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Principles Governing Construction Contracts in Construction Projects and Establishing A Relationship Between Cost and Schedule

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Abstract

This research was done with the aim of identifying and ranking how to set up the commitment contract and legal measures of the owner and the investor for the construction and completion of the project on time. This research was a descriptive survey study with a mixed method (quantitative and qualitative). In this research, the statistical population of North are active experts in the field of construction and familiar with legal contracts, and 8 people were selected using the available method. The ranking and weighting of the identified criteria were done using the fuzzy method. In the next step, the best contract was selected among the existing contracts using the obtained weights. The results of the ranking of the criteria using the Swarafazi method showed insufficient management skills with a weight of 0.55 in the first place, delay by contractors with a weight of 0.35 in the second place, delay in confirming the completed work with a weight of 0.24 in the third place. Material price fluctuations with a weight of 0.15 were identified as the most influential factors in project delays and costs in the fourth place. In the next step, the best contract between the contractor and the employer was selected using the obtained weights, and the results showed that the A8 contract was the best.

Keywords: Delay in project delivery, Cost of project implementation, Caucus, Multi-criteria decision making.

1 | Introduction

The construction industry, on the one hand, is one of the most important infrastructure sectors in the current economy, and on the other hand, in terms of the fact that interest in owning real estate is institutionalized in our culture, is of special importance. This has led to an increase in land and housing transactions and has become an incentive for the owners of land and so-called shanty houses to start reconstruction and new

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construction by resorting to the financial ability of the builders. But the noteworthy point is that since in writing the provisions of many civil partnership contracts, experienced people in legal matters are not used, every day we witness the overflow of many cases to the judicial system, which needs a fundamental solution. In this research, while examining the dimensions of the current contracts, in order to prevent some disputes, alternative solutions will be provided. In residential projects in the form of partnership, based on the type and financial conditions and timing of the project, as well as existing uncertainties, different methods are used, especially for payments, in setting the contract [1].

One of the most important issues affecting the success of projects is choosing the method of their implementation based on various factors such as type, volume, amount of the project contract, completion time, the scope of authority, the existence of an efficient information system, and the responsibilities of the employer and contractor in carrying out the project, which the employer chooses. On the other hand, employers choose the best way to do the project by analyzing the methods of doing the project, paying attention to their conditions, and consulting experts in their field of activity [2].

As a result, employers should implement the project with the lowest price and the highest quality; They should pay attention to the maximum efficiency of facilities and manpower and the most reasonable time. Considering the stated content and the many problems that exist in construction project contracts and the wide variety of construction project contracts, in this research, construction participation contracts, which are very common in the western region of Mazandaran province, have been selected and we intend to examine the various dimensions of this type of contract. Check and measure its relationship with the time and cost of the project [3].

2|Delay in the Project

With the increase in the duration of construction projects, a lot of capital, including construction credits, expert manpower, and machinery and equipment, is blocked in the project. As a result, the ratio of the value of the works to exploitation and the works in progress is reduced. One of the problems affecting most of the country's construction projects is the prolongation of the project implementation period and, as a result the cost and risk increase. It should be noted that the duration of construction projects has a direct effect on the amount of investment and the efficiency of the capital used in that project. Due to the fact that the delay in carrying out the projects causes the country's financial and physical resources to be wasted in the form of half-finished projects, and sometimes the projects end so late that they no longer have economic justification and do not even meet the initial goals from a practical point of view. It is necessary not to neglect the effect of delays in the continuation of projects as well as future projects by examining and knowing the techniques and methods of delay analysis and analysis [4].

However, due to the existence of problems and unknown factors in the construction process, it will be impossible to completely prevent the occurrence of delays in the completion of projects since any delay in construction projects can cause additional costs for the factors involved in the project, In case of delays, it is necessary to determine the impact of the delays with a detailed evaluation and using the delay analysis technique, and to calculate the damage caused by the delay to each of the factors involved in the construction process, as well as to calculate the appropriate extension of the period. Delays are analyzed from several aspects, separable and finally [5].

