



Reasons of any delay in dam making projects in Iran

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ABSTRACT

As an important part, Construction Industry provides important compositions for promotion of economy. Meanwhile most of projects have experienced various delays in a special form which are mostly for primary time and estimation of costs. Delay in construction is one of the specific problems with a converse effect on projects success from viewpoints of time, costs, quality and safety. This paper is about time function in dam making projects in Iran and defining any reasons for delay and also their severity according to the ideas of contractors and consultants through a questionnaire research. Its field research includes 34 contractors and 30 consultants. About 52 factors of delay were defined through this research. The conclusion of research was defining five serious reasons of delay including: Political conditions, Economic conditions, Limited imports, Granting of project with least tender prices, Delay in payment by employer and lack of equipment.

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Introduction

Construction industry is really a tool through which society will find its civil & rural goals. (Enshassi et al, 2006). This has a considerable effect on economy of most countries (Leibing, 2001). This is a part of important compositions for promotion of economy. However it is more complex due to complexity of construction process and great number of involved persons in construction. It means employers, users, designers, supervisors, contractors, suppliers, sub-contractors and consultants. (Enshassi et al.).

All three factors of costs, time and quality have proved importance in success of all projects. According to a research by Ahmad et al (2003), it was concluded that all delays in construction projects are world phenomena. These cases are usually accompanied with great costs. Delay has a negative effect on employers, contractors and consultants in the field of mutual relations, mistrust, jurisdiction and various problems in cash and general feeling about other parties. (Ahmad et al. 2003).

The above-mentioned problem is not very clear and unique for developed problems but it may be experienced in most developed economy. (Kaliba,2009). It is impossible to consider any effort as successful one except it is in compliance with relevant costs, time and quality limits. By the way, it is not inevitable to have a constructional project which is unable to find considered goals in its scope of costs, time and quality. (Nega, 2008).

With a growth rate of %24.5, construction industry is related with gross growth of Iran. (Enshassi et al. 2006). It is related with a great part of covered cases especially mentioned factors by Chitkara (2004) through which construction industry has %6-9 of GDP in most countries. As a result, it will affect on most economic, social, educational and profession sectors. In spite of estimated success of construction industry in Iran, still we have economic growth and responding to local needs of Iranian as the goals affected by time, costs and quality. (Gandomi et al. 2008). Followings are some the mentioned problems according to the Krit Ara (2010):

- Great number of workers in comparison with number of projects
- Closing of territories and reduction of materials in markets
- Dependence to foreign countries for finding building materials
- Continuous increase of materials price
- Non-fixed economic situation and its relation with international sanctions
- Updating the economic conditions

According to the report issued by Central Bank of Iran, there is not any study about overrun in constructional projects but general observations point out that overrun is a common phenomenon in building projects. This study intends to present various findings out of the research for determining some of the most important reasons of delay in dam making projects in Iran. Chang (2002) has stated various reasons which are mostly obvious in primary steps when we want to evaluate the problems and present modifying functions accordingly. Hope the presented findings could be considered as a complete effort for enrichment of any functions at constructional industry.

Goals of study

Followings are major goals of this study:

- Determining any reasons of delay in dam making project at Iran
- Determining the severity of delay reasons from viewpoints of consultants and contractors
- Testing and accepting any classification of severity of delay reasons among contractors and consultants

Literature review

There are various studies for specifying any reasons of delay in constructional projects. Lishman (1991) has stated some legal results in construction. Asef et al. (1995) has pointed out to 56 major reasons of delay in great constructional projects. All delay reasons are designed with nine major groups and different levels for various parties. Enshassi & Abu Mousa (2008) concluded that employers believe in granting of the task to the hands of non-experienced people will cause an increase in risks of construction along with various defects and occurrence of different accidents. The real reason of the mentioned case is

applying of weak safety methods. Oode & Batineh (2003) found out that contractors and consultants agree that any interfere of employer, low experienced contractor, financial supply and payments, benefiting from job and slow decision making, non-suitable designing and presence of sub-contractors are 10 important reasons of delay in construction at Jordan. Almomani (2000) made a research about any delay reasons in 130 general projects at Jordan. The major reasons of delay were designer, changes in design, climatic conditions, site conditions, delayed delivery, economic conditions and increasing the quantity.

