

Causes of Delays in Construction Projects: A Case Study for Petrochemical Industry of Iran

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Abstract—Delays in construction projects are one of the most common risky problems and regardless of the causes, the delays can occur in all projects and all industries. The impact of delays has a wide range from neglectable ones to losing the project's importance or its economic justification. In this paper, by doing research and interview with managers, executors, consultants and supervisors of construction projects in the petrochemical industry, their opinions about reasons of delays in projects have been gathered.

Keywords—Analysis of delays, causes of delays, delays in petrochemical projects, project delays.

I. INTRODUCTION

DELAYS in projects are due to the complexity in their natures and are inevitable. According to the “International Journal of Project Management” a project delay is when the projected completion time exceeds the agreed-to completion date [1]. Where this can be a common problem, reasons of delays in large construction projects can differ and can be the fault of the owner, consultant, contractor, and combination of them or none of them. On the other hand, because of direct relationship between time and cost, the more time causes the more total cost of constructing project. Delays can affect the quality and safety too. Hence reducing the delays as much as possible can be a competitive advantage and vice versa. If this does not exert in long term, bankruptcy would be definite. These factors represent that in today’s world, it is impossible to conduct projects like years ago and there is a high need for ways to reduce the costs. Exploring for the reasons of delays in the construction projects and finding ways to prevent or reduce them is a significant subject in all over the world.

II. METHODOLOGY

In this research, the following steps have been taken:

- 1- From a library study, the main causes of delays were determined which were considered in the previous researches [3].
- 2- From an interview with managers, executors, consultants and supervisors of construction projects in petrochemical industry their opinions about reasons of delays in projects have been gathered (Table I) [4].
- 3- A questionnaire according to information extracted from the above-mentioned steps was prepared [5]. Then it was distributed through the managers, executors, consultants and supervisors [6].

- 4- The validity and reliability of collected data have been tested through Cronbach's alpha and Kaiser-Meyer-Olkin (KMO) and Bartlett’s tests. Subsequently, some variables or group of variables are deleted.
- 5- The collected data are analyzed.
- 6- Suggestion for reducing the effects of delay in projects are given.

In the analysis, first by using the frequency feature in SPSS, the most important reasons in delays would be identified. Then for the most important reasons, the responsible items would be recognized based on the respondents’ answers. In the final stage, the suggested approaches given by respondents would be classified and presented.

III. RESULTS AND DISCUSSION

Based on the literature review and unstructured interviews, the reasons that may cause delays in petrochemical construction projects in Iran are limited to 57 items that have been categorized into eight groups. 48 of them were reliable & valid for being studied. Different groups of reasons of delays are Force Majors, Contract Related, Design Related, Procurement Related, Construction Related, Financial/Economic Related and Management Related and Governmental Factors.

In this research referring to a study done by Ahmed et al. at Florida International University [2], those reasons that the average for them equal or greater than 2.5 (at least 50% chance of occurrence) are known as the most significant reasons that cause delays.

Based on Table II, consultants are the main ones responsible for design-related reasons. Consultants issue the required specifications and conceptual study and review engineering documents. On the other hand, the contractor is the one who should issue and execute the activities. In Table II, percentages in consultant – contractor alternative are the highest ones.

The main responsibility of owner in these reasons is to select qualified consultants and contractors in order to reduce these kinds of delays.

Table III represents that the two factors investigated in procurement group are significant reasons of delays. The highest responsibilities for delays are because of contractors. It is the owner responsibility for selecting qualified contractors. It should be noted as experience, usually the transportation delays are due to contractor’s problem for covering the specified terms in the contract. Thus, in some situations, by the supports of owner and consultant, some changes in terms of contracts can

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reduce this delay.

