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Identification and Prioritization of Risk in Civil Projects Using Gray Systems Theory

Davod Darvishi Salokolaei[1]*, Armin Vali[2]

[1] Assistant Professor, Department of Mathematics, Payame Noor University, Tehran, Iran.
[2] Master of Civil Engineering in Construction Management Tendency, Maziar University, Tehran, Iran.

***Corresponding Author**

Abstract: *There are many concrete structures that need to be retrofitted for different reasons, such as computational errors, mistakes in construction, use change, loading etc. Risk is inherent in all projects and is not possible to eliminate it. However, it can be effectively managed to reduce the impact of risk in achieving project objectives. However, it is likely to occur at least in one aspect of the project such as time, scope, cost or quality. In these retrofit projects, if the existing risks are not identified and reviewed, they can create a lot of damage and hazards which are very difficult to compensate for these risks and injuries and even sometimes impossible. For this reason, the risks involved in the retrofitting of concrete structures should be evaluated. In present study, Expert choice software is used to identify important factors of risk assessment of concrete structures using grey analytical hierarchy process method.*

Keywords: *Civil Project, Risk, Grey systems theory, Grey analytical hierarchy*

INTRODUCTION

In the past, managers used their experiences to take a percentage of the cost and time to take risks and opportunities, but today there are ways to look more closely at the unknown. In general, it must first identify the risks and acquire its roots in order to find any uncertainties that lead to risk. In order to investigate the retrofit of concrete structures, there is no doubt that the identification of different types of damage in concrete structures is important and inevitable. Investment in different sectors of the industry, including the building industry, has many vague and unknown items. Such cases, called uncertainty, can change the result of the work sometimes to better and sometimes worse than predicted. Risk is the potential that can cause problems in implementing the project and achieving its goals. Therefore, identification and prioritization of risk can play a significant role in project success.

Problem Statement

Many concrete structures do not meet the requirements of earthquake regulation, due to various reasons, including computational errors, errors in construction and implementation, weakness of old codes, use change and the loads applied to the structure, reinforcement corrosion, etc. On the other hand, the destruction and reconstruction of these buildings, in addition to huge cost, will have many adverse effects on the environment. This is why buildings need to be retrofit by various methods against the earthquake. Risk is the potential that can cause problems in implementing the project and achieving its goals. However, it can be effectively managed to reduce the impact of risk in achieving project objectives. However, it is likely to occur at least in one aspect of the project such as time, scope, cost or quality. Therefore, identification and prioritization of risk can play a significant role in project success. The contractors' conditions have a strong impact on the risk level of construction projects.

Research`s Background

A study was conducted by Falehdoost (2018) about the analysis of new methods of retrofit concrete structures that ultimately found that retrofit of the structures should be in accordance with the construction code to reduce risks in projects.

In a study conducted by Morrote and Vila (2011) on a fuzzy approach to assess the risk of construction projects, they have concluded that project risk management is an essential and critical task of the project manager and project team, and when the risk identification is complete, risk analysis is used to identify the probability identified risks occurrence. The risks must also be prioritized, because if a risk is impossible or the probability of its occurrence is low, it will be difficult to deal with the possible risks and with high probability of occurrence in any stage of project.

Jeng Lee et al. (2010) conducted a study called the classification of damage caused by an earthquake for reinforced concrete structures, in which they found Buildings often require retrofit, and because these structures that needs to be retrofitted are too many, they has to be prioritized, and this prioritization is based on their risk. These losses can be reduced using the techniques of retrofit and extended the service life of the building. Ardeshir et al. (2016). have conducted a research on Evaluation of safety risks in construction using Fuzz Failure Mode and E_ect Analysis (FFMEA) that is the result related risk analysis is one of the most signi can tasks that to be undertaken when managing major construction projects and the risk of falling from height was found to be the most important risk in any project. Osman Taylan (2014) Research in Construction projects selection and risk assessment by fuzzy AHP and fuzzy TOPSIS methodologies has done that is the result Construction projects are initiated in dynamic environment which result in circumstances of high uncertainty and risks due to accumulation of many interrelated parameters. The results showed that these novel methodologies are able to assess the overall risks of construction projects, select the project that has the lowest risk with the contribution of relative importance index. This approach will have potential applications in the future.

The Research Method

The present study is a descriptive-analytic one in terms of method and is field and survey research in terms of data collection method. The full description of the research method by type of purpose, type of data and method of execution is as follows:

This research is in field library method, due to the observe and test tools, i.e. questionnaire and interview. In this study, we first study books and articles on the safety of projects (in the library method) and then use field method to collect data, so that according to the statistical population, we first evaluate the questionnaire whose questions will be designed according to research purposes and then the questionnaire is completed by the selected statistical sample. The spatial domain of this study is Tehran metropolis. The time domain of this study is the data collected in the second

semester of 1397. The subject domain of this study is to analyze and evaluate the risk of retrofitting concrete structures using Grey Analytic Hierarchy Process (GAHP) method.
The study population of this thesis can be divided into two main categories: the first group consists of academic professors in risk management and second group, including engineers working in the city development project in Tehran. Sampling method in this study is of purposeful sampling type; the criteria mentioned in previous researches, Delphi method and interview have been used to identify risks. Then, the opinions of experts are collected as paired comparisons, and the individual paired comparisons matrix will be made for opinions of each expert.

