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ANALYSIS OF INFLUENTIAL SELECTION FACTORS THAT AFFECT SUSTAINABLE CONSTRUCTION MANAGEMENT OF STEEL STRUCTURE BUILDING

K. Albohameedi S. Naimi

Civil Engineering Department, Altinbas University, Istanbul, Turkey
na0382010@gmail.com, sepanta.naimi@altinbas.edu.tr

Abstract- Construction is a complicated procedure that often occurs in a loosely supervised environment. The materials used to construct a building are critical towards its long-term sustainable development. The components used in building projects play an important role in deciding a tower's energy use and ecological impact. Despite the fact that there have been few studies on assertions, modification orders, as well as cost overruns due to the market specification in Iraq. This study used the Delphi method to create a regulated system for tracking building projects in Iraq. The first step was to identify the key elements in steel construction project. Follow that, the combined data was used to create an Odds ratio for possible threats. The information collected was analyzed using the Adapted, which has been evolved using MATLAB programming, to ascertain the factor rating. The findings revealed the most significant factor was the technical difficulty of the material process of transporting. The most significant determinants in this type of structure in Iraq are the characteristic of building company content availability free markets. It was possible to contrast the RII research results to those of the Order of preference by similarity study. In this field, the outcomes were better compared in assessing hazards.

Keywords: Steel Building Construction, Construction Management, TOPSIS, *RII*.

1. INTRODUCTION

1.1. Background

Construction is a complex process that happens in an unregulated setting. The many people (clients, contractors, designers, suppliers, etc.) involved in a construction project, the many tasks (design, operation, planning, maintenance), the many materials (concrete, wood, cement, steel), and the many resources (time, manpower, money) all combine to make construction projects diverse and critical [1]. While it is possible to plan projects well in advance, there is always the chance that unexpected events or crises can disrupt those plans and have an effect on the progress of the project [1, 2].

Since construction projects often need large up-front investments, companies in the industry are vulnerable to suffering heavy losses should a crisis arise. An unexpected event that threatens an organization to the point that immediate action is required is considered a crisis [3]. It's also the kind of thing that can't be handled by following the usual procedures of a person, a group, or an organization. An emergency might be triggered by events and consequences that are impossible to foresee. In addition, it is characterized as a sudden change from one state to another during which a whole new system form. Even while crises include qualities like danger, suddenness, high uncertainty, urgency, stress and emotions, lack of information resources, and destructiveness, they also provide opportunity if managed correctly [4].

Sustainable construction indicates that sustainable development is a major issue all over the world. There are numerous ways to improve quality of life while also balancing assets and recycling materials through sustainable building [5]. Cities may use sustainability objectives and design in this type of construction to reduce some impact on the environment through the incorporation of technology in constructing buildings. Also known as "green buildings," these really are dwellings that use power technologies to provide people with a relaxed, safe, and wholesome living situation [6]. These institutions, which form the backbone of our economy, facilitate all aspects of modern life, from logistical issues to retail manufacturing. Steel structure construction is a low-cost for elevated, and tall tower that is simple to work with, fast to install, and easy to maintain. Concrete and steel structures have indeed been especially in comparison in a wide range of ways to decide the amount of pollution they emit. To avoid any kind of complexity or difficulties that may arise during execution of a project, identifying the key factors or elements that contribute to the construction operation is important [7]. Therefore, this study performs a questionnaire survey to using Delphi method and analyze the survey data using Relative Importance Index (*RII*) to identify the key factors that contribute to selecting of construction work.

2. LITERATURE REVIEW

2.1. Overview

Investment in infrastructure by multinational and national financial institutions that promote socioeconomic development has been a major driver of continued construction activity in emerging nations [8]. But if governments prioritize unchecked growth without regard for sustainability, it would inevitably lead to environmental damage [9]. In order to ensure economic growth while also protecting biodiversity and ecosystems, building project management must use sustainability planning [10]. Even though sustainability theory and practice are all over the existing literature, scholars haven't paid much attention to how it applies to plan management in emerging countries. However, there has been some progress made by scholars in incorporating sustainability aims into the administration of building projects [11]. Since the construction company is considered for roughly 41% of worldwide energy consumption and 40% of total carbon dioxide (CO_2) emissions, this knowledge gap should be of concern [12].