For example, from the aspect of creating it, as an example, factors involved in projects can lead to delays in projects. To charity, that originates from the employer's performance failures, for example, thinking optimistically about the initial schedule and starting the project before the plans or requesting changes that are in the middle of the project process. The contractor's performance deficiencies cause delays, for example, rework due to inaccuracy in construction, failure to employ skilled and expert personnel in construction, failure to use up-to-date technologies in construction, as well as delays that are caused by the consultant's performance deficiencies. For example, not developing a suitable and accurate schedule and inappropriate designs that lead to errors in the contractor's activity [6].

Delays that are caused by external factors (outside the project environment), for example, are called a group of delays that are caused by outside the project and happen unexpectedly, and mostly preventing it from happening is a very difficult task that requires detailed planning and use according to experts, such as inflation, bad weather conditions, floods, and wars. No internal part of the project may be responsible for causing the delay, such as force majeure conditions which are unpredictable, unpreventable, beyond the will of the parties involved in the project, such as the employer, contractor, consultant, and make it impossible to continue work obligations [7].

Quantitative costs are costs that are tangible and material in the way that, due to the increase in project time, there is a need to spend more due to the extension of the project in other areas, such as paying more rent for machinery and paying more employees' wages. Qualitative costs are costs that Due to the increase in the project time and the lack of supply of the construction project to the market, the reputation and credibility of the company or the organization in charge of construction decreases among competitors and others.

The source of compensability also classifies delays. For example, in unforgivable delays, in addition to the fact that the payment of damages is not made to the other party, the extension of time is also not realized for the contractor. While in forgivable delays, the activity time is increased, and the payment is made to the other party. Delays have a complex structure. A delay in one activity does not necessarily result in the same amount of delay in the entire project. A delay in one part may cause a delay in the completion of the project as well as in other parts of the project [8].

3 | Causes of Delay in the Project

The causes of delay may be the employer, contractor, contract manager, third party, or due to factors beyond the control of the parties. This delay may result in a renewal of the completion time. Sometimes, only some tasks or activities are delayed and do not require an extension of time to complete, but may lead to disruption. In other words, work conditions become difficult [9].

Delay can cause damages to the employer, such as the following:

- *The result (public interest) of the investment is delayed.*
- *The amount of work increases, and problems arise in relation to the lender.*
- *Cash flow is disturbed.*

If the contractor is found responsible, he may be dismissed from continuing the work or forced to pay damages in the form of the following:

- *Damages for delay in the contract.*
- *Compensation.*
- *Loss of bonus.*
- *Or loss of good performance.*

4 | Delivery of Work

A common issue of dispute is whether the project work has been substantially completed. Then, the employer will hand over the work in such a condition that it does not impose contractual penalties or claim damages for delay. For example, in one of the cases of the International Chamber of Commerce, the contractor claims that the work of the project has the requirements of issuing a delivery certificate on a specific date and that the project can be used on that date. The project engineer refused to issue the delivery certificates on that date; based on this, a number of final works remained suspended and this prevented the testing and commissioning operations. The court ruled that in order to issue a certificate, the delivery of the work must be at a stage where it can be used profitably.

From the point of view of the court, the work items that do not disrupt the beneficial operation of the employer after the delivery certificate is issued, can be properly delivered. Based on this, the arbitration court did not see the need to reverse the engineer's decision and rejected the contractor's claim regarding the premature issuance of the delivery certificate.

5 | Identifying the Effective Factors in the Delay of the Project

Delays can be divided into forgivable (allowed), unforgivable (unallowable), compensable, and non-compensable types. If a delay is forgivable and compensable, the criticality of that delay should be determined by referring to a reliable critical path analysis. The implementation of a successful delay analysis requires the preparation of a valid and accurate program schedule. If we have a reasonable program timing, the effect of delay methods will increase significantly. It can be used as a starting point for analysis when the delay is detected. Unfortunately, there are many ways to manipulate the program schedule and project progress schedule [10].

