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An Investigation into the Delay Factors Affecting the Construction Projects in the Petrochemical Industries in Bahrain

Faisal Ebrahim Alali*, Saad M. A. Suliman, Khaled Al-Shafie

Mechanical Engineering Department, College of Engineering, University of Bahrain, Bahrain

Abstract This investigation addressed the delay factors and the delay consequences in the construction projects in the petrochemical industries in Bahrain from two aspects; likelihood of occurrence, and severity level. Initially, 117 delay factors and 29 delay consequences were identified based on the analytical review of relevant literature. Then, the list was refined based on the relevancy to petrochemical industries in Bahrain to 42 delay factors, and 14 delay consequences. The ranking of the delay factors and delay consequences was developed by calculating the adjusted frequency index (FAII). Also, the risk matrix was developed to classify the delay factors and delay consequences under different risk zones. The study revealed late delivery of material or equipment, adoption of the lowest bid price system for awarding the contract, inadequate project planning, and late design changes as the main delay factors. Also, the extension of works beyond normal working hours, time overrun, cost overrun, and delay of other related projects were concluded as the main delay consequences in petrochemical industries in Bahrain. The contractor's perception of the delay consequences was found to be significantly lower than the petrochemical industries employees. The recommendation stressed the importance of including the delay in the high-level objective and cascading it to all departmental objectives. Also, it emphasized on developing a criterion to rank the construction projects based on their importance and complexity during the planning stage.

Keywords Delay Factors, Delay Consequences, and Petrochemical Industries

1. Introduction

The delay in construction projects has a significant impact and consequences on the organizations in terms of profitability and competitiveness in the market. Petrochemical industries are not an exceptional situation in this phenomenon. The nature and complexity of the process of such companies necessitate more stringent management to control the process and mitigate the impact and consequences of the delay to the projects. This research aims to identify and assess the main delay factors and the main delay consequences in the construction projects in the petrochemical industries in Bahrain.

2. Previous Studies

Several studies have been reviewed to identify the relevant delay factors and delay consequences in construction projects around the world. The delay in Iranian petrochemical industries constructions projects was studied by (Naimi et al., 2008) [1]. The study revealed that the delay in delivering the material, shortage of material, lack of competent and skilled manpower, inflation, and unrealistic planning during the bidding stage are the main contributors to the delay. As per Le-Hoai et al. (2008) [2], the planned duration and final cost at project closing are two important factors of successful projects and successful project management. Salama et al. (2008) [3] indicated that despite the similarity shared with construction projects, some factors might not apply to the oil and gas industry due to the distinction between the two areas. The methodology used after the literature review was interviewing experts in the oil and gas field. Khoshgoftar et al. (2010) [4] specified the successful project factors such as completion on time, within budget, within specified quality, and within client satisfaction. Since delay is regarded as a failure, then it was important for the researchers to investigate the causes of delay in Iranian construction projects. Pourrostam and Ismail (2011) [5] quoted that delays can only be minimized when the causes are identified. Abedi et al. (2011) [6] developed a paper aimed at identifying the effects of delay that could threaten project objectives in the construction field. The study identified six major effects of delay: time overrun, cost overrun, disputes, arbitration, total abandonment, and

