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Providing an optimal impact model of contractors' claims in Design-Bid-Build (DBB) construction projects with system dynamics approach

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Abstract

The purpose of this study is Presenting the optimal impact model of contractors' claims in Design-Bid-Build (DBB) construction projects with system dynamics approach. Therefore, the purpose of the current research is fundamental at the national level, and because of this, the current situation is examined and analyzed. The current research is considered a type of system dynamics studies, in general, a mixed (quantitative-qualitative) method is used in system dynamics studies, in this research two statistical populations have been determined: theoretical experts: including university professors Azad Tehran South, whose expertise is in the field of designing and operating dynamic systems. Experienced experts: including experienced managers who work as managers of Design-Bid-Build (DBB) construction projects. And the theoretical method is used for the sample. 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. In inferential statistics, the questions were investigated using the system dynamics test and Vensim software. Based on the results obtained in the first loop, the absence or lack of materials increases the project schedule and consequently increases the project cost. In the second loop, employing skilled labor reduces the incorrect estimation by the consultant company, which leads to the reduction of the financial delays of the employer. In the third loop, the delay in providing designs increases the project schedule, which leads to an increase in the project cost. In the fourth loop, the Corona outbreak causes a decrease in the employees' performance and productivity, which results in a delay in providing designs. In the fifth loop, the change in technical specifications increases the delay in providing designs, which increases the project schedule and, consequently, increases the project cost. Accordingly, the employer benefit and employing skilled labor decreases. As a result, incorrect estimation by the consultant company and change in technical specifications will increase.

Keywords: Presenting the optimal impact model, contractors' claims, Design-Bid-Build (DBB) construction projects, system dynamics approach
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1 Introduction

The construction industry plays a major role in the economic growth of a country and has a central position in the country's development plans. In fact, one of the characteristics of the economic development of any country is its construction plans, which are considered as a major criterion and index in the economic prosperity of that country, therefore, the progress, prosperity and excellence of a nation is closely dependent on the success of its country's construction plans. Success in the implementation of construction projects requires mechanisms and factors so that the loop of affairs can be completed in an optimal way with the least cost and the most benefit [15]. In evaluating the success of construction projects, what is most objective is their technical engineering, while other factors that seem invisible may play an important and prominent role. For example, project management may be one of those very effective factors, the success of which becomes tangible during the implementation of the project. It is possible that each of the sides of the construction projects evaluates and ranks these factors from one dimension and angle. In any case, although prioritizing some functions is considered important, what is of special and extraordinary importance is the alignment and balancing of all factors involved in the success of the project [18]. Construction projects are complex works. These projects are inevitably described with a unique set of drawings and technical specifications and are implemented by the main contractor and a number of second-hand (sub)contractors, many of whom have not worked with each other before. The unique aspects of each project and the unique set of members of each team are common causes of disagreements that occur. Because every project is unique, the designer cannot be expected to see and predict all its aspects. As a result, mistakes and in some cases contradictions occur in the contract documents. It is even possible that there is no agreement on the interpretation of the items mentioned in the contract documents by the different parties involved in the construction work process [23]. Regardless of the origin of the disagreement, disputes are common in the construction industry. Many professionals working in construction projects feel that the frequency of disputes in these projects has increased, along with the costs related to solving them. In the current climate of new standards, advanced technologies, owner-desired additions and modifications, construction projects are becoming more and more complex. While the successful completion of projects was thought to depend largely on cooperation between the contractor, consultant and owner, problems and disputes have always arisen due to conflicting opinions on various aspects of design and construction. The construction industry in most countries is notorious for planning and high costs, low quality, high number of disputes and many other problems, and this is also true for developing countries like Iran, considerable time and cost in the project. There are various sections that lead to claims. Projects among different employers suffer from high cost, which is mainly driven by development time [25]. Because the causes of claims are intricately related to various factors, a deep mechanistic understanding of the causes of claims can help project parties to choose contracting strategies appropriately, proactively reduce project risks and finally improve the performance of the project.

2 Problem statement

Design-Bid-Build (DBB) contracts, which is also known as the contract method and is the most common method of project implementation, in this way that the employer first finalizes the project design with the designer (consultant) and then entrusts the implementation of the project to the contractor. It undertakes the financing of the project itself. The feature of this method is the separate communication between the consultant and the contractor. In this method, generally, both the consultant and the contractor are required to announce the mistakes that have happened mutually, and the responsibility of coordination and the risk of non-coordination between the designs, construction, and commissioning of the project is the responsibility of the employer. One of the disadvantages of Design-Bid-Build (DBB) contracts is the difference in the attitude of the designer and the contractor. The lack of coordination between these two factors threatens the achievement of project goals and the client, the lack of knowledge of the consultant in the design stage about the knowledge and ability of the construction contractor, the lack of motivation of the consultant to reduce the implementation costs, the lack of clarity of the construction costs until the end of the design. The length of the process, the lack of direct involvement of the employer in the implementation decisions and the construction stages, and the lack of selection of contractors are the merits, and the time-consuming process of selecting consultants and contractors is due to their multiplicity. From the past, several studies have been conducted on the sources of trust in contractors. One of the most important sources of trust in contractors is the claims and commitments that contractors make in carrying out projects [12]. In contracts related to construction projects, the contractor's commitment is a very important factor. In fact, various types of contracts with the contractor have started different courses on the way to a comprehensive and complete solution. The obligations of contractors can include many things such as design, engineering, procurement of goods and equipment, construction, implementation and commissioning, and even the responsibility of financing the implementation of the project [5]. This is while despite the very high importance of the contractor, there is not even a clear definition of the contractor in the laws

of the country. Therefore, one of the topics raised in the field of rights of obligations is the civil and contractual responsibility of construction and construction project contractors. Compensation for the damages caused by the professional activities of engineers in today's industrial life will be possible only in the shadow of recognizing the responsibilities and obligations of contractors in the implementation of projects [4].

