

Validation and determination of scenarios of the contractor claim model in three-factor construction projects

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Abstract

The aim of this study is to validate and determine scenarios of the contractor claim model in three-factor construction projects. The present study is of a fundamental theoretical nature, as the situation is examined analytically. In general, a mixed method (quantitative-qualitative) is used in system dynamics studies. In this study, there are two statistical populations: theoretical experts, who are university professors whose expertise is in the field of construction, management, industries and dynamic systems, and empirical experts, who include experienced managers who are active in the positions of managing directors and managers of three-factor construction projects. The theoretical method was used for sampling, and library and internet resources, including books, articles and case studies, were used to collect data related to theoretical foundations and extract primary factors and indicators. The questions were examined using the system dynamics method test and the Vensim software. Based on the results obtained in the first cycle, the absence or shortage of materials increases the project time and consequently increases the project cost. In the second cycle, the use of specialized labor reduces the consultant's incorrect estimate and consequently reduces the employer's financial delays. In the third cycle, the delay in submitting the drawings increases the project time, which increases the project cost. In the fourth cycle, the outbreak of Corona reduces the performance and productivity of employees, which leads to a delay in submitting the drawings. In the fifth cycle, the change in technical specifications increases the delay in submitting the drawings, which increases the project time and consequently increases the project cost. As a result, the employer's profit decreases, and the use of specialized labor also decreases. As a result, the consultant's incorrect estimate increases and changes in technical specifications also increase.

Keywords: model validation, contractor claims, three-factor construction projects, dynamic C approach
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1 Introduction

Every year, a large part of the country's credits and financial resources is spent on investing in large construction and infrastructure projects. Therefore, systematic planning of these projects is essential and necessary in order to achieve the lowest cost-benefit ratio [1]. Given that most construction projects are assigned to contractors with a conventional execution system, it is necessary to pay special attention to preparing documents for these types of contracts and allocating risks related to them [2]. In Iran, despite the government's tendency to use other project

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execution methods, this construction method is still more popular according to necessity and need. Accordingly, Article 23 of the Program and Budget Law was updated on July 20, 2019, to specify the conditions for implementing the three-factor approach. This indicates the importance of the method under consideration in the country.

As a result of chronic delays, approximately 86,000 construction projects remained unfinished by the end of winter 2019. Disputes have become an inevitable part of construction projects in the country, as in other regions of the world. Given the prevalence of three-factor contracts in Iranian projects, it seems necessary to investigate and identify the factors that cause claims in order to reduce their effects or avoid them [3].

On the other hand, a major part of the capital of any country, especially developing countries, is dedicated to its construction and infrastructure projects. In fact, one of the factors of economic growth and development of any society is the success in implementing its construction projects. Therefore, since construction projects and related projects are the basic infrastructures of the development and prosperity of any country's economy, paying attention to related issues is of great importance [11]. In the meantime, construction project contractors are at the forefront of development and construction projects, and the transformation of finite capital into replicable and infrastructure capital is carried out by them. The implementation of construction projects requires the expenditure of time, money, and other resources by the relevant project factors, and the expenditure of those resources itself creates rights for the parties. Therefore, contracts in this area should be carefully considered. Accurate regulation of contracting contracts and fair distribution of responsibilities and authorities, along with the correct attitude towards dealing with contractors, should be considered [12]. In achieving the set goals, construction projects face threats and opportunities related to key project elements, including time, cost and quality. Therefore, the method of contracting with contractors is of great importance in the implementation of construction projects [14].

In recent years, the use of outsourcing has increased significantly to achieve an effective response in various projects of the organization. Organizations try to complete their projects within the defined cost, time and quality framework by selecting and directing contractors. The successful implementation of outsourced projects is a major challenge for employer organizations. Considering the important and influential role of construction projects in the industrial development of countries and the prevalence of outsourcing strategy in this industry, identifying and evaluating claims contributes significantly to the success of outsourcing projects [15]. For a long time, most organizations considered outsourcing as a support function and not as a core function, so it has always been considered as an alternative to internal departments of the organization. For many companies, outsourcing is not an activity that is carried out under their direct management, but rather an activity that they can receive from outside experts. The way in which these services are received can also have a significant impact on the efficiency and overall quality of the company's supply chain [5]. One of the important considerations in the issue of outsourcing services is the selection of the appropriate option for cooperation and outsourcing of service activities of companies, and therefore, to select a contractor from among the available contractors for outsourcing service activities, an appropriate and comprehensive process should be prepared in this regard [6]. The failure rate and the high number of incomplete projects have made this issue a research necessity. Finally, considering the fact that the conventional method of construction projects is based on a three-factor approach, this study presents a model of the impact of contractors' claims in three-factor construction projects with a system dynamics approach.

2 Theoretical foundations

2.1 Application of the three-factor method in the implementation of construction projects

The three-factor method in the implementation of construction projects was invented during the Industrial Revolution when different specialties, including design, engineering and contracting, were separated. And for many years, it has been a standard method for carrying out projects. In general, the purpose of the three-factor method in the implementation of construction projects is the way to combine and organize the services of design, procurement of goods (materials, equipment and equipment), construction (construction and installation of equipment), operation, maintenance and dismantling of project facilities. The main characteristic of this method is its three-stage implementation and the existence of separate contracts between the consultant and the employer, and the contractor with the employer. The scheduling of work is usually sequential (linear). In this method, there are three main pillars or independent entities: the employer, the consultant and the contractor.

The employer employs the consultant to design and prepare the construction documents for the project. These documents are used for the construction tender of the project, and after the tender, the contractor is selected, and then the contract is concluded.

This method has been known for many years as the standard method of carrying out projects, and its model can be used and implemented for any type of project, especially those projects that are implemented by government employers and are legally required to select contractors with the most appropriate bid price.