* Corresponding author:
f_ebr@hotmail.com (Faisal Ebrahim Alali)
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litigation. The time and cost overruns were analyzed to be the highest impacts. Mohammed and Isah (2012) [7] studied the delay in a Nigerian construction project and concluded that improper planning, lack of communication, design errors, and shortage of supply were the top-ranked causes of delay. Delay in projects is a universal phenomenon, which is not only affecting the construction industries but the overall economy of the countries as well (Mydin et al., 2014) [8]. Hasan et al. (2014) [9] investigated the delay factors for road projects in Bahrain and analyzed the delay factors with their frequency and severity. Pham and Hadikusumo (2014) [10] said that petrochemical plays a significant role in economic development and inferred that many of their projects suffered from schedule delays. One of the major contributors to project delays is rework, where it has been investigated in detail by (Hwang and Yang, 2014) [11]. Research on oil and gas construction projects in Oman done by Ruqaishi and Bashir (2015) [12] concluded the unique factor for the delay in the oil and gas industry, which was the poor interaction with vendors in the engineering and procurement stage. Srdić and Šelih (2015) [13] said that delay can have different origins. It can be compensable or not, and may appear concurrently or subsequently. Mahamid and Al-Ghonamy (2015) [14] concluded the significant delay factors from consultants point of view as a bid award system for lowest price, changes in material types and specification during construction, contract management, duration of the contract, market fluctuation, frequent changes, improper planning and lack of adequate manpower. Kumar (2016) [15] investigated the delays in Indian construction projects, identified 103 causes of delays, and categorized them into 8 different groups, from which, the most significant factors were found to be inadequate contractor's work and experience, poor communication between project stakeholders, delay in material delivery and lack of early planning of the project. Also, a study was made for petrochemical projects in Saudi Arabia showed the most influencing factors that contributed to the schedule delay during the construction of petrochemical projects in Saudi Arabia by (Alhajri and Alshibani, 2018) [16]. These factors were as follows: poor site management, poor supervision by contractor, conflict arising between the main contractor and subcontractor, poor planning and scheduling of projects by contractor, delays in material delivery, and delay in handing over the construction site to contractor. The main consequences for the delay in the construction phase in oil and gas projects, according to Suppramaniam and Ismail (2018) [17] are abandonment, arbitration, cost overrun, disputes, litigation, and time overrun. A survey done by Seddeeq et al. (2019) [18] revealed the major causes of time and cost overrun in Saudi Arabia's oil and gas construction industry. The research showed that the change in design and scope by the owner during the construction stage is the main reason for time overrun while underestimating the cost to the benefit is the main reason for cost overrun. In pipeline construction projects in Bahrain, delay factors with their associated risk were identified by (Mohammed and Suliman, 2019) [19]. Delay factors were identified with their impacts and illustrated using a risk mapping matrix for the classification of delay factors under different zoning.

3. Methodology

This study used a descriptive research design to identify and prioritize delay factors affecting the construction projects in petrochemical industries in Bahrain, and their associated impact and consequences.

These factors were analyzed quantitively by using FI, RII, and FAII indices in order to rank the main delay factors, main delay consequences, and to develop risk matrix to classify the delay factors and delay consequences under different risk zones.

4. Data Collection

The data collection process has been done as per the flow chart shown in Figure 1 in sequential order.