Choosing the method of doing the project and choosing the most suitable contract is one of the important decisions of the project. The project implementation system refers to a set of processes in which the type of contract, the method of payment, the scope of responsibility of each of the parties to the contract, the method of resolving disputes among the project participants, and the method of distribution and allocation of risk during the life of the project are explained. Due to the importance of the subject, several methods have been presented in this field in recent years [6].

Despite the benefits of outsourcing construction projects and using specialist contractors to do things, it also brings issues and problems. One of the most important issues is related to the fulfillment of obligations and claims made by the contractor [23]. Since construction projects are very costly, that is why the evaluation of construction project contractors focuses more on the material benefits of the contract. This is despite the fact that not paying attention to quality issues and the contractor's obligations in such projects causes irreparable damage. Therefore, a fundamental revision in planning the selection of contractors for construction projects is very necessary [23]. In recent years, the increase in the demand for the implementation of infrastructure projects, which has occurred due to various reasons, has caused policies to be made regarding their optimal implementation. Construction projects, like other construction projects, have goals such as cost, time and quality. One of the important factors that can affect these goals is the ability of contractors. Therefore, it is necessary to identify the appropriate contractor and the executors of such projects in order to apply the necessary measures [3]. However, few studies have investigated the impact model of contractors' claims in construction projects. Since most of the contracts in the country's construction field are based on Design-Bid-Build (DBB) contracts, therefore, in this study, an effort has been made to examine the impact model of contractors' claims in Design-Bid-Build (DBB) contracts. In such contracts, several variables with intertwined relationships and different degrees of effectiveness play a role. Changes in one of these variables can be associated with changes in other variables. From this point of view, it is not possible to deal with the relationships between the variables involved in the problem with a static approach. It seems that the nature of the elements of this problem is more consistent with the methods related to system dynamics. Therefore, in the current study, presenting the optimal impact model of contractors' claims in Design-Bid-Build (DBB) construction projects with system dynamics approach will be discussed.

3 Research objectives

3.1 General purpose

Presenting the impact model of contractors' claims in Design-Bid-Build (DBB) construction projects with system dynamics approach

3.2 Special objectives

1. Determination of impact model variables of contractors' claims in Design-Bid-Build (DBB) construction projects
2. Determining the cause and effect diagram impact model of contractors' claims in Design-Bid-Build (DBB) construction projects
3. Determining the reinforcing and balancing loops of the impact model of contractors' claims in Design-Bid-Build (DBB) construction projects
4. Determining the accumulation and flow diagram of impact model of contractors' claims in Design-Bid-Build (DBB) construction projects
5. Determination of dynamic hypotheses of impact model of contractors' claims in Design-Bid-Build (DBB) construction projects
6. Validation of impact model of contractors' claims in Design-Bid-Build (DBB) construction projects

4 Research questions

1. How is it possible to determine the variables of the impact model of contractors' claims in Design-Bid-Build (DBB) construction projects?
2. What is the causal diagram of impact model of contractors' claims in Design-Bid-Build (DBB) construction projects?

3. How is the reinforcement and balance impact model of contractors' claims in Design-Bid-Build (DBB) construction projects?
4. What is the accumulation and flow diagram of the impact model of contractors' claims in Design-Bid-Build (DBB) construction projects?
5. What are the dynamic hypotheses of impact model of contractors' claims in Design-Bid-Build (DBB) construction projects?
6. How valid is the impact model of contractors' claims in Design-Bid-Build (DBB) construction projects?

5 Theoretical foundations

5.1 Contractors' claims

Considering claims and disputes too negatively 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 the difference requires a special finesse and art and has an artistic aspect and at the same time scientific and experimental, according to the definition of management, it means making a decision and choosing among the options, on the other hand, management is both science and art, so Dealing with disputes requires a special management, the management of disputes and lawsuits will have a preventive and halal role with a very wide field of action. The strategies developed and implemented by the project in this regard will have a comprehensive effect on the life of the project due to the general establishment of the management pyramid in the project. It is possible to analyze the management of lawsuits and disputes from different perspectives. From the aspect of personality analysis, having autocratic and anti-collaborative and totalitarian characteristics will question the entire body of each system and will be effective. Therefore, the personality of the manager is of special importance. Technical and specialized knowledge also has an undeniable role in management. Predictions and preventions, if they are kept away from the sharp eyes of the management, may make the entire project structure ill with the plague of discord. In short, due to the power of transmitting morale from the manager to other parts of the organization of each party, the lack of cooperative spirit will add to the differences of the parties and will have an aggravating effect. By taking a close look at the issue of claims in construction projects, we can see that this issue not only has continuous changes over time, but in it we can find many feedback loops that are the cause and effect of each other and project information is exchanged between them. Based on this, claim can be considered a smaller system in direct connection with the bigger system of the project, which has all the features of a single system. In this view, we consider the claim as a system that is examined within the closed boundary of its environment, and the effects of the interrelationships of its components and its cause and effect relationships must be displayed. It is worth mentioning that all considerations are described based on the conditions and processes that are continuously changing and dependent on each other to help understand the behavior of the system and its performance. In addition, the system approach that pays special attention to the source of feedback, and the conditions that cause stability or instability of the system, plays a significant role in preparing the proposed models. A model can show all the influencing factors of the claim and the relationship of the feedback loops related to the claim in the construction project system. In the model, cause and effect, which is considered an inherent feature of a dynamic system, is used to build a conceptual model that can show managers the essential aspects of internal dependencies and behavior between key variables that can cause differences in order to With this insight, they can know the appropriate solutions to prevent incidents that cause disputes in their current project, and make the best decision to handle and resolve them, and improve their conditions in future projects. It can be inferred from the model 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, are effective on what exactly the employer wants from the contractor. It should be noted that usually the type of contract and execution method are overshadowed by the risks of the project, which this parameter has an impact on the claim and financial management and should be taken into account in the schedule and budgeting of the contractor, otherwise these risks are the roots of the project. There will be many claims in the future of the project. On the other hand, the employer's expectations and requirements also determine the scope of the project, which, if not specified correctly, will have a negative effect on the scope of the project, and the scope of the project will cause errors, contradictions, or ambiguity in technical and contractual documents. Most of the design errors in the technical documents lead to the employer notifying the contractor of the need for changes in the technical documents in the form of a change order, which itself causes delays in the project and claims [16].