The stages of implementing the three-factor method of construction projects are as follows:

Design: After completing the justification stage and the employer's decision to carry out the project, the employer selects the design team and assigns them to complete the design and prepare the construction documents.

Award: After completing the design stage, the construction documents required for the construction tender are used. The contractor is selected based on the most appropriate acceptable price, and the requirements and commitments related to costs are specified.

Construction: The employer signs a construction contract with the contractor or contractors and the project implementation begins.

Another type of this method, called negotiated selection, has the same contractual conditions as the design-bid-build method; the difference is that the contractor is selected and enters the project through negotiation and agreement without holding a tender. This method is used in special cases.

Negotiated selection: By observing the relevant conditions and limitations, it can be considered as a suitable strategy for carrying out a project. This method allows for the design of the project with accurate quality. In other words, the employer and the consultant have the necessary experience and ability to consider all aspects of the designs.

The employer prefers to take direct responsibility for the work, to manage the design and construction itself or through its consultants as the employer's representative.

There is sufficient time to design the project before construction begins.

The employer prefers that the project design be completed completely and consistently (without major changes during the construction phase) before signing the contract with the contractor [7].

The main advantages of this method are its wide application, familiarity with it by project stakeholders, and linearity of the process, which makes it easy for employers to manage. The clear role of each institution, and the completion of the design before the tender stage, allows the employer to be more aware of the project details over time. On the other hand, this method makes the details clear for the contractor, reducing their risk and the possibility of submitting a lower price offer. The main disadvantage of this method is the sequential nature of the stages, which makes the implementation process longer. Another disadvantage is the separation of design and construction from each other, which leads to limited useful connections in the project implementation process and, as a result, the contractor's experience and knowledge in the field of construction and design are not used. In this method, the possibility of needing to change the design is higher than in other methods due to the low level of construction and design and its consequences, the possibility of delaying claims and increasing costs [8, 9].

2.2 Understanding the contractor claims system

Negatively considering claims and disputes and applying a negative view in dealing with them, as well as not paying attention to them, can cause problems for the project. Therefore, dealing with disputes requires a certain delicacy and art, and has an artistic aspect, as well as a scientific and experimental one. According to a definition, management means making decisions and choosing from among options. On the other hand, management is both a science and an art, so dealing with disputes requires certain management. Managing disputes and disputes will have a preventive and resolving role with a very wide functional scope. The strategies developed and implemented by the project in this regard, considering the general establishment of the management pyramid in the project, will have a comprehensive effect on the life of the project. It is possible to analyze the management of disputes and disputes from different perspectives. From the aspect of personality analysis, having authoritarian and anti-cooperation and integrity-seeking characteristics will question and affect the entire body of any system [10, 13]. Therefore, the individual personality of the manager is of particular importance in this regard. Technical and specialized knowledge also plays an undeniable role in management. If predictions and preventions remain out of the sharp eye of management, they may plague the entire project structure with the plague of disagreement. In short, given the power of spreading the spirit from the manager to other parts of the organization of each party, the lack of a spirit of cooperation will add to the differences between the parties and will have an aggravating effect. Demands in construction projects change continuously due to the interconnected nature of their various parts. Accordingly, we can imagine the claim as a smaller system in direct connection with the larger project system that also has all the characteristics of a system on its own [16]. In this view, we consider the claim as a system that is examined within the closed boundary of its environment and the effects

resulting from the mutual relationships of its components and cause and effect relationships must be displayed. It is worth noting that all considerations are described based on conditions and processes that are constantly changing and interdependent to help understand the behavior of the system and its performance. In addition, the systems approach that pays special attention to the source of feedback and the conditions that cause the system to be stable or unstable, plays a significant role in preparing the proposed models. A model can show all the factors that affect and influence the claim and the relationship of feedback loops related to the claim in the construction project system. In the model, cause and effect, which is an inherent feature of a system dynamic, is used to build a conceptual model that can show managers the essential aspects of the internal dependencies and behavior between key variables that can cause conflict, so that with this insight they can both identify appropriate solutions to prevent the occurrence of events that cause conflict in their current project and make the best decision to address and resolve them, and improve their conditions in future projects. From the model, it can be inferred that, for example, environmental factors directly affect the expectations and requirements of the employer. For example, the laws governing the project, such as the provisions of FIDIC contracts and the economic and political conditions of the country where the project is located, affect what the employer exactly wants from the contractor [17]. It should be noted that the type of contract and the method of implementation usually overshadow the project risks, which in turn affect the management of claims and finances and must be fully considered in the contractor's schedule and budgeting; otherwise, these risks will be the roots of numerous claims in the future of the project. On the other hand, the expectations and requirements of the employer also determine the scope of the project, which, if not specified correctly, will have a negative impact on the scope of the project and the scope of the project will cause errors, contradictions or ambiguity in the technical and contractual documents. Often, design errors in the technical documents lead to the employer announcing the need for changes in its technical documents to the contractor in the form of change orders, which in turn causes project delays and claims [4, 18].

3 Research method

This research aims to present a model of the impact of contractors' claims in three-factor construction projects with a system dynamics approach. This research aims to develop and validate scenarios for a contractor claim model in three-factor construction projects. It adopts a descriptive-analytical method to ensure the findings are practical and applicable. This study is of mixed type. The present research is considered a system dynamics study. In general, a mixed method (quantitative-qualitative) is used in system dynamics studies. This study is inductive-deductive in terms of logic. The statistical population of the present research, in addition to using design knowledge in this research, a survey of experts was also used to validate the design and development activities of the model. Accordingly, two statistical populations have been determined in this research; theoretical experts including university professors and empirical experts including experienced managers who work as CEOs and managers of three-factor construction projects. The theoretical expert population will be used to validate the model designed in accordance with the principles of dynamic systems. The empirical expert community is also used to design the cause-and-effect diagram and the state-flow diagram. The sampling method used is the theoretical sampling method. The first step in calculating the sample size is to define an expert based on the exact characteristics of the experts. A comprehensive and non-discriminatory definition of experts must be provided. In the present study, an expert is someone who has the following characteristics:

- Has an education related to construction project management.
- Has at least a master's degree.
- Has at least 15 years of work experience in three-factor construction projects.
- Has at least 10 years of management experience in three-factor construction projects.

