A Brief Study on Residential Construction Projects from View of Delay Causes Ranking

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***Abstract*—**The construction industry plays an extraordinary role in the economy, wealth and employment in all countries particularly developing countries such as Iran. Construction industry like other industries has common problems, one of them is construction delays. These problems arise mostly during project life-cycle and have negative effects on project achievement. In Iran, Few researches have been done on causes of delays and also there are not any studies related to residential construction projects. Hence, it is vital to study, define, recognize and analyze causes of residential construction delays to diminish and avoid the delays in the most of residential construction projects. For this aim a list of construction delay causes is adopted from literature and interview with construction expert. One hundred and eighty (108) causes were recognized and categorized into nine groups. A questionnaire survey was designed and conducted to realize the causes of delay based on Frequency of Occurrence and Severity of Delay from viewpoint of clients, consultants and contractors in residential construction project in Mashhad Iran.

***Keywords*—**Delays, Reduction of time, Residential construction projects, Speedup project.

I. Introduction

The construction industry is one of the main industries contributing significantly to the growth and economy of the country [1]. Residential construction sector is allocating 30% of national per capita income [2]; and the annual turnover in the construction industry amounts to US$38.4 billion and is grown with average growth of 4.4% from 2008 until 2012. Having a house is one of the most important demand for Iranian people and every year there is need for 750000 additional units for young couples [3]. For instance, statistics are shown 2,500,000 m^2 building permits have been issued in 2014 by Mashhad Construction Engineering Organization.

There are many problems and difficulties which can be happened during the execution of residential construction projects; one of the most serious problems in the construction industry is time overruns (delay) and is acting a major role in any project success [1] and are very important and chronic problems in construction projects [4]; therefore, causes of delay have crucial importance to the profitability of most construction projects [5].

The time delay to construction projects is a worldwide and very frequent phenomenon and Iran is not an exception to this risk [6]. Delays happen in the most of construction projects and the size of these delays extremely varies from one project to another project [7].

Stumpf defined delay as an act or event that extends the time required to perform the tasks under a contract. It usually shows up as additional days of work or as a delayed start of an activity [8]. In addition, Assaf and Al-Hejji [9] defined delay in construction projects as the time overrun either beyond completion date specified in a contract, or beyond the date that the parties agreed upon for delivery of a project.

According to studies of Assaf and Al-Hejji's and Davis et al., the percentage of delayed projects is reported more than 70% in Saudi Arabia and 60% in UK [10]. According to reports in 2001, 2002 and 2003, Iranian construction projects had a delay of about 30%, 74.5%, and 75% respectively [11]. According to the statistics reported, there were losses from delay in more than 40% of Iranian construction projects [12]. According to the head of Islamic council of Tehran (capital of Iran) more than 40% of construction projects are behind the schedule, 37% of them are suspended and only 23% of projects are completed on time [12].

The main objectives of this research are to identify the causes of delays in execution of residential construction projects and determine factors that have high severity of effects on delay and finally, introduce the top rank of causes that can effect on completion time of projects. The research focuses on residential construction projects in Mashhad, Iran and the respondents of the research were the project managers, civil engineers, consultants, clients (owner) and companies who are involved in residential construction projects in Mashhad, Iran.

II. Literature review

Many articles and researches are operated on causes and impacts of delay in construction projects in all around the world but a few studies conducted in Iran and nothing has been done in section of residential construction projects. According to research operated by Assaf and Al-Hejji, 56

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major causes of delay in large construction projects were identified. Delay factors are collected into nine main categories with different levels of importance to different sections. The most important causes of delay included approval of drawings, delays in payments to contractors and resulting cash problems during constructions, design changes, conflict in work schedules of subcontractors, slow decision making and executive bureaucracy in the owner's organizations, design errors, labor shortage and inadequate labor skills [9].