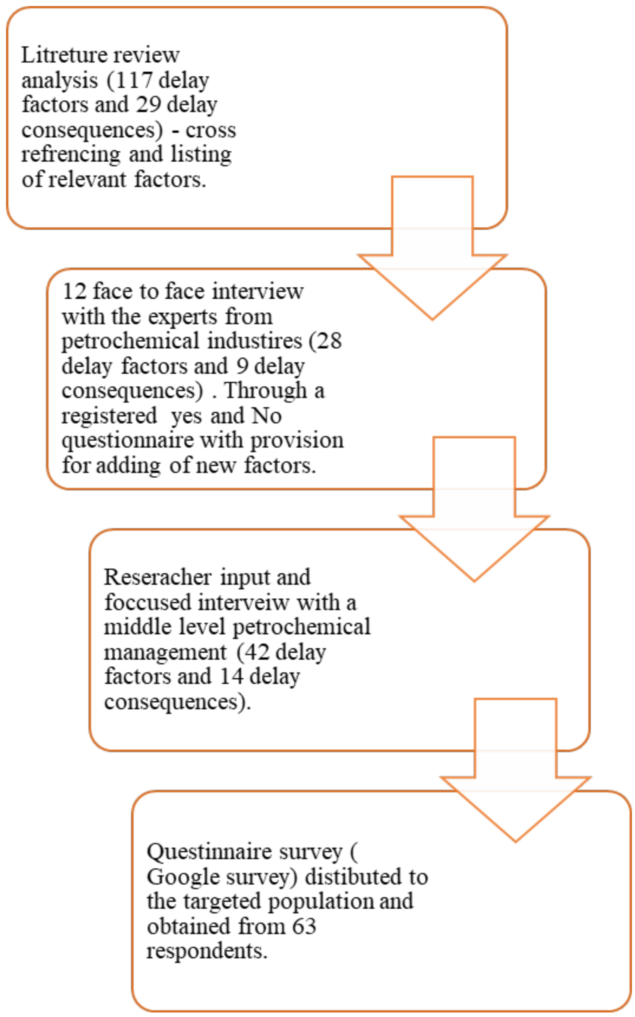

Figure 1. Data collection flow chart

1. First, a comprehensive review of previous studies was conducted by cross-referencing and listing relevant factors.

This process revealed 117 delay factors and 29 delay consequences.

2. Then, face-to-face interviews were conducted with 12 experts in the construction projects in petrochemical industries in Bahrain. The aim was to evaluate the level of agreement with the identified delay factors and consequences by qualifying the factors that obtained a consensus for their relevancy (at least 8 votes out of 12). The outcomes deduced the delay factors to 28 number, and delay consequences to 9 number.

3. An extensive discussion was conducted with middle-level petrochemical management to have their overview before going through the questionnaire process. As a result, a minor adjustment has been made, and delay factors were finalized to 42 factors, and delay consequences increased to 14.

4. A Likert-scale questionnaire survey was designed to obtain the quantitative measure of the frequency and severity of the delay factors and the delay consequences of delay. The data collection and compilation of responses were done via online mean (Google survey), and personally by hand to hand distribution to the selected categories of the questionnaire's sample. The target population was petrochemical employees who are dealing with construction projects as the main sample for this research. Also, the petrochemical responses were supported with expertise from the contractors working in petrochemical fields, and engineers from oil and gas industries that share the export facility with petrochemical industries (stakeholders).

5. Results and Analysis

This section illustrated the results and analyzed them systematically and statistically.

5.1. Likert Scale Questionnaire

The Likert scale questionnaire survey was designed and developed with 42 delay factors and 14 delay consequences as per Table 1. and Table 2.

Table 1. Delay Factors Relevant to Petrochemical Industries in Bahrain

SN	Delay Factor
1	Late design changes initiating in the project life cycle
2	Incomplete/ unclear drawing and project documents
3	Delay in preparation, approval, and issuance of drawings and documents
4	Mistakes and discrepancies made in design documents
5	Bureaucracy in the organization.
6	Owner influence (Unrealistic project duration)
7	Owner interference (Changes, and scope variation)
8	Slow decision making and approval by the owner organization
9	Adoption of fast-track project delivery strategy
10	Adoption of the lowest bid price system
11	Poor definition of interfaces causing scope creep
12	Inadequate project duration defined in the original contract
13	Complicated and long tendering procedures to award the contract
14	Late delivery of material or equipment
15	Material shortage or scarcity
16	Poor procurement programming of materials (Late order or wrong sequence of order)
17	Problem with equipment transportation and delivery to the site
18	Poor contract and schedule management by the project team
19	Inadequate project planning, budgeting, and scheduling
20	Delay in performing inspection and testing
21	Inadequate quality assurance and quality control
22	Lack of ownership in the project, and conflict between owners of the project
23	Delay in handing over the construction site to the contractor
24	Accidents during the construction
25	Security and slow site clearance (checking process for quality, safety, and other purposes)
26	Difficulties and delays in obtaining work permits
27	Weather effect: (hot weather, rain, wind, sand storm, etc.)
28	Summer restriction on time of work
29	Delay in Way-leave approval from authorities
30	Shortage of manpower