In fact, this research used two library and field methods to collect information. In the present study, using relevant domestic and foreign articles, existing theoretical frameworks, as well as the opinions of experts and professors of the research committee and the interview form, the factors related to the subject were identified and the required information was collected. In this method, the primary data collection tool is a systematic interview. The system dynamics approach is used to analyze the data to model the causal relationships between variables.

Modeling in Vensim typically involves using equations and formulas to describe the relationships between variables, stocks, and flows. Here are some examples of formulas and structures commonly used in Vensim:

1. Simple Stock and Flow Equation: Stock and flow are the most basic elements in system dynamics modeling. In general, the stock equation looks like this:

$$Stock(t) = Stock(t_0) + \int_{t_0}^t (Inflow(\tau) - Outflow(\tau))d\tau \quad (3.1)$$

where, $Stock(t)$ is the value of the stock at time t , $Stock(t_0)$ is the initial value of the stock at the starting time t_0 , $Inflow(\tau)$ is the rate at which the stock is increasing at time τ , $Outflow(\tau)$ is the rate at which the stock is decreasing at time τ . The integral $\int_{t_0}^t$ accumulates the net flow (inflow minus outflow) over time from t_0 to t [4].

2. Using Delay: Delays are used to model behaviors that occur over time. For example, in manufacturing systems:

$$\frac{dX(t)}{dt} = \frac{Y(t) - X(t)}{\tau} \quad (3.2)$$

where, $X(t)$ is the delayed output at time t , $Y(t)$ is the input or desired value at time t , τ is the delay time constant, representing how quickly the system responds (larger τ means a longer delay) [4].

3. Lookup Formula: Lookup functions are used to model nonlinear relationships:

$$Output_{Value} = Lookup_{Function}(Input_{Value}) \quad (3.3)$$

here, the $Lookup_{Function}$ can be in the form of a graph or table that shows the nonlinear relationship between input and output [4].

4. Exponential Growth or Decline Power: To model exponential growth or decline, the following formula can be used:

$$X(t) = X_0 \times e^{rt} \quad (3.4)$$

where, $X(t)$ is the value of the variable at time t , X_0 is the initial value of the variable at time $t = 0$, r is the growth rate (if $r > 0$) or decay rate (if $r < 0$), e is the base of the natural logarithm, and t is time.

5. If then else function: This function is used to manage conditions and make decisions:

$$Y = \begin{cases} A, & \text{if condition is TRUE} \\ B, & \text{if condition is FALSE} \end{cases} \quad (3.5)$$

where, Y is the output of the function or results.

Condition: A logical statement that evaluates to TRUE or FALSE.

A is the value returned if the condition is TRUE, and B is the value returned if the condition is FALSE [4].

4 Research findings

4.1 State and flow diagram

The state and flow diagram of the research model is shown in the figure below. In this diagram, the variables of employer profit and employment of skilled labor are considered as state variables and the other variables are considered as flow variables.

Next, the initial behavior of some variables is shown in the following figures during the simulation period of 60 months. These diagrams are obtained from the simulation of the state and flow diagram in the Vensim software during the period of 60 months.

4.2 Simulation results

The figure below shows the simulation result for the project time variable. Over 60 months, the output demonstrates a growth pattern that aligns with the target scenario, starting near zero and rising steadily to approach a value of 100. This behavior suggests a gradual increase in project time over the specified period.

Such a growth pattern signals that delays are compounding over the project's lifecycle, potentially due to financial, resource, or scope-related issues. Project managers can leverage this insight to forecast bottlenecks and implement corrective actions, ultimately mitigating delays and driving more efficient project completion.

The following figure shows the simulation result for the project cost variable, which has the growth behavior of the target atmosphere. This chart illustrates the simulation for project cost, displaying a growth pattern that aligns with