Demographic information of the study

Table 1: A summary of the demographic description of the research sample

Relative Frequency (in percent)	Count	Characteristics	Characteristics type	No.
79	39	Male	Gender	1
21	10	Female		
65	32	Bachelor	degree of education	2
20	10	Masters		
15	7	Phd		
18	9	3 to 5 years	Related work experience	3
20	10	6 to 10 years		
62	30	More than 10 years		

Data Analysis Method

Analytic hierarchy method is one of the most important multi-attribute decision making methods that proposed by Saaty. In this method, the decision problem is divided into different levels of purpose, criteria, sub-criteria, and options. In this process, different options are involved in decision-making and there is a possibility of sensitivity analysis on criteria and sub-criteria. Another advantage of this multi criteria decision-making method is determination of compatibility and incompatibility level of decision. By analyzing complex problems, analytic hierarchy process transforms them into a simple form.

Grey Systems Theory

The gray theory introduced in 1982 by Deng is one of the mathematical concepts that has been widely used in multi-criteria decision making. This theory is an effective technique in dealing with uncertainty problems associated with unknown and incomplete information. In general, information on decision-makers preferences on criteria and for different reasons is expressed in terms of their qualitative judgment, as well as in practice the judgment of decision-makers is often uncertain and cannot be expressed by accurate numerical values.

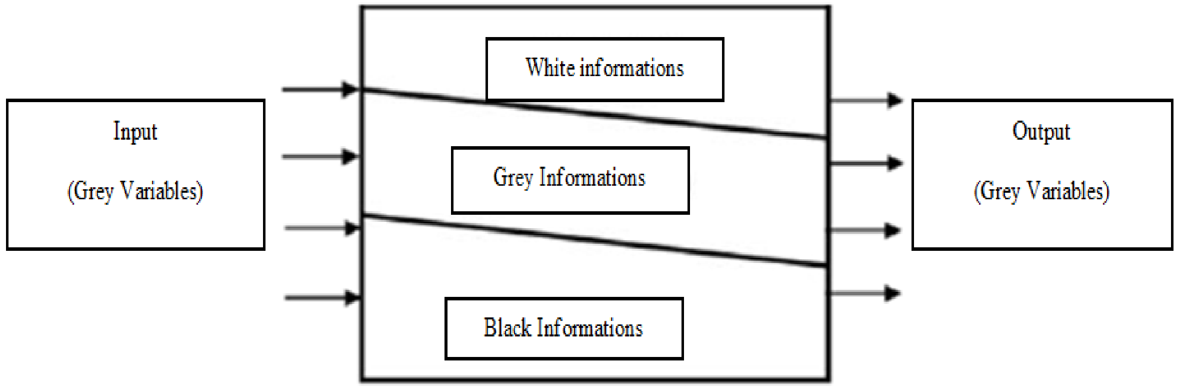

Figure 1: Grey system

Modeling the Analytic Hierarchy Process

The purpose of the hierarchical analysis process technique is to select the best option based on different criteria through paired comparisons. This technique is also used to weighting criteria. Since the increase in the number of elements of each cluster makes a couple of comparisons difficult, so the decision criteria are usually divided into sub-criteria.

Criteria: That is what you choose based on.

Option: It is what you choose from.

The present study has the criteria (the risks in the following model) and the option (three projects).