On the other hand, if the employer has enough budgets, in the conditions of necessary changes, he will order the changes to the contractor, which, of course, entitles the contractor to extend the project schedule and receive additional costs due to overtime and sometimes rework, which it is affected by work compression. They can be, will

be. On the one hand, the compression of the contractor's work inevitably changes the project execution process and increases work congestion, and on the other hand, it causes poor work, both of which lead to rework, and rework is also affected by changes and wrong documentation. Also, force majeure conditions and non-progressive events, on the one hand, due to the need to rework, delay or stop the entire work or a part of it, increase the project costs and cause financial claims, and on the other hand, put the contractor in a situation He says that he needs to extend the project and raise a time claim due to the lost time. Therefore, in order to better understand claim as a dynamic system, it is necessary to identify all the factors affecting (or affecting) claim, which is important by using library studies including books, articles and previous studies in the field of claim and its management in construction projects. Also, a survey is conducted among the community of experts in this field of project management knowledge, including legal and contractual experts, engineers and senior managers in international contracting projects [23].

5.2 Factors related to contractors' claims in construction projects

It can be said that the claim is caused by three main factors, which are: 1) changes, 2) delays and 3) strategy and management practices. In order to understand the concept of claim in construction projects, it is necessary that the influencing factors that are identified are modeled in the form of dynamic systems in such a way that the relationship between all the state variables with each other and with the claim is determined [8].

It is also necessary to determine the relationship of all identified factors and factors affecting the claim in the form of feedback loops using the system dynamics approach. Usually, the main factors are the state variables that have a direct relationship with the claim, and the variables and parameters related to each of them indirectly affect the claim. In other words, the effect of the main factors on the claim is caused by all the factors that affect each of them. For example, the factors related to contractual documents directly affect the claim due to factors such as the type of contract, ambiguities in the contractual documents and its attachments. Also, the relationship of important state variables that can be affected by several parameters and related to the claim and is interrelated with each other. In the following, the basic parameters related to the contractor claim system in construction contracts are briefly described.

1. Total delays:
   The total delays that directly affect the contractor claim can be directly influenced by the state variables of the employer's total delays, the contractor's total delays, the environmental factors of the project, the strategy and management practices, and the total changes in the project, which are described below [10]:
   Total employer delays:
   This state variable is generally affected by the factor of delays related to the employer's performance, which can be considered as a result of delays in the following cases:

   - Payments
   - Project workshop delivery
   - Delay of modifications in design, drawings and technical specifications
   - Presentation of workshop plans
   - Issuing change orders or confirming the contractor's proposal
   - Issuing orders for additional work
   - Creating security of manpower
   - Provision of necessary permits
   - Inspection and control procedure
   - Slow decisions
   - The employer's interference in the contractor's affairs

   In addition to the mentioned parameters, the important factor of contractual documents and technical documents is also a state variable that directly affects the performance delays of the employer and is itself affected by the defect factor in contractual matters and includes the following:

   - Errors and ambiguities in the designs and basic technical specifications
   - Error and ambiguity in the schedule

   Ambiguity and contradictions in the contract and attached documents

   - Incorrect choice of contract type

Ambiguity in the goal or scope of the project
It is worth noting that all the mentioned factors are somehow influenced by the state variable "weakness in financial capability and funding of the project" which is related to the budget deficit and problems in the project financing system, and if the employer does not have enough financial resources for the project, all factors which cause his delays will intensify.

Total contractor delays:

This state variable has a direct effect on the total project delays through the delay factor related to the contractor's performance, which includes the following:

- Errors during execution
- Not taking the right of governance from the employer
- Poor project management
- Improper implementation methods
- Improper planning
- Insufficient experience of the contractor
- Delays caused by the performance of subcontractors
- Weakness in financing the project
- Contractual disputes
- Failure to allocate project risks

On the other hand, the state variable of delays related to the contractor is caused by problems in the project resource management system, which is directly influenced by four state variables, which are:

(a) Delays related to equipment and machines,
(b) Delays related to human resources,
(c) Delays related to materials
(d) Delays of the contractor consultant (if any) or the technical office [17].

Usually, the state variable "delays related to manpower" has an effect on both the state variables "delays related to equipment and machines" and "delays related to materials" and it can be stated that delays related to manpower in turn cause It creates delays related to materials and equipment, as well as equipment, machinery, and work, because the absence of experts will reduce the productivity of machinery and equipment, as well as delay in their supply and the materials needed for the project. Also, the lack of specialist forces in many cases causes overtime and slows down the speed of project implementation.
The subsets of each of these three state variables are listed below:

(a) "delays related to materials" including problems in the process of supplying materials such as unfavorable quality of materials, lack of materials and delays in supplying materials
(b) "Delays related to labor" affected by problems in the process of providing specialist staff, including: lack of training of specialist staff in the project team, forcing to provide staff from within the country where the project is located, laws governing the provision of manpower, weakness in manpower management Inadequate skills and knowledge, lack of appropriate organizational structure for division of work and authority, low labor productivity.
(c) "Delays related to equipment and machines" including problems in the process of supplying equipment and machines and working with them, such as the mismatch of equipment and machines, unavailability of equipment and machines, breakdown of equipment, interruption in the maintenance of machines, Border and international obstacles in the entry of foreign machines. It is obvious that the employer's delays affect the contractor's delays.