Aas and Alhaji (2006) discussed any delay in constructional projects at Saudi Arabia. Totally about 73 reasons were specified in their research. They concluded that the most common reasons of delay presented by contractors, consultants and owners are known as "Changes in order". Abdolmajid & Mack Kaufer (1998) found out that major reasons of delay in functions of contracts at UK are materials, equipment and relevant delays of labor force. Uganlana et al. (1996) studied any delays in constructional projects at Thailand as an example of under-developing economies. They concluded that we may classify current problems in construction industry in under-developing economies as follows:

- (1) Any problems in lack of industrial infrastructures, especially in supplying of resources
- (2) Any problems resulted by employers and consultants
- (3) Any problems out of competency of contractors

Mazhar et al. (2006) had a research about any reasons of delays in constructional industry at Lebanon and from viewpoint of owners, contractors, architectural/engineering companies. They found out that employer have more attention to financial issues and contractors are focusing more on contractual relations as the most important discussion while consultants stated relevant issues of project management as the most important reasons of delay. Mansfield et al. (1994) stated various reasons of delay and additional costs in constructional projects at Nigeria. According to the results, it was obvious that the most important reasons are as follows: Financial supply and payment of salary for complete jobs, weak contractual management, changes in site conditions of workshop, lack of materials and non-suitable designing. Coming et al. (1997) started to prepare a questionnaire about sky scrapers project at Indonesia.

They have stated about 11 variants of delay and 7 variants of additional costs. From among all mentioned items, the costs of increased materials due to inflation, non-suitable delay in job and increase costs of work caused by environmental limitations are included in three major additional costs. Meanwhile any changes in designing, little efficiency of labor force, non-suitable designing, lack of materials and lack of efficiency and estimation of materials are included in first five reasons of delay. Gandomi (2008) has stated 20 most important factors of delays in dam making projects of Iran from among 47 factors. Therefore after specifying the percentage and quantity of shares according to SPS statistical method and with regard to explanatory statistics, 9 highest rate factors of dam making are as follows:

- Lack of credits with %100 of frequency as the first factor of delays
- Lands ownership problems and any delay in payments of contractors with %86 of frequency as the second factor of delays
- Lack of specialty and experience of contractors and their weak management with %80 frequency as the third factor of delays
- Lack of efficient and special human force, lack of materials, lack of following up the shortages of project by employer and

lack of machinery with a frequency of %66.7 as the fourth factor of delays

- Economic situation and increasing of prices with a frequency of %60 as the fifth factor of delays.

Methodology

This research is based upon all required information and in an effective form. It has presented 52 reasons of delay according to an investigation about any delays in construction and also relevant data, revisions and modifications by the constructional parties. (Table I). The considered questionnaire is for serious evaluation of specified reasons.

Group index is as follows by the use of average indexes of severity in each group and as follows:

$$\text{Group severity index (\%)} = \frac{\sum_{i=1}^n X_i}{n}$$

Where: X_i is the same severity index if i in relevant group and n is the same number of reasons in each group.

The parties of this research are consultants and contractors approved by Iranian Contractors Union in the field of special contractual jobs. The required information of contractors and consultants were obtained from Iranian Contractors Union including the address, grades and their names. (Personal communications, 2012). Employers have not been included in this research because dam making projects are some general projects which are always financed directly by government (Employer). This means that there is only one employer for which it is impossible to study relevant viewpoint through a questionnaire. Also we used simple random sampling for selection of participants.

Data collection was through analysis and by the use of severity index and considering the viewpoints of contractors and consultants. There was an agreement for classification of delay reasons among contractors and consultants. There were some instructions for minimizing any delays in constructional projects by focusing on the study results.

Designing of questionnaire

The above-mentioned questionnaire was divided into two major parts. Part I was related to general information of both company and respondent. Both contractors and consultants were asked to answer to the questions with regard to their experiences in construction industry and also according to their own viewpoints and ideas about any overrun in concerned projects. Part II includes a list of specified reasons of delay in dam making projects. The mentioned reasons were classified in eight groups and according to the resource of delay such as: Project, Employer, Contractor, Consultant, Project, Labor force, Materials, Equipment and foreign cases. There were some questions for mentioned reasons: How much the high or low degree of delays in various projects? There was a six-degree criterion as follows: Very High, High, Moderate, Low and Very low and without any effects and with zero to five degrees.

Data analysis

Classification of any reasons of delay

The proposed reasons of delay in constructional projects would be classified through measuring of severity index. Following formula is used for relevant classification and according to the specified effects by participants:

(1)

$$\text{Severity Index (\%)} = \sum a \left(\frac{n}{N} \right) * 100 / 5$$

Where:

a =Fixed weight of responds with a scope of zero for without any effects up to 5 as very high

n =Frequency of responses

N =Total number of responses

Therefore if all participants pointed out to one of the reasons without any effects, therefore the severity index is equal to zero.

This means that mentioned reason was irrelevant and would be remained in relevant classification. In contrast, if all responses are about very high interfering therefore the severity index is equal to 100. This means that this reason has a high relation and is considered as the first case in our classification. Table II illustrates possible scopes for severity index and effective level.

Severity index for each reason is based upon equation (1) which may be calculated from combined viewpoint of contractor and consultant.

