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Explanation of construction and risk management in mass housing (Case study: Tehran province construction projects)

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Abstract

This study evaluated the effect of three factors of project, construction, and risk management on the time, cost, and execution process of the projects based on a case study regarding building mass construction projects. This survey study was conducted on 150 professors, experts, and contractors in the field of housing mass construction in Tehran province. A total of 108 people were selected as a statistical sample by determining the sample size of Morgan's table by simple random method. The data collection tool is through a questionnaire, the validity of which has been evaluated based on the opinion of professors' experts and its reliability based on Cronbach's alpha coefficient. Cronbach's alpha was 0.82, indicating the research tool's appropriate reliability. In this research, different descriptive and inferential statistical methods were used to analyze the data using SPSS software to classify the characteristics of the respondents and the statistical population. Cronbach's alpha test was used to check the reliability of the questionnaire, and tests, including the Kolmogorov-Smirnov test were utilized to check the normality of the data distribution and the sample t-test. The results showed that mass housing projects have more risks than normal constructions. Contrary to the fact that mass construction projects with high importance are in the first rank, mass construction projects with low importance were in the first rank, and after that, high and medium projects were in the second and third ranks, respectively.

Keywords: project management, construction management, risk management, mass production project
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1 Introduction

Unpredictable conditions, various uncertainties, and many changes in human life and, naturally, in the state of construction projects have caused the emergence of a relatively new science called construction management and risk management. Despite being young, risk management is a new branch of management science that is expanding and overgrowing and has been welcomed by experts and managers in various trends. Studies such as risk and risk assessment have found their place in a wide range of topics such as finance and investment, trade, insurance, safety, health and treatment, industrial and construction projects, and even political, social, and military issues. Construction projects, often included in large projects, are implemented in a dynamic and complex environment, so uncertainty and risk are part of their inherent characteristics [13].

Project construction management, planning, and directing the project within the time, cost, and quality framework are towards creating specific results. Project management includes the activities of planning, organizing, monitoring,

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and directing the implementation and tries to deliver specific and expected results at the right time with the previously agreed cost by using the resources properly. In other words, project management is the application of knowledge, skills, tools, and techniques necessary to manage the flow of activities to meet the needs and expectations of those in charge of project implementation. Project management uses the two powerful arms of project planning and control to implement this task [14].

Construction management is the overall planning, coordination, and control of the construction process from beginning to end to create a project that meets people's needs based on budget and planning with quality, safety, and acceptable risk. Project managers often earn their place by proving their effective management of projects of similar value. Developing construction as a group is necessary for their success in managing various projects, which leads to high-quality construction and sustainable and coordinated progress. Good workers prevent mismanagement of construction materials, lack of cleanliness of the project site, and construction defects, which play a very influential role in reducing the costs of the entire project. A good and skilled project manager ensures the project's success through his knowledge of construction management guidelines and techniques. The project manager should provide the relevant map to the team members regarding how to implement the project, which informs the members about the process of management, execution, observation, and control. The requirement for updating the project management roadmap is that the project manager adds details related to how to manage the new phase to the plan, puts any changes in the focus of the project, and predicts the costs and schedule of the project against all changes. Based on the dimensions of the project and its related complexities, one or more support plans, such as quality management, crisis management, and contract management, should be added to the main plan [10].

The process of project management begins with recognizing and identifying user needs, project limitations, and required resources considering real goals to achieve strategic objectives. This process may be iterative because new information is always available to the manager with the efforts of experts. The construction phase is also crucial because the quality of the completed project has a direct relationship with construction management. The quality of the construction depends on the completion and quality of the documents related to the contract that the designer, workers, and field supervisors and the quality of the materials prepare. A skilled workforce and effective management are among the essential requirements to improve the quality of the project [12]. Raising costs and complexities in projects and increasing uncertainty and risks in business environments have caused project managers to use risk management in the planning and control of projects at the forefront of their activities to reduce the riskiness and deviation of the project from the set goals. Studies have shown that construction management is considered one of the pillars of project management, and its purpose is to identify, evaluate and prevent random events that can have positive or negative effects on project goals. Therefore, regardless of the construction management, the goals and achievements of the project can be subject to severe risks, the research shows. Construction projects have complexity and high-risk potential due to the high variety of activities, the extent of relationships, and the variety of required items. This study initially assessed the effect of the mentioned factors on the execution and economic process of construction projects, such as mass construction projects, in the form of a case study. Therefore, concepts of project management, construction management, and risk management were examined.