For example, if the status report is not approved on time, or the contractor's plans are not approved on time, or the permits for the entry of machinery to the project country are not issued on time, each of them will have significant effects in delaying the contractor's executive affairs. On the other hand, the contractor's delays (whether authorized or not) cause the employer's delays, the final result of which is the late completion of the project and financial damage to the project, and when the contractor is guilty of causing delays, suspension of a part of the work or the entire project. He was not able to extend the project and the employer will be entitled to submit a claim.
The state variable "Delays of the contractor's consultant (if any) or the technical office" which is affected by the problems related to the consultant or the contractor's technical office, actually indicates the facts that if the

contractor's technical office of design and construction or his consultant in preparing and presenting the plans If the testing and inspections are delayed and the quality control and assurance is weak, or if there is a mistake in doing these things, and the control of the initial plans of the client is not done correctly, and their problems and contradictions are not identified at the beginning of the project, the process of the contractor's affairs will be It is postponed, which will result in delays in the entire project [1].

2. Total changes:
   It can be concluded that changes in contracting projects have a wide scope, which can be divided into the following:
   (a) Value engineering
   (b) Revision of project reports, designs and documents (after delivery from the employer)
   (c) Rework
   (d) Additional work
   (e) Changes in contractual documents or technical documents attached to it (which includes changes in price and time)
   (f) Change in schedule
   (g) Change in the scope of the project
   (h) Change in working volumes and technical specifications

   By applying changes in the project based on each of the aforementioned cases, a high potential for claims from the contractor is created, which if managed correctly, the contractor is likely to succeed in obtaining additional costs and damages, as well as extending the project for the duration. The time spent applying these changes. On the other hand, the total changes variable, which directly affects the claim, has a direct and two-way relationship with the total delays state variables, and it can be inferred that applying any changes has led to delays in the project implementation process, and vice versa, if the contractor or the employer If they face delays in the project for some reason, they will definitely want to make changes to make up for the lost time. It should be noted that in case of agreement in cases caused by changes, naturally the project will be extended by the amount of the contractor's allowed delay and the overdue costs and damages (if necessary) will be given to him [25].
3. Strategy and management methods:
   The existence of a management system according to international standards such as PMBOK plays a significant role in facilitating the project affairs in both the employer and the contractor. Certainly, the implementation of affairs in a predetermined framework can prevent the occurrence of numerous claims and reduce their negative effects in the project. In a situation where there is such a system for project management from both the employer and the contractor, it is obvious that with change management and planning management, both of which are affected by management practices, project changes and delays are dealt with more correctly, and both parties in situations Project managers deal with claims in a friendlier atmosphere and with better performance.
   The important thing is that the strategy and management practices are under the direct influence of the state variable "environmental factors of the project" and if the project is in unfavorable conditions due to internal or external reasons, the management practices must be fully compatible with the project and its environment. In other words, the management practices are influenced by the environmental factors of the project, and for this reason, it should be flexible so that according to the circumstances, senior managers are able to choose the best decision and policy to solve various problems. It goes without saying that this does not mean that one type of management system should be used in every situation, but it is necessary to use different tools and methods in a management system that is pre-determined and compatible with any project conditions [23].
4. Environmental factors:
   The environmental factors of the project, which generally have a direct effect on each of the variables of total delays, total changes and management practices, as well as on the delays of the contractor and the employer, which are among the subsets of project delays, can be divided into the following three variables:
   (a) Organizational internal causes affected by factors caused by internal causes include: Poor coordination and communication between project participants, incorrect handling of changes and unforeseen results, misplaced expectations of each party.
   (b) External causes affected by factors caused by external causes include:
   Technological issues, climatic conditions of the project site, environmental and climate issues, legal issues, economic issues.
   (c) Other causes affected by issues such as force majeure conditions, unexpected events (strikes, etc.), as well as language and cultural differences, unfavorable economic conditions, which are external causes and a subset of environmental factors, sometimes cause the employer to delay the project slow and ask the contractor to do it faster than usual. Another example is the situation where the contractor foresees the risk of inflation

