

Identifying The Effective Factors for Cost Overrun and Time Delay in Water Construction Projects

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Abstract—Water construction projects in Iran frequently face problems which cause cost overrun and time delay, the two most common issues in construction projects in general. The objective of this survey is to identify and quantify these problems and thus help in avoiding them. This survey represents a collection of the most significant problems found in the literature, classified into 11 groups according to their source. The questionnaire form used contains 84 questions which were answered by random engineers who work in water construction projects. The Relative Importance Weight (RIW) method is used to weight the importance of each one of the 84 problems. The focus of this survey is on overall top ten issues which are: bureaucracy in bidding method, inflation, economical condition of the government, not enough information gathered and surveys done before design, monthly payment difficulties, material cost changes, law changes by the government, financial difficulties, mode of financing and payment for completed work and changes made by the owner. A section for each of these issues provides additional information about them. In the full text of this survey the same weighting method is used to classify the main groups, and the results show that issues related to the groups of government, owner and consultant has the most significant impact. The last part of this survey describes the point of view of the engineers who took part in this survey and the recommendations they made.

Keywords—*construction projects; water construction projects; Iran construction projects; time delay; cost overrun*

I. INTRODUCTION

Project success can be defined by achieving successful technical performance, staying on planned schedule and not exceeding the initial budget or the anticipated time. In lots of construction projects across the world especially in the developing countries, most of the projects participants cannot reach their goal as finishing the project on time and without additional cost. Delay in time and cost overrun are the two most common issues that occur in a construction project. However, cost overrun is more common than time delay. It should be noted that time delay can have a different impact on the contractor and the owner, from losing money to losing other projects due to the delay. Delivering without additional time or cost depends on many factors such as personnel performance, owner, contractor, consultant, labors and design

team, availability of material and other sources, contractual relations and etc.

Project management techniques play an important role in having a complete organized project which covers managing the materials, people, machinery, budget and methods used. This study, investigates factors that affect the time and cost in water construction projects specifically in Iran by the means of identifying and ranking them according to their importance. The outcome can help all practitioners to develop a more complete view of the factors causing cost overrun and time delay for constructing water projects, and provide guidance and some recommendations for efficient solution for construction managers.

II. AIM AND OBJECTIVES

The objectives of this work is an attempt to show the common causes of delay and cost overrun in construction projects in developing countries and identify and examine these factors according to engineers that participate in water construction projects in Iran.

To summarize the main objectives of this survey:

- To study the factors that developing countries other than Iran, face in construction projects (especially water construction projects)
- To identify the main issues that influence the time and cost schedule of water construction projects in Iran
- To examine the importance of the studied issues
- To identify which group is more responsible about delay and overrun in a given project
- To give some information and recommendation about the top ten of this list

III. LITERATURE REVIEWS

Because of the nature of groundwater projects the main factors for time delay and cost overrun are generally the following:

- Bad planning that causes poor technical performance
- Not enough procurement procedures.

- Schedule not updated frequently
- Not enough attention to resources allocation (human, financial and material resources)
- Lack of management experience from contractors
- Financial difficulties (owner/contractor)
- Design changes

Literature reviews are selected from countries which are somehow similar to Iran in terms of weather, geographical location or being a developing country. The considered countries are Nigeria, Ghana, Saudi Arabia, Vietnam and Pakistan.

A. Nigeria [1]

A problem that surfaces is that most of the projects are given to the lowest bidder and lots of these bidders have a lack of experience in management and neglect the importance of contractor's plan, cost control and site management. An added reasoning in [1] is that many contractors are entrepreneurs who are in business of making money instead of good management. Material procurement and poor technical support are two other top-ranked problems in [1].

B. Ghana [2, 3].

The information for the study in Ghana was collected by questionnaire from three groups:

1. owners as key decision-makers
2. consultants from groundwater projects
3. contractors from drilling projects

Results show that there are several factors that may cause cost overrun and time delay. The top five of these factors which are agreed between owners, consultants and contractors can be name as monthly payment difficulties from agencies, poor contractor management, material procurement, poor technical performance and change in the price rate of material. However, there are some disagreements between owners, contractors and consultants in the rankings. For example contractors and consultants are unhappy with the monthly payments (but not the owners). Another example of this disagreement can be the poor contract management according to the study of University of Sydney [2]. The lack of experience is also hinted in this case. In addition to what mentioned above, weather and geological factors are also mentioned, as the main interest in Ghana is on groundwater construction projects.