The group index was calculated by using the average of the severity indexes of the reasons under each group as follows:

$$\text{Group severity index (\%)} = \frac{\sum_{i=1}^n X_i}{n} \quad (2)$$

Where:

X_i = Severity index of cause i under the group

n = number of causes under the group

Rank correlation

Spearman rank correlation has been used for measuring any correlation between both lists of classification out of sample observation. This test is used for obtaining and comparing any agreement rate of contractors and consultants for the reasons of delay.

The obtained positive relation ($r_s=+1$) points out to two sample classification while negative one ($r_s=-1$) is related to classification of both samples and their converse relation. It is assumed that mentioned sample is able to estimate any correct relation with considered correlation while any amounts close to zero show any lack of relation or a weak one. Following formula is used for calculation of Spearman correlation:

$$r_s = 1 - \left[\frac{6 \sum d^2}{n^3 - n} \right] \quad (3)$$

Where:

r_s = Spearman rank correlation between both parties

d = Any difference between relevant groups and variants of each reason

n = Number of pairs at each group

Findings & Results

General specifications of respondents

About 37 contractors and 37 consultants received the concerned questionnaire. They were requested to classify 52 reasons of delay by the use of general criterion. Totally 34 contractors and 30 consultants filled out the questionnaires. The responding rate by contractors and consultants were respectively %92 and %81. Both groups of consultants and contractors had averagely 12 years of experience.

Analysis of overrun in dam making projects

Followings are relevant analysis of responses by contractors and consultants about any delay in dam making projects within last 7 years:

- About %75 of contractors of this research point out to this problem that any average delay in most projects are experienced between %50 and %70 of primary period of project.
- About %20 of contractors of this research pointed out that %70-%90 of delays were compared with primary specific period.
- About %70 of consultants pointed out that average delay in most projects was about %50 and %70 of primary period of project.
- About %25 of consultants pointed out that %70-%90 of delays are related to primary period of project.
- About %5 of consultants pointed to %70-%100 of delays

- None of consultants and contractors pointed out to any delay more than %100 of primary period of contract.

Figures 1 & 2 illustrate some of respondents of participants about overruns in dam making projects within last 7 years.

Classification of delay reasons

All presented reasons as below each group would be classified through measuring of severity index and according to equation (1).

Project group

Table 3 illustrates the severity index and classification of reasons in project group from viewpoint of contractors, consultants and composed attitudes of both mentioned parties. Table 3 illustrates the most serious reasons from all viewpoints with lowest bid price.

Table 3 illustrates similar classified reasons from viewpoint of contractors and consultants. It is obvious that severity index from composed viewpoint for any reasons of present group has a wide life span from %42 to %75.

The obtained results point out to the highest rate of reasons in this group which is any difference in severity index and more than %15.

Owner group

About 11 reasons are classified in this group. Table 4 illustrates the highest reasons effective on combined viewpoints and contractors which are the same delay in salary by the owner.

Table 4 shows that both contractors and consultants have completely similar viewpoints. But they have clear differences in some classifications of project with a scope of 8 and 5 respectively from viewpoint of contractors and consultants.

Also table 4 illustrates severity index from composed viewpoint and relevant reasons of employer with a short life span. Its scope is 49 to 69. This means that the effect of reasons has a scope from moderate up to high rate.

Contractors group

About 10 causes are listed under this group. Table 5 illustrates the highest causes from a composed viewpoint which is a contrast between contractors and other parties.

Table 5 illustrates that classification of causes are similar from viewpoint of contractors and consultants. But there is a specific difference in classification of causes as well:

- Any problems in financial supply of project by contractor in a way to have a rank 1 and 4 from viewpoint of contractors and consultants.
- Ineffective scheduling of project by contractor which has a scope of 5 and 1 from viewpoint of contractors and consultants.

Table 5 shows that severity index of a combined view has a short span in related to contractor and a rank of 44 to 64. This means that reasons effect ranks from average to high.

Consultants group

Table 6 shows the severity index and classification of all mentioned causes in consultants group. About five causes are specified in this group. Table 6 shows the most serious cause for delay from contractors' view which is delay in inspection by consultant.

Table 6 shows that no significant difference is obvious in causes from viewpoint of contractors and consultants. According to the results it is obvious that severity index has a short span for delay causes in project group and a range of %40 to %55. This means that all causes of this group have a moderate effect on delay in dam making projects.

Design group

Table 7 shows the severity index and classification of all causes in design group. There are three causes in this group.

Table 7 shows the most sever causes from all viewpoints which is any delay in designing tasks.

Table 7 shows that classification of reasons is exactly similar from viewpoint of contractors and consultants. According to the results, it is obvious that severity index has a short span for causes of this group and a rank from %39 to %52. This means that all causes of this group have a little or moderate effect on delay in dam making projects.