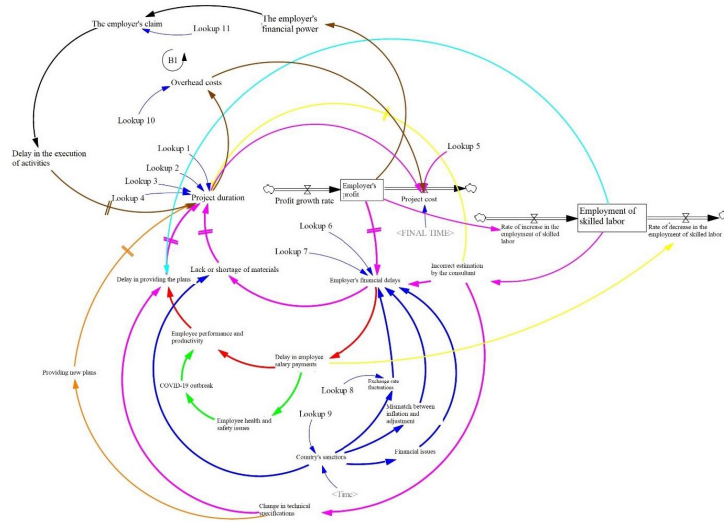


Figure 1: State Flow Diagram

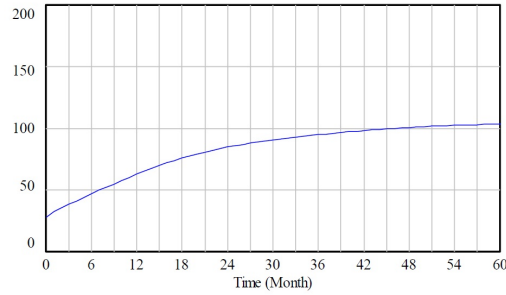


Figure 2: Time Simulation

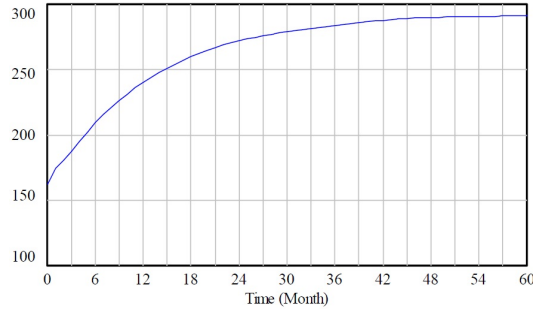


Figure 3: Cost Simulation

the projected trend. The horizontal axis represents time in months, and the vertical axis shows the cost. The curve shows costs rising rapidly initially, after which the growth rate slows and gradually stabilizes around a value of 300. This is a common pattern in projects, where initial expenditures are high, and costs then level off as the project nears completion.

The following figure shows the simulation result for the employer profit variable, which has an exponential decay behavior. The simulation for employer profit, illustrated in the chart, follows an exponential decay pattern. The value begins at approximately 200 and declines steadily over the project's timeline, eventually becoming negative. This suggests a significant erosion of profitability, likely caused by increasing costs or declining revenues, leading to potential losses.

The figure shows the simulation for employer financial delays, which exhibits a consistent growth pattern. Over 60 months, the value increases from around 50 to nearly 100. This trend indicates that financial delays from the employer

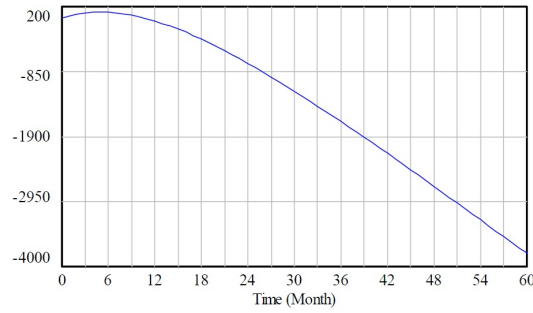


Figure 4: Employer Profit Simulation

become a progressively more severe issue as the project continues, potentially leading to significant cost overruns and schedule disruptions.

In simulation studies focusing on employer financial delays in construction projects, such delays are often linked to cash flow issues that could result in project slowdowns, disputes, and inefficiency. These financial setbacks can cause significant disruptions, leading to extended project timelines as subcontractors and suppliers require timely payments to sustain operations, potentially resulting in idle labor and increased costs.

In complex scenarios, delays in one project might affect multiple ongoing ones, creating a domino effect on scheduling and cash flow. To address these issues, simulation models suggest the importance of timely payments and enhanced communication between employers and contractors to mitigate adverse effects.

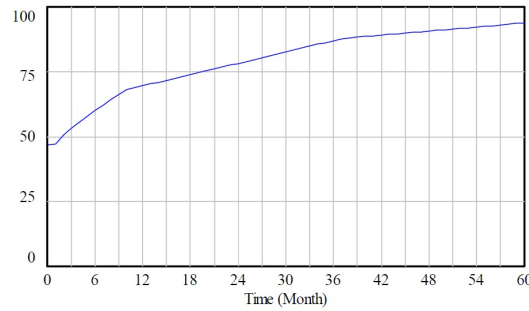


Figure 5: Simulation of financial delays

4.3 Model validation

After obtaining the state and flow diagram and before using the model for analysis, the validity of the model should be tested using one or more methods. In this study, after the simulation, the validity of the created model was examined by several tests, which are described in the following and the results of their application to the model in question will be shown.

1. Boundary adequacy test: The main question of this test is whether important concepts related to the problem are considered within the model or not. In fact, we want to check whether the behavior of the model changes significantly after removing the boundary assumptions. Therefore, by removing the ineffective variable or the shortage of materials and examining their effect on the model, the resulting changes indicate a change in the behavior of other variables, which confirms the importance of this factor. The figures below show the results of Test 1 for the project cost and time variables, which indicate the high effectiveness of Test 1
2. Limit condition test: This test examines whether the model behaves appropriately when its inputs are in limit conditions such as zero or infinity. In other words, in this test, the stability of the model in measured limit conditions is displayed. To examine this test, the influential variable of overhead costs has increased tenfold (in the high limit state) and its results are shown in the graphs below.
The above figures clearly show the effectiveness of the model for boundary conditions.
3. Sensitivity Analysis Test: This test examines the reasonableness of the sensitivity analysis results for different model parameters. For example, with a 50% increase in the change in technical specifications, it is expected that the project time and cost will increase, which is also confirmed by the results of the sensitivity analysis test.