C. Saudi Arabia [4]

Saudi Arabia was able to deliver only 31 out of 76 projects on scheduled time in the water and sewage section between 1985 and 1994. The first thing that should be considered in sewage projects is that most of these projects are in urban areas so special adjustments and safety activities should be considered. In this case, the main problems are the size of the project and finding the best bidder. In large projects, delay should be considered more possible. Most of the responsibilities of delays in construction projects fall on the

contractors, thus finding the best bidder for a project surfaces as an important factor. The solution of the government of Saudi Arabia is to divide the contractors into five different groups considering their abilities and size and then allow contractors only from specific groups (i.e. with certain background) to bid on certain projects.

D. Vietnam [5-6]

Vietnam raised its activities in the field of construction management since 2000. Vietnam has similar weather condition to Ghana (high temperature, heavy tropical rain which causes problems in the speed of the workers and material and machinery delivery). In addition, Vietnam as a country which has the history of great wars faces some not so ordinary problems, as unknown facilities and unknown war equipment may be found in construction areas.

E. Pakistan [7-8]

Pakistan is considered mainly regarding two dam projects (Koram Tangi and Demer-Bahshi). In the first case, the delay caused by changing the design of this project (increasing the height and width of the dam) caused a significant increase in the cost of the project. In the second case, due to government delays there was also a significant additional cost.

IV. FACTORS TO AVOID DELAY

A list of factors that can help minimize the project delays according to [9] is given below:

1. Continuous meeting between different groups of a construction project
2. Using reasonably modern equipment
3. Proper material procurement
4. Sufficient and clear information
5. Keeping the record of every project's issues

V. RESEARCH METHODOLOGY

A list of 84 issues which are more common and repeated throughout the considered cases (and Iran) are collected to make a questionnaire form. A total number of 55 people asked to fill the questionnaire forms were random engineers involved in Iranian construction companies that have experience in water construction projects as consultants, contractors or owners. Analysis was made and recommendations to help minimizing delay and cost overrun are given according to the top 10 issues.

VI. QUESTIONNAIRE DESIGN

The questionnaire of this survey contains 84 issues which are found repeated, important and common in such projects. These issues are classified into 11 groups which are project (problems that can refer to more than one groups), owner, contractor, consultant, design team, material, equipment, labor, land/weather, government and extra issues (accidents, cultural and social). Each engineer was asked to rank the issues

according to the frequency and importance from very low to very high (very low- low- medium- high- very high).

VII. DATA ANALYSIS METHOD

The method used in analyzing the results of the questionnaire forms is the Relative Importance Weight (RIW). This method is used to show the importance of each factor by weighting them with the means of summing up the scores that each person gave to the issues. Every single issue can be ranked between very low to very high (very low, low, medium, high, and very high).

Relative Importance Weight (RIW) equation is:

$$RIW = \frac{\sum_{i=1}^5 a_i \cdot n_i}{\sum_{j=1}^N X_j} \times 100$$

Where a_i refers to the coefficient of each answer ($a_1=1$ for “very low” to $a_5=5$ for “very high”) and n_i refers to the number of responses for each score ($n_1=1$ for “very low” to $n_5=5$ for “very high. N refers to the number of issues which is 84 in this project. J refers to the issue number (1, 2, 3... N). X_j refers to the summation of all the answers to issue number j .

In the full text of this survey this method has been used to rank all 84 problems, classify them in each group and at last analyzing the importance of each group.

VIII. FINDINGS AND RESULTS

The results are shown in Table I. The overall results show the top 10 most important issues in water construction projects in Iran:

1. Bureaucracy in bidding methods (Owner): Iran like lots of over countries has the problems of finding the best contractor. In Iran there are 3 ways of choosing a contractor:
 - Public tender: for small projects advertisement is given to the television and newspaper to inform the contractors of the project
 - Restricted tender: a list of trusted and qualified contracted is prepared by the owner and they will be contacted to be informed and the winner will be the lowest bidder
 - No bidding: in most of the large construction projects there will be no bidding procedure and the project goes to a known and accepted contractor
2. Inflation (Government): inflation has a serious impact on employment, when the inflation rate is high companies have to reduce the number of their workers and thus the quality of their works [10]. The inflation in Iran has a couple of big changes from 1980 till this day due to the oil shock in Middle East in 1985 and 1986, the great war against Iraq for 8 years from 1980 and implementing the economic reform program between 1989-1993. In 1995 the inflation in Iran reached 49.5% which was the highest recorded and the rate of inflation is now twice as it was in 2010 (almost 25%) [11].
3. Economical condition of the government (Government): Iran has the government as the major owner of big construction projects and when the government faces economical problem this affects these construction projects.
4. Not enough surveys and information done and collected before the beginning (Design team): In a high-populated country like Iran the speed of work is important so unfortunately some design teams only do preliminary survey on the site. This lack of time for proper survey is able to cause further problems in the project.
5. Monthly payment difficulties (Owner): because of the economical problems in Iran contractors are not sure that they will be paid on schedule so they ask their money for watch section beforehand. This may cause problems since an inability of the owner to make these payments will result to contractors being less motivated to complete their task with the best quality and at exact time.
6. Inconstancy of the price of the materials (Material): Due to the fast change of exchange rates, preparing the proper material for a big construction site may be tricky and any change in the rates can result to a project costing way more than its original budget.
7. Changes in the government laws (Government): such changes is usually to compensate the damage and delay (mostly beneficial but not always).
8. Financial difficulties (Contractors): contractors poor management causes them financial problems which force them to work non-constructional on the side to compensate.
9. Mode of financing the project and the disbursement for the completed project: Most of the owners try to stay in the zone of their anticipated budget and most of the time it is possible to pay the debt to the contractor from it.
10. Changes that is done by the owner in the middle of project process (Owner): according to what mentioned in number 4 of the issues design problems may force the owner to take some new decisions and this may take significant time.

The same weighting method is used to pin point the groups that are more responsible for these issues (Table II). Based on the information gathered from engineers, issues related to the government are labeled as the most significant for time delay and cost overrun in water construction projects in Iran, followed by the owner and consultants groups.

IX. CONCLUSION

This report investigates the problems related to water construction projects in Iran through the use of a questionnaire designed for this project which includes 84 problems divided into 11 groups according to their source. The impact of each issue was ranked from “very low” to “very high”. In the last section of questionnaire form an space was given for additional ideas. These questionnaires were filled by random engineers who had a background in water construction projects in Iran.

Similar problems from countries somehow similar to Iran were considered to form the questionnaire. The questionnaire form results were scored by the Relative Importance Weight method which shows the importance of each issue according to their weight. Comparing the results leads the reader to the top issues in water construction projects in Iran in the view of Iranian engineers. Top overall issues are: bureaucracy in bidding method, inflation, governments economical condition, not enough survey and information before design, difficulties in owners' monthly payment, instability of the material prices,

change in government laws, financial difficulties, mode of financing and order changes by the owner.

In general, preventing ideas and considerations found on other countries are: holding continuous meetings between members, using best equipment and methods, avoid using insufficient and unclear methods, using information and educated guesses for the exact time and cost of a project. The last preventing activity can be considered to be record keeping (keeping records of previous similar projects issues and considering them in new projects).