TABLE I
REASONS OF DELAY IN CONSTRUCTION PROJECTS IN THIS STUDY

Item	Cause of Delay	Chance of Occurrence (Scale:1-5)					Responsible				Any approach to reduce delay
							Owner	Consultant	Contractor	None of mentioned	
		1	2	3	4	5					
Force Majors											
1	Flood										
2	Fire										
3	Hurricane										
Contract Related											
4	Type of contract failure										
5	Contract modification										
Design Related											
6	Project location in terms of access to resources										
7	Design Development										
8	Delay in reviewing and approving design document										
9	Change Orders										
10	Change in Drawings										
11	Change in Specifications										
12	Shop Drawings Approval										
13	Incomplete Documents										
14	Not applicable drawings										
Procurement Related											
15	Material and equipment Procurement										
16	Transportation										
17	Not definite about material										
Construction Related											
18	Inspections										
19	Subsurface Soil Conditions										
20	Lack of material on work										
21	Fabrication delays										
22	Lack of qualified craftsman										
23	Poor Subcontractor Performance										
24	Defective Work										
25	Different Site Conditions										
26	Labor injuries										
27	Damage to structure										
28	Construction mistakes										
29	Poor supervision										
30	Equipment Availability										
31	Lack of appropriate equipment										
32	Lack of special tools										
Financial/Economic Related											
33	Lack of acceptable cost estimation										
34	Financial Process										
35	Financial Difficulties										
36	Delayed Payments										
37	Economic Problems										
38	Access to foreign currency										
39	Inflation rates										
40	Currency transferring										
Management Related											
41	Lack of completely defined scope of work										
42	Ineffective planning and scheduling										
43	Inefficient project controlling										
44	Lack of attention to planning and controlling techniques (like CPM, PERT...)										

Item	Cause of Delay	Chance of Occurrence (Scale:1-5)					Responsible				Any approach to reduce delay
							Owner	Consultant	Contractor	None of mentioned	
		1	2	3	4	5					
45	Lack of coordination between Owner, Consultant & Contractor										
46	Lack of true estimation of productivity										
47	Staffing problems										
48	Lack of coordination on site										
49	Lack of close coordination between the E, P and C departments										
50	Suspensions										
51	Lack of high – technology										
52	Poor managerial skills										
53	Slowness in decision making										
Government											
54	Construction permits and approval process										
55	Safety rules										
56	Political situations										
57	International sanctions										
Others											
*											

Scale of Chance of Occurrence: 1-Unlikely, 2-As likely as not, 3-Likely, 4-Almost certain, 5-Certain
Responsible: Responsible of any cause can be one of the mentioned items or a combination of Two or more

TABLE II
ANALYSIS FOR DESIGN RELATED REASONS

Reason(s)	Mean	Significant Reason of Delays	Percentage of selected option							
			Owner	Consultant	Contractor	Owner- Consultant	Owner- Contractor	Consultant- Contractor	Owner - Consultant - Contractor	None of Mentioned
Project location in terms of access to resources	2.66	Yes	12.5	1.8	0	85.7	0	0	0	0
Design Development	3.04	Yes	3.6	14.3	0	25	0	35.7	21.4	0
Delay in reviewing and approving design document	3.21	Yes	16.1	0	0	48.2	0	0	35.7	0
Change Orders	2.54	Yes	7.1	8.9	17.9	1.8	1.8	44.6	14.3	3.6
Change in Drawings	2.73	Yes	8.9	5.4	3.6	0	0	82.1	0	0
Change in Specifications	2.52	Yes	5.4	1.8	3.6	0	0	89.3	0	0
Shop Drawings Approval	2.55	Yes	0	0	33.9	0	0	66.1	0	0
Incomplete Documents	2.66	Yes	0	0	71.4	0	0	28.6	0	0
Not applicable drawings	2.2	No	0	26.8	10.7	0	1.8	60.7	0	0

TABLE III
ANALYSIS FOR PROCUREMENT RELATED REASONS

Reason(s)	Mean	Significant Reason of Delays	Percentage of selected option							
			Owner	Consultant	Contractor	Owner- Consultant	Owner- Contractor	Consultant- Contractor	Owner - Consultant - Contractor	None of Mentioned
Material and equipment Procurement	3.61	Yes	0	0	55.4	0	26.8	8.9	8.9	0
Transportation	2.96	Yes	0	0	64.3	0	16.1	0	19.6	0

Table IV shows that 8 factors in Construction Related Reasons are significant ones in delays. The contractor is mainly responsible for construction related reasons. The next main responsible is the consultant.

Contractors have a responsibility percentage of 91.1%, 87.5%, and 75%, for equipment availability, the lack of appropriate equipment and materials for work, respectively. This requires identification of some criteria for preventing these kinds of delays like specifying them in the process of bid.

Table V is a bit different with the rest. It is obvious that financial/economic reasons are highly affecting the progress of

project. But as it was declared in the table, the main responsibility of delays in this group are classified under the “none of mentioned” category. This represents that in most of the cases, controlling of these reasons is impossible for owner or consultant or contractor in Iran. This somehow represents the effect of sanctions on Iran.

Based on Table VI, it can be understood that 9 factors of 13 investigated are known as effective ones in delays. In most cases, responsibilities for causing delays due to managerial related ones are shared by owner, consultant and contractor. In this group of reasons, the owner has the highest responsibilities.