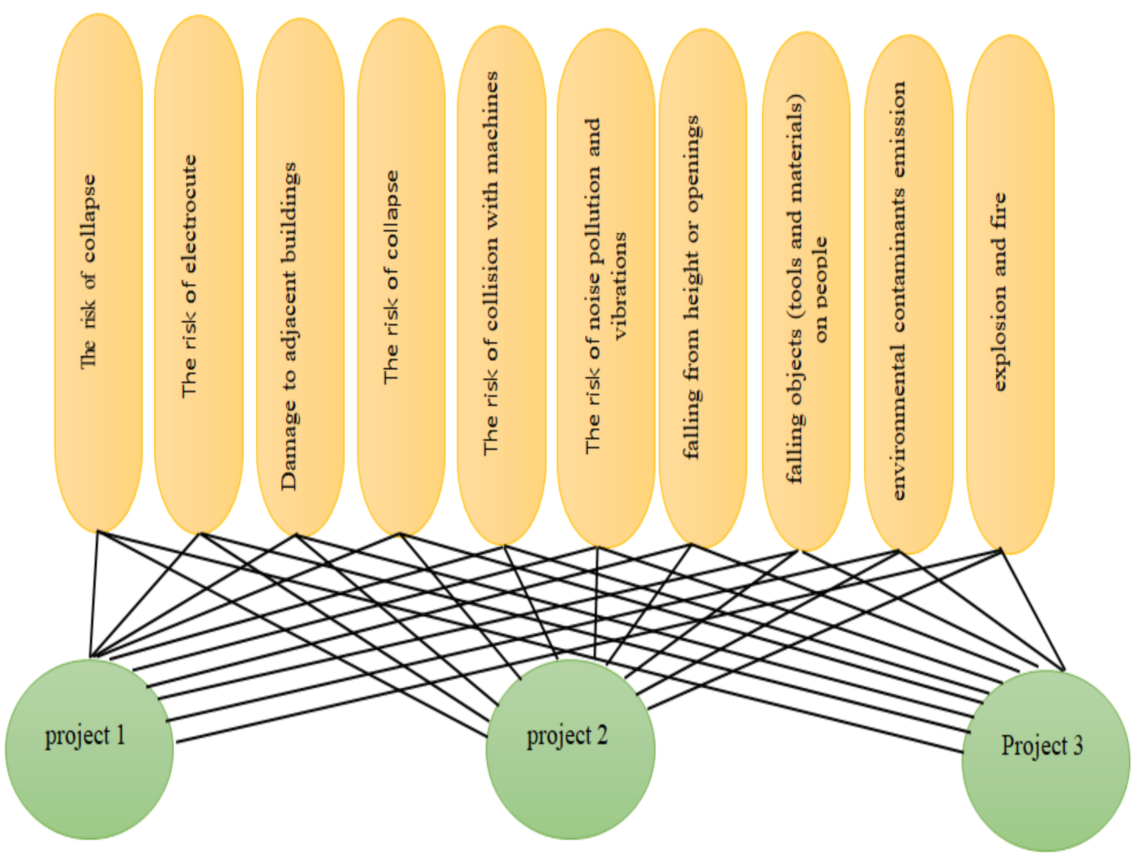

Figure 2- Analytic hierarchy process model

Descriptive Statistics

In order to describe the data, the mean and standard deviation of the research data are used. The risks involved in the retrofitting of concrete structures are as follows.

Collapse risk:

1. Not checking the building before destruction by the competent person,
2. Poor management and oversight of executives and workers by the destruction contractor,
3. Poor control and oversight of all stages of destruction by supervising engineers,
4. Lack of safety standards and regulations,
5. Lack of training and a special training workshop on the principles of destruction and the safety of destruction to update the information of engineers and observers by the engineering system organization,
6. Unauthorized destruction without regard to safety standards,
7. Collapse caused by a mistake in contractor assumptions and decisions,
8. Carelessness of workers when destruction a building,
9. Lack of competence and training of workers,
10. Non-determination of competence to contractors of destruction and not requiring to employ competent authorities to destruct buildings and issues related to the safety of destruction by the organization of the engineering system
11. Choosing inappropriate destruction method,
12. Use of improper equipment,
13. Stacking of scraps over floor resistance capacity on floor,
14. Lack of coordination and communication between stakeholders,
15. Adverse weather or environmental conditions

The Risk of Collision with Machines

1. Failure to enforce safety regulations in the workshop,
2. Lack of preventive or protective equipment,
3. Car operator carelessness,
4. Machine and equipment operator inexperience,
5. Lack of protection between the workers' crossing with the machinery,
6. Worn out machinery and equipment,
7. Improper layout of the workshop,
8. Insufficient visibility of the car operator,

Risk of Falling Objects (tools and materials) on People

1. Not considering obstacles such as scaffolding and protective nets in places where workers are likely to be harmed by falling objects and equipment,
2. No mounting of protective or cornering edge around edge of work platform on scaffolding to prevent objects from falling off the work platform,
3. Failure to apply the competent destruction contractor,
4. Not installing danger strips and warning signs (such as the risk of tools and materials falling) around the destruction site,
5. Not installing equipment properly,

The Risk of Falling from Height or Openings

1. Failure to apply the competent destruction contractor,
2. Improper installation of scaffolding and work platforms, etc.,
3. Not using personal protective equipment by workers,

4. Lack of preventive and protective equipment,
5. Lack of proper protection around the openings or lack of warning stripes,
6. Warning signs around openings

The Risk of Damage to Adjacent Buildings

1. Use of inappropriate tools and equipment for destruction,
2. The non-standard buildings around,
3. Lack of sufficient experience of the destruction contractor or not execute the destruction by a competent contractor,
4. Non-compliance with standards and immunization measures due to negligence and cost savings by the contractor or employer (owner),
5. Failure to disclose characteristics of adjacent buildings to the owner of the building by the municipality or non-existence of them in the municipal archives,

The Risk of Sudden or unplanned Collapse of the whole Structure

1. Unauthorized destruction
2. Lack of expertise and experience of contractors (not qualified contractor),
3. False sequence of destruction,
4. Choosing inappropriate destruction method,
5. Use of improper equipment,
6. Lack of coordination and communication between stakeholders,
7. High building burnout and lack of standing against dead and living loads of the site,
8. Inappropriate environmental conditions (severe winds, etc.)