Al-Momani [13] studied causes of delay in 130 public projects in Jordan. The major causes of delay were linked to weather, designer, user changes, late deliveries, site conditions, economic conditions and increase in quantity; and the researcher recommended that specific notice to factors will assist industry practitioners in diminishing contract conflicts. Delays have strong severe connection with inefficiency performance of contractors.

Zakeri et al., figured out that the five most important issues of Iranian construction projects as follows: (1) materials shortage, (2) weather and site conditions, (3) equipment breakdown, (4) drawing deficiencies/change orders, (5) and lack of proper tools and equipment [11].

Sambasivan and Soon studied the causes of delays confronting in the Malaysian construction projects. A questionnaire was created and distributed among the three major groups of participants (Owners, Consultants, and Contractors). They recognized main causes of delay and ten most important causes were as follows: (1) Contractor's improper planning; (2) Contractor's poor site management; (3) Inadequate contractor experience; (4) Inadequate owner's finance and payments for completed work; (5) Problems with subcontractors; (6) Shortage in material; (7) Labor supply; (8) Equipment availability and failure; (9) Lack of communication between parties; and (10) Mistakes during the construction stage [5].

Emam, Farrell and Abdelaal. [10] designed questionnaire survey and identified 120 factors can effect on infrastructure construction projects. The results were then analyzed to produce ranking for each of the factors. The top five factors were: (1) long response from utility agencies; (2) major change in design during construction; (3) ineffective planning and scheduling; (4) ineffective control of progress; (5) changes in the scope of the project.

Ahmed, Azhar, Kappagantula and Gollapudi. [7] identified the major causes of delays in the Florida Construction Industry. The ten most critical causes of delays are: (1) Building Permits Approval, (2) Change order, (3) Changes in Drawings, (4) Incomplete Documents, (5) Inspections, (6) Changes in Specifications, (7) Decision During Development Stage, (8) Shop Drawings Approval, (9) Design Development, (10) Changes Laws Regulations. The literature related the field of causes and effects of delay in construction projects has been reviewed over the last decade.

III. Research Methodology

For this research, a questionnaire survey method has been chosen to discover the causes of delays from two different views in Mashhad's residential construction industry. In order to identify the causes of delay in residential construction projects, the authors used literature review and inquiry with authorities in construction sector. The gathered information was based on these two ways.

First of all the authors try to recognize the causes of delay by reviewing the different studies and researches projects in different countries that were collected from books, journal articles and websites. Then we make a list of causes that could possibly and potentially cause delay in construction projects. By categorizing them we narrowed them down into the causes that could happen in developing countries such as Iran. After that we tried to check the results that were on the list out with experts in residential construction industry such as consultants, clients, contractors and project managers. In order to tailor our data to appropriate circumstances in the scope of region we interviewed with experts that were mentioned before. The experts that we chose, have at least 10 years of experience and resume in residential construction projects.

We asked them two main questions about our data that we had gathered before. The first question was "Do you think, from your expert view, these causes cause delay in residential construction in Mashhad, Iran?" and the next question was are there any further causes you might like to add? By finishing this part our data were fitted to our circumstances in Mashhad [14].

Based on result of our interviews some factors were added to list of causes and some of them merged with each other and modified or omitted. After we reviewed the final data that came from consulting with experts we identified one hundred and eight (108) main causes of delay that they categorized into nine major groups namely, Client Related Factors, Contractor Related Factors, Consultant or design Team Related Factors, Material Related Factors, Contract or Contract Relationship Related Factors, Equipment Related Factors, Labor Related Factors, External Factors, Environment Related Factors.

Questionnaires were designed into two major parts (A and B). Part (A): General information of the respondent and company was collected. Part (B): this part includes the list of the recognized causes of delay in residential construction project. In this part for each causes two questions were existed and asked. The first one is: What is the frequency of occurrence for this cause? And the second question is: What is the severity of affects for this cause? The ranking of questionnaire is based on five point Likert Scale for both questions. Ranking of frequency of occurrence is divided into: never, seldom, about half the time, often and always (on 1 to 5 point scale). Similarly, Ranking of severity of affects is divided into: not affect, a little affect, average affect, high

affect and very high affect (on 1 to 5 point scale) [5], [9].