Among the reasons, “lack of coordination on site”, “lack of close coordination between the E, P and C departments” and “lack of coordination between the Owner, Consultant & Contractor” with the percentages of 80.4, 64.3 and 58.9 respectively represent this claim for owners.

TABLE IV
ANALYSIS FOR CONSTRUCTION RELATED REASONS

Reason(s)	Mean	Significant Reason of Delays	Percentage of selected option							
			Owner	Consultant	Contractor	Owner-Consultant	Owner-Contractor	Consultant-Contractor	Owner - Consultant - Contractor	None of Mentioned
Inspections	2.66	Yes	0	1.8	12.5	0	5.4	80.4	0	0
Subsurface Soil Conditions	2.21		0	0	8.9	0	0	46.4	44.6	0
Lack of material on work	3.25	Yes	0	0	7.5	0	7.1	0	0	17.9
Fabrication delays	3.2	Yes	0	0	80.4	0	0	19.6	0	0
Lack of qualified craftsman	2.46		0	0	66.1	0	26.8	7.1	0	0
Poor Subcontractor Performance	2.95	Yes	0	0	32.1	0	1.8	55.4	10.7	0
Defective Work	2.34		0	0	10.7	0	0	89.3	0	0
Different Site Conditions	1.8		0	0	1.8	0	0	32.1	28.6	37.5
Labor injuries	1.7		0	0	30.4	0	0	66.1	3.6	0
Damage to structure	1.75		0	0	48.2	0	0	51.8	0	0
Construction mistakes	2.59	Yes	3.6	0	12.5	1.8	1.8	80.4	0	0
Poor supervision	3.09	Yes	0	1.8	0	8.9	3.6	33.9	51.8	0
Equipment Availability	3.18	Yes	0	0	91.1	0	1.8	7.1	0	0
Lack of appropriate equipment	2.8	Yes	0	0	87.5	0	0	12.5	0	0
Lack of special tools	2.48		0	0	50	0	0	50	0	0

TABLE V
ANALYSIS FOR FINANCIAL/ECONOMIC RELATED REASONS

Reason(s)	Mean	Significant Reason of Delays	Percentage of selected option							
			Owner	Consultant	Contractor	Owner-Consultant	Owner-Contractor	Consultant-Contractor	Owner - Consultant - Contractor	None of Mentioned
Lack of acceptable cost estimation	3.29	Yes	0	0	0	62.5	5.4	0	30.4	1.8
Financial Process	3.43	Yes	0	0	12.5	0	3.6	21.4	26.8	35.7
Financial Difficulties	3.57	Yes	32.1	0	55.4	0	0	0	0	12.5
Delayed Payments	3.36	Yes	50	0	23.2	0	0	0	8.9	17.9
Economic Problems	3.14	Yes	8.9	0	0	0	1.8	0	0	89.3
Access to foreign currency	3.45	Yes	0	0	0	1.8	94.6	0	0	3.6
Inflation rates	4.13	Yes	0	0	0	1.8	8.9	0	0	89.3
Currency transferring	3.73	Yes	0	0	37.5	1.8	17.9	0	1.8	41.1

TABLE VI
ANALYSIS FOR MANAGEMENT RELATED REASONS

Reason(s)	Mean	Significant Reason of Delays	Percentage of selected option							
			Owner	Consultant	Contractor	Owner-Consultant	Owner-Contractor	Consultant-Contractor	Owner - Consultant - Contractor	None of Mentioned
Lack of completely defined scope of work	2.71	Yes	0	0	0	1.8	1.8	1.8	91.1	3.6
Ineffective planning and scheduling	2.88	Yes	0	0	0	7.1	0	89.3	3.6	0
Inefficient project controlling	3.11	Yes	1.8	0	0	0	5.4	1.8	91.1	0
Lack of attention to planning and controlling techniques (like CPM, PERT...)	2.88	Yes	0	0	1.8	0	3.6	57.1	37.5	0
Lack of coordination between Owner, Consultant & Contractor	3.11	Yes	58.9	0	0	28.6	1.8	7.1	3.6	0
Lack of true estimation of productivity	2.96	Yes	0	0	42.9	0	3.6	26.8	26.8	0
Staffing problems	2.07		0	0	30.4	0	33.9	0	35.7	0
Lack of coordination on site	2.43		80.4	0	1.8	0	7.1	3.6	7.1	0
Lack of close coordination between the E, P and C departments	2.68	Yes	64.3	0	17.9	0	0	0	17.9	0
Suspensions	1.77		12.5	0	37.5	0	7.1	42.9	0	0
Lack of high – technology	2.02		0	0	0	0	3.6	89.3	3.6	3.6
Poor managerial skills	3	Yes	0	0	0	0	3.6	0	96.4	0
Slowness in decision making	3.11	Yes	0	0	0	0	8.9	0	91.1	0

