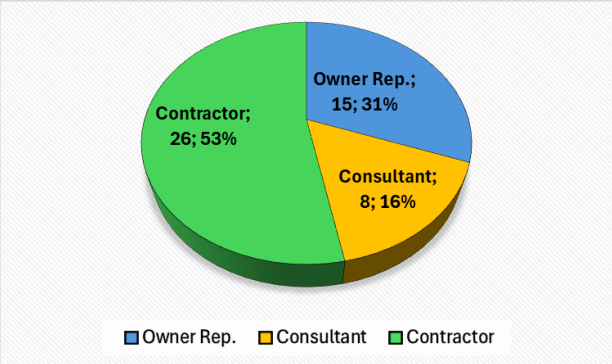

Figure. 1. Companies where respondents work

Regarding the classification of participants' specializations, Figure 2 shows the percentage of engineering specializations: 10% Architects, 39% Civil engineers, 41% Mechanical engineers, and 10% Electrical engineers. The percentage of participants from Mechanical and Civil engineers is higher than others. The reason behind this is that they prepare working drawings in the early stages of projects. As per author's experience, the project initiation phase typically requires more effort in gathering and coordinating information, which increases the probability of unwanted delays.

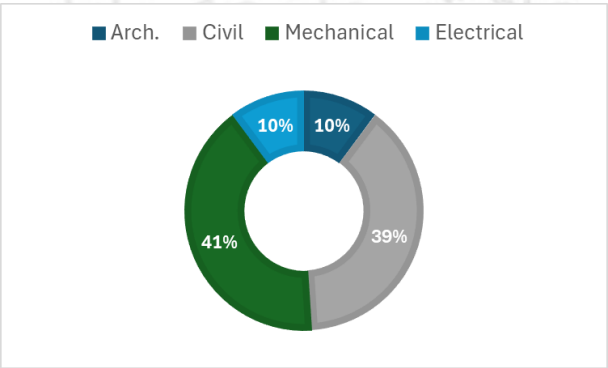

Figure. 2. Percentage of engineering disciplines

The final results in this section identified each participant's years of experience: 41% of participants had between one and ten years of experience, 37% between 11 and 20 years, 14% between 21 and 30 years, and 8% between 31 and 35 years. Figure 3 clearly illustrates these results. The highest percentage of participants have experience ranging from 1 to 20 years. The reason is that most engineers with less than 20 years of experience work on-site and are responsible for submitting documents with details such as drawings while those with more than 20 years of experience typically hold managerial positions. The first category is more aware of the daily challenges they face on the site and that is why their participation rate is high.

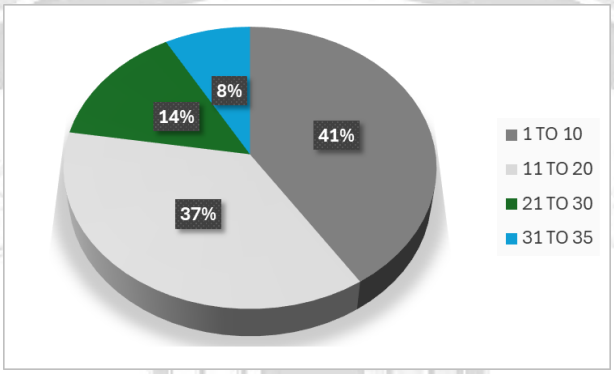

Figure. 3. Percentage for years of experience of participants

Section B of the questionnaire presents the 20 factors that cause delays in the preparation of shop drawings and asks participants to rank the impact of these factors according to their experience. According to Migahed et al. 2019 [4], Alpha Cronbach test must be carried out before conducting analysis for the collected data to check the internal consistency of all responses. This ensures that all responses within the instrument measure the same thing. In this study, Excel was used to calculate Alpha value. The reliability statistics for the 20 factors list in the questionnaire was 0.97. This Alpha value is more than the acceptable range of (0.7-0.8). This means the responses are in high degree of internal consistency and can rely on them in analysis.