2 Theoretical foundations and research background

Risk management is the process of identifying, analyzing, and responding to risk factors that may occur during the life of a project. Proper risk management can prevent possible risks by controlling future events. Correct risk management reduces the probability of its occurrence and the scope of its effects. Risk management systems can also predict their impact on the project, identify risks, and determine quality. Accepting or not accepting risk usually depends on the project manager's resilience level. Regular risk management easily complements other processes such as organization, planning, budgeting, and cost control to identify potential problems and find solutions. A project manager who is a pioneer in this field can prevent unexpected events during the project's life [9].

Risk management should be conducted at the project's beginning and throughout the project's life. For example, when the estimated time for a project is three months, the risk assessment should be done at least at the end of the first month and the end of the second month. After identifying and determining the quality, new risks should be evaluated and managed at each stage of the project's life. After identifying all the possible risks to the project's success, the project team must choose the risks more likely to occur [18]. This choice should be made based on past experiences, learnings, and available information. At the beginning of a project, many risks get closer to those risks as the project progresses. Therefore, risk management should start from the very beginning of the project and proceed step by step. The critical point is that, in general, the opportunity and risk during project planning (the beginning of the project life cycle) remain relatively high. However, the financial risk is small because this stage's investment is

low. On the other hand, during the implementation of the project, the risk levels gradually reach their lowest level because ambiguous cases are gradually identified. Since the invested resources needed to complete the project increase, financial risk also increases [1].

The process of project management begins with recognizing and identifying user needs, project limitations, and required resources and considering real goals to achieve strategic objectives. This process may be iterative because new information is always available to the manager with the efforts of experts. The construction phase is also critical because the quality of the completed project has a direct relationship with construction management. The quality of the construction depends on the completion and quality of the documents related to the contract prepared by the designer, workers, field supervisors, and material quality. In addition, a skilled workforce and effective management are among the essential requirements for improving the quality of the project [5].

Providing housing as one of the first human needs has its unique place in all plans and programs. Housing through mass production is one of the topics related to supply housing, where mass production methods are used to build residential units. This method has its roots in history and special conditions. Mass housing is a construction model with high economic, technical, and managerial justifications and should optimize three areas of quality, time, and cost. Implementing and applying this model is also one of the cases that will bring different results in its efficiency and effectiveness [8]. In today's competitive world, the ever-increasing value of resources and their optimization and proper use has been the focus of many people involved in various industries. The construction industry has not been excluded from this due to its strategic and infrastructure importance in a country's economy [7]. The use of new technologies in construction, the implementation of scientific models, the improvement and acceleration of mass processes, and the reduction of construction costs have been important goals of most builders. Solving problems such as extended time, implementation, low helpful life, and high cost of implementing projects requires solutions for the scientific use of new systems and new building materials to reduce weight and construction time and ultimately reduce costs. Azimi Amoli and Khosravi Largan [3] compared the number of environmental problems caused by housing massification from the point of view of city managers and citizens. According to this study, few measures have been taken to protect the environment in residential complexes, and mass housing impacts the environmental problems created in the urban environment. Shokrgozar and Rezaipour [15] conducted an analytical article on the role of mass builders in the housing development of the Rasht metropolis. The findings showed an inverse relationship between the factors affecting the production of land housing, labor materials, taxes, and facility fees and mass housing production in Rasht. In recent years, the housing construction activity in Rasht, Iran, did not have a good trend and constantly witnessed ups and downs. In the last few years, there has been a direct relationship between the reduction of construction in the whole country and the government's adoption of supportive housing policies, and the massive activity of housing builders in Rasht. The more the government makes the conditions more favorable for the mass construction of builders in various ways such as payment of bank facilities, reduction of municipal taxes, and price stability tax, the construction of mass housing will also increase in the same proportion. Taghipour et al. [17] concluded that based on a conceptual review of the maturity of risk management (ARAM) around the world, their comparison explains the principles and methodologies of ARAMAM considered for large-scale construction projects. This system includes three practical components, including evaluation and evolution capabilities, developed by an integrated application of theories in the urgency and application of system engineering and multi-criteria decision-making in addition to the management system and construction project management. Silvati [16] found that the informal risk management process is part of the normal business process according to industry standards. Many interviewees agree that knowing the financial risk and fear of non-compliance with such residential projects have prevented them from being accused of such investment projects. Risk acceptance levels are not always consistent across housing providers, which creates the opportunity to partner with multiple companies to reduce overall risk. This study shows that implementing improvements in the risk reduction and management framework can help promote the provision of affordable housing by non-government providers.