SN	Delay Factor
31	Unexpected low manpower productivity
32	Poor understanding of the scope during the bidding stage
33	Poor estimation of project time, the material before contracting
34	Inadequate project planning, budgeting, and scheduling by the contractor
35	Inadequate contractor experience
36	Delay or problems caused by subcontractors
37	Rework due to errors, mistakes, and defective works during construction
38	Poor communication & conflict between contractor and project parties
39	Insufficient contractor's manpower (or resources)
40	Shortage of skilled laborers by the contractor
41	Lack of communication between parties involved
42	Lack of periodic meetings among the management, site personnel, and contractors

Table 2. Delay Consequences Relevant to Petrochemical Industries in Bahrain

SN	Delay Consequence
1	Time overrun
2	Disputes between project parties
3	Idling of resources
4	Lack of continuity by the management
5	Cost overrun
6	Declination of reputation and confidence in the project team
7	Distrust with the contractor
8	Blacklisting the contractor by the owner
9	Delay of other projects related to the main project
10	Extension of works beyond the normal working hours
11	Importing the utilities and material that the company is not able to produce during the delay period of the project and outage of the unit
12	Change the form of delivery of material from Sea to air freight
13	Compromising the quality of work under pressure
14	Not achieving the production target

From the questionnaire survey, 63 responses were obtained with a response rate equal to 58.33% of total distributed questionnaires, which was above the average response rate for studies that utilized data gathered from organizational respondents and equal 35.6% (Baruch and Brooks C, 2008) [20]. The detailed analysis of the population response rate was calculated in Table 3.

Table 3. Population and Response Rate

	Petrochemical	Oil & gas	Contractor
Target population	68	20	20
Responses	39	13	11
Response %	57.35%	65.0%	55.0%

5.2. Validity Test

Pearson correlation test was used to assess the validity of the data when correlated with the overall composed sum of delay factors and delay consequences.

The majority of the factors have shown a very high correlation with the total sum in terms of frequency and severity. For instance, the value obtained for [delay in preparation documents] was 0.634 which is significant at 0.01 level and 99% confidence interval. The only exception of all correlations (84 correlations) was the validity of the severity level of the [Late design change] which was found equal to 0.217 with P-value =0.088, while the Pearson value for the frequency of occurrence was 0.526 which is also significant at 0.01 level.

Also, the analysis of the validity of the delay consequences in terms of the frequency and impact has shown that all the delay consequences constructed a high association with composed sum value of delay consequences. The Highest Pearson coefficient r was found to be equal to 0.780 for [Declination of reputation and confidence in project team] in the impact level correlation. The lowest correlation was obtained for the delay consequence impact level was for the delay consequence [Extension of works beyond the normal working hours] and equal r = 0.391 with p-value=0.002 which was still significant at 0.01 level.

5.3. Reliability Analysis

Reliability of the delay factors and delay consequences were evaluated through SPSS software by obtaining the Cronbach factor.

The results indicated a very high internal consistency with a maximum 0.947 Cronbach Alpha value and a minimum of 0.886. Although the Cronbach factor for delay consequences was found on the lower side when compared with the result of the delay factors, it was still considered as a high value at 88.6% and 87.6% of consistency. The reliability analysis is detailed in Table 4.

Table 4. Reliability Test

Reliability test	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
Delay factors frequency of occurrence	0.945	0.946	42
Delay factors severity level	0.947	0.947	42
Delay consequences frequency of occurrence	0.886	0.888	14
Delay consequence impact level	0.876	0.876	14

5.4. Ranking of Delay Factors and Delay Consequences

Adjusted frequency index used to rank the delay factors and delay consequences based on their frequency of occurrence and severity level (importance).