and rising costs of his project, and in this case, in the form of proposed changes, he asks the employer to approve his proposed changes in order to complete his work faster, sometimes the water conditions and Air causes the previous implementation method to not meet the requirements of the project, and the contractor and employer must agree on changing the implementation method. Obviously, all these cases have led to numerous claims from the contractor, and handling them will require the application of claim management by its expert team in the project. In general, the project manager in abnormal conditions cannot be satisfied with the predetermined methods in the project organization and it is necessary to make necessary changes in the organizational strategies according to the new conditions and after the approval of the senior managers of the organization in line with the advancement of the new strategies with Act according to the conditions that have arisen. It should be mentioned that it is one of the most important factors of covid-19; covid-19 had a destructive effect on the world and stopped its activities. As countries struggled to control the spread of the disease, several industries have paid dearly as a result of the consequences of the common disorder. There are recent studies related to Covid-19 in construction. Simpeh and Amoah [24] identified three categories of measures to contain the spread of COVID-19 among construction site workers, namely screening, access to the site, and handling the delivery of materials and equipment on site. Osunsanmi et al. [20]suggested that there is a high prospect for the development of smart buildings as a preventive mechanism against the corona virus. The type of construction industry is no different as many projects under construction are affected in various ways, for example, shortages of building materials including roofing materials and timber in the UK [14]. In addition, the measures taken to contain the virus such as quarantine, self-isolation and restrictions on the movement of people and vehicles have a wide impact on the ability of contractors to finish the project on time and within the budget [2]. The terms of the relevant contracts should be carefully evaluated to assess whether these considerations could affect the timing and cost of projects under construction and in the planning phase. The construction industry is no stranger to risks, from insufficient labor and rising tariffs to government changes, Covid-19 is another big factor that could affect construction companies. Companies have devised tools such as working on weekends only when the site is usually empty, while others use other strategies such as working from home [19]. But there are strategies and preventative measures that construction businesses can take to mitigate the risks of litigation related to potential breach of contract due to the COVID-19 pandemic and its effects on construction business operations. For example, in construction contracts, force majeure, as used in US common law and civil law, refers to a provision in a contract that relieves a party of its contractual obligations if a natural or unavoidable event prevents the performance of the contract. He gets rid of himself. This legal concept exists in many civil law jurisdictions around the world that relate to physical confiscation or personal damage [9]. Force majeure events are exceptional events beyond the control of the parties that disrupt the performance of construction contracts, either physically or legally. This is in contrast to the sheer difficulty, time consumption or costs incurred in executing construction contracts [13]. Although an important provision in construction contracts, force majeure is not a generally recognized common law doctrine of uncertain meaning. This is because its recognition depends on a specific clause in the contracts where what constitutes a force majeure event is clearly and precisely defined [13]. Force majeure is defined as an exceptional event or circumstance that is beyond the control of one party and is not substantially attributable to the other party. Since the Corona virus pandemic outbreak, there has been much debate about whether a force majeure clause is justified for Covid-19 as an unforeseeable event outside the contractor's control. While the debate continues, important factors to consider in deciding whether the effects of Covid-19 qualify as force majeure include: (a) whether the language used in the force majeure clause clearly mentions the outbreak beyond the control of the parties, (b) whether the unforeseeableness of the force majeure event can be defended; and (c) whether the poor performance or lack of performance is attributable to the Force Majeure Event. If force majeure is limited exclusively to certain events such as earthquakes and storms, proving that Covid-19 is also intended by it will be objectionable [22]. In the absence of specific contractual provisions or clauses and the extent to which the parties to the transaction deal with Unforeseeable incidents, no force majeure is considered. Since force majeure is used due to conditions independent of human will and is not under his control, it is clear that the epidemic of Covid-19 can be a related event [21].

6 Research methodology

This research is done with the aim of contractors' claims in Design-Bid-Build (DBB) construction projects with system dynamics approach. Therefore, the purpose of the current research is fundamental at the national level, and

because of this, the current situation is examined and analyzed. The method used in this research is descriptive-survey. It is worth mentioning that the survey method is the most common way of describing the findings, this study is mixed.

In this research, two statistical populations have been determined:

- Theoretical experts: including professors of South Tehran Azad University whose expertise is in the field of designing and operating dynamic systems.
- Experienced experts: including experienced managers who work as managers of Design-Bid-Build (DBB) construction projects.

The community of theoretical experts will be used to validate the model designed according to the principles of dynamic systems. The community of experimental experts is also used to design cause and effect diagrams and state-flow diagrams. The sampling method used is the theoretical sampling method. Theoretical sampling is a method of collecting data to present a theory in which experts discuss and analyze simultaneously and in interaction with each other to finally reach a single theory [11].

The first step to calculate the sample size is defining the expert based on the exact specifications of the experts. A comprehensive definition should be provided that prevents experts. In this study, an expert is a person who has the following characteristics:

- Having education related to project management.
- Having at least a master's degree.
- Having at least 15 years of experience in Design-Bid-Build (DBB) construction projects.
- Having at least 10 years of management experience in Design-Bid-Build (DBB) construction projects.

Based on this, in this study, the point of view of experts in Design-Bid-Build (DBB) construction projects will be used until theoretical saturation is reached with the conditions listed in the Table 1.

Table 1: Expert sampling criteria

Expertise index	**Condition**	**Symbol**
Degree of relevant experience	At least 20 years or $\alpha \geq 5$	α
Management experience	At least 15 years $\beta \geq 5$	β
Level of Education	Minimum master's degree (master's degree $\leq C$)	C
Ultimate experts	More than 15 years of management experience and graduate degree	$\alpha \cap \beta \cap C$

It should be mentioned that in inferential statistics, we use the system dynamics approach and Vensim software to analyze the results.

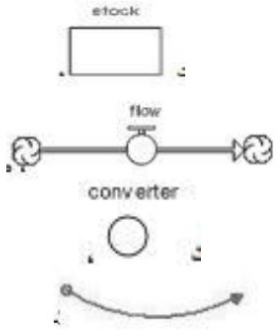
The research model was developed based on the system dynamics methodology. System dynamic methodology is based on modern control theory in which system behavior is simulated by differential and integral equations. The term system is used in several fields of science, but in dynamic system modeling, the concept of system is very specific. The concept of system in the method is a set of components which are connected to each other through four elements including:

Stocks or reservoirs with symbols

Flows or processes with symbols

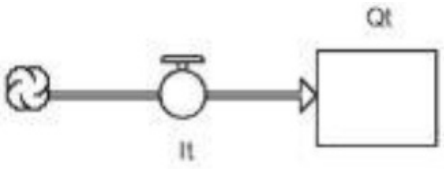
Converters or system constants with symbols

Connectors with symbols



And represent the nature of the real system in the computer space [7].

In this way, with the help of different combinations of these system structures, the relationship between the variables affecting the trust and public participation is formulated, but the main foundation of the dynamic modeling of the systems is based on quantitative differential equations, and the symbols mentioned in the above are only tools to simplify the formulation of mathematical models.



For example, in the above schematic relationship, which is the simplest type of relationship in the system dynamic modeling space, the way to calculate Q (t) values is as follows:

$$Q(t) = Q(0) + \int_0^t i(t)dx \tag{6.1}$$

Euler or multi-point integration method is used to calculate the above integral in dynamic analysis. Of course, Euler's integral method is more practical due to the greater flexibility it creates in the use of mathematical and conditional functions, and the integration technique of the present research is also based on this method. Euler's integration method is as follows:

$$\int_t^{t+DT} (x)dx = DT.1(t) + \frac{DT^2}{2} I'(\mu); \qquad t \le \mu \le t + DT \tag{6.2}$$

Since the function $I(t+DT)$ is usually unknown and is not available to calculate $\int_t^{t+DT}(x)dx$, this type of integral is designed to solve numerical differential equations. In the above expression, DT is the time step of performing the calculations and μ is the time value between the time intervals.