The collected data were analyzed through descriptive analysis method. The analysis included ranking the different causes of delay according to mean for each data. The result of analysis shown the most contributing factors and groups causing delays.

IV. Result and Discussion

The ranking of causes of delay was determined by mean calculation of all data obtained from the questionnaire. The all collected raw data were analyzed by SPSS (Statistical Package for Social Sciences) ver.23 program. The results of analysis are presented in table I.

TABLE I
MEAN AND RANKING OF FACTORS

No.	Group name	Causes of delay	Frequency Mean	Frequency Rank	Severity Mean	Severity Rank
1	Client Related Factors	Delay in running bill payments to the contractor	3.54	4	3.79	6
2		Suspension of the work (client interference)	2.68	70	3.82	5
3		Delay in approving documents and drawing	3.61	3	3.86	3
4		Delay in contractor's claims settlements	2.93	36	2.89	93
5		Change order during construction by client	3.04	23	3.57	15
6		Delay to deliver the site	2.32	102	2.79	101
7		Poor communication and coordination	2.57	85	2.79	101
8		Bureaucracy in client's organization	3.32	9	3.29	45
9		Lack of motivation for contractor for early finish	2.89	40	3.36	36
10		Slowness in decision making	3.11	20	3.39	31
11		Cash flow problems/Financial difficulties	3.68	1	4.14	1
12	Contractor Related Factors	Conflicts between joint-ownership	2.50	92	3.18	54
13		Improper project feasibility study	2.64	76	3.00	79
14		Lack of capable representative	2.64	76	3.18	54
15		Lack of proper consultant and adequate in project	2.79	54	3.50	21
16		Lack of owner experience in construction project	2.54	89	3.46	23
17		Long period between design and time of bidding/tendering	2.75	55	3.04	72
18		Poor planning and scheduling of the project	3.04	23	3.68	10
19		Improper technical study by the contractor during the bidding stage	2.82	48	3.79	6
20		Construction mistakes	2.50	92	3.43	28
21		Inadequate experience	2.71	60	3.43	28
22		Defective of work (rework)	2.75	55	3.54	18
23		Unsuitable construction methods	2.57	85	3.07	69
24		Frequent change of sub-contractor	3.04	23	3.32	39
25		Lack of control over sub-contractor	2.71	60	3.29	45
26		Lack of contractor's administrative personnel	2.89	40	2.93	86
27		Shortage of technical professionals in the contractor's organization	3.18	15	3.61	13
28		Ineffective quality control	2.82	48	3.18	54
29		Poor communication and coordination	2.75	55	3.04	72
30		Bureaucracy in contractor's organization	2.36	101	2.57	106
31		Poor site management and supervision	2.96	32	3.68	10
32		Delay in site mobilization by contractor	2.86	45	3.11	63
33		Difficulties in financing project by contractor	3.39	8	3.86	3
34		Unsuitable allocation budget in different sections	3.18	15	3.61	13
35		Safety rules and regulations are not followed within the contractor's organization	3.21	13	3.04	72
36		Delays in contractor's payments to subcontractors	3.50	5	3.57	15
37		Spending prepayment outside of project	2.93	36	3.57	15
38		The conflict between contractor and consultant	2.82	48	3.14	58
39		Claims of contractors	3.25	12	3.32	39
40		Late valuation work	2.61	78	3.00	79
41		Late issue of instruction	2.82	48	3.25	50
42		Rework due to change of design or deviation order	3.18	15	3.46	23
43		Consultant or architect's reluctance for change	3.11	20	3.00	79
44		Defects, mistakes and discrepancies in design	2.86	45	3.39	31
45		Delay of work approval and approval changes during construction	3.04	23	3.39	31
46	Consultant or design Team Related Factors	Unclear and inadequate details in drawings	3.29	10	3.32	39
47		Inadequate supervision to contractor	2.93	36	3.36	36
48		Lack of proper supervisor and adequate in project	3.07	22	3.46	23
49		Poor communication and coordination	2.61	78	2.79	101
50		Slow inspection of complete works	2.71	60	2.93	86
51		Misunderstanding of owner's requirements by design engineer	2.54	89	2.86	96
52		Inflexibility (rigidity) of consultant	2.68	70	2.96	84
53		Insufficient data collection and survey before design	3.00	30	3.25	50
54		Un-use of advanced engineering design software	2.68	70	3.00	79