Frederico et al. [6] provided a brief description of the research effort, and its goal was to create a knowledge-based approach to risk management in construction projects. The motivation of this research is the minimal application of risk management in Chilean construction projects reported in previous research and the urgent need to improve this performance in both owners and contractors. Angour et al. [2] project risk analysis effectively ensures that the strategies used to control potential project risks are profitable. Risk analysis, the starting phase of the project, is the starting point for developing a risk management plan after the steps and activities are carried out in the project risk analysis model. Pablo et al. [11] proposed performance indicators for the design of housing projects. Generally, every project should have indicators that monitor compliance with the set goals. In construction projects, there are a large number of indicators provided by many researchers. However, the analysis of the state of art shows frequent confusion between the result, process, and leadership indicators of these three indicators for the design phase of

residential projects, based on the indicators provided by the same authors in previous research. Therefore, all project stakeholders can have a control panel that will monitor if an indicator is excessive and, as a result, can take corrective actions promptly and effectively.

A project risk is an uncertain event that, if it occurs, will affect at least one of the project's objectives (including quality, cost, and time). Project risk management aims to increase the probability and impact of positive events and reduce the probability and effect of negative events. Therefore, implementing risk management improves project performance by ensuring the achievement of project objectives and pursuing opportunities that lead to an increased positive impact on objectives. On the other hand, risk management is among the ten fields of knowledge in project management (PMI, 2019). Stakeholders and stakeholders can understand the impact of risk on project performance [4]. Construction projects should be managed carefully so that the project does not exceed the estimated cost and time. Despite its high importance, risk management is neglected in mass construction, often due to its high cost and a large amount of information worldwide.

3 Methodology

The present research is field-based in data collection, and a questionnaire was used to collect the data because this research aims to identify and manage the risk of mass housing projects. The use of research methodology is considered an integral part of the overall research process, and the primary strategy of the current research is quantitative. Experts' opinions are used to determine the validity of the data collection tool in terms of content. Cronbach's alpha was also used to determine the reliability or reliability and internal consistency between the questionnaire questions. The statistical population in this research are professors, experts, and contractors in the field of mass housing in Tehran province, which 108 people. A simple random sampling method was used to select the sample, and the sample size in this research was calculated as 108 people based on Morgan's table. Since the present research is a survey type, like many research studies, a researcher-made questionnaire was used to collect the primary data to test the hypotheses.

Cochran's formula is one of the essential and widely used methods for calculating statistical sample size and was introduced by William Cochran. Using Cochran's formula makes it easy to estimate the sample size. Cochran's formula for calculating sample size is unlimited over time and population. In Cochran's formula, the P value is the probability of trust or success, and q is the probability of not trusting or failing, and they are usually considered equal to 0.5 to obtain the sample size. The Z value is 1.96 when the alpha error level is 0.05. The value of e, representing the error, is usually considered 0.05.

$$n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}}$$

Cochran's formula for calculating the sample size when the population is finite.

The n_0 value was previously calculated, and N represents the population size.