For construction projects to use environmentally friendly methods, it is essential that leaders in project management prioritize sustainable building strategies [13]. This is due to the vital function that project management serves in the planning, organizing, and carrying out of building endeavors. There are several strategies that are used to identify the key factor for construction selection criteria. It has been demonstrated that Delphi is a useful method for identifying, evaluating, and predicting purposes in construction engineering management (CEM) research throughout the fields of project operation and design, tendering, labor and manpower, and organizational obstacles [14].

2.2. Project Management Variations

The implemented simultaneously of a project can be viewed as an incidence or a circumstance. In some cases, an unexpected incidence may occur despite the possibility of foreseeing it beforehand [15]. Facts that have already been established and though are now challenged serve as the basis for risk estimations [16]. Much of good project management could be regarded as effectively managing risk, identifying what can be done, deciding what must be done, and ensuring that everything is done as planned. Guesstimating, project gatherings, and project management plan all strong powerful as academic concerns [17]. There are several risk factors that may hamper the project management. Factors that pose a threat to the successful completion of building projects were the focus of a study [18].

The study's findings revealed that inconsistency in structure specifications (76.89%), delays in machinery and materials arriving from their home country (75.74%), design changes (75.77%), lack of communication between the client and the contractor (72.29%), the internal problems between the project stakeholders (71.17%), a lack of precision in contractual regulations (71.17%), and dues payment delays (71.17%) were the most influential factors. Due to the magnitude of the finances and resources involved, construction projects are among the most important industries [19]. The ever-evolving nature of a construction site, as well as the constantly shifting personnel and external elements that shape it, makes each project distinctly its own. In order to maintain construction project efficiently, the efficient use of materials or resources, identifying the key barriers or influential factor play significant role.

2.3. Building Material Sustainability

Sustainable materials are important in the field of building construction. The building industry consumes approximately 24% of the world's largest raw materials and a substantial percentage of its energy. Traditional building materials like steel, cement, aluminum, as well as glass all use a lot of energy. Concrete is a common material used in the construction industry [20]. While the initial energy consumption of cement materials is relatively low, the overall energy consumption of building construction is quite high due to the massive amount of concrete used in building construction [21].

Several studies have been conducted to demonstrate the importance of low-energy materials in addition to the overall operational energy consumption of a building [22]. According to the study, construction materials with low construction phase energy consumption may not reduce the total life cycle energy consumption of the structure. "Sustainability" encompasses many issues, including human well-being and the reliability of the human living environment [23]. Environmental sustainability is the idea that green building should protect the natural climate instead of polluting it. This is done by inspiring the utilization of renewable energy and reducing the use of materials, water, energy, and land at every stage of the project [24]. Decision to adopt environmentally friendly construction technology and materials is critical to ensuring the technical sustainability of a structure.

3. MATERIALS AND METHOD

The goal of this study is to analyze the Influential Selection Factors That Affect the Sustainable Construction Management of Steel Structure Building. Therefore, a rigorous literature review was performed, and a questionnaire survey was conducted following Delphi method. Using a structured process, the Delphi Method solicits advice from a panel of subject matter experts. The ultimate goal is to arrive at an indisputable agreement among a selected group of specialists. The Delphi method is often carried out using a set of questions. Members of the panel do not know one another and all communication between them is handled in a strictly anonymous manner [25]. The questionnaires were divided into two sections. Part one of questionnaire asked for basic information about the respondent's history; this included things like how long they've been working on projects, what kind they are, what they do, and what degrees they have.

The second section asked important questions about labelling risks, categorizing them, assigning relative importance to different criteria for risk assessment, and so on [26]. A Likert scale was used for all replies in this section, with 1 representing "extremely low" and 5 representing "very high". Around 50 respondents participated in the study. In order to find out the impact of the influential factors Relative Importance Index (*RII*) was considered to analyze in this study.