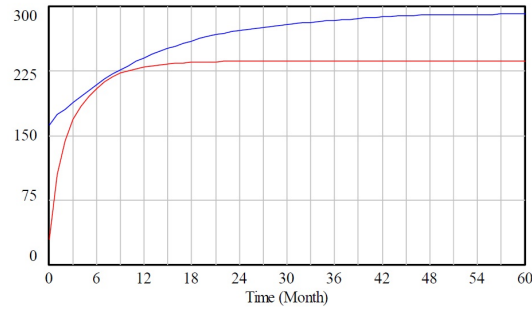


Figure 6: Validation 1

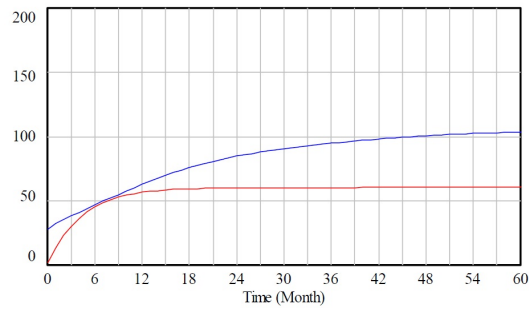


Figure 7: Validation 2

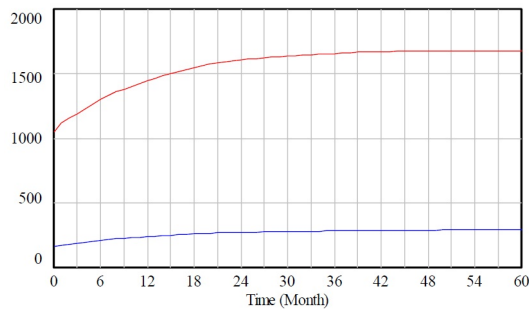


Figure 8: Validation 3

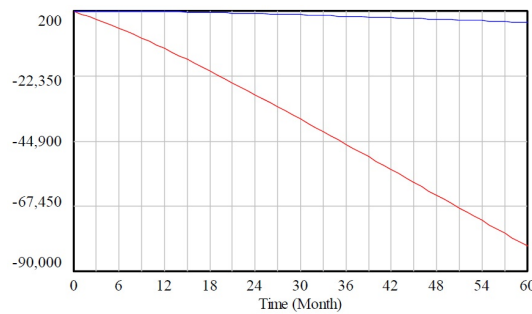


Figure 9: Validation 4

4. Parameter Verification Test: This test shows the verification of the simulated value for a parameter compared to the value in the real world. That is, the value of the parameters is expected to be within the reasonable range found in the real world. For example, the values obtained for the project cost variable indicate a logical and increasing trend with this variable.

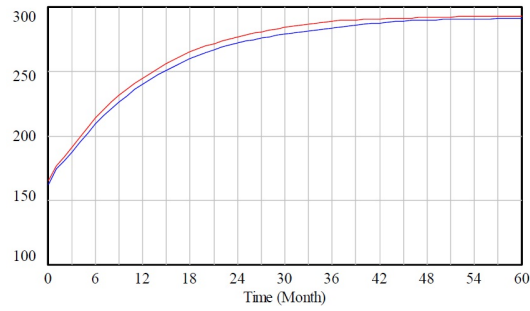


Figure 10: Validation 5

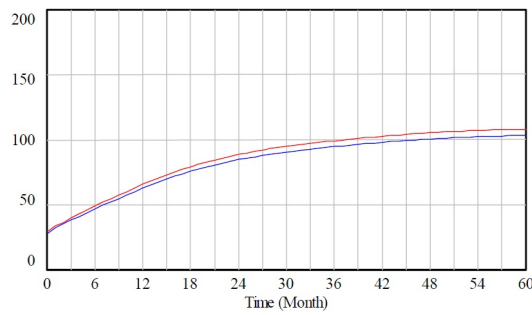


Figure 11: Validation 6

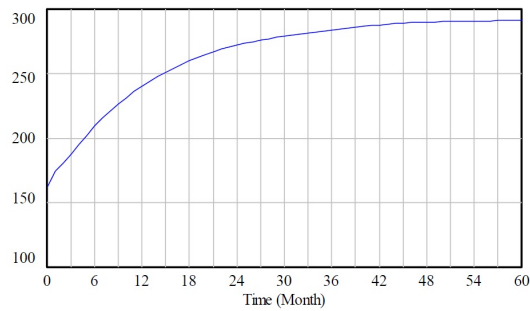


Figure 12: Validation 7

4.4 Scenario creation

To improve the simulation results, two scenarios are proposed as follows, and at the end, the improvement results from the scenarios are compared and the best scenario is selected.

Scenario 1: Double reduction in the absence or shortage of materials: This scenario reduces project time and project cost.

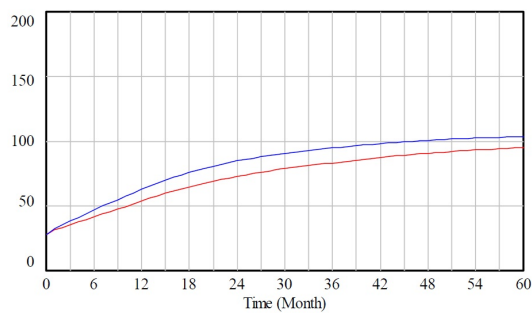


Figure 13: Scenario 1

Scenario 2: Halving Financial Issues: This scenario also reduces project time and project cost.

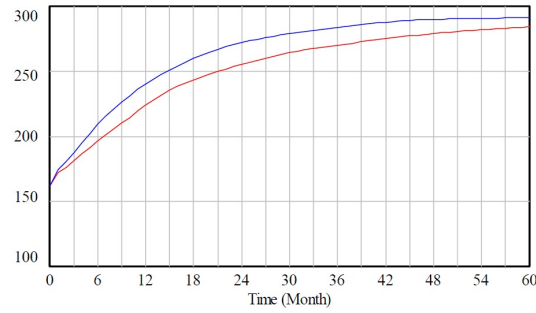


Figure 14: Scenario 2

Scenario 3: Halving the country's sanctions: This scenario also reduces the project time and project cost.