The structural characteristics of the research questionnaire are closed and organized into propositions with a 5-point Likert range from very low (1) to very high (5) according to the following characteristics. The questionnaire is distributed according to the number of statistical samples and analyzed after collecting the answers. The questionnaire consisted of two parts; one part is related to personal information, and the other is related to categories and propositions related to hypotheses that extract the opinions of sample units and subjects. The validity of the content of this questionnaire is confirmed by asking for the opinions of professors and experts familiar with the subject. Cronbach's alpha coefficient is one of the most widely used measurement tools for internal consistency, used in most research. The tests performed in this research are:

1. Descriptive statistics for examining the characteristics of the respondents and the statistical population
2. Cronbach's alpha test to check the reliability of the questionnaire.
3. Kolmogorov-Smirnov test to check the normality of data distribution.

The Kolmogorov-Smirnov test is one of the critical statistical tests in SPSS software. As said in the independent t-test, it is decided whether to use parametric or non-parametric tests when choosing a test. The Kolmogorov-Smirnov test is one of the main criteria for this selection.

Kolmogorov-Smirnov test shows the normality of data distribution. In other words, this test compares the distribution of an attribute in a sample (for example, age among 100 nurses) with the distribution assumed for society (for example, the age of all nurses). If the data has a normal distribution, it is possible to use the parametric test; otherwise, the non-parametric test should be used.

Point: After SPSS analysis, in the output of the Kolmogorov-Smirnov test, if the test was significant, it means that p was less than 5%. This means the distribution is abnormal, and a non-parametric test should be used. Therefore, if the result of this test is not significant, it is possible to use parametric tests.

4 One sample T-test

The One Sample T-Test examines the difference between having or not having the mean of a sample with a fixed number.

The statistics of the T-Tech test are as follows:

$$T = \frac{\bar{x} - \mu_0}{\frac{s}{\sqrt{n}}} \sim t_{(n-1)}$$

$\bar{x}$ = Mean of the studies sample

μ_0 = Constant number

s = Standard deviation of the studied sample

n = Volume of the studied sample

$\frac{s}{\sqrt{n}}$ = Standard error

T has a t-Student distribution with n-1 degrees of freedom.

In this research, various descriptive and inferential statistics methods are used in SPSS software to analyze data and test hypotheses.

5 Results

A series of options and criteria should be considered according to the relevant discussion to conduct studies in this section. Different types of mass-building projects are considered regarding the options. Massification projects can be divided based on various criteria. The most important and best criterion is the dimensions of the project according to the level of the entire infrastructure, the number and level of the infrastructure, the number of floors of the units, the method of implementation, and the materials used. Therefore, mass construction projects can be divided into three categories of high importance, medium importance, and low importance. Significant projects have more than 90 units, the buildings are built with new and high-quality materials, and the executive conditions and supervision are high. In addition, the number and height of tall buildings in this project can be considerable. The average number of units for essential projects is up to 45 units, and the construction is based on a combination of traditional and modern methods and relatively good materials. Further, the height of buildings for these projects is equivalent to mid-range buildings, and the number of tall buildings is low. Finally, less critical projects generally use traditional methods and materials. Buildings are generally low (short) and have limited dimensions and types, which is not the case for medium and large projects, and the dimensions and heights of buildings can be diverse and different. The high, medium, and low mass production projects are considered according to the following criteria for ranking purposes.

1. Expert human resources and related risks
2. Machinery and related risks
3. Speed in supplying materials and their proper quality.
4. Engineering studies, reviews before starting implementation, and related risks
5. Liquidity and financial problems of the contractor.
6. Inflation and economic policies.
7. Management and supervision, along with estimates and controls in all stages of the project and related risks
8. Sampling and laboratory matters.
9. Technical and engineering consultations.

5.1 Quantitative description of research variables

Table 1: Descriptive index values regarding the main variables

Variable	Mean	Median	Mode	Standard deviation	Min	Max
Construction management of mass housing projects	4.42	4.66	4.67	0.52	2.33	5
Risk sources of housing massification	4.08	4.33	4.33	0.80	1.67	5
Identified construction management solutions	4.41	4.66	4.67	0.55	2	5
Appropriate measures to face the possible risks of the project	4.32	4.50	4.75	0.66	2.75	5

5.2 The results of the normality test of the variables

Table 2: One-sample Kolmogorov-Smirnov test results for normality

Variable	Sample volume	Test statistics	p-value
Construction management of mass housing projects	108	0.312	0.051
Risk sources of housing massification	108	0.226	0.107
Identified construction management solutions	108	0.286	0.091
Appropriate measures to face the possible risks of the project	108	0.264	0.105

The significance level of the above table shows that the variables of this research are of normal type at a significance level above 0.05. Therefore, specific parametric tests have been used according to the normality of the data.