External group

About seven causes are listed in this group. Table 8 shows some major and effective reasons on delay from viewpoint of consultants in political conditions.

Table 8 shows that no significant difference is obvious in causes from viewpoint of contractors and consultants. In contrast, they are completely the same. According to the results it is obvious that a long span is defined for delay causes in external group from %30 to %85. This means a rank of low up to very high for effects. According to the results, two major reasons of this group are signaling the cases with high level of effects.

Workers' group

Table 9 shows the severity index and classification of any causes in workers' group. There are five reasons in this group. Table 9 shows the most sever cause which is low efficiency of workers.

Table 9 shows that both contractors and consultants have similar classification of causes. But they are different in following causes:

- Low level of skills of operators in benefiting from equipment which may cause presenting of groups 2 and 4 from viewpoint of contractors and consultants
- Personal conflicts among workers as mentioned in classifications 5 and 3 from view of contractors and consultants.

Materials & Equipment group

About four reasons are listed in this group. Table 10 shows the highest and most effective causes of delay which is lack of equipment. Table 10 shows various classifications of causes from view of contractors and consultants which are completely similar. According to the results, severity index from combined view is related to external group have wide span and rank. Its rank is from 50 to 69 that mean moderate effects of all causes mentioned in this group.

Ranking of general causes

Table 11 shows the severity index and ranking of all 52 causes of delay in dam making projects at Iran from view of contractors and consultants and combined view.

Table 11 shows that both groups of reasons for severity index are available with target more than %80 and as follows:

- Political conditions
- Classification of sanctions

According to the results, only one of the causes of severity index is more than %70 which is granting of project with lowest proposed price in a bid. Table 11 shows that only three presented causes are related to severity index lower than %40 as follows:

- Non-suitable designing
- Monopoly
- Natural disasters

Five major causes

Table 12 explains a classification of five major causes of delay in dam making projects. This table shows that two causes are related with external group. It means that two cases are related to owner group and one for workers' group. According

to the results, two major causes have a severity index more than %80. In addition, it has been revealed that five major causes have a severity index more than %70.

Table 14 shows five major causes of delay from combined view. Combined view shows that political conditions are the major effective cause with severity index of %84.69. According to the results, two major causes are related with external group.

Table 14 shows that two major causes out of five items are common among consultants and contractors as mentioned in tables 12 and 13.

- Political conditions
- Classification of sanctions

Five major causes in agreement or disagreement Table 15 explains five major causes of delay in any agreements among contractors and consultants. The mentioned causes have little differences in severity index from view of contractors and consultants. According to the results, current differences are lower than %1.

Table 16 shows the five top causes of delay in disagreement of contractors and consultants which are the same differences in severity index among contractors and consultants. Table 16 shows the absolute difference in severity index with a rank from %13 to %16.

Classification of groups

Causes of delay are classified in eight groups. The classifications are related with severity degree from view of contractors and consultants as mentioned in tables 17-19.

Table 17 shows three top groups of delay in dam making projects as follows:

- Employer (Severity index= %62.09)
- Materials & equipment (Severity index=%60)
- Workers (Severity index= %58.59)

Table 17 shows that severity index of groups with short span have a rank from 49 to 62. According to the results, design group is one of the lowest severity index equal to %49.02.

Table 18 shows three top groups of delay in dam making project from consultants' view as follows:

- Materials & equipment (Severity index=%60.5)
- Contractors (Severity index= %60.47)
- Owner (Severity index=%56.73)

Table 18 shows the severity indexes of a group with a short span and a rank from 41.3 to 60.5. According to the results, design group is one of the groups with lowest severity index equal to %41.33.

Table 18 shows the severity indexes of different groups with short span. Its rank is variable from %54.4 up to %60.2. According to the results, design group has the lowest rate of severity index with a value %45.42.

Correlation of severity rank

Spearman rank correlation has been used for comparing the agreement rate of contractors and consultants on severity of delay causes in dam making projects. Also equation (3) was used for the same purpose. According to the results, there is a suitable agreement among contractors and consultants up to %75. Due to the relevant agreement between both parties for classifying of delay reasons, the obtained results of this study are reliable and confident.

Discussion & Results

Top five major causes of delay

Political conditions

Political conditions in Iran are defined as a non-fixed condition resulted from international sanctions. Such a situation would be resulted in an increase in materials and lack of

resources, limitations in import of materials and delay. The mentioned results may usually cause an increase in total costs of project. The real reason of delay has not been specified in content of any researches.

Classification of foreign sanctions

Classification of sanctions means dividing of them into different sectors which may limit or prevent any import of goods and services for these projects. Any classification due to sanctions of U.S.A will cause limited free movement of business. For instance the sanctions may cause a delay or prevention from timely arrival of materials and equipment to the constructional site. Classification has bad effects on work activities and delay in job because it may reduce the quantity of equipment and building materials. Such a reason has not been mentioned in any other researches.