7 Research findings

The first cause and effect hypothesis:

Loop 1

The absence or shortage of materials increases the project schedule and consequently increases the project cost. As a result, the employer benefit decreases and the financial delays of the employer increase, which leads to an increase in the absence or lack of materials (Fig. 1).

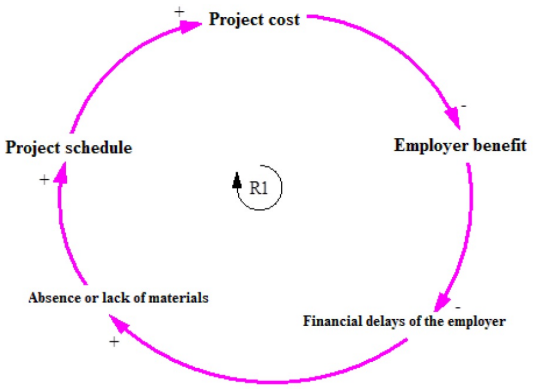


Figure 1: Loop 1

Loop 2

Employing skilled labor reduces the incorrect estimation by the consultant company, which leads to the reduction of the financial delays of the employer. As a result, the absence or lack of materials is reduced, which reduces both the project schedule and cost. Therefore, the employer benefit and employing skilled labor increase (Fig. 2).

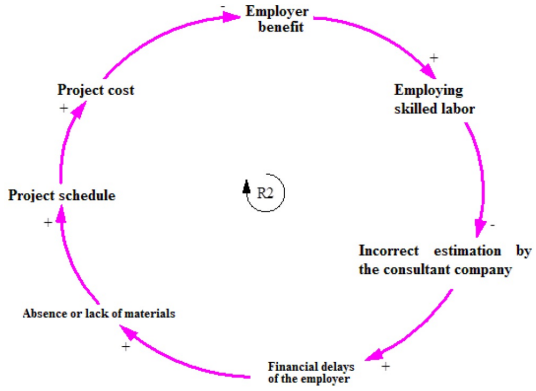


Figure 2: Loop 2

Loop 3

The delay in providing designs increases the project schedule, which leads to an increase in the project cost. As a result, the employer benefit decreases, which increases the financial delays of the employer and, in turn, increases the delay in the payment of employees' salaries. As a result, the employees' performance and productivity decreases while the delay in providing designs also increase (Fig. 3).

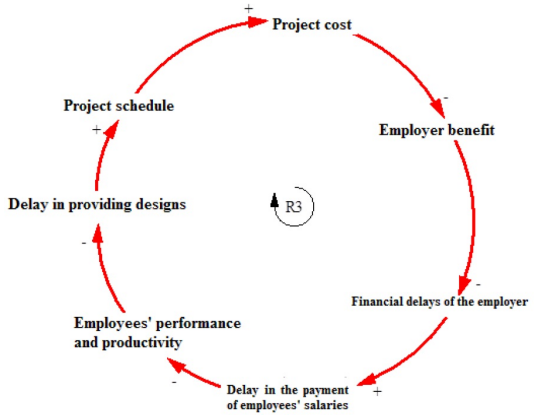


Figure 3: Loop 3

Loop 4

The Corona outbreak causes a decrease in the employees' performance and productivity, which results in a delay in providing designs. As a result, the project schedule and cost increases, which leads to a decrease in the employer benefit. Therefore, the financial delays of the employer and the delay in the payment of employees' salaries increase. As a result, health problems of employees and the Corona outbreak also increase (Fig. 4).

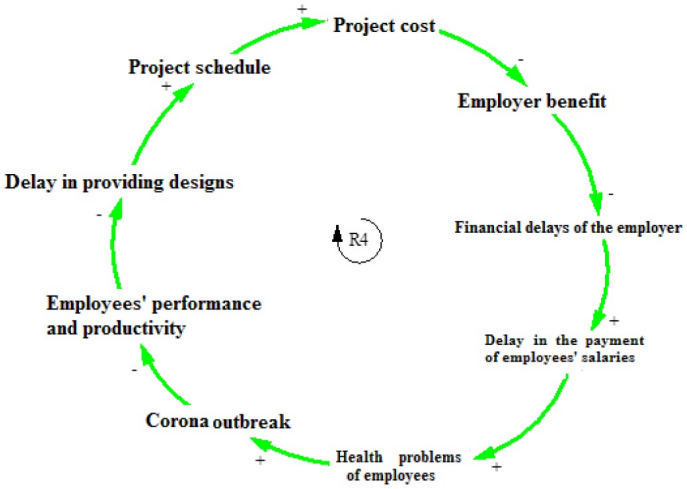


Figure 4: Loop 4

Loop 5

Change in the technical specifications increases the delay in providing designs, which increases both project schedule and cost. As a result, the employer benefit decreases and employing skilled labor also decrease. Consequently, the incorrect estimation by the consultant company and change in technical specifications will also increase (Fig. 5).