TABLE I (CONTINUED)

No.	Group name	Causes of delay	Frequency Mean	Frequency Rank	Severity Mean	Severity Rank
55		Shortage of Material	2.71	60	3.21	52
56		Improper storage of materials leading to damage	2.61	78	3.07	69
57		Delay in material deliveries	3.00	30	3.54	18
58	Material Related Factors	Delay in material fabrication	2.68	70	3.11	63
59		Change in material types and specification during construction	2.82	48	3.18	54
60		Material procurement problem (late procurement)	2.61	78	3.11	63
61		Delay in manufacturing special building material	2.68	70	2.82	100
62		Unreliable suppliers	2.43	97	2.93	86
63		Bureaucracy in material procurement	3.04	23	3.14	58
64		Unrealistic contract duration	3.68	1	3.79	6
65		Unrealistic contract budget	3.43	7	3.68	10
66		Unsuitable type of contracts for contractor	2.96	32	3.50	21
67		Unsuitable type of contracts for consultant	2.89	40	3.29	45
68	Contract or Contract	Ambiguity in specifications and conflicting interpretation by parties.	2.96	32	3.11	63
69		Lack of communication between parties	2.68	70	2.79	101
70	Relationship	Difficulties of coordination between parties	2.71	60	2.89	93
71	Related Factors	Poor means of contracting	2.96	32	3.04	72
72		Unrealistic inspection and testing methods proposed in contract	2.61	78	2.86	96
73		Poor contract management	2.89	40	3.14	58
74		Nonadherence to contract conditions	3.04	23	3.39	31
75		Mistakes and discrepancies in contract documents	2.82	48	3.32	39
76		Equipment shortage or Equipment allocation problem	2.71	60	3.46	23
77		Late delivery of equipment	2.75	55	3.29	45
78	Equipment	Inadequate skill of operators	2.46	96	3.07	69
79	Related Factors	Wrong selection of equipment	2.25	106	3.04	72
80		Low efficiency and production of equipment	2.54	89	3.11	63
81		Lack of high-technology mechanical equipment	3.04	23	3.11	63
82		Equipment breakdown and maintenance problem	2.89	40	3.32	39
83		Unqualified workforce	3.18	15	3.75	9
84		Absenteeism	2.71	60	3.14	58
85		Low motivation and morale of labor	3.21	13	3.32	39
86	Labor Related	Shortage of manpower	2.75	55	3.54	18
87	Factors	Labor disputes and strikes	2.21	108	2.86	96
88		Personal conflicts among labor	2.43	97	2.39	107
89		Low productivity level of labor	3.14	19	3.46	23
90		Labor injuries and accident in site	2.50	92	2.96	84
91		Nationality of labors	2.25	106	2.25	108
92		Act of god	2.32	102	3.39	31
93		Civil disturbance	2.32	102	3.04	72
94		Inflation	3.50	5	3.89	2
95		Slow progress of building permit	3.29	10	3.43	28
96	External Factors	Change in government regulation and laws	2.71	60	3.36	36
97		Delay in performing final inspection by third party	2.71	60	2.79	101
98		Force majeure	2.61	78	3.21	52
99		Inadequate production of raw material in the country	2.43	97	3.14	58
100		Thefts done on site	2.57	85	2.86	96
101		Problem with neighbors	2.86	45	2.93	86
102		Unforeseen site condition	2.32	102	2.93	86
103		Unforeseen weather condition	2.50	92	2.93	86
104	Environment	Inaccurate specification of site condition	2.39	100	3.00	79
105	Related Factors	Effect of subsurface condition	2.61	78	2.93	86
106		Traffic control and restriction at site	2.57	85	2.89	93
107		Lots of public holidays (in some countries)	2.71	60	3.04	72
108		Delay in providing services from utilities (water & electricity)	2.93	36	3.29	45