Granting of project to lowest bid price

Owners grant their projects to the lowest bidders. But usually the lowest bid price belongs to those contractors with minimum experience level and without enough resources and facilities which may cause weak functions and further delays in job completion. As a result, any pre-evaluation of standards and granting of cases may prevent from any further problems and controls. This result has been approved through a research by Alkhalil & Alghofli (1999) and also Lou et al. (2006) in a way that awarding the project with lowest price is one of the major reasons of delay.

Payment delay by owner

Constructional jobs are involved with great daily costs in a way that most of contractors are unable to supply these costs especially when there is some delays in their salary payments. Because of any delay in salary payment by owner, there is some delays in work progress due to non-enough cash for supporting of constructional costs especially for contractors who are not satisfied financially.

“Delay in payment” is also a critical cause of delay in other countries such as Saudi Arabia (Asef et al. 1995, Alhaji, 2006) (Group 2 in both studies), Kuwait (Kooshki et al. 2005), (Group 2), Malaysia (Sambasivan & Soon, 2007), (Group 4), Ghana (Frimpong et al., 2003), (Group 1) and Nigeria (Aibinu and Jagboro 2002), (Group 2), Gandomi (2008).

Lack of equipment

Most of contractual companies of Central Bank are small in size and therefore most of contractors have no more equipment required for construction. Usually the mentioned companies have no chance just to rent required equipment. When there are lots of constructional project, there is a reduction in quantity of equipment and as a result it is impossible to have good maintenance of hem. This may cause a weakness in equipment and further delays in projects. In addition, political conditions and various limitations in import may cause some problems in investment and purchase of new equipment. This is for approving a research by Aibinu and Jagboro (2002) in which the critical reason of delay was lack of equipment.

Various instructions for reducing overrun in dam making

Following points can be recommended for all involved parties in order to control any delays in construction projects of dam making:

1- Performing of continuous educational programs with cooperation of Iranian Syndicate Contractors' Union for upgrading managerial skills of involved parties in the field of dam making and job skills

- Accepting of risk when the made delay is due to small size of companies and lack of capital.

- Modifying and development of rules for responding to orders, new regulations for more profits of companies

2- Owners should pay more attention to following cases:

- Allow enough time for proper planning and finding documented data and submission of tender. This helps to avoid any errors and omission and further prevention of overrun and delay in work performance.
- Timely payment of contractors because it is effective on financial facilities of contractors and correct performance of job.
- Evaluation of all resources and facilities prior to granting of contract with lowest proposed price
- Check for complete site evaluation at the same planning phase in order to prevent from any overrun through construction phase.

• Better communications with other involved parties (consultants & contractors) for making suitable decisions

3- Contractors are obliged to consider following cases:

- They should hire enough and skilled staff for constructional projects especially in very great size projects.
- They should encourage higher percentage of skilled workers for increasing of output.
- Contractors are obliged to manage their financial resources and specify cash flow for payment of salary.
- Supply enough equipment for obtaining reliable equipment and/or new ones along with new investments.
- Better communications with other constructional parties (consultants & owners) for obtaining the goals in a better form and concerned time and with suitable costs and quality.

4- Consultants are obliged to pay attention to the following cases:

- Present complete information for easy interpretation of drawings and settings.
- To be more reflective in contractual jobs with better obligations against high quality and costs.

Conclusion

Various causes of delay in dam making projects of Iran were defined in this research. This paper intends to study any delay causes from viewpoint of contractors and consultants. Through a complete review of content, about 52 causes were specified for delay. We classified the mentioned causes into eight groups. Field research includes 34 contractors and 30 consultants.

According to an analysis of responses by contractors and consultants about overrun of dam making projects were as follows according to their various experiences within last 7 years:

- About %75 of contractors and %70 of consultants are pointing out that moderate delay in most projects is experienced between %50 and %70 of primary period of project.
- About %20 of contractors and %25 of consultants pointed out that %70-%90 of delays are compared with primary period of project.

None of consultants and contractors pointed out to any time delay more than %100 of primary period of contract.

The above-mentioned results are in compliance with most of previous studies in the field of overrun as a phenomenon in dam making projects. (Ahmad et al. 2003, Nega 2008, Caliba, 2009). This may support from previous study by Alnajjar (2008). It was specified that construction industry is suffering from various effective problems in relevant projects. The mentioned problems include political conditions, territorial problems and financing difficulties.