Construction management of mass housing projects

A sample T-Tech test is used to examine the above question, and the results are presented in Table 3.

Table 3: Construction variable of mass housing and building projects

Variable	t-value	Degree of freedom	Significance level	Mean
Construction management of mass housing projects	91.99	107	0.000	4.28

Based on Table 3, the average rating of the answers given by the statistical sample about the existence of construction management in housing massification projects is 4.28 out of 5 on the Likert scale.

If this average is generalized to society, the average of the responses will be in the range (4.19) to (4.39) because the lower limit of this range (4.19) is higher than the average limit (3). Thus, construction management in housing mass construction projects is one of the main factors and drivers in construction and mass construction. Considering that the significance level of the test is less than 5% (0.000), the obtained result is statistically significant. As a result, the first variable of the research is confirmed.

Risk sources of housing massification

According to Table 4, the average rating of the responses provided by the statistical sample regarding the most important sources of risk of housing massification based on the Likert scale is 4.45 out of 5. If this average is generalized to society, the answers will range from (4.31) to (4.55). Since the lower limit of this range (4.31) is more than the average limit (3), it can be argued that what are the sources of housing massification risk. Considering that the significance level of the test is less than 5% (0.000), the obtained result is statistically significant. As a result, the second research variable is confirmed.

Table 4: Risk sources of housing massification

Variable	t-value	Degree of freedom	Significance level	Mean
Risk sources of housing massification	83.035	107	0.000	4.45

Identified construction management solutions

A sample T-Tech test is used to examine the above question, and the test results are shown in Table 5.

Table 5: Risk sources of housing massification

Variable	t-value	Degree of freedom	Significance level	Mean
Identified construction management solutions	67.52	107	0.000	4.32

According to Table 5, the average rating of the responses provided by the statistical sample regarding the existence of construction management solutions identified in housing massification is 4.32 out of 5 on the Likert scale. If this average is generalized to society, the average answers will be in the range of (4.22) to (4.45) because the lower limit of this range (4.22) is more than the average limit (3). Therefore, what are the construction management solutions identified in housing massification? Considering that the significance level of the test is less than 5% (0.000), the obtained result is statistically significant. As a result, the third variable of the research is confirmed.

Appropriate measures to face the possible risks of mass production projects

A sample T-Tech test is used to examine the above question, and the test results are given in Table 6.

Table 6: Risk sources of housing massification

Variable	t-value	Degree of freedom	Significance level	Mean
Appropriate measures to face the possible risks of mass production projects	72.73	107	0.000	4.21

As shown in Table 6, the average rating of the responses provided by the statistical sample regarding the existence of appropriate measures to face the possible risks of mass housing projects is 4.21 out of 5 on the Likert scale. If this average is generalized to society, it can be argued what the appropriate measures to face the possible risks of mass housing projects are. Considering that the significance level of the test is less than 5% (0.000), the obtained result is statistically significant. As a result, the fourth research variable is confirmed.

6 Conclusion

The construction industry is one of the sectors that contribute significantly to the economy of most countries, including Iran. According to the Eco Development and Trade Bank report, in 2022, the construction sector will make up 19% of Iran's gross national product. The annual increase in the budget of national construction projects is another reason for the critical role of the country's construction industry. The number of small construction projects has been increasing in recent years, considering the current state of Iran's economy and its impact on all sectors, including the construction industry, and the tendency of employers and significant contractors to divide large and complex construction projects into smaller and simpler projects through subcontractors. Therefore, it is essential to ensure the success of these types of projects. Projects can be classified in different dimensions and sizes and with other goals. However, there is a common but intangible feature in all projects: project risk. Projects of any type, size, and component have a degree of risk and uncertainty. As the project risk increases, managing and controlling the project becomes difficult.