The causes are arranged in each group by order of ranks, that causes with highest mean show they have the maximum effects on the delay while the causes with lowest rank show that they have the minimum effects on delay.

According to the result of analyses and all participants, the top main causes from view of Frequency of Occurrence for time overruns in residential construction projects are:

- Cash flow problems/Financial difficulties
- Unrealistic contract duration
- Delay in approving documents and drawing
- Delay in running bill payments to the contractor
- Delays in contractor's payments to subcontractors
- Inflation

and also the top major causes from view of severity of affects for time overruns are:

- Cash flow problems/Financial difficulties
- Inflation
- Delay in approving documents and drawing

- Difficulties in financing project by contractor
- Suspension of the work (client interference)

Cash flow problems/Financial difficulties is found to be a critical cause participating in the delay from view of frequency of occurrence and severity of affects and it belongs to the client. Labor disputes and strikes and Nationality of labors are found to be less important from view of frequency of occurrence and severity of affects respectively and they belong to the Labor Related Factors. According to the result, the most critical groups that have the most effect on delay from view of frequency of occurrence and severity of affects are:

A. Client Related Factors

Among the top ten ranked causes, client included four causes from view of frequency of occurrence and five causes from view of severity of affects. The most major delay causes from client's point of view of frequency of occurrence are Cash flow problems/Financial difficulties, Delay in approving documents and drawing and Delay in running bill payments to the contractor. The most major delay causes from client's point of view of severity of affects are Cash flow problems/Financial difficulties, Delay in approving documents and drawing and Suspension of the work (client interference).

B. Contractor Related Factors

There were 22 Contractor Related delay Factors were contained. Based on survey results, Delays in contractor's payments to subcontractors, Difficulties in financing project by contractor and Claims of contractors were top ranked causes from view of frequency of occurrence and Difficulties in financing project by contractor, Suspension of the work (client interference), Poor planning and scheduling of the project were top ranked causes from view of severity of affects.

C. Contract or Contract Relationship Related Factors

Contract or Contract Relationship Related Factors were consisted of 12 causes of delay where Unrealistic contract duration, Unrealistic contract budget, Nonadherence to contract conditions with highest mean in their group was chosen as the most main causes of delay causes from view of frequency of occurrence and severity of affects.

D. Labor Related Factors

The Labor Related Factors were included of 9 delay causes. Based on survey results, unqualified workforce, Low productivity level of labor, Low motivation and morale of labor from view of frequency of occurrence and severity of affects are the main delay causes from labor related point.

According to the result of analysis, the less critical groups that have the less effect on delay from view of frequency of occurrence and severity of affects are:

A. External Factors

The Labor Related Factors were included of 9 delay causes. Based on survey results, Act of god, Civil disturbance, Inadequate production of raw material in the country labor from view of frequency of occurrence and Delay in performing final inspection by third party, Thefts done on site from view of severity of affects had less effect on time overruns of residential projects.

B. Environment Related Factors

Environment Related Factors were consisted of 8 causes of delay where Unforeseen site condition, Unforeseen weather condition, Inaccurate specification of site condition with lowest mean in their group were chosen as the less main causes of delay from view of frequency of occurrence and Traffic control and restriction at site, Effect of subsurface condition, Problem with neighbors, Unforeseen site condition, Unforeseen weather condition were chosen as the less important causes of delay from view of severity of affects.

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