Table I: List of reasons of delay and relevant group

Major group	Reasons according to each group
1-Project group	Award the project to lowest bid price
	Disturbance to public activities
	Limited construction area
	Inconvenient site access
	Poor ground condition
	Poor soil quality
	Poor terrain condition
2-Owner group	Progress payments delay by owner
	Delays in decision making by owner
	Poor communication by owner with other construction parties
	Unreasonable project time frame
	Financial status of owner
	Delay in approving sample materials
	Undefined scope of working
	Late land handover by owner
	Change orders by owner during construction
	Late issuing of approval documents by owner
3-Materials & Equipment group	Lack of equipment efficiency
	Shortage of equipment
	Changes in material types and specifications during construction
	Shortage in construction material
4-Laborers group	Low productivity of laborers
	Low level of equipment –operator’s skill
	Insufficient laborers
	Personal conflict between laborers and management team
	Personal conflicts among laborers
5-External group	Segmentation of the West Bank and limited movement between areas
	Political situation
	Exchange rate fluctuation
	Changing of bankers’ policy for loans
	Weather condition
	Monopoly
6-Design group	Natural disaster
	Late design works
	Mistake in design
7-Contrator group	Inappropriate design
	Difficulties in financing project by contractor
	Poor communication by contractor with other construction parties
	Conflict between contractor and other parties
	Poor resource management
	Rework because of errors during construction
	Ineffective scheduling of project by contractor
	Poor qualification of the contractors’ technical staff
	Delay in commencement
	Poor site supervision by contractor
Improper construction method	
8-Consultant group	Inflexibility of consultant
	Poor communication by consultant with other construction parties
	Delay in performing inspection by consultant
	Incapable inspectors
	Insufficient inspectors

Table II: Severity index Scale and Corresponding Impact Level

Range (%)	Impact level
0	No influence
0-20	Very low
20-40	Low
40-60	Moderate
60-80	High
80-100	Very high

Table 3: Ranking of reasons under project group

Cause	Combined view		Contractors’ view		Consultants’ view	
	Severity index	Rank	Severity index	Rank	Severity index	Rank

Award project to lowest bid price	75.00	1	69.41	1	81.33	1
Disturbance to public activities	60.31	2	57.06	3	64.00	2
Limited construction area	58.75	3	54.71	4	63.33	3
Inconvenient site access	56.88	4	58.24	2	55.33	4
Poor soil quality	44.38	5	47.06	6	41.33	5
Poor terrain condition	43.13	6	50.59	5	34.67	7
Poor ground condition	42.50	7	44.12	7	40.67	6

Table 4: Ranking of reasons under owner group

Cause	Combined view		Contractors' view		Consultants' view	
	Severity index	Rank	Severity index	Rank	Severity index	Rank
Progress payments delay by owner	69.38	1	71.18	1	67.33	1
Delays in decision making by owner	68.44	2	70.00	2	66.67	4
Delay in approving sample materials	67.19	3	66.47	3	68.00	1
Poor communication by owner with other construction parties	66.88	4	66.47	4	67.33	2
Postponement of project by owner	61.88	5	58.82	8	65.33	5
Change orders by owner during construction	58.44	6	64.12	5	52.00	6
Financial status of owner	56.88	7	61.18	6	52.00	7
Unreasonable project time frame	55.94	8	60.00	7	51.33	8
Late land handover by owner	51.88	9	56.47	9	46.67	10
Undefined scope of working	51.56	10	55.29	10	47.33	9
Late issuing of approval documents by owner	46.88	11	52.94	11	40.00	11

Table 5: Ranking of reasons under contractors group

Cause	Combined view		Contractors' view		Consultants' view	
	Severity index	Rank	Severity index	Rank	Severity index	Rank
Conflict between contractor and other parties	64.38	1	62.35	2	66.67	3
Poor communication by contractor with other construction parties	64.06	2	61.18	3	67.33	2
Difficulties in financing project by contractor	63.13	3	63.53	1	62.67	4
Ineffective scheduling of project by contractor	62.19	4	55.29	5	70.00	1
Rework because of errors during construction	58.75	5	55.29	6	62.67	5
Delay in commencement	58.44	6	55.29	4	62.00	6
Poor qualification of the contractors' technical staff	54.69	7	54.71	7	54.67	8
Poor resource management	53.44	8	51.76	8	55.33	7
Poor site supervision by contractor	51.56	9	50.59	9	52.67	9
Improper construction method	44.69	10	39.41	10	50.67	10

Table 6: Ranking of reasons under consultants group

Cause	Combined view		Contractors' view		Consultants' view	
	Severity index	Rank	Severity index	Rank	Severity index	Rank
Delay in performing inspection by consultant	55.31	1	61.76	1	48.00	2
Inflexibility of consultant	55.31	2	56.47	2	54.00	1
Poor communication by consultant with other construction parties	51.25	3	54.12	4	48.00	3
Incapable inspectors	48.44	4	55.88	3	40.00	4
Insufficient inspectors	40.94	5	45.88	5	35.33	5