3.1. Factors Used

The manufacturing and construction of structural steel must adhere to ISO compliance codes. The tensile strength of a material is not determined after it has been installed in a building structure; rather, it is determined throughout the manufacturing process [27]. When compared to structures made of other materials, such as concrete, the amount of waste produced by a steel structure is significantly lower. Over 90% of structural steel is recycled or reused, and steel structures can be updated and expanded as needed to meet changing needs. Steel constructions are more durable and fire resistant than other building materials, resulting in lower insurance rates. When given a choice, Structural steel buildings are the first option that engineers and architects consider [28]. This is because structural steel structures eliminate the need for interior support columns and provide the greatest amount of uninterrupted floor space possible, allowing for greater design flexibility. This section presents the assumptions made by independent researchers for each of the numerous performance metrics used to determine whether or not project management is relevant.

Table 1. The Main factors used in this research

No.	FC	Construction Selection factors
1	F1	Quality of construction project
2	F2	Flexibility to change design
3	F3	Technical complexity of the project
4	F4	Prefabrication process
5	F5	Material transportation process
6	F6	Site risk factors
7	F7	Available resources of project
8	F8	Material distribution
9	F9	Project size-high
10	F10	Project site location
11	F11	Material availability
12	F12	Market forces

Table 2. The Common Influence Factors

No.	FC	Frame Conditions
1	FC1	Foundations
2	FC2	Cladding costs
3	FC3	Steel intensity (kg/m^2)
4	FC4	Floor-to-floor heights
5	FC5	Types of steel frame
6	FC6	The design of the frame
7	FC7	Quantifying the weight of the frame
8	FC8	Section sizes and availability
9	FC9	Connections and fittings
10	FC10	Erection costs of the frame

When the early pioneering process is complete and the intended building layout is defined, the choice of frame material is frequently made. Costs will be shown as a rate per m^2 of gross interior floor area (GIFA), based on the adjustment of typical cost ranges for similar structures, until the design has progressed sufficiently to generate specific cost information on individual items and systems. As the design evolves and more information becomes available, it is possible to quantify the major materials and compare the initial allowances made during the outline design phases with the actual construction.

3.2. Relative Importance Index (*RII*)

After finding out the important factors, it is crucial to analyze the impact of the factors. The analysis using RII on survey responses is primarily used to determine the impact of financial constraints. This is accomplished by assigning a value of each variable. This same goal of the analysis conducted for this study was to determine the relative value of several identified factors as critical to the successful completion of the project expenses. The total of the responses received for that component from the respondents is used to calculate the score for that element. To calculate *RII*, the following formula was used.

$$RII = \sum (P_i U_i) / N_n \quad (1)$$

where,

RII: Relative importance index

P_i: Respondent's rating of cost

U_i: Number of respondents placing identical weighting/rating on the cost

N: Sample size people responded to the survey

n: The highest attainable score for each cost

3.3. TOPSIS

The acronym TOPSIS refers for the "Technique for Order of Preference by Similarity to Ideal Solution," and it describes a way to weigh many criteria simultaneously. The TOPSIS method begins with the creation of a decision matrix via the use of an expert-driven decision matrix questionnaire. The relevance of factors may be evaluated using this matrix. The TOPSIS method, developed by Hwang and Yoon [29], consists of the following eight steps: The steps consist of I. Setting risk assessment criteria, II. Refining the decision matrix based on the questionnaires, III. Turning the decision matrix into a scaleless matrix, IV. Creating a weightless scale matrix, V. Identifying positive and negative ideal solutions, VI. Calculating the distance between the positive and negative ideal solutions, VII. Figuring out how close each alternative is, and VIII. Choosing the most important alternative. As TOPSIS has been shown to perform successfully in a wide variety of application domains and industrial domains with a wide variety of terminology and topic matter, its adoption represents a significant step forward [30].