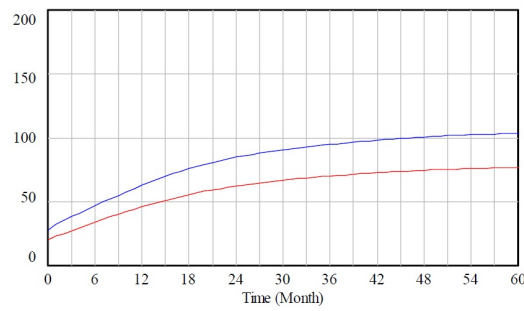


Figure 15: Scenario 3

Scenario 4: Reducing employer financial delays by half

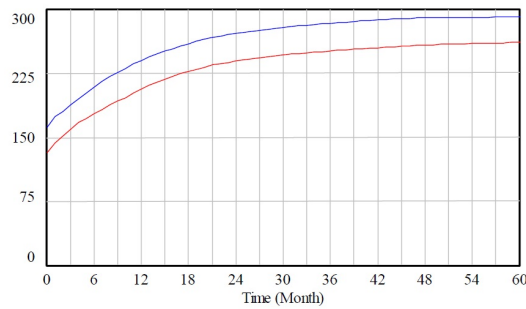


Figure 16: Scenario 4

Scenario 5: Halving the delay in the execution of activities

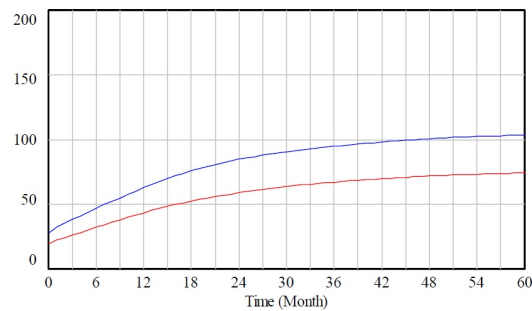


Figure 17: Scenario 5

Scenario 6: Double reduction in consultant's incorrect estimate

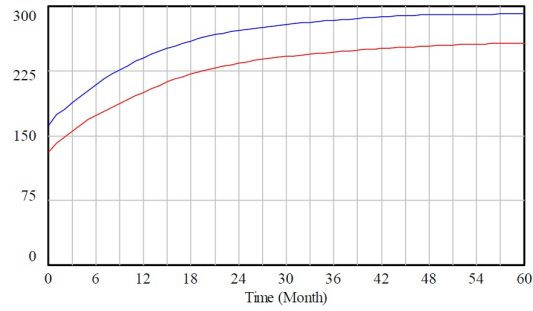


Figure 18: Scenario 6

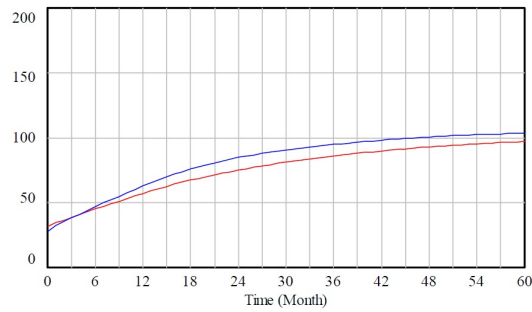


Figure 19: Scenario 7

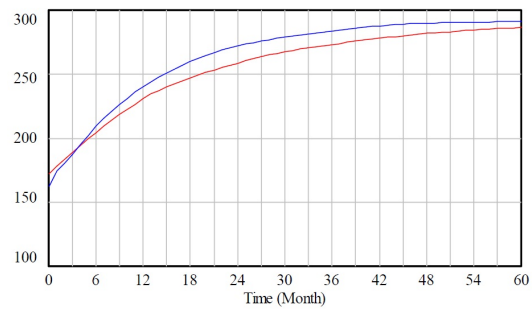


Figure 20: Scenario 8

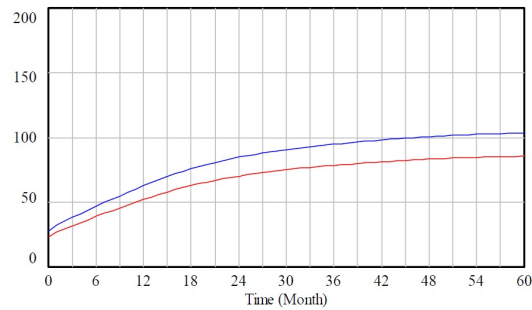


Figure 21: Scenario 9

4.5 Comparison of scenarios

Next, to select the superior scenario and the best solution, we have compared the results of the above six scenarios, the results of which are given below.