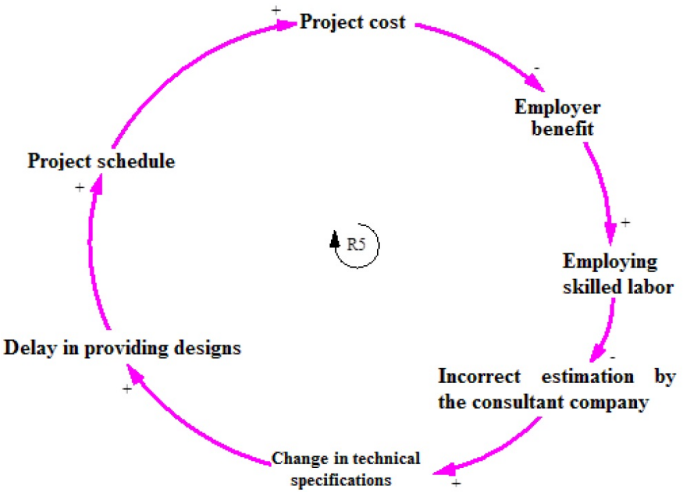


Figure 5: Loop 5

The final diagram of cause and effect loops

These diagrams are obtained from the combination of the above cause and effect loops and can be used to draw state and flow diagrams and simulation operations (Fig. 6).

State and flow diagram

The state and flow diagram related to the above cause and effect diagram is shown in the figure below. In this diagram, project cost variables and employer benefit is considered as state variables and other variables are considered as flow variables (Fig. 7).

In the following, the initial behavior of some variables is shown in the figures below, during the simulation period

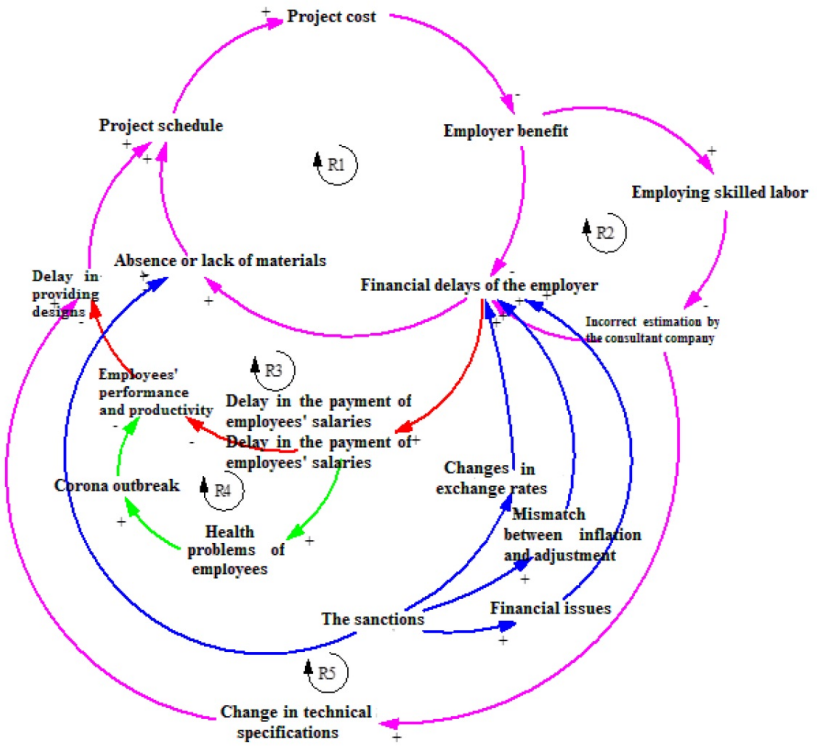


Figure 6: Final diagram of cause and effect loops

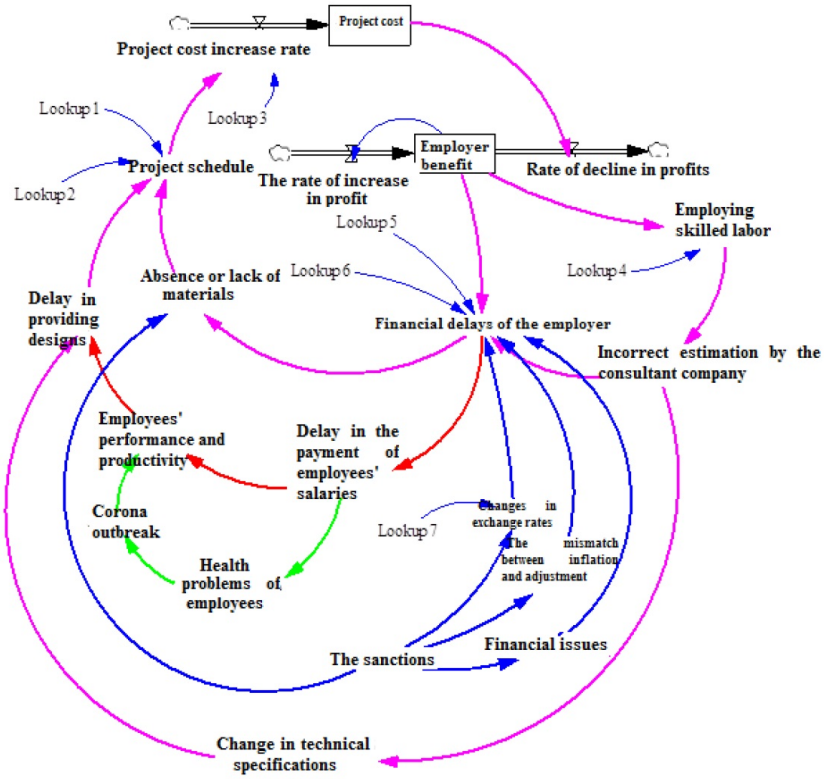


Figure 7: State and flow diagram

of 100 months. These diagrams are obtained from the simulation of state and flow diagram in Vensim software during 100 months.