The risk of electrocute

1. Failure to observe car safe distance from power lines,
2. Failure of machine operator (loader, shovel, etc.) and collision of machine accessories (chains, etc.) with power cables,
3. Failure to take precautions for buildings adjacent to power lines,
4. Lack or failure to use personal protective equipment,
5. Defects in electrical equipment and supplies,
6. Failure to disconnect electricity before destructing the building,
7. Non-use of competent destructing contractor

The risk of explosion and fire

1. Failure to apply the competent destruction contractor,
2. Gas regulator fire due to carelessness of workers,
3. Lack or failure to use preventive or protective equipment,
4. Lack of safe planning for destruction operations,
5. Presence of hazardous substances and liquefied gas cylinders and other combustible materials in the workshop,
6. Insecurity of gas pipes of adjacent buildings such as not installing shielding and mesh installation,
7. Cutting of steel pillars adjacent to the City Gas regulator,
8. Lack of proper location for refueling of machinery on site and necessary measures to prevent fire,
9. Lack of coordination and communication between stakeholders,

The risk of environmental contaminants emission

Failure to thoroughly inspect the building by the competent contractor and supervisor engineers and mark parts with asbestos, unauthorized destruction, and disregard safety rules and principles.

Table 2: Descriptive information about research risks

Skewness	Standard deviation	Average of Expert response	Maximum of Expert response	Minimum of Expert response	Number of data	affecting factors	Weighted average	Risks
.515	.881	5.12	7	3	49	Not checking the building before destruction by the competent person,	5.39	The risk of collapse (12th discussion of building national regulations, 2013)
.697	.809	5.37	7	4	49	Poor management and oversight of executives and workers by the destruction contractor,		
.418	.990	5.24	7	3	49	Poor control and oversight of all stages of destruction by supervising engineers,		
.710	.843	5.45	7	4	49	Lack of safety standards and regulations,		
.429	1.041	5.43	7	4	49	Lack of training and a special training workshop on the principles of destruction and the safety of destruction to update the information of engineers and observers by the engineering system organization,		
.248	.944	5.67	7	4	49	Unauthorized destruction without regard to safety standards,		
.023	1.055	5.63	7	3	49	Collapse caused by a mistake in contractor assumptions and decisions,		
.416	.915	5.53	7	4	49	Carelessness of workers when destruction a building,		
.324	.996	5.39	7	3	49	Lack of competence and training of workers,		
.319	.889	5.20	7	3	49	Non - determination of competence to contractors of destruction and not requiring to employ competent authorities to destruct buildings and issues related to the safety of destruction by the organization of the engineering system		
.515	.881	5.12	7	3	49	Choosing inappropriate destruction method,		
.697	.809	5.37	7	4	49	Use of improper equipment,		
-.359	.796	5.31	7	3	49	Stacking of scraps over floor resistance capacity on floor,		
.382	.957	5.57	7	4	49	Lack of coordination and communication between		

						stakeholders,		
.269	1.023	5.47	7	3	49	Adverse weather or environmental conditions		
.541	.916	5.49	7	4	49	Failure to enforce safety regulations in the workshop,	5.60	The risk of collision with machines Tayebi et.al 2010
.429	1.041	5.43	7	4	49	Lack of preventive or protective equipment,		
.248	.944	5.67	7	4	49	Car operator carelessness,		
.069	1.016	5.73	7	4	49	Machine and equipment operator inexperience,		
-.029	1.131	5.63	7	3	49	Lack of protection between the workers' crossing with the machinery,		
.198	.979	5.71	7	4	49	Worn out machinery and equipment,		
.541	.916	5.49	7	4	49	Improper layout of the workshop,		
.198	.979	5.71	7	4	49	Insufficient visibility of the car operator,		
.098	.913	5.71	7	4	49	Not considering obstacles such as scaffolding and protective nets in places where workers are likely to be harmed by falling objects and equipment,	5.43	Risk of falling objects (tools) on individuals)Construction Workshop Protective Regulation, 2002(
.198	.979	5.71	7	4	49	No mounting of protective or cornering edge around edge of work platform on scaffolding to prevent objects from falling off the work platform,		
.515	.881	5.12	7	3	49	Failure to apply the competent destruction contractor,		
.697	.809	5.37	7	4	49	Not installing danger strips and warning signs (such as the risk of tools and materials falling) around the destruction site,		
.418	.990	5.24	7	3	49	Not installing equipment properly ,		
.710	.843	5.45	7	4	49	Failure to apply the competent destruction contractor,	4.95	The risk of falling from height or openings
-.012	1.115	5.61	7	3	49	Improper installation of scaffolding and work platforms, etc.,		
.440	.832	5.12	7	3	49	Not using personal protective equipment by workers,		
.352	1.603	3.18	7	1	49	Lack of preventive and protective equipment,		
.430	.866	5.43	7	4	49	Lack of proper protection around the openings or lack of warning stripes,		
.278	1.441	3.39	7	1	49	Use of inappropriate tools and equipment for destruction,	4.18	The risk of damage to adjacent buildings (Ravanshadnia&Fool adi, 2014)
.254	1.035	5.37	7	3	49	The non-standard buildings around,		
.732	1.833	3.18	7	1	49	Lack of sufficient experience of the destruction contractor or not execute the destruction by a		