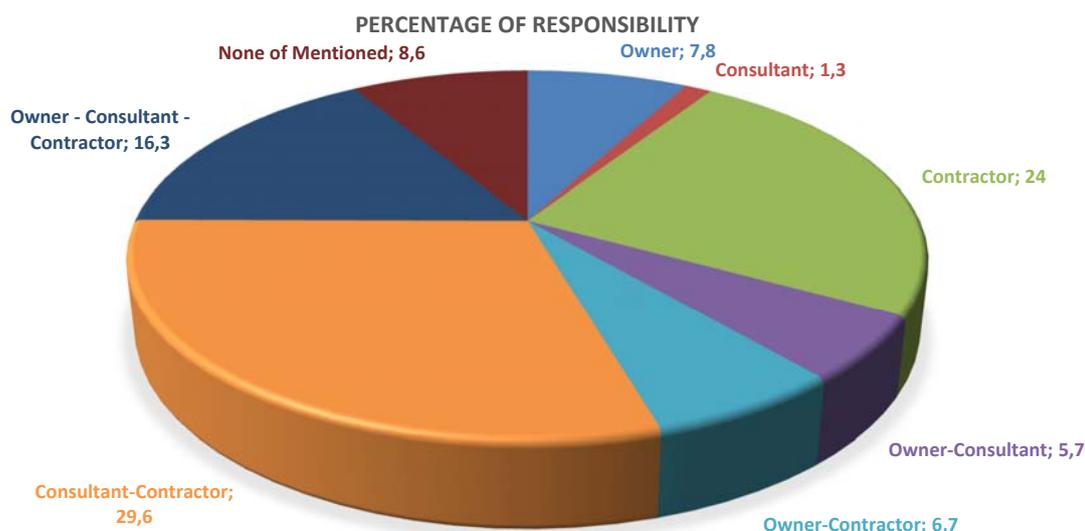


Fig. 1 Analysis for Responsibilities in All Reasons

As represented in Fig. 1, based on the gathered data it can be concluded that contractor with the amount of 24% has the highest responsibility for delays occurred in the petrochemical construction projects. Moreover, it should be noted that the contractor has more responsibilities in delays because contractor has a shared responsibility by other parties too. Such as Consultant – Contractor, Owner – Contractor and Owner – Consultant – Contractor ones. Consultant lonely has just 1.3% of responsibility for delays occurred which is the lowest rate among the parties in the projects.

IV. APPROACHES FOR REDUCING DELAY

Since the approaches given in the questionnaire have been similar for reasons in the same groups, the consequences are mentioned in groups too. In Table VI, the approaches collected by questionnaires are cited.

V. CONCLUSION

Financial/economic reasons are the most critical group of causing delay that all the reasons in this group are known as significant ones. This is followed by the procurement related, construction related, management related and design related reasons which are represented here:

- 1- Financial/economic related causes: 100% of reasons in this category are known as significant with overall mean of 3.51.
- 2- Procurement related causes: 100% of reasons in this category are known as significant with overall mean of 3.28.
- 3- Design related causes: 89% of reasons in this category are known as significant with overall mean of 2.68.
- 4- Management related causes: 69% of reasons in this category are known as significant with overall mean of

2.67.

- 5- Construction related causes: 53% of reasons in this category are known as significant with overall mean of 2.56.

Overall, the first 10 significant reasons in the above-mentioned categories are:

- 1- Inflation rate with mean of occurrence equal to 4.13
- 2- Currency transferring with mean of occurrence equal to 3.73
- 3- Material and equipment procurement with mean of occurrence of 3.61
- 4- Financial difficulties with mean of occurrence equal to 3.57
- 5- Access to foreign currency with mean of occurrence equal to 3.45
- 6- Financial process with mean of occurrence equal to 3.43
- 7- Delayed payments with mean of occurrence equal to 3.36
- 8- Lack of acceptable cost estimation with mean of occurrence equal to 3.29
- 9- Lack of material on work with mean of occurrence equal to 3.25
- 10- Delay in reviewing and approving design documents with mean of occurrence equal to 3.21

Based on data gathered through this research, the responsibilities can be classified as follows:

- 1- Consultant and contractor (29.6%)
- 2- Contractor (24%)
- 3- Owner – consultant – contractor (16.3%)
- 4- None of mentioned (8.6%)
- 5- Owner (7.8%)
- 6- Owner – contractor (6.7%)
- 7- Owner – consultant (5.7%)
- 8- Consultant (1.3%)