3.4. MATLAB R2018a Software Used to Develop the Code

The MATLAB was used to find out the Delphi results. There are several types of structural data in MATLAB. As all variables in MATLAB are groupings, a more appropriate name for this type of array would be "structural array", with the same field names for each individual element. The fact that all of its elements have the same names distinguishes this type of array. Furthermore, MATLAB users have a variety of options for documenting and sharing their work with others. It also allows for dynamic fields. Users of MATLAB can integrate the code they wrote in MATLAB with the code of other language families and programs, and they can share their MATLAB techniques and software with one another.

```
Delhi_Results = [10 10 10 7 6
12 15 5 10 8
10 10 5 8 9
15 16 5 8 6];
\\ Eucledean distance from ideal best and worst
for j=i:length(Weights_Factors)
   for 1=i:Xval
      Sp (i,j)=(Vw(i,j)-Vp(j)*^2);
      Sn (i,j)=(Vw(i,j)-Vp(j)*^2);
   end
end
 for j=1:length(Weights_Factors)
   for i=i:Xval
      Splus (i)=sqrt(sum(Sp(1,i));
      Snegative (i)=sqrt(sum(Sn(1,i));
   end
\\ Calculating the performance score
P_Zeros (Xvar,i);
for i=i:XVar
   P(i)= SpNegative(i)/Splus(i)+Snegative(i);
end
Performance_Score **num-2atr([P]);
Performance_Score = P;
```

Figure 1. The MATLAB codes

4. RESULTS

4.1. Delphi Results

The Delphi technique has been shown to be an efficient and widely used tool in research on information systems for determining and prioritizing issues for management decision. However, the vast majority of these studies did not employ a methodical approach when conducting a Delphi study. When researchers' information available is either scarce or subject to a certain degree of doubt, and they are unable to use different methods that provide greater degrees of proof, those who frequently turn to the Delphi methodology. The Delphi method necessitates the participation of building cost experts in order to accurately calculate the outcomes of possible future scenarios, determine the probability of an event occurring, or make a decision on a specific matter. As a result, the participation of specialists in the survey is made possible. The application of the fraction of a percent scoring system discussed earlier in this dissertation was used to ascertain how much money should be spent on building construction. The identification process necessitates a methodical approach capable of recognizing all of the components that contribute to the construction project's operation. According to results shown in Table 3, quality of construction project influence most in case of foundation group factor. Some other factor that contributes to the foundation group factors are market force, project site location, materials transportation system and materials availability, respectively. Least impact is contributed by flexible to change design in this group.

Table 4 represents the Delphi Results of Cladding costs group factors. In this group, the most influential factor is identified as technical complexity of the project where 17 participants strongly agreed to this point. In this case, immediate impactful factors are considered as flexibility to change design, market forces, material availability, material distribution and so on.

According to results shown in Table 5, quality of construction project influence most. Some other factors that contribute to the group factors are material availability, market force, material transportation process, respectively. Least impact is considered by prefabrication process in this group.

Table 6 represents the Delphi Results of Floor-to-floor heights factors. In this group, the most influential factor is identified as flexibility to change design where 18 participants strongly agreed to this point. In this case, immediate impactful factors are considered as material transportation process technical complexity of the project, quality of construction project respectively. Project size-high was considered as least influential matter.

Table 3. Delphi results of foundations group factors

Factors	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Quality of construction project	16	10	13	7	4
Flexibility to change design	8	8	16	10	8
Technical complexity of project	10	10	13	8	9
Prefabrication process	9	14	11	10	6
Material transportation process	14	10	8	10	8
Site risk factors	13	15	11	6	5
Available resources of project	8	8	18	10	6
Material distribution	11	13	14	7	5
Project size-high	10	15	10	10	5
Project site location	15	11	15	4	5
Material availability	14	8	13	10	5
Market forces	15	10	7	10	8