Table 7: Ranking of reasons under design group

Cause	Combined view		Contractors' view		Consultants' view	
	Severity index	Rank	Severity index	Rank	Severity index	Rank
Late design works	51.56	1	57.06	1	45.33	1
Mistake in design	45.00	2	47.65	2	42.00	2
Inappropriate design	39.69	3	42.35	3	36.67	3

Table 8: Ranking of reasons under external group

Cause	Combined view		Contractors' view		Consultants' view	
	Severity index	Rank	Severity index	Rank	Severity index	Rank
Political conditions	84.69	1	82.94	2	86.67	1
Classification of sanctions	83.75	2	84.12	1	83.33	2
Fluctuations in currency rate	56.88	3	52.94	3	61.33	3
Climatic condition	46.25	4	48.82	4	43.33	4
Changes in banking policies for loan	42.50	5	42.35	5	42.67	5
Monopoly	38.13	6	38.82	6	37.33	6
Natural disasters	30.31	7	30.59	7	30.00	7

Table 9: Ranking of reasons under workers' group

Cause	Combined view		Contractors' view		Consultants' view	
	Severity index	Rank	Severity index	Rank	Severity index	Rank
Low productivity of employees	67.81	1	70.00	1	65.33	1
Low level of equipment-operators' skill	62.50	2	68.82	2	55.33	4
Insufficient workers	61.25	3	61.18	3	61.33	2
Personal conflicts among employees	49.69	4	43.53	5	46.67	3
Personal conflict between employees and management team	47.19	5	49.41	4	44.67	5

Table 10: Ranking of reasons under Materials & Equipment group

Cause	Combined view		Contractors' view		Consultants' view	
	Severity index	Rank	Severity index	Rank	Severity index	Rank
Shortage of equipment	69.06	1	66.47	1	72.00	1
Lack of equipment efficiency	63.75	2	61.76	2	66.00	2
Changes in material types and specifications during construction	57.81	3	55.29	4	60.67	3
Shortage in construction material	50.31	4	56.47	3	43.33	4

Table 11: General ranking of delays

Cause	Combined view		Contractors' view		Consultants' view	
	Severity index	Rank	Severity index	Rank	Severity index	Rank
Political conditions	84.69	1	82.94	2	86.67	1
Classification of sanctions	83.75	2	84.12	1	83.33	2
Award project to lowest bid price	75.00	3	69.41	6	81.33	3
Progress payments delay by owner	69.38	4	71.18	3	67.33	7
Shortage of equipment	69.06	5	66.47	8	72.00	4
Delays in decision making by owner	68.44	6	70.00	4	66.67	10
Low productivity of laborers	67.81	7	70.00	5	65.33	13
Delay in approving sample materials	67.19	8	66.47	9	68.00	6
Poor communication by owner with other construction parties	66.88	9	66.47	10	67.33	8
Conflict between contractor and other parties	64.38	10	62.35	13	66.67	11
Poor communication by contractor with other construction parties	64.06	11	61.18	16	67.33	9
Lack of equipment efficiency	63.75	12	61.76	14	66.00	12
Difficulties in financing project by contractor	63.13	13	63.53	12	62.67	17
Low level of equipment-operator's skill	62.50	14	68.82	7	55.33	24
Ineffective scheduling of project by contractor	62.19	15	55.29	28	70.00	5
Postponement of project by owner	61.88	16	58.82	20	65.33	14
Insufficient laborers	61.25	17	61.18	17	61.33	20
Disturbance to public activities	60.31	18	57.06	22	64.00	15
Limited construction area	58.75	19	54.71	33	63.33	16
Rework because of errors during construction	58.75	20	55.29	29	62.67	18
Delay in commencement	58.44	22	55.29	30	62.00	19
Change orders by owner during construction	58.44	21	64.12	11	52.00	30
Changes in material types and specifications during construction	57.81	23	55.29	31	60.67	22
Exchange rate fluctuation	56.88	26	52.94	36	61.33	21
Inconvenient site access	56.88	24	58.24	21	55.33	25
Financial status of owner	56.88	25	61.18	18	52.00	31
Unreasonable project time frame	55.94	27	60.00	19	51.33	32
Inflexibility of consultant	55.31	29	56.47	24	54.00	28
Delay in performing inspection by consultant	55.31	28	61.76	15	48.00	34
Poor qualification of the contractor's technical staff	54.69	30	54.71	34	54.67	27
Poor resource management	53.44	31	51.76	38	55.33	26
Late land hand-over by owner	51.88	32	56.47	25	46.67	37
Poor site supervision by contractor	51.56	34	50.59	39	52.67	29
Undefined scope of working	51.56	33	55.29	32	47.33	36
Late design works	51.56	35	57.06	23	45.33	38
Poor communication by consultant with other construction parties	51.25	36	54.12	35	48.00	35
Shortage in construction material	50.31	37	56.47	26	43.33	40
Personal conflicts among laborers	49.69	38	43.53	47	56.67	23
Incapable inspectors	48.44	39	55.88	27	40.00	46
Personal conflict between laborers and management team	47.19	40	49.41	41	44.67	39
Late issuing of approval documents by owner	46.88	41	52.94	37	40.00	47
Weather condition	46.25	42	48.82	42	43.33	41
Mistake in design	45.00	43	47.65	43	42.00	43
Improper construction method	44.69	44	39.41	50	50.67	33
Poor soil quality	44.38	45	47.06	44	41.33	44
Poor terrain condition	43.13	46	50.59	40	34.67	51