8 Conclusion

In general, it can be said that construction projects are complex, unparalleled and unique. The reality of the construction scene is not ideal. Conflicts and problems occur inevitably during construction projects. On the other hand, the mismatch of professional attitudes of the factors involved in the project increases the potential of claims and disputes in construction projects. According to the studies, the source of disputes in many construction projects are 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 the macro and micro level. It takes about two years for the process of the trial and the necessary expertise to issue the final verdict. However, due to the occurrence of unfriendly relations and financial problems for the parties, sometimes it is not possible to expect the project operation to continue and the work will not stagnate, so knowing the causes and factors and applying the correct project management will not only speed up the project execution time, but also It will also reduce costs. Every action that each of the parties to the contract performs in the implementation of the project has legal effects. On the other hand, engineers and project managers are generally not lawyers and therefore cannot play the role of lawyers, but due to their involvement with construction projects, they must have a comprehensive understanding of the practical and legal principles underlying construction projects and also alongside it. Initiate the timely and effective use of efficient legal advisors. According to the definition, science and art management is decision-making and selection among the options in order to facilitate the achievement of the project goals. The project manager, in case of mastering the causes and factors of the superstructure and infrastructure, within and beyond the project, in the occurrence and occurrence of claims and disputes. It will have a wider and more effective range of action for decision-making and strategic counter-measures of the project. Changing the project culture from a loser-winner to a winner-winner has a fundamental role in reducing differences, and management is effective in creating a platform and spreading vision through the generally pyramidal function. During the claim and settlement of the claim, despite the existence of a dispute, it is in the interest of the contract parties that the other parts of the project continue and be completed even without compromise, and the related factors 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, the following results were obtained:

In the first loop, the the absence or lack of materials increases the project schedule and consequently increases the project cost. As a result, the employer benefit decreases and the financial delays of the employer increase, which leads to an increase in the absence or lack of materials. In the second loop, employing skilled labor reduces the incorrect estimation by the consultant company, which leads to the reduction of the financial delays of the employer. As a result, the absence or lack of materials is reduced, which reduces both the project schedule and cost. Therefore, the employer benefit and employing skilled labor increase. In the third loop, delay in providing designs increases the project schedule, which leads to an increase in the project cost. As a result, the employer benefit decreases, which increases the financial delays of the employer and, in turn, increases the delay in the payment of employees' salaries. As a result, the employees' performance and productivity decreases while the delay in providing designs also increase. In the fourth loop, The Corona outbreak causes a decrease in the employees' performance and productivity, which results in a delay in providing designs. As a result, the project schedule and cost increases, which leads to a decrease in the employer benefit. Therefore, the financial delays of the employer and the delay in the payment of employees' salaries increase. As a result, health problems of employees and the Corona outbreak also increase. In the fifth loop, the change in the technical specifications increases the delay in providing designs, which increases both project schedule and cost. As a result, the employer benefit decreases and employing skilled labor also decrease. Consequently, the incorrect estimation by the consultant company and change in technical specifications will also increase.

9 Research suggestions

Based on the obtained results, the following suggestions are presented as practical solutions:

Claims management: Prevention, identification and follow-up of claims requires a strong management and in this case it will have an appropriate effect. Claims management is an important subset of project management.

Strong documentation: converting irregular and inefficient documentation and filing into an efficient and justifiable system had a significant effect on the prevention and control of unsubstantiated claims.

Reforming the risk distribution system between the parties to the contract: Unfair and one-sided risk distribution is one of the main causes of claims. Too much flexibility in risk distribution or, on the contrary, rigidity in distribution will not bring interesting results. As a general rule, "risk cannot be destroyed and can be distributed", so in case of improper distribution, this risk will appear elsewhere, therefore, transferring most of the risk to the other party without considering us in return will definitely affect the difference between interests. It will be a transition.

Changing the culture from "accusing the parties" to "participation culture": "Your success is my success and vice versa". If this matter is accepted, many disputes and claims will fade away and the current spirit will be on the process of the participation project. The role of the project manager will be significant in this regard.

Continuous and beneficial use of legal consultants: Engineers are generally not lawyers and lawyers are not generally engineers. On the other hand, the world is moving towards specialization at a high speed. However small and purely technical performance, 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 legal consultants has improved the investigation and performance to the technical-legal limit, and predictions and prevention. As a general principle, the hiring of a legal consultant should not be included in the list of expenses, because with a long-term view, this act of investment is considered to be an investment and avoids many heavy expenses due to the lack of a legal perspective. The successful project manager puts the legal advisor aside and not in front of him and at the right time.

Useful and continuous negotiations and meetings of the contract parties before and during implementation: most disputes in construction projects start from small issues. At this stage, before the parties of the dispute enter the higher layers of the dispute, the lack of agreement can be resolved well. If both parties flexibly discuss the issue and listen carefully to each other's explanation, there will be a good opportunity to resolve the problem in a satisfactory manner. Both parties should also note that they have a common goal and are members of a "team". It is important that as soon as a case becomes a "issue" that needs to be "fixed", it should be transferred to the opposite party or parties. This situation is related to the time when the parties have not yet taken strong positions on the issue and it is more likely that they will try to resolve the issue according to its own "merits". It is even possible that one party realizes the right and legality of the other party's opinion and gives him the right. The parties may realize that each of them is right, and as a result, some kind of permanent agreement will be reached. Holding meetings with different levels of importance will help clarify the ambiguities and accurately send the professional pulses of each party.

Suggestions for researchers:

Considering that this research is a developmental and theoretical research, first, research proposals based on the results of the systematic review are presented to future researchers.

- It is suggested that in future studies, presenting the optimal impact model of contractors' claims in projects related to the PPP family, including BOT with system dynamics approach, should be discussed.
- It is suggested to use other methods of analysis, for example fuzzy ranking, as well as meta-analysis qualitative methods in future studies.
- It is suggested that in future studies, the factors affecting the occurrence of contractors' claims in Design-Bid-Build (DBB) projects should be identified and evaluated using data mining methods or using neural networks.
- It is suggested to analyze the claim package model in Design-Bid-Build (DBB) construction projects in future studies.
- It is suggested to study the effect of contractors' claims on the cost and time of Design-Bid-Build (DBB) construction projects and ways of controlling it in future studies.

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