						competent contractor,		
.324	.918	5.69	7	4	49	Non-compliance with standards and immunization measures due to negligence and cost savings by the contractor or employer (owner),		
.547	1.607	3.29	7	1	49	Failure to disclose characteristics of adjacent buildings to the owner of the building by the municipality or non-existence of them in the municipal archives,		
.010	1.077	5.61	7	3	49	Unauthorized destruction	4.26	The risk of sudden or unplanned collapse of the whole structure Tayebi et.al 2010
.639	1.590	2.82	7	1	49	lack of expertise and experience of contractors (not qualified contractor),		
-.702	1.124	5.16	7	1	49	False sequence of destruction,		
.891	1.575	2.76	7	1	49	Choosing inappropriate destruction method,		
.057	.960	5.53	7	3	49	Use of improper equipment,		
.462	1.581	3.29	7	1	49	Lack of coordination and communication between stakeholders,		
.371	.892	5.47	7	4	49	High building burnout and lack of standing against dead and living loads of the site,		
.129	1.647	3.47	7	1	49	Inappropriate environmental conditions (severe winds, etc.)		
.264	.998	5.41	7	3	49	Failure to observe car safe distance from power lines,	4.47	The risk of electrocute (Risk Management Standard 4360, 2004)
.513	1.766	3.39	7	1	49	Failure of machine operator (loader, shovel, etc.) and collision of machine accessories (chains, etc.) with power cables,		
.253	.895	5.31	7	3	49	Failure to take precautions for buildings adjacent to power lines,		
.654	1.871	3.43	7	1	49	Lack or failure to use personal protective equipment,		
.449	.874	5.16	7	3	49	Defects in electrical equipment and supplies,		
.449	1.645	3.20	7	1	49	Failure to disconnect electricity before destructing the building,		
.430	.866	5.43	7	4	49	Non-use of competent destructing contractor		
.394	1.662	3.22	7	1	49	Failure to apply the competent destruction contractor,	4.14	The risk of explosion and fire Risk Management) Standard 4360, (2004
-.103	.816	5.29	7	3	49	Gas regulator fire due to carelessness of workers,		
.234	1.519	3.33	7	1	49	Lack or failure to use preventive or protective equipment,		
.371	.916	5.49	7	4	49	Lack of safe planning for destruction operations,		

.741	1.632	3.04	7	1	49	Presence of hazardous substances and liquefied gas cylinders and other combustible materials in the workshop,		
.382	.969	5.35	7	3	49	Insecurity of gas pipes of adjacent buildings such as not installing shielding and mesh installation,		
.843	1.810	3.12	7	1	49	Cutting of steel pillars adjacent to the City Gas regulator,		
.436	.891	5.45	7	4	49	Lack of proper location for refueling of machinery on site and necessary measures to prevent fire,		
.479	1.633	3.00	7	1	49	Lack of coordination and communication between stakeholders,		
.540	.975	5.39	7	4	49	Failure to thoroughly inspect the building by the competent contractor and supervisor engineers, and mark parts with asbestos,	4.54	The risk of environmental contaminants emission (OSHASA 18001, 2007)
.391	1.651	3.06	7	1	49	unauthorized destruction, and disregard safety and hygiene principles.		
-.017	.957	5.80	7	4	49	Lack of binding on the employing the safety, health and environment experts while destructing by concerned bodies		
.695	1.777	3.27	7	1	49	Carelessness of workers and damage to encapsulated surfaces		
.060	.979	5.71	7	4	49	Not encapsulating asbestos surfaces to prevent the release of asbestos as fine particles suspended in the air		
.808	1.633	3.00	7	1	49	Not covering the structure before launching the destruction operation		
.078	1.061	5.57	7	3	49	No splashing on debris while destruction		
.532	1.784	2.84	7	1	49	Lack of binding on the employing the safety, health and environment experts while destructing by concerned bodies	4.32	The risk of noise pollution and vibrations
.118	.990	5.76	7	4	49	The carelessness of the workers		
.478	1.554	3.20	7	1	49	Use of inappropriate and noisy equipment		
.291	.845	5.51	7	4	49	Inappropriate destruction method selection		