To compute the FAII, it is necessary to calculate both the frequency index of (FI) and relative importance index (RII) based on the responses obtained from the survey.

$$\text{Frequency mean}=\sum_{i=1}^{5}\left(\frac{\text{nij}*\text{i}}{\text{N}}\right),\ \text{for j=1,2,...42} \quad (1)$$

$$\text{Importance mean}=\sum_{i=1}^{5}\left(\frac{n'ij*i}{N}\right),\ \text{for j=1,2,...42} \quad (2)$$

$$FI(j)=\frac{\sum_{i=1}^{A} nij*i}{\text{A}*\text{N}} \quad (3)$$

$$RII(j)=\frac{\sum_{i=1}^{A} n'ij*i}{\text{A}*\text{N}} \quad (4)$$

Where FI = the frequency index for factor j, and RII = relative importance index for factor j, and j (j = 1, 2, 3,..42); whereas A is the highest possible score in the Likert scale =5.

Finally, FAII was computed based on both (FI) and (RII) from the analysis of the data obtained from the survey and results of Equation (3) and (4). FAII was calculated as per Equation (5), which was used in the analysis to rank the delay factors and delay consequences groups.

$$\text{FAII(j)=RII(j)*FI(j)} \quad (5)$$

For instance, for delay factor number 1 (j=1) [late design changes initiating in the project life cycle], the following calculations were conducted:

$$FI(j)=\frac{\sum_{i=1}^{A} nij*i}{\text{A}*\text{N}}= 2.97/5 = 0.594.$$

$$RII(j)=\frac{\sum_{i=1}^{A} n'ij*i}{\text{A}*\text{N}} =3.38/5= 0.676.$$

FAII(j) =RII(j)*FI(j) = 0.594 x 0.676 = 0.401

The entire calculation results were summarized in Table 5 and Table 6.

Table 5. FI, RII, and FAII analysis for Delay Factors

SN	Delay factor	Analysis	Petrochemical industries	Rank
1	Late design changes	FI	0.594	9
		RII	0.676	11
		FAII	0.402	4
2	Incomplete documents	FI	0.570	11
		RII	0.642	18
		FAII	0.366	10
3	Delay in preparation of documents	FI	0.600	8
		RII	0.626	23
		FAII	0.376	8
4	Mistakes in design	FI	0.476	31
		RII	0.698	6
		FAII	0.332	21
5	Bureaucracy in organization	FI	0.570	12
		RII	0.584	35
		FAII	0.333	20
6	Unrealistic project duration	FI	0.534	19
		RII	0.616	26
		FAII	0.329	24
7	Variation	FI	0.600	7
		RII	0.642	17
		FAII	0.385	6
8	Slow decision making	FI	0.528	20
		RII	0.584	36
		FAII	0.308	30
9	Fast-track project delivery strategy	FI	0.580	10
		RII	0.600	29
		FAII	0.348	14
10	lowest bid price system	FI	0.724	1
		RII	0.606	28
		FAII	0.439	2
11	Poor definition of interfaces	FI	0.508	24
		RII	0.590	34
		FAII	0.300	32
12	Inadequate project duration	FI	0.508	23
		RII	0.662	13
		FAII	0.336	19
13	Complicated tender procedures	FI	0.636	3
		RII	0.610	27
		FAII	0.388	5
14	Late delivery of material or equipment	FI	0.534	18
		RII	0.852	1
		FAII	0.455	1