Table 4. Delphi results of cladding costs group factors

Factors	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Quality of construction project	8	11	10	14	7
Flexibility to change design	16	8	10	10	6
Technical complexity of project	17	11	6	10	6
Prefabrication process	8	5	10	17	10
Material transportation process	9	11	7	8	15
Site risk factors	13	15	11	6	5
Available resources of project	5	7	10	18	10
Material distribution	14	9	10	14	3
Project size-high	10	11	6	10	13
Project site location	8	18	10	4	10
Material availability	14	14	7	10	5
Market forces	15	10	7	10	8

Table 5. Delphi results of steel intensity (kg/m^2)

Factors	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Quality of construction project	18	10	13	7	2
Flexibility to change design	6	7	16	10	11
Technical complexity of the project	10	9	13	7	11
Prefabrication process	5	6	11	15	13
Material transportation process	14	15	8	10	3
Site risk factors	13	10	11	6	10
Available resources of project	7	8	18	10	7
Material distribution	10	6	14	7	13
Project size-high	10	8	10	10	12
Project site location	6	5	15	8	16
Material availability	16	6	13	10	5
Market forces	15	10	7	10	8

4.2. *RII* Results

The *RII* is used by the Industrialized Building System to rate all of the factors that influence the quality of the end product while working on a construction project. Based on the results of the ranking criteria, it was determined that the cost should be given high priority. The criteria were ranked based on their relative relevance using relative index analysis. The tables that follow show the results of using the relative index analysis to arrive at these rankings for each category. An efficient way for sorting indicators based on participant replies, relative relevance index analysis will help you zero in on the vast majority of the most crucial factors. The construction elements that could cause a delay or budget overruns were ranked in descending order based on the relative importance index results (*RII*). The most significant impact is made by the variable with the greatest *RII*, while the least significant impact is made by the variable with the lowest *RII*. The questionnaire analysis results were presented in ten graphs, as shown below:

According to findings, quality is the most important effective factor in this group bearing the *RII* value about 0.70. Quality is a major concern in the construction industry, but it is often overlooked during the design and construction phases of a project's life cycle. The input of stakeholders, particularly architects, is frequently delayed, despite its high value in terms of cost and time associated with quality.

Figure 3 shows the *RII* results of cladding costs effect. According to analysis, it was observed that site risk factors influenced the most in this case with RII value of 0.70. The immediate impactful factors are considered as technical complexity of the project, material availability, material distribution with a *RII* value near about 0.70.

Basic building frame structures, portal frames, truss structures, and grid structures are the four steel frame structures. It is important to remember, however, that there are many different types and variations of frames that are used in more specialized or unique applications. The basic structure is made up of adaptable steel beams and columns that can be used to construct areas of nearly infinite sizes and configurations.

Figure 4 presents the *RII* Results of Section Sizes and Availability Effect of steel structure building. In this case, technical complexity of the project ranked as top with *RII* value about 0.68. Others significant factor were available of resource of project (*RII* value of about 0.67), materials availability (*RII* value of about 0.66), prefabrication process (*RII* value of about 0.65), respectively.

Table 7 and the Figure 5 represent the analysis of the most influential factors of the Steel Building Construction with respect to *RII* and TOPSIS analysis. Construction performance and material public transport are two of the most significant risk factors in Iraq's construction industry. Controlling the quality of materials, assessing worker abilities, and monitoring activities in a specific location are all examples of quality assurance. Controlling material quality necessitates ensuring that the builder is capable of making quick decisions on delivered materials and providing guidance on problems that may have a negative impact on building quality.