As can be seen, based on the opinions and experiences of experts, professionals and civil engineers, within a seven-point spectrum, the weighted-average risk of collapse equal to 5/39, the weighted-average risk of collision with machines equal to 5.60, the weighted-average risk of falling objects (tools and materials) on people equal to 5.43, the weighted-average risk of falling from height or openings equal to 4.95, the weighted-average risk of damage to adjacent buildings equal to 4.18, the weighted-average risk of sudden or unplanned collapse of the whole structure equal to 4.26, the weighted-average risk of electrocute equal to 4.47, the weighted-average risk of explosion and fire equal to 4.14, the weighted-average risk of environmental contaminants emission equal to 4.54, and the weighted-average risk of noise pollution and vibrations equal to 4.32 are calculated.

Inferential analysis

On the other hand, Cronbach's alpha test, or reliability, is the research tool of a statistical test in order to test reliability, a tool that is designed as a spectrum and answers are multi-choice. The table related to the reliability statistics showed the experts' opinions on the risks of the research using the alpha's alpha test

Table 3: Reliability statistics of research risks using Cronbach's alpha test

research risks	Cronbach's alpha coefficient	Number of items
collapse	0.944	73
collision with machines		
falling objects (tools and materials) on people		
falling from height or openings		
damage to adjacent buildings		
sudden or unplanned collapse of the whole structure		
electrocute		
explosion and fire		
environmental contaminants emission		
noise pollution and vibrations		

The results of reliability statistics of research risks using Cronbach's alpha test indicate high reliability of data collection tool because Cronbach's alpha coefficients means were calculated above 0.8 indicating that expert opinions were reliable and have a good reliability.

Risk ranking based on analytic hierarchy model

The four-step process to evaluate decision alternatives in order to assess the risk of retrofitting concrete structures by Analytic hierarchy technique in Super Decisions setting is as follows:
First Step–modeling Analytic hierarchy: To start, there must be a problem first. Since the main objective of this research is the risk assessment of concrete structures retrofitting projects in the Super Decisions setting by Analytic hierarchy, the risks associated with each of the factors were determined and then the tool that the reliability of it has been tested is distributed. Paired comparison tools used for the decision-making process of hierarchical analysis and multi-criteria decision-making is known as an expert paired comparisons tool. For each level of hierarchical analysis, an expert paired comparisons tool is developed which is used to score within the nine-scale by "saaty" as follows.

Table 4: Expert paired Comparison Tool for paired Comparison of Options

Explanation	Comparison status i to j	value
Risk i is of equal importance to j or does not prefer each other.	Equally Preferred	1
Option or risk i is slightly more important than j.	Moderately Preferred	3

Option or risk i is more important than j.	Strongly Preferred	5
Option i is much more preferred than j.	Very strongly Preferred	7
The option i is absolutely important than j and is not comparable to j.	Extremely Preferred	9
Indicates intermediate values, for example, 8, indicating a significance greater than 7 and lower than 9 for i.	Intermediate	2-4-6-8

Table 5: paired Comparison Tool of Analytic hierarchy method

paired Comparison																		
Risk B	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Risk A

Risks of retrofitting Concrete Buildings											
noise pollution and vibrations	environmental contaminants emission	explosion and fire	electrocute	sudden or unplanned collapse of the whole structure	damage to adjacent buildings	falling from height or openings	falling objects (tools and materials) on people	collision with machines	collapse	paired Comparisons	
									1	collapse	Risks of retrofitting Concrete Buildings
								1		collision with machines	
							1			falling objects (tools and materials) on people	
						1				falling from height or openings	
					1					damage to adjacent buildings	
				1						sudden or unplanned collapse of the whole structure	
			1							electrocute	
		1								explosion and fire	
	1									environmental contaminants emission	
1										noise pollution and vibrations	