Many project failures can be attributed to risk and instability in the environment and within the project structure. However, due to its intangible nature, a comprehensive and complete definition of risk has not yet been provided. In addition, a comprehensive quantitative relationship that can measure the risk of a project and include all dimensions of risk has not yet been provided. This research was conducted to investigate and manage the construction and risk management in mass housing and the effect of its implementation on the project's performance in Tehran province.

Considering that less than one-third of the reviewed projects have a systematic construction management system, the conditions for implementing this system are not very suitable, and it is necessary to make more efforts to implement the construction management system as much as possible. If the results are generalized, it can be said that implementing construction management in the country, especially for construction projects and mass housing, is not suitable and desirable.

Contrary to what was thought on the surface, the results obtained that massification projects with high importance are ranked first were based on the fact that massification projects with low importance are ranked first. Then, significant and medium projects are placed in the second and third ranks. This issue is caused by the fact that traditional and low-quality materials are used in mass construction projects with little importance. In addition, the level of studies before and during design and implementation is low, and workshop supervision, tests, and samplings are not carried out with sufficient accuracy. In executive matters, worn-out machines are sometimes used, and human resources do not have the necessary expertise and experience. In the end, the supply of materials was delayed, the problems of liquidity and the contract went hand in hand, and the final product was of low quality.

Based on all the stated contents, the risks caused by the stated issues and problems can be considered higher. High sensitivities to executive and financial issues lead to its high importance regarding mass production projects in second place. Massification projects with low importance are the exact opposite of high importance. In the first, the

low importance of the project, and in the second, the exceptionally high importance of the project. As a result, the related sensitivities increase cost and time and affect the final quality of the project. In mass construction projects of medium importance, the implementation process still has better conditions because the project is not so important that it leads to a waste of money and time and quality reduction, and it is not so important that the implementation requires special conditions and requirements. Therefore, the best state of the mass building in the discussion of mass building in the country is at an average level.

Table 3 is related to the average rating of answers the statistical sample gave regarding the construction management of mass housing projects. Since the significance level of the test is less than 5% (0.000) for the construction management variable of mass housing projects, the result obtained is statistically significant. Therefore, the null hypothesis of the research is rejected, and the research question is confirmed. As shown in Table 4, the average rating of the responses provided by the statistical sample regarding the existence of the essential sources of housing massification risk and considering that for the variable of housing massification risk sources, the significance level of the test is less than 5% (0.000). The result is statistically significant, the research's null hypothesis is rejected, and the research question is confirmed.

Based on Table 5, the average rating of the responses provided by the statistical sample is about construction management solutions in housing massification. The significance level of the test for the variable of construction management solutions is less than 5 percent (0.000), and the obtained result is statistically significant. As a result, the null hypothesis of the research is rejected, and the research question is confirmed.

Table 6 shows that the average rating of the answers provided by the statistical sample is about the appropriate measures to face the possible risks of housing massification projects. Since the significance level of the test is less than 5% (0.000) for the variable of appropriate measures to face the possible risks of the project, the result obtained is statistically significant. As a result, the null hypothesis of the research is rejected, and the research question is confirmed.

Finally, the research hypotheses regarding the effect of the implementation of the construction management and risk management system on the critical factors of the project were confirmed. The execution and implementation of the management system effectively increase the quality, reduce the cost, and improve the planning of the mass housing projects in Tehran province.

The government in Iran plays a crucial role in ensuring the healthy development of the construction industry. Small and medium contractors are economic organizations with limited current assets and cannot allocate additional resources for construction management. The government should provide financial incentives such as tax rebates or grants that directly impact profitability and cover the costs of implementing construction management and risk to encourage contractors to adopt construction management. In this way, contractors will not experience increased costs and will be more willing to implement risk management.

The government can provide training programs for employees and management in contractors and introduce good risk management practices to help these companies deal with risks and ensure access to the performance. Other solutions include employing risk management experts in the project and implementing the risk management system in construction projects.

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