15	Material shortage or scarcity	FI	0.430	38
		RII	0.728	3
		FAII	0.313	29
16	Poor procurement programming	FI	0.476	32
		RII	0.698	7
		FAII	0.476	22
17	Problem with equipment transportation	FI	0.400	41
		RII	0.642	19
		FAII	0.257	37
18	Poor contract management	FI	0.544	15
		RII	0.636	20
		FAII	0.346	17
19	Inadequate project planning	FI	0.606	6
		RII	0.682	10
		FAII	0.413	3
20	Delay in inspection and testing	FI	0.502	26
		RII	0.636	21
		FAII	0.319	25
21	Inadequate quality assurance and quality control	FI	0.426	39
		RII	0.652	15
		FAII	0.278	36
22	Lack of ownership	FI	0.502	27
		RII	0.630	22
		FAII	0.316	27
23	Delay in handing over the site to the contractor	FI	0.446	36
		RII	0.564	37
		FAII	0.252	39
24	Accidents	FI	0.344	42
		RII	0.698	8
		FAII	0.240	42
25	Security and slow site clearance	FI	0.620	5
		RII	0.508	42
		FAII	0.315	28
26	work permits	FI	0.472	34
		RII	0.512	41
		FAII	0.242	41
27	Weather effect	FI	0.472	33
		RII	0.518	40
		FAII	0.244	40
28	Summer restriction	FI	0.672	2
		RII	0.582	39
		FAII	0.355	12
29	Way-leave approval	FI	0.626	4
		RII	0.544	38
		FAII	0.347	15
30	Shortage of manpower	FI	0.524	22
		RII	0.662	12
		FAII	0.347	16
31	Manpower productivity	FI	0.426	40
		RII	0.594	32
		FAII	0.253	38
32	Poor understanding of scope by contractor	FI	0.538	17
		RII	0.656	14
		FAII	0.353	13
33	Poor estimation of time by contractor	FI	0.544	14
		RII	0.688	9
		FAII	0.374	9
34	Poor project planning by contractor	FI	0.524	21
		RII	0.698	5
		FAII	0.365	11
35	Inadequate contractor experience	FI	0.436	37
		RII	0.702	4
		FAII	0.306	31
36	Subcontractors	FI	0.488	30
		RII	0.600	30
		FAII	0.293	34
37	Rework	FI	0.502	25
		RII	0.754	2
		FAII	0.379	7
38	Poor communication between contractor and project parties	FI	0.456	35
		RII	0.620	25
		FAII	0.283	35
39	Insufficient contractor's manpower	FI	0.492	29
		RII	0.646	16
		FAII	0.318	26
40	Shortage of skilled laborers by the contractor	FI	0.498	28
		RII	0.594	31
		FAII	0.296	33
41	Lack of communication between parties involved	FI	0.544	16
		RII	0.620	24
		FAII	0.337	18
42	Lack of periodical meetings	FI	0.558	13
		RII	0.590	33
		FAII	0.329	23

All the delay factors with an FAII score that exceeds ''0.36'' were considered as the main delay factor in the petrochemical industries in Bahrain. This interpretation was based on the assumption that ''FAII=0.36'' is reflecting in average the following criteria; frequency of occurrence equal to "at least sometimes = 3", and impact level equal to "at least moderate=3" in the five-points Likert scale.

The score of 3 on the Likert scale is equivalent to (3/5 points = 0.6) in the FI and RII indices, and FAII would be at least equal to 0.6*0.6=0.36, according to Equation (5).

When comparing FI to RII of delay factors, it was found that the FI was at the higher side by an average of 0.49 on the Likert scale, which is equal to 0.49/5 = 9.8% in total. This could be attributed to the system of work that is designed and implemented by petrochemical industries in Bahrain to control the construction projects. However, due to the relatively high severity level, more stringent controls must be emphasized to pro-act to any delay consequences.