The analysis of the results in Section B relied on using Excel to calculate the importance index of each factor individually and then importing the results into a Pareto chart. Table 4 shows the importance of index (IMP.I), with values ranging from 0.771 to 0.641. Responses were ranked (IM. P) value from the first factor, which is conflicts, delays, and errors made by subcontractors, to the last factor, which is undisciplined outsourcing of shop drawings work. The reason why outsourcing is ranked last on the list is that shop drawings are only used in large projects, and contractors do not outsource such work in small projects. This information was gathered during the survey. The first step in importing (IMP.I) values into a Pareto chart is to calculate the total percentage of each factor:

(TP) Total Percentage = IMP.I (for each factor)/ Σ (IMP.I (factor 1) to IMP.I (factor 20) (3)

Next step is to calculate the cumulative frequency as per the formal:

Cumulative Frequency = ΣTP (for each factor) + TP (for next factor) (4)

To simplify the display of results, the cumulative frequency percentage values have been rounded to numbers without decimals (Table 4). Using Excel, Figure 4 shows the Pareto chart after importing the values from Table 4 into the chart.

In this study, the top 5 factors causing delays are specifically related to conflicts and errors by subcontractors, inefficient project scheduling, site errors, delayed decisions, delayed payments. These factors are similar to the main factors of studies [3], [5], only the site preparation time factor was not included in study [5] due to difference in the objectives. It seems logical, as this study deals with a specific activity in the performance of contractors in Iraq which is the preparation of shop drawings. The Preparation of the work shop drawings is the responsibility of the contracting company [3].

In Table 4, the 20 factors have approximately the same level of influence on the production of shop drawings, and the difference in cumulative frequency values between each factor and the next is approximately a frequency ratio ranging from 5% to 6%, and the difference in IMP.I values is less than 0.1 between one factor and the next. The 5% is equal to 1/20. This means that the participants agreed in their responses that all factors have the same degree of influence should receive equal attention, with an effort to minimize their impact.

Table 4. Factors Causing Delays In The Production Of Shop Drawings, Imp. 1ndex. Values, And Their Cumulative Percentage Impact

No.	Factors Causing Delay	Imp. Index	Tot. Perc.	Com. Perc.
1	Conflicts, delays and mistakes by subcontractors.	0.771	5.5%	5.0%
2	Preparing an ineffective project schedule and not being able to meet its deadlines.	0.763	5.4%	11%
3	Rework due to site construction errors	0.751	5.3%	16%
4	Inability to make timely decisions.	0.731	5.2%	21%
5	Delay in payments progress.	0.731	5.2%	27%
6	Delay in preparing submittals as per consultant comments, revised IFC drawings, and new orders.	0.731	5.2%	32%
7	Changes in design drawings during the construction phase due to client requirements.	0.722	5.1%	37%
8	Insufficient team experience.	0.714	5.1%	42%
9	The shop drawings are not detailed or coordinated properly.	0.710	5.0%	47%
10	Unrealistic time schedule for project work.	0.710	5.0%	52%
11	Lack in the system of information flow and the documents control system	0.706	5.0%	57%
12	Failure to provide an appropriate communication	0.698	4.9%	62%

	system between all the project's stakeholders.			
13	The design drawings are not detailed or coordinated properly.	0.698	4.9%	67%
14	Inability to control material purchasing procedures that affect the production of workshop drawings for MEP work (mechanical, electrical, plumbing) and the architectural finishes.	0.686	4.9%	72%
15	Mistakes and discrepancies between the documents of the bidding tender and the issued-for-construction documents.	0.686	4.9%	77%
16	Sudden stop of project work.	0.686	4.9%	81%
17	Delay in issuing the revised drawings (changes during the construction phase).	0.673	4.8%	86%
18	Ignoring the new technology of producing drawings and doing coordination between different engineering disciplines, such as using BIM technology (3D models).	0.665	4.7%	91%
19	Delay in reviewing and approving the submittals.	0.649	4.6%	95%
20	Uncontrolled outsourcing shop drawing works.	0.641	4.5%	100%