TABLE VII
ANALYSIS FOR MANAGEMENT RELATED REASONS

Reasons		Solutions
Design Related		
1	Project location in terms of access to resources	
2	Design Development	
3	Delay in reviewing and approving design document	
4	Change Orders	<ul style="list-style-type: none"> • Selecting qualified consultants • Employing experienced engineers and technicians
5	Change in Drawings	<ul style="list-style-type: none"> • Improving the culture of documentation in organization in aim of access to previous outcomes and data
6	Change in Specifications	<ul style="list-style-type: none"> • Paying sufficient attention to international and national standards and requirements
7	Shop Drawings Approval	
8	Incomplete Documents	
9	Not applicable drawings	
Procurement Related		
10	Material and equipment Procurement	<ul style="list-style-type: none"> • Selecting qualified managers
11	Transportation	<ul style="list-style-type: none"> • Selecting qualified and well – known companies
Construction Related		
12	Inspections	
13	Subsurface Soil Conditions	
14	Lack of material on work	
15	Fabrication delays	
16	Lack of qualified craftsman	
17	Poor Subcontractor Performance	
18	Defective Work	<ul style="list-style-type: none"> • Selecting more qualified and well – known contractors
19	Different Site Conditions	<ul style="list-style-type: none"> • Selecting qualified consultants as supervisors on construction sites
20	Labor injuries	<ul style="list-style-type: none"> • Integrate all the engineering, procurement and construction phase through EPC or BOT (all kinds) contracts
21	Damage to structure	
22	Construction mistakes	
23	Poor supervision	
24	Equipment Availability	
25	Lack of appropriate equipment	
26	Lack of special tools	
Financial/Economic Related		
27	Lack of acceptable cost estimation	
28	Financial Process	
29	Financial Difficulties	<ul style="list-style-type: none"> • Utilizing internal financial resources
30	Delayed Payments	<ul style="list-style-type: none"> • Utilizing Available Foreign financial resources
31	Economic Problems	<ul style="list-style-type: none"> • Utilizing special kinds of contracts like EPCF or BOT (all kinds)
32	Access to foreign currency	<ul style="list-style-type: none"> • Helping the contractors to overcome financial problems and inflation
33	Inflation rates	<ul style="list-style-type: none"> • Reducing the bureaucracy
34	Currency transferring	
Management Related		
35	Lack of completely defined scope of work	
36	Ineffective planning and scheduling	
37	Inefficient project controlling	
38	Lack of attention to planning and controlling techniques (like CPM, PERT...)	
39	Lack of coordination between Owner, Consultant & Contractor	
40	Lack of true estimation of productivity	<ul style="list-style-type: none"> • Integrating the tasks in project through EPC, EPCF or BOT (all kinds) contracts
41	Staffing problems	<ul style="list-style-type: none"> • Employee qualified personnel
42	Lack of coordination on site	<ul style="list-style-type: none"> • Preparing applicable planning and assigning people for pursuing the activities
43	Lack of close coordination between the E, P and C departments	
44	Suspensions	
45	Lack of high – technology	
46	Poor managerial skills	
47	Slowness in decision making	

REFERENCES

- [1] S. A. Assaf, S. Al-Hejji, "Causes of delay in large construction projects", *international journal of project manajment*, 24, 2006, p.p 349-357.
- [2] S. M. Ahmed, S. Azhar, M. Castillo, P. Kappagantula, "construction delays in florida: an empirical study", in *Department of Community Affairs*, Final Report, florida: florida international university, 2002, pp. 1-44.
- [3] R. Singh, "Delays and Cost Overruns in Infrastructure Projects: An Enquiry into Extents, Causes and Remedies", *Dehli, India: Department of Economics Delhi School of Economics University of Delhi*, 2009.
- [4] T. Pourrostam, I. Amiruddin, "Significant Factors Causing and Effects of Delay in Iranian Construction Projects", *Australian Journal of Basic and Applied Sciences*, 5, 2011, p.p 450-456.
- [5] L. Le-Hoai, Y. Dai Lee, J. Yong Lee, "Delay and Cost Overruns in Vietnam Large Construction Projects: A Comparison with Other Selected Countries", *KSCE Journal of Civil Engineering*, 12, 2008, p.p 367-377.
- [6] S. Dayi, "Schedule Delay Analysis in Construction Projects: A Case Study Using Time Impact Analysis Method", *Graduate School of Natural and Applied Sciences of Middle East Technical University*, 2010.