Table 6. FI, RII, and FAII analysis for Delay Consequences

SN	Delay Consequences	Analysis	Petrochemical industries	Rank
1	Time overrun	FI	0.610	2
		RII	0.672	5
		FAII	0.410	2
2	Disputes	FI	0.492	6
		RII	0.558	12
		FAII	0.275	8
3	Idling of resources	FI	0.554	4
		RII	0.482	14
		FAII	0.267	11
4	Lack of continuity by the management	FI	0.426	12
		RII	0.580	10
		FAII	0.247	12
5	Cost overrun	FI	0.570	3
		RII	0.688	4
		FAII	0.392	3
6	Declination of reputation of project team	FI	0.430	11
		RII	0.620	7
		FAII	0.267	10
7	Distrust with the contractor	FI	0.452	10
		RII	0.524	13
		FAII	0.237	14
8	Blacklisting the contractor	FI	0.416	13
		RII	0.580	11
		FAII	0.241	13
9	Delay of other related projects	FI	0.534	5
		RII	0.728	3
		FAII	0.389	4
10	Extension of works beyond normal working hours	FI	0.728	1
		RII	0.600	8
		FAII	0.437	1
11	Importing the utilities and material from outside	FI	0.462	8
		RII	0.594	9
		FAII	0.274	9
12	Change the form of delivery of material	FI	0.492	7
		RII	0.626	6
		FAII	0.308	6
13	Compromise the quality of work	FI	0.456	9
		RII	0.784	2
		FAII	0.358	5
14	Not achieving production target	FI	0.364	14
		RII	0.810	1
		FAII	0.295	7

The analysis of delay consequences from the petrochemical industries revealed that delay consequence 10 [Extension of time beyond working hours] has secured a very high rank in terms of FI of 73%, followed by delay consequence 2 [time over run] at FI= 61%, and then cost overrun, delay consequence 5, at FI = 57%. Also, [Delay of other related projects] as a delay consequence 9, scored an FI of 53%.

The impact of the delay consequences was also analyzed in terms of the RII index. The highest impact was associated with delay consequence14 [Not achieving the production target] which was one of the strategic goals of the petrochemical industries in Bahrain and got 81%, followed by delay consequence 13 of [having compromised quality of work] at RII=78%, and then [delays of other projects related to the main project] with RII=73% (delay consequence 9).

5.5. Risk Matrix Index

The final analysis was to classify the delay factors by using the risk-based criteria for each factor (Frequency of occurrence, versus the severity level).

Similarly, the risk mapping was deployed for the delay consequences in the term of (consequences of occurrence) versus the impact on the organization which represents the importance of the delay consequence.