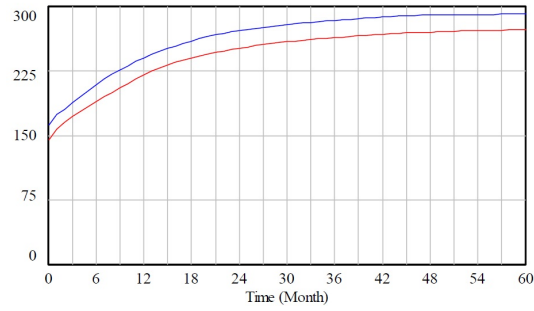


Figure 22: Scenario 10

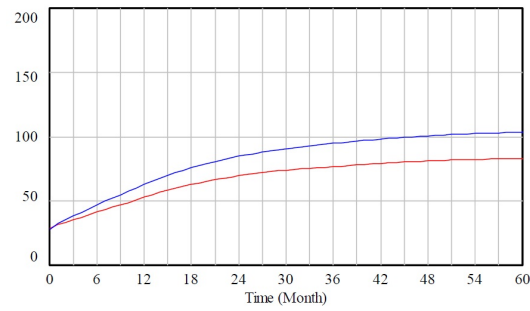


Figure 23: Scenario 11

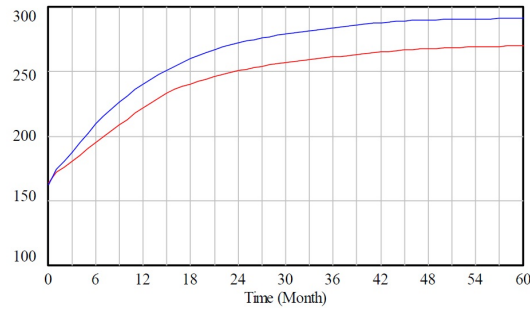


Figure 24: Scenario 12

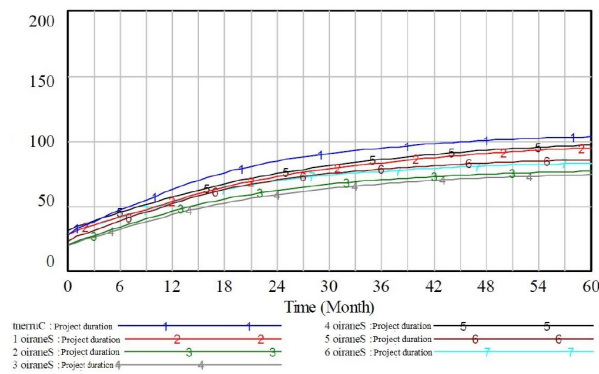


Figure 25: Scenario comparison

From the comparison of scenarios, it can be concluded that Scenario 3 (halving sanctions) has the best result in terms of project time and cost and is therefore selected as the best scenario. Relationships between variables (Dynamo equations)

$$\text{FINAL TIME} = 60$$

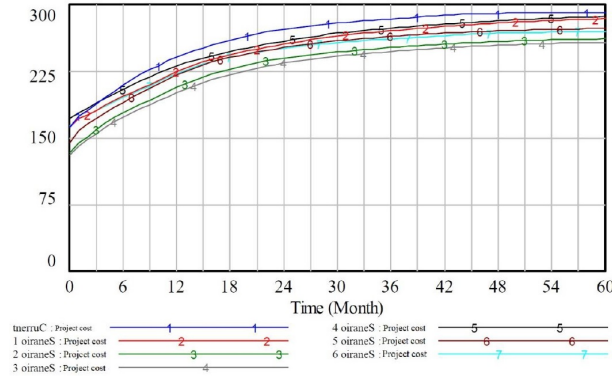


Figure 26: Scenario comparison

Units: Month

The final time for the simulation.

Lookup 1)

$[(0, 1) - (50, 100)], (0.458716, 4.47368), (2.29358, 23.1447), (10.5505, 52.6711),$
 $(20.7951, 68.7368), (33.3333, 80.8947), (43.8838, 86.5395), (49.0826, 87.8421)$

Lookup 10)

$[(0, 0) - (100, 10000)], (0.611621, 745.614), (7.95107, 3114.04), (29.3578, 6096.49),$
 $(50.4587, 7500), (80.4281, 8771.93), (99.3884, 9210.53)$

Lookup 11)

$[(0, 0) - (10000, 10)], (152.905, 0.394737), (1223.24, 3.72807), (5229.36, 7.63158),$
 $(8379.21, 8.68421), (9877.68, 9.03509)$

Lookup 2)

$[(0, 2) - (50, 100)], (0.152905, 7.15789), (2.75229, 32.9474), (9.93884, 52.2895),$
 $(25.9939, 73.7807), (38.2263, 81.9474), (49.0826, 84.5263)$

Lookup 3)

$[(0, 1) - (50, 100)], (0.30581, 5.34211), (4.43425, 23.5789), (12.6911, 46.5921),$
 $(25.9939, 70.0395), (34.2508, 80.4605), (43.1193, 90.4474), (49.5413, 95.2237)$

Lookup 4)

$[(0, 1) - (50, 100)], (0.30581, 4.90789), (3.0581, 25.75), (10.2446, 53.1053),$
 $(16.8196, 67.8684), (30.4281, 83.5), (40.2141, 93.0526), (49.3884, 97.3947)$

Lookup 5)

$[(0, 1) - (200, 10000)], (0.611621, 351.842), (17.1254, 2939.3), (59.3272, 6228.45),$
 $(99.6942, 8158.08), (150.459, 9429.88), (180.428, 9868.43), (196.942, 9956.14)$

Lookup 6)

$[(1000, 0) - (10000, 24)], (1055.05, 1.36842), (2706.42, 10), (4743.12, 13.6842),$
 $(7220.18, 17.3684), (9614.68, 19.3684), (9917.43, 19.6842)$

Lookup 7)

$[(1e + 006, 0) - (1e + 008, 24)], (1.90826e + 006, 23.5789), (2.00734e + 007, 18.1053),$
 $(4.88349e + 007, 12.8421), (6.76055e + 007, 9.05263), (8.87982e + 007, 6.21053), (9.84862e + 007, 5.68421)$

Lookup 8)

$[(0, 1000) - (10, 10000)], (0.030581, 1394.74), (0.764526, 3802.63),$
 $(2.69113, 6052.63), (4.55657, 7000), (7.95107, 7828.95), (9.78593, 7986.84)$

Lookup 9)

$[(0, 0) - (100, 50)], (0.917431, 2.41228), (9.78593, 17.7632), (37.3089, 34.4298),$
 $(70.3364, 41.4474), (99.0826, 45.1754)$