Changing of banker's policy for loans	42.50	47	42.35	48	42.67	42
Poor ground condition	42.50	48	44.12	46	40.67	45
Insufficient inspectors	40.94	49	45.88	45	35.33	50
Inappropriate design	39.69	50	42.35	49	36.67	49
Monopoly	38.13	51	38.82	51	37.33	48
Natural disasters	30.31	52	30.59	52	30.00	52

Table 13: Top five causes of delay and relevant groups of consultants view

Cause	Relevant group	Severity index	Rank
Political conditions	External	86.67	1
Classification of sanctions & limitations for import of materials	External	83.33	2
Award of project with lowest proposed price	Project	81.33	3
Reduction in equipment	Equipment & materials	72.00	4
Non-suitable scheduling of project by contractor	Contractor	70.00	5

Table 14: Top five causes of delay and relevant groups of combined view

Cause	Relevant group	Severity index	Rank
Political conditions	External	84.69	1
Classification of sanctions & limitations for import of materials	External	83.75	2
Award of project with lowest proposed price	Project	75.00	3
Delay in payment by owner	Owner	69.38	4
Reduction in equipment	Equipment	69.06	5

Table 15: Top five delay causes in agreement between contractors and consultants

Cause	Combined view		Contractors' view		Absolute difference in index value
	Severity index	Overall Rank	Severity index	Overall Rank	
Poor qualification of the contractors' technical staff	54.71	34	54.67	27	0.04
Insufficient workers	61.18	19	61.33	20	0.16
Changing of banking policy for loans	42.35	49	42.67	42	0.31
Natural disasters	30.59	52	30.00	52	0.59
Sanctions and limited import	84.12	1	83.33	2	0.78

Table 16: Top five delay causes in disagreement between contractors and consultants

Cause	Combined view		Contractors' view		Absolute difference in index value
	Severity index	Overall Rank	Severity index	Overall Rank	
Low level of equipment-operators' skill	68.82	7	55.33	24	13.49
Delay in performing inspection by consultant	61.76	15	48.00	34	13.76
Ineffective scheduling of project by contractor	55.29	30	70.00	5	14.71
Incapable inspectors	55.88	27	40.00	46	15.88
Poor terrain condition	50.59	39	34.67	51	15.92

Table 17: Main groups ranking from contractors' view

Group	Severity index	Rank
Owner	62.09	1
Materials & Equipment	60.00	2
Workers	58.59	3
Contractor	54.94	4
Owner	54.82	5
Project	54.45	6
External	54.37	7
Design	49.02	8

Table 18: Main groups ranking from consultants' view

Group	Severity index	Rank
Owner	60.50	1
Materials & Equipment	60.47	2
Workers	56.73	3
Contractor	56.67	4
Owner	54.95	5
Project	54.38	6
External	45.07	7
Design	41.33	8

Followings are top major causes of delay from combined view of contractors and consultants:

- Political conditions
- Iranian conditions in limited import
- Award of project with lowest bid price
- Delay in payment by owner
- Shortage of equipment

In contrast, followings are major five reasons at lowest cases from viewpoint of contractors and consultants:

- Weak terrain condition
- Insufficient inspectors
- Non-suitable design
- Monopoly
- Natural disasters

Spearman coefficient of %75 points out that a suitable relation is there between contractors and consultants about various causes of delay.

Table 19: Main groups ranking from combined view

Group	Severity index	Rank
Owner	60.23	1
Materials & Equipment	59.80	2
Workers	57.69	3
Contractor	57.53	4
Owner	54.64	5
Project	54.42	6
External	50.25	7
Design	54.42	8

According to statistical analysis of information, it is obvious that:

- (1) The answer of none of participants was an effective reason for delay in dam making projects.
- (2) There is not any reason with lower severity index than %30
- (3) The inter-group index was between %45 and %61.

The mentioned factors have a deep relation with delays in dam making projects at Iran.

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