TABLE I. RIW OF ISSUES IN WATER CONSTRUCTION PROJECTS IN IRAN

Issues	RIW	Issues	RIW
Bureaucracy in bidding method	5.1	High cost of maintenance of machinery	3.459
Inflation	4.947	Low level of efficiency from the equipment	3.459
Economical condition of the government	4.947	Mistakes and reworks wanted for them during construction	3.437
Not enough information collected and surveys done before design	4.422	Lack of sufficient contact between consultant and other groups	3.437
Monthly payment difficulties	4.356	Low level of experience in design team	3.415
Inconstancy of the price of materials	4.356	Effect of hot/cold weather on the construction and the materials	3.415
Changes in the laws provided by the government	4.356	Disagreement between consultant and design team	3.393
Financial difficulties	4.334	Domination of construction industry by foreign firms and aids	3.393
Mode of financing and payment for completed work	4.312	High number of public holidays (negative effect on incentives for contractor for finishing on time)	3.371
Sudden order change by owner during construction (Incessant variation order)	4.268	Wrong consideration about the owners requirements	3.349
Poor contract management	4.225	Lack of variety of materials in market	3.327
Poor supervision on the site	4.225	Traffic facilities	3.262
Insufficient scheduling of project by contractor	4.203	Shortage of technical and qualified personnel	3.196
Low-speed decision making process	4.115	Taxes on the construction utility and equipment (Electricity, water, telephone, etc.)	3.196
Delay in decision making for deciding the final materials selected of many available types	4.072	Suspension	3.174
Delay in delivering the site to contractor	4.049	Shortage of equipment	3.174
Problems in sub-contractors schedule for finishing the project	4.028	Low level of qualification and technical staff	3.13
Not having enough experience by consultant	4.028	High cost of the qualified personnel	3.13
Delay in accepting and performing the changes in the scope of the project by consultant	3.984	Effect of subsurface condition	3.13
Unstable cost and delay in preparing special materials	3.962	Sub-contractor delay work	3.087
Delay in delivering the imported materials	3.919	Effect of precipitation on the construction activities	3.065
Rigidity of consultant (not able to be flexible)	3.875	Third party final inspection and certification delay by a third party	3.065
Delay in producing and completing the design documents	3.875	Ground problems	3.021
Contrast and poor communication between Contractor and consultant/owner	3.831	Delay in site mobilization	2.977
Late preparation of the materials	3.809	Unexpected geological condition/ natural disaster	2.977
Poor communication and coordination with other parties	3.787	Waste on site	2.955
lack of proper mechanical equipment/machinery	3.765	Domination of construction industry by foreign firms and aids	2.933
Unclear information on the drawings	3.743	Materials damage on the site while they are needed	2.89
Unsuitable methods for construction	3.7	Sub-contractor change (cause of insufficient work)	2.846
Inadequate contractor work/ Low bid	3.7	Lack of harmony between contractor and sub-contractor	2.824
Interest rate changes (on the loans from banks)	3.7	Accidents during construction	2.824
Short contract duration	3.699	Machinery breakdown	2.758
Having complexity in the documents	3.656	Ineffective delay penalties	2.736
High transportation costs	3.656	Not using the best proper software in design	2.736
Delay in reviewing and accepting the design documents	3.634	Need of import because of lack of raw materials in country	2.715
Late action in inspection and testing by consultant	3.634	Level of creativity of the labors	2.583
Delay in gaining the needed permissions from municipality	3.612	Nationality of the labors	2.561
Contrast between joint-ownership of the project	3.568	Delay in providing the utilities on the site	2.496
Change of the types of selected materials during the construction	3.503	Late revision of the documents and approving them	2.473
Lack of skilled people in using the equipment	3.503	Legal argument between different parts	2.408
Delay in accepting the materials and drawings	3.502	Contrast between technical person and labors	2.408
Change in the documents because of mistake	3.459	Unavailability of utilities	2.255

TABLE II. RANKING OF RESPONSIBLE GROUPS FOR ISSUES

Groups	RIW
Government	336.666
Owner	331.911
Consultant	309.114
Material	302.851
Design team	297.500
Contractor	295.84
Project	274.429
Equipment	269.772
Additional	267.272
Weather and land	258.333
Labor	231.386

X. VIEWS AND RECOMMENDATIONS

Considering the point of view of the engineers, the most significant points are discussed below along with a proposal to overcome each one. In the full text of this report 9 more views and recommendations are given.

1. Choosing the bidding winner in water construction project is not as easy as other construction projects due to the size issue. Most of very large sized projects are given to big contractors and consultants. However, the bidding methods are limited because of the financial and inflation status and trust issues arise. Proposal: Lowest and highest bidders may be neglected and the bidding winner can be chosen from the remaining bidders.
2. Inflation is the main cause of material and equipment costs rises. Proposal: the government (the most usual customer) may compensate the contractor by adjusting the price lists.
3. Economic problems in 3rd world countries. Proposal: the contractors should follow the government directives about changing prices
4. Hastiness is one of the major problems for the design teams at the start of the project.. Proposal: the project should be divided into a couple of sections and when a section is under construction the next phase is studied.
5. Monthly payments due to economic problems has an impact on most of the projects as contractors usually do not risk their assets to provide further finance in a given month (when needed) and that reduces the overall speed of the process. Proposal: the length of the contract may be extended in such cases but no compensation should be given.
6. Material cost change is possible in countries with unstable economic conditions. A change the material cost will change the whole project cost estimation. Proposal: there are a couple of solutions for this matter: cutting cost of smaller projects to obtain the budget for the bigger and more important ones and collect all the needed material before implementation. Further, it is sometimes more advantageous for the owner to start its own factory for producing the needed material and machinery (Tehran Water Agencies and Gilan Water Agencies use this method).
7. Changes in country laws mostly happen due to government changing, which are considered to compensate the damages or delays. These changes are mostly beneficial, but not all of them. Contractors' financial problems, mostly due to their poor management or economical conditions. This has led the contractors to work on other projects (non-constructional) to compensate. Staying in the zone of budget estimation is important for the owners. Proposal: the owner keeps 10% of each section of the contractors work as a guarantee that the project will be done according to the estimated time and cost.

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