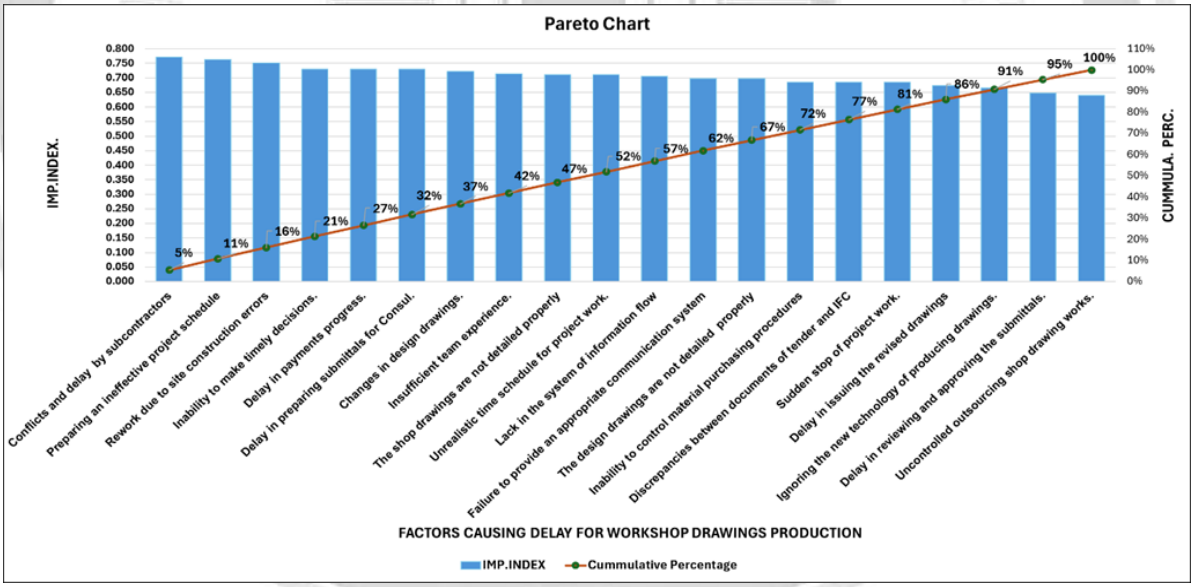

Figure 4. Pareto Chart

Moreover, the values in the Pareto chart reflect the same outcome. When the project team intends to control delays in submitting and obtaining shop drawing approvals, it will need to sequentially reduce the impact of delay factors. If the target is to reduce delay by 52%, the first

ten factors listed in the chart must be controlled and their influence overcome. A success rate of up to 77% can be achieved by overcoming the first 15 factors, and so on until 100% is achieved. In this study, the process of identifying the top 5 factors with higher values in the Pareto chart similar to the analysis in study [4] is not the ideal approach. Based on the chart results, the first five factors account for 27% of the delay problem. It is important to find a solution for the impact of the 20 factors and schedule the solution steps according to the arrangement shown in the chart. Causes of delay must be examined from a new perspective to mitigate their effect on the cost and time of projects [7]. The project team can use the outputs of this study and manage the solution methods based on the project schedule and budget.

V. Conclusion and Recommendations

To identify the factors causing delays in the process of submitting and obtaining approvals for construction projects in Iraq, a structured questionnaire was conducted on 49 experienced engineers. Mechanical and civil engineers working in contracting companies were most interested in participating in this survey. The 20-factor questionnaire was designed based on the results of a comprehensive review of previous literature. Statistical analysis was performed on the collected data to calculate the IMP.I for each factor and then imported into the Pareto chart to obtain the final result.

Based on Pareto Chart results:

1- The 20-factor that cause delays in the workshop drawings submission/approval process have the same level of impact. Therefore, to reduce project delays, it is recommended to eliminate their effect in the same sequence shown in the chart.

2- It is clear that project activities are suffering from delays due to the delay in the process of preparing shop drawings. Based on respondents' feedback, the Pareto chart shows that to reduce the delay by 52%, the project team must overcome the impact of the first 10 factors. In the same context, the team could achieve a 77% reduction by addressing the impact of the first 15 factors. This requires developing an effective plan to mitigate the causes of delays and taking care of all or at least 15 causes in the early stage of construction work. This will provide sufficient time for contracting teams to gather the required information and begin preparing the drawings.