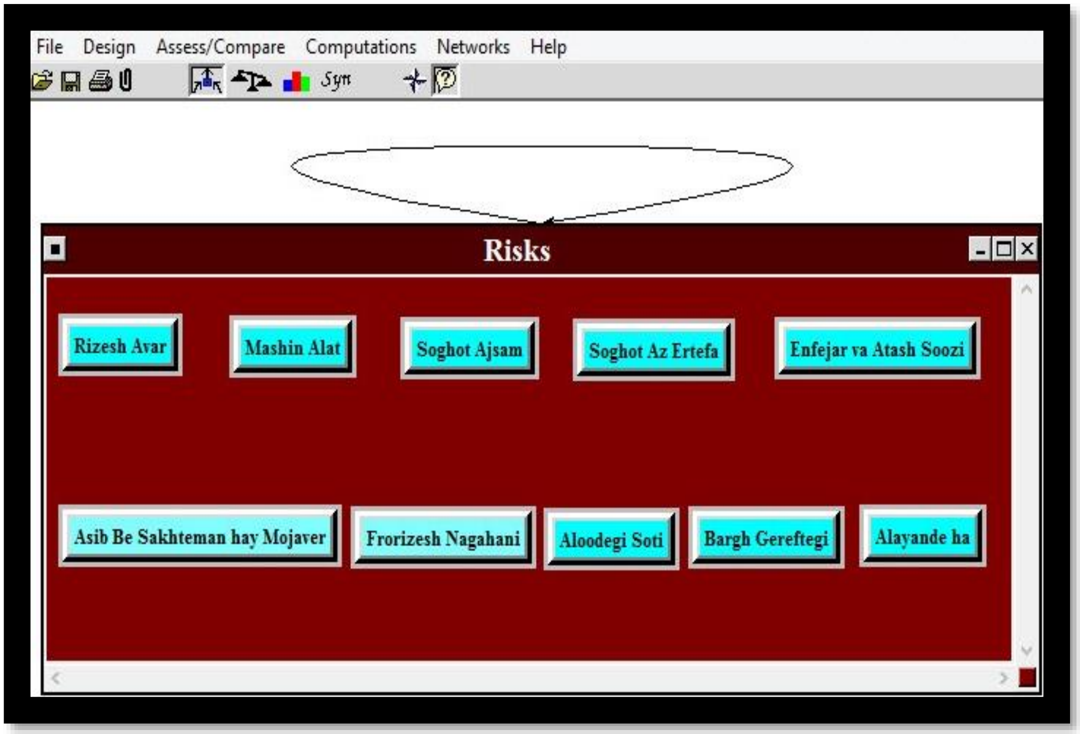

Figure 3: Modeling, Analytical Hierarchy

The second step - paired comparisons and determining the weight of risks in the retrofitting of concrete structures by analytical hierarchy technique, based on experts' opinions, the main risks constitute the first level of hierarchical analysis.

The expert paired comparison tool firstly prioritizes each of the major risks by paired comparing the key risks by purpose. Therefore, we need to compare risks based on the goal, pairwise. If the significance of element i over j equals n, then the significance of j over i is $1/n$, and in this respect, it is sufficient to fill only the values above the original diameter in the following matrix. The following figure illustrates the determination of the weighting of the risks affecting the risk assessment of concrete building retrofit projects in Super Decisions setting by analytical hierarchy technique, based on expert opinions:

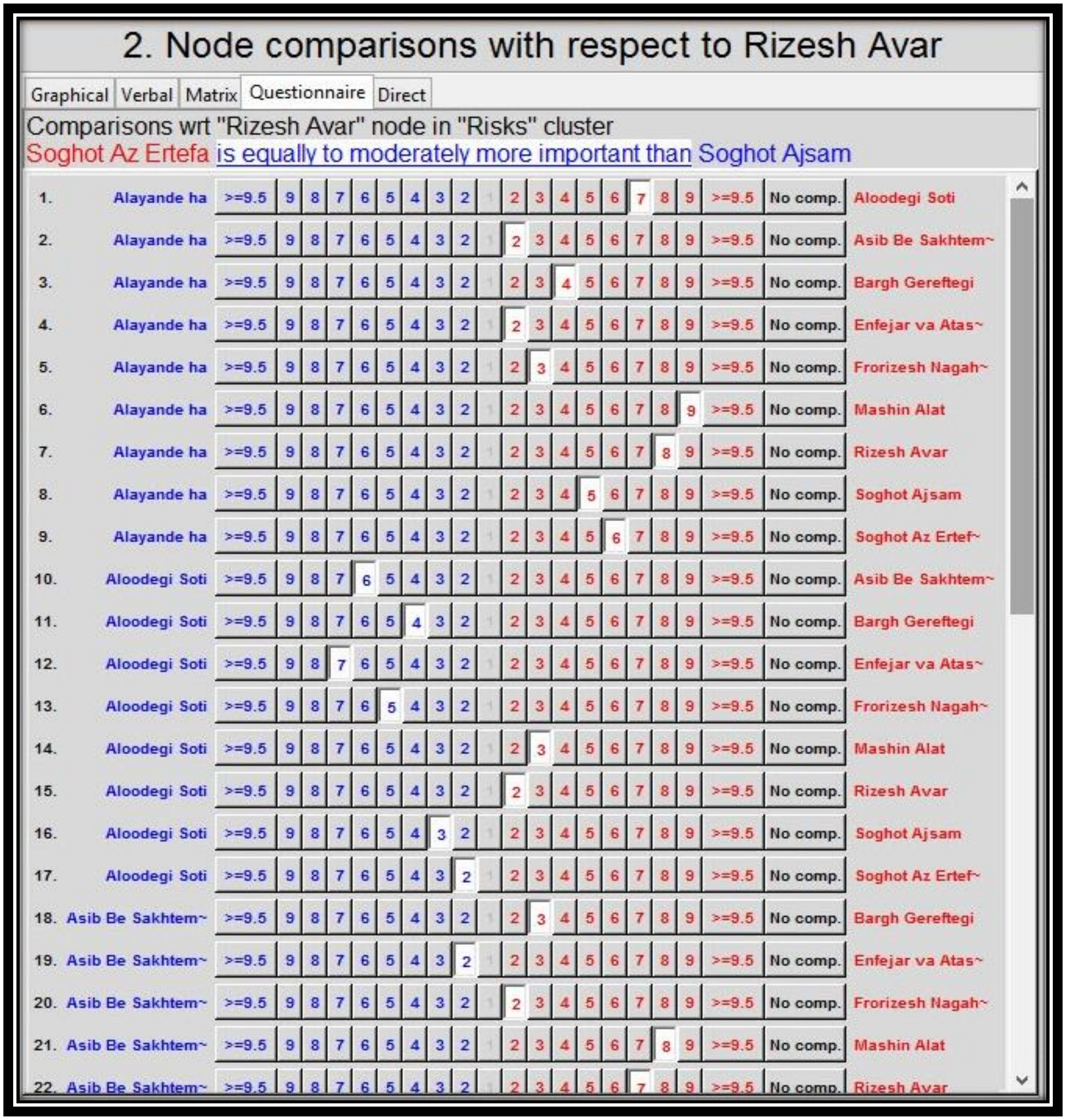

Figure 4: Weighting the research risks

The third step: the ranking of the risks of retrofitting concrete structures by analytical hierarchy technique, is based on the super decisions software analysis: to determine priorities, the normalizing concept described in the previous step is used. After normalization, the weight of each option will be obtained based on the desired risk. In other words, the calculation of the eigenvalue of each line is calculated by estimating the geometric mean: the geometric mean of that row to the sum of the geometric mean. We will do the same paired comparisons for other risks. In this way, we compute the priority of each individual on the basis of each risk as above. The figure and table below show the ranking based on relation between the risks of retrofitting concrete structures.

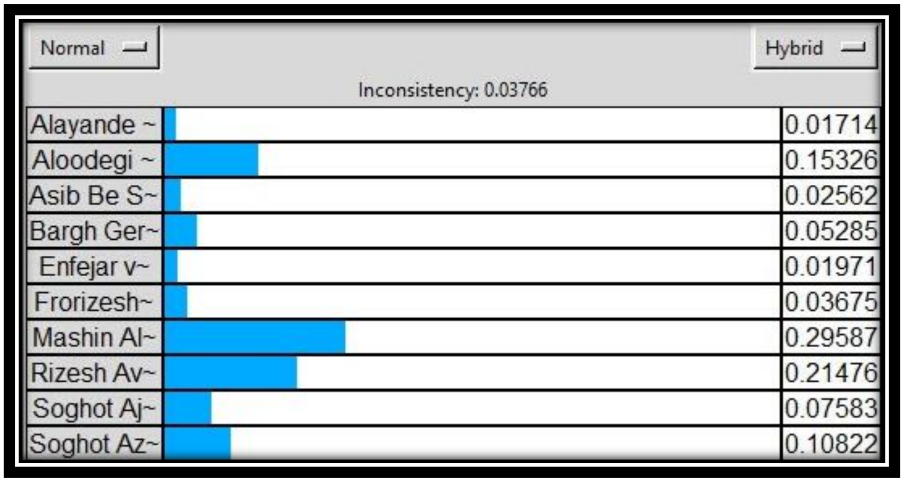

Figure 5. Weighting the research risks

Table 6: Ranking based on hierarchical analysis model

Weight of the risk	Research risks	rank
0.295	collision with machines	1
0.214	collapse	2
0.153	noise pollution and vibrations	3
0.108	falling from height or openings	4
0.075	falling objects (tools and materials) on people	5
0.052	electrocute	6
0.036	sudden or unplanned collapse of the whole structure	7
0.025	damage to adjacent buildings	8
0.019	explosion and fire	9
0.017	environmental contaminants emission	10

Discussion and Conclusion

The inconsistency rate in the present study identifies consistency and showing to what extent comparative priorities can be trusted. The above forms give the final analysis and the ranking of the risks affecting the risk in concrete buildings retrofit projects by hierarchical analysis technique with the least inconsistency of 0.037. Given the final analysis and determining the risk priority of concrete structures retrofit projects, it is evident that the risk of collision with machines with 0.295 weight, the risk of collapse with 0.214 weight, the risk of noise pollution and vibrations with 0.153 weight; are determined as the most important risks, by analytic hierarchy method for concrete buildings retrofit projects

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