One of the main objectives of delay analysis is to create a matrix of events along with the chronological order of the events that delay the completion time of the project. One of the important uses of this information is in the creation and validation of scheduling, such as construction. Ideally, during the duration of the project, the construction schedule is also prepared. It is necessary to keep this information for several periods in order to use it in updating the schedule [11], [12].

The process of identifying delaying events is one of the basic aspects of delay analysis and is implemented in two ways: the base cause approach-with the base effect approach.

6 | The Results of Prioritizing Indicators with the Method of Swarafazi

Step 1. In this step, the identified indicators were provided to the experts based on the order of importance and the indicators were ranked in descending order. At first, the identified indicators were coded using C1 to C2, which is shown in *Table 1*.

Table 1. Ranking of time and cost indicators in construction projects.

Rank	Identified Agent	Code
1	Inadequate management skills	C1
2	Delays by contractors	C2
3	Delay in confirming completed work	C3
4	Material price fluctuation	C4
5	Inexperience of the contractor	C5
6	Complexity of project construction	C6
7	The quality of the performance of the engineering contract	C7
8	Lack of materials	C8
9	Inadequate planning	C9
10	Make changes to the scope of the project	C10
11	Equipment failure	C11
12	Incorrect estimate	C12
13	Slow delivery of materials	C13
14	Make changes to the scope of the project	C14
15	Insufficient equipment	C15
16	Poor site organization	C16
17	Design changes	C17

Step 2. In this step, the relative importance of each index compared to the previous more important index from the point of view of each expert was compiled based on the range of verbal expressions and the corresponding fuzzy numbers and shown in *Table 2*, then the fuzzy importance of each criterion compared to its previous criterion. The calculation and its results are shown in *Table 2* [13].

Table 2. The relative importance of each index compared to the previous, more important index according to experts and the range of verbal expressions and corresponding fuzzy numbers.

Criteria	Expert 1			Expert 2			Expert 3			Expert 4		
C1	0.66	0.5	1.5	0.66	0.5	1.5	0.4	0.5	0.66	0.28	0.33	0.4
C2	1.00	1	1	0.4	0.5	0.66	0.28	0.33	0.4	0.22	0.25	0.28
C3	0.28	0.33	0.4	0.4	0.5	0.66	0.22	0.25	0.28	1	1	1
C4	0.4	0.5	0.66	0.4	0.5	0.66	0.4	0.5	0.66	0.4	0.5	0.66
C5	0.28	0.33	0.4	1	1	1	1	1	1	0.4	0.5	0.66
C6	0.22	0.25	0.28	0.28	0.33	0.4	0.28	0.33	0.4	0.4	0.5	0.66
C7	0.66	0.5	1.5	0.4	0.5	0.66	0.28	0.33	0.4	0.4	0.5	0.66
C8	0.4	0.5	0.66	0.4	0.5	0.66	0.22	0.25	0.28	0.28	0.33	0.4
C9	0.4	0.5	0.66	0.4	0.5	0.66	1	1	1	0.22	0.25	0.28
C10	0.28	0.33	0.4	0.28	0.33	0.4	0.4	0.5	0.66	1	1	1
C11	0.22	0.25	0.28	0.22	0.25	0.28	0.4	0.5	0.66	0.4	0.5	0.66
C12	1	1	1	1	1	1	0.22	0.25	0.28	1	1	1
C13	0.4	0.5	0.66	1	1	1	0.22	0.25	0.28	0.28	0.33	0.4
C14	1	1	1	0.28	0.33	0.4	0.66	0.5	1.5	0.28	0.33	0.4
C15	0.28	0.33	0.4	0.4	0.5	0.66	0.4	0.5	0.66	0.22	0.25	0.28
C16	0.28	0.33	0.4	0.28	0.33	0.4	0.28	0.33	0.4	1	1	1
C17	0.22	0.25	0.28	0.22	0.25	0.28	0.4	0.5	0.66	0.28	0.33	0.4

7 | Choosing the Best Contract by the Cocoso Method

At this stage, using the weights obtained in the Swarafazi method, the best contract has been selected using the Cocoso method.