5 Conclusion

In general, it can be said that construction projects have dynamic, unique and unique complexities. The reality of the construction scene is not ideal. Conflicts and problems inevitably arise during construction projects. On the other hand, the mismatch of professional attitudes of the factors involved in the project increases the potential for claims and disputes in construction projects. According to studies, the source of disputes in many construction projects is possible changes and delays in the projects, and the design of their control systems should be one of the strategic goals of the project at both the macro and micro levels. The process of litigation and conducting the necessary expertise, and issuing a final decision requires approximately two years. However, due to the emergence of unfriendly relations and financial problems for the parties, it is sometimes not possible to expect that the project operations will continue and the work will not stagnate, so understanding the causes and factors and implementing proper project management will not only accelerate the project implementation time, but will also reduce costs. Every action taken by either party to a contract in the execution of a project has technical and legal implications. On the other hand, engineers and project managers are generally not lawyers and therefore cannot act as attorneys, but due to their involvement in construction projects, they must have a comprehensive understanding of the practical and fundamental legal relationships of infrastructure in construction projects, and they must also make timely and effective use of legal consultants. By definition, management is the science and art of making decisions and selecting from among options to facilitate the achievement of project goals. If the project manager has mastered the causes and factors of superstructure and infrastructure, intra- and extra-project, in the occurrence and occurrence of claims and disputes, he will have a wider and more effective scope of action for decision-making and strategic countermeasures for the project. Changing the project culture from loser-win to winner-win plays a fundamental role in reducing disputes, and management through performance is generally effective in this context and the dissemination of vision. During the claim and resolution of the claim, despite the existence of a dispute, it is in the interest of the contracting parties that other parts of the project continue and are completed, even without compromise, and the relevant stakeholders should

not allow the disputes to disrupt the progress of the work. In the present study, based on the analysis using the system dynamics method, we reached the following results: In the first cycle, the absence or shortage of materials increases the project time and, as a result, the project cost. As a result, the employer's profit decreases and the employer's financial delays increase, which leads to an increase in the absence or shortage of materials. In the second cycle, the use of specialized labor reduces the consultant's incorrect estimates, which leads to a decrease in the employer's financial delays. As a result, the absence or shortage of materials decreases, which leads to a decrease in the project time and, as a result, the project cost. As a result, the employer's profit increases and the use of specialized labor also increases. In the third cycle, the delay in providing the drawings increases the project time, which leads to an increase in the project cost. As a result, the employer's profit decreases, which causes an increase in the employer's financial delays and, as a result, an increase in the delay in paying employees' salaries. As a result, the performance and productivity of employees decrease, and the delay in providing the drawings also increases. In the fourth cycle, the outbreak of the coronavirus causes a decrease in the performance and productivity of employees, which causes a delay in providing the drawings. As a result, the project time and its cost increase, which leads to a decrease in the employer's profit. As a result, the employer's financial delays increase, and the delay in paying employees' salaries also increases.

As a result, the health and safety problems of employees increase, and the spread of the coronavirus also increases. In the fifth cycle, the change in technical specifications causes an increase in the delay in providing the drawings, which causes an increase in the project time and, as a result, an increase in the project cost. As a result, the employer's profit decreases, and the use of specialized labor also decreases. As a result, the consultant's failure to estimate correctly increases and changes in technical specifications also increase.

Based on the results obtained, the following suggestions are presented:

- Claims Management: Preventing, identifying and following up on claims requires strong management, and in this case, it will have an appropriate effect. Claims management is a very important subset of project management.
- Strong Documentation: Converting unorganized and inefficient documentation and archives into an efficient and justifiable system will have a significant effect on preventing and controlling unreported claims (Project Analysis).
- Reform the risk distribution system between the contracting parties: Unfair and one-sided risk distribution is one of the main causes of claims. Excessive flexibility in risk distribution or, conversely, rigidity in distribution will not produce interesting results. As a general rule, "risk cannot be eliminated and can be distributed", so in the event of improper distribution, this risk will manifest itself elsewhere. Therefore, transferring most of the risk to the other party without considering us in return for a suitable amount will definitely be effective in the emergence of a conflict between interests.
- Changing the culture from "blaming both parties" to "participatory culture": "Your success is my success and vice versa". If this is established, many disputes and claims will fade, and the spirit of the project process will become participatory. The impact of the role of the project manager in this regard will be significant.

Continuous and beneficial use of technical and legal consultants: Engineers are generally not lawyers, and lawyers are generally not engineers. On the other hand, the world is moving towards specialization at a rapid pace. Performance, however small and with a purely technical perspective, especially in the stages related to the obligations of the parties, such as the conclusion of contracts, will sometimes result in large losses. The use of technical and legal consultants will improve the review and performance to the technical-legal level and will provide reasonable predictions and precautions. As a general principle, hiring a technical and legal consultant should not be considered an expense, because in the long term, this action is considered an investment and will prevent many heavy costs resulting from the lack of a legal perspective. A successful project manager places the legal consultant aside, not against him, and at the right time. * Useful and continuous negotiations and meetings between the parties to the contract before and during implementation (project monitoring): Most disputes in construction projects start from small issues. At this stage, before the parties to the dispute enter higher layers of the dispute, disagreements can be resolved well. If both parties are flexible in discussing the issue and listening carefully to each other's point of view, there is a good chance that the problem will be resolved satisfactorily. Both parties should also remember that they have a common goal and are members of a "team". It is important to transfer the issue to the other party or parties as soon as it becomes "objective" and needs to be "resolved". This is when the parties have not yet taken strong positions on the issue and are more likely to try to resolve the issue on their own "merits". It is even possible that one party will realize that the other party's point of view is right and legitimate and will give it to them. The parties may realize that each has a right, and as a result, some kind of mutual agreement will be reached. Holding meetings of varying importance will help to clarify areas of ambiguity and accurately send professional signals to each party.

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