It is recommended to develop a framework to control the 20 factors causing the delay in the preparation of shop drawings. This framework will be considered as the first step in a strategy to control project delays. This framework will consist of the following:

1- Design of an effective time scheduled for the project according to the work sequence.

2- Strategy for achieving the solution to factors related to cost, payments, design details, and changes.

3- A pre-qualification formula can be used to ensure that the team of consultants, contractors, and subcontractors are experienced and qualified. This will solve the problem of delays in decision-making, avoid discrepancies and errors on the site, and ensure the quality and accuracy of document preparation.

4- Communications management, which provides appropriate tools and use the latest and most effective communication technologies. This can resolve problems, such as delayed document submission and approval, delayed receipt of orders or materials, and ensures the secure storage and organization of documents.

Future research will focus on how to design this framework. It is expected to be a qualitative study, and to collect data, field meetings will be held with expert engineers to obtain their opinions on the 4 items mentioned above.

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تحديد العوامل المسببة لتأخير عملية أنجاز الرسومات التنفيذية في مشاريع البناء : دراسة حالة

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الخلاصة:

يُعد الالتزام بالجدول الزمني للمشروع دون تأخير تحديًا رئيسيًا يُظهر كفاءة مشاريع البناء. ولكن يمكن السيطرة على هذه التأخيرات إذا تم تقييم أسبابها الحقيقية بشكل صحيح. وبما أنه يُعدّ التأخير في تقديم واعتماد الرسومات التنفيذية من العوامل الأكثر شيوعًا في المشاريع التنفيذية لذلك فأنه من المهم أجراء دراسة للتحقق في أسباب هذا التأخير.

هدف هذه الدراسة هو تحديد وتقييم العوامل المسببة في تأخير أنجاز الرسومات التنفيذية في سوق الإنشاءات العراقي. ولتحقيق هذا الهدف، أُجريت مراجعة شاملة للأدبيات السابقة التي تتناول أسباب تأخير المشاريع وقد تم تحديدها، وتحليل نتائجها، وإبراز أهميتها لهذا البحث. واستنادًا إلى نتائج هذه المراجعة، تم تحديد عشرين سببًا يؤدي الى تأخير العمل. وقد كانت هذه الاسباب بصورة رئيسية لها علاقة بجدول العمل للمشروع وكلفته وأداء الاطراف المشاركة به.

لقد تم التحقق من مدى تأثير هذه الاسباب من خلال أجراء أستبيان مُنظّم شارك به 49 مهندسًا عراقيًا. ويعتبر هذا البحث من البحوث ذات الطابع الكمي حيث يعتمد على المنهج الإحصائي لتحليل البيانات. ولهذا فأن النتائج عُرضت وحللت باستخدام مخطط باريتو وبناءا" على ذلك كانت خطوات الحل متتالية ومنظمة . لقد كانت الخطوة الاولى تتمثل بحساب مؤشر الأهمية (IMP.I) لكل عامل من عوامل التأخير، ومن ثم ترتيبها تنازليًا للحصول على نسبة التكرار التراكمي، ثم إدخال النتائج على مخطط باريتو. وبناءً على مخرجات المخطط، فإن العوامل العشرين لها نفس درجة التأثير على إعداد الرسومات التنفيذية وينبغي أن تحظى بنفس الدرجة من الاهتمام من قبل فريق العمل لكي يتم محاولة التقليل من تأثيرها على أداء المشروع او القضاء عليها . وبذلك، يجب على العاملين في المشروع القضاء على تأثير أول عشرة اسباب لكي يتم حل 52% من مشكلة التأخير، وحل أول خمسة عشر سبب لحل 77%، وهكذا حتى يتم القضاء على اسباب التأخير 100%.

يمكن الاستفادة من نتائج هذه الدراسة لوضع خطط استراتيجية فعالة للقضاء على عوامل تأخير أنجاز المشاريع أخذين بنظر الاعتبار ميزانية المشروع وظروف الموقع بصورة عامة كشرطين اساسيين في تحديد أولويات هذه الأساليب والتقنيات التي يمكن أستخدامها.

الكلمات الدالة:– التأخير، الرسومات التنفيذية، مراجعة الأدبيات، أستبيان منظم، مؤشر الأهمية، مخطط باريتو.