Table 3. Characteristics of candidate options for selection.

	C1	C2	C3	C4	C5	C6	C7	C8
A1	1	2	6	9	8	7	9	2
A2	5	3	9	8	7	9	7	4
A3	3	6	8	7	2	8	9	6
A4	6	9	6	6	6	9	6	6
A5	6	7	5	3	7	6	5	3
A6	7	7	9	9	1	3	9	2
A7	1	9	7	4	8	3	7	4
A8	8	8	9	6	6	6	6	6
A9	9	6	5	2	3	6	5	3
A10	8	7	7	4	7	9	9	2

Table 4. Weight matrix of criteria and unscaled values.

	C1	C2	C3	C4	C5	C6	C7	C8
A1	0.0000	0.0000	0.2500	1.0000	1.0000	0.6667	1.0000	0.0000
A2	0.5000	0.1429	1.0000	0.8571	0.8571	1.0000	0.5000	0.5000
A3	0.2500	0.5714	0.7500	0.7143	0.1429	0.8333	1.0000	1.0000
A4	0.6250	1.0000	0.2500	0.5714	0.7143	1.0000	0.2500	1.0000
A5	0.6250	0.7143	0.0000	0.1429	0.8571	0.5000	0.0000	0.2500
A6	0.7500	0.7143	1.0000	1.0000	0.0000	0.0000	1.0000	0.0000
A7	0.0000	1.0000	0.5000	0.2857	1.0000	0.0000	0.5000	0.5000
A8	0.8750	0.8571	1.0000	0.5714	0.7143	0.5000	0.2500	1.0000
A9	1.0000	0.5714	0.0000	0.0000	0.2857	0.5000	0.0000	0.2500
A10	0.8750	0.7143	0.5000	0.2857	0.8571	1.0000	1.0000	0.0000

8 | Conclusion

The five main causes of delays in construction projects are: contractor's financial problems, delay in the approval of completed work, slow delivery of materials, poor site organization and coordination between different parties, and poor planning of resources and duration estimation. planning. The top seven weighted indicators for evaluating the success of NEC projects in Hong Kong are [14]: 1) time performance, 2) safety performance, 3) quality performance, 4) development of mutual trust and cooperation, 5) cost performance, 6) fair risk management mechanism, and 7) project team satisfaction. Analyzes the reasons for cost or time deviations that include underestimation of project budget, delays by contractors, lack of preventive measures, and addition of new items or changes in project scope. Inadequate equipment, inadequate management skills, complexity of project construction, equipment failure, and lack of materials were important factors affecting the timely completion/implementation of road construction projects in Nigeria [15], [16].

Client-related causes (CLE), consultant-related causes (COS), and contractor-related causes (CON) are among the factors affecting the time and cost of projects. Factors affecting the delay in the project include design changes, poor management at the site, delay in payment of progress by the owner, and fluctuating material prices. Design changes, poor management on the site, delays in payment of progress by the owner, and fluctuating prices of materials are among the factors affecting time and cost in construction projects.

Author Contributions

This research was carried out with the collective efforts of all authors. Fazel Siasar Nejad developed the study's concept and design. Hossein Nematian Jelodar gathered and examined the data and helped in composing and revising the manuscript. All authors have reviewed and accepted the final version of the manuscript.

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Data Availability

The datasets used and analyzed during the current study are available from the author upon reasonable request.

Conflicts of Interest

The author declares no conflicts of interest regarding this research.

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