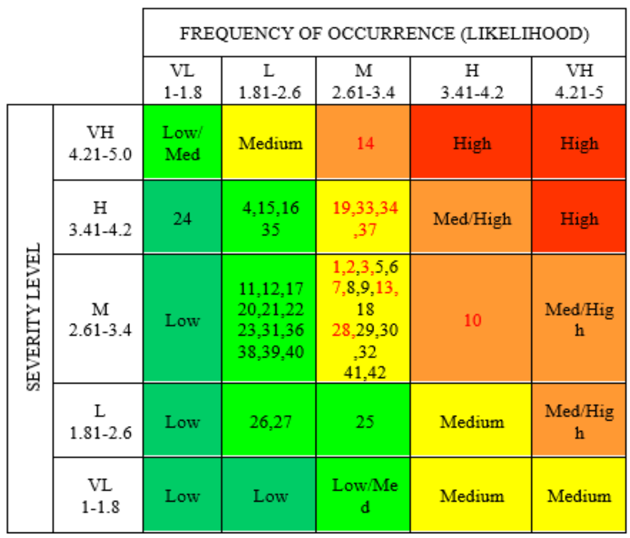

Figure 2. Risk Matrix for Delay Factors

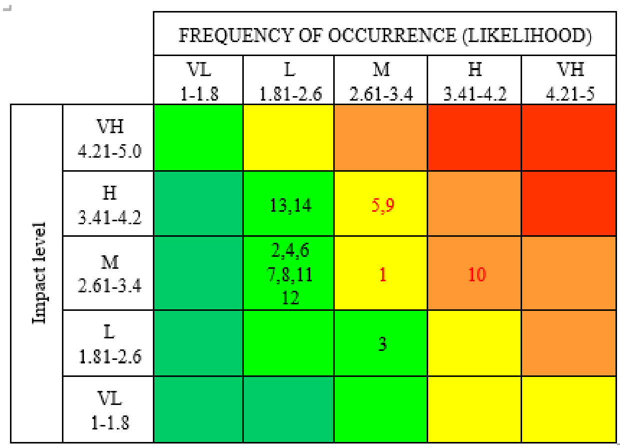

Figure 3. Risk Matrix for Delay Consequences

Table 7. Main Delay Factors in Petrochemical Industries in Bahrain

Rank	Delay Factor	Description	FAII	Color code
1	14	Late delivery of material or equipment	0.455	Orange
2	10	Adoption of the lowest bid price system for awarding the contract	0.439	Orange
3	19	Inadequate project planning, budgeting, and scheduling	0.413	Yellow
4	1	Late design changes initiating in the project life cycle	0.402	Yellow
5	13	Complicated and long tendering procedures to award the contract	0.388	Yellow
6	7	Changes, and scope variation by the petrochemical industries	0.385	Yellow
7	37	Rework due to errors, mistakes, and defective works during construction	0.379	Yellow
8	3	Delay in preparation, approval, and issuance of drawings and documents	0.376	Yellow
9	33	Poor estimation of project time, and material quantity requirement before contracting	0.374	Yellow
10	2	Incomplete drawing and project documents	0.366	Yellow
11	34	Poor project planning by contractor	0.365	Yellow
12	28	Summer restriction on time of work*	0.355	Yellow

* This factor was considered due to achieving FAII that is more than 0.36 when considering the overall respondents.

Table 8. Main Delay Consequences in Petrochemical Industries in Bahrain

Rank	Delay consequence	Description	FAII	Color code
1	10	Extension of works beyond the normal working hours	0.437	Orange
2	1	Time overrun	0.410	Yellow
3	5	Cost overrun	0.392	Yellow
4	9	Delay of other related projects	0.389	Yellow

The risk matrix shown in Figure 2. and Figure 3." included the delay factors and delay consequences obtained from the analysis of the FI and RII and classified under different risk zones.

The above risk matrix depicts the risk region for the delay factors and highlighted the 12 critical delay factors in red font. As such, two delay factors were found to be in the orange zone (Med/high risk), namely delay factor 14 [late delivery of material and equipment] and delay factor 10 [adoption of lowest bid price system]. The other 10 critical delay factors were found to be laid in the yellow zone (medium risk). The critical delay factors in the yellow zone were differentiated from other factors by attaining a high FAII score that was greater than 0.36.

The above risk matrix shows one delay consequence in the orange zone (Med to high risk), that is delay consequence 10 [Extension of works beyond working hours], and three factors in the yellow zone (Medium risk).

5.6. Ranking of Main Delay Factors and Consequences in Petrochemical Industries in Bahrain

As a result of the FAII computation and the risk matrix development, Table 7 and Table 8 were formed to constitute the main delay factors and delay consequences respectively in construction projects in the petrochemical industries in Bahrain. These tables summarize the ranking of the delay factors and delay consequences according to their FAII and classify them according to their risk zones.

6. Conclusions and Recommendations

This chapter covers the conclusion of the study and provides the final recommendations.

6.1. Conclusions

The highest delay factor factors and delay consequences were ranked according to the adjusted frequency index (FAII) and were concluded as follows; For delay factors: late delivery of material or equipment, adoption of the lowest bid price system for awarding the contract, inadequate project planning, budgeting, and scheduling, late design changes initiating in the project life cycle, rework, and delay in approval, issuance of drawing and document. Also, the top-ranked delay consequences were concluded as: extension of works beyond the normal working hours, cost overrun, delay of other related projects, and time overrun.

6.2. Recommendations

The findings from this research prompt various procedural recommendations toward addressing the way to control and mitigate the top rank delay factors and their associated delay consequences, as mentioned below:

- Add the delay as a key performance indicator (KPI) in the high-level objective, and cascade it to departmental objectives.
- Develop a criterion to rank the construction projects based on their importance and complexity during the

planning stage. High-ranked projects shall follow different routes for bidding procedures and get the priority to complete the projects' documents on time.

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