Table 6. Delphi results of floor-to-floor heights

Factors	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Quality of construction project	11	10	13	7	9
Flexibility to change design	18	10	8	6	8
Technical complexity of the project	14	13	9	8	6
Prefabrication process	10	10	11	10	9
Material transportation process	15	13	8	6	8
Site risk factors	9	5	14	14	8
Available resources of project	8	9	13	10	10
Material distribution	8	10	13	15	4
Project size-high	5	15	10	10	10
Project site location	8	13	15	4	10
Material availability	6	7	14	14	9
Market forces	10	7	12	14	7

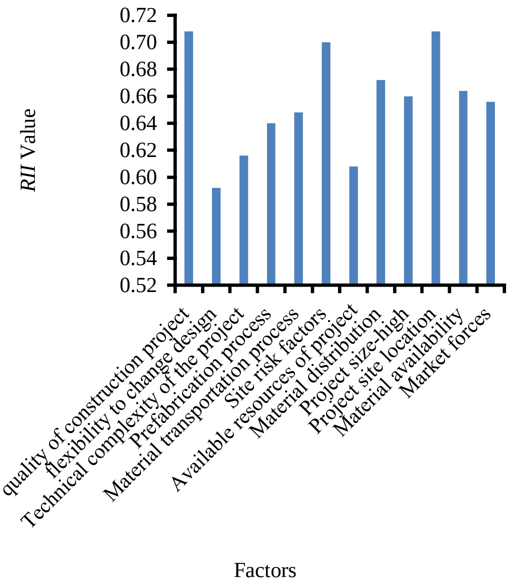

Figure 2. *RII* results of foundations effect

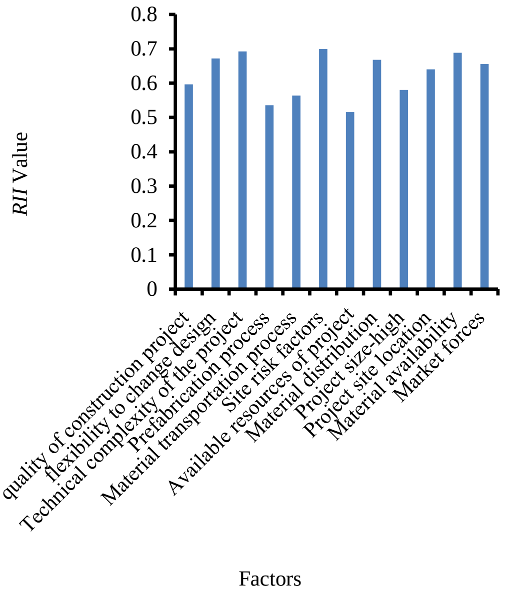

Figure 3. *RII* results of cladding costs effect

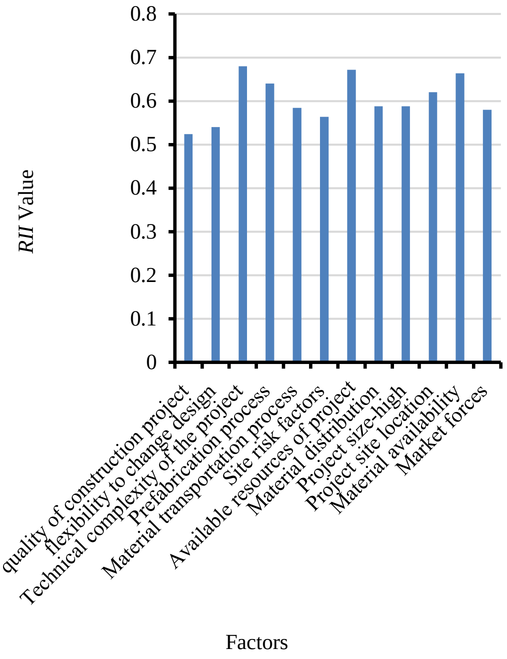

Figure 4. *RII* results of section sizes and availability effect

Table 7. The Main effective factors

Factors	*RII* Results	TOPSIS Results
Quality of construction project	5.00	1.00
Flexibility to change design	3.00	2.00
Technical complexity of the project	4.00	4.00
Prefabrication process	3.00	1.00
Material transportation process	2.00	5.00
Site risk factors	2.00	0.00
Available resources of project	2.00	3.00
Material distribution	0.00	1.00
Project size-high	1.00	3.00
Project site location	1.00	3.00
Material availability	4.00	1.00
Market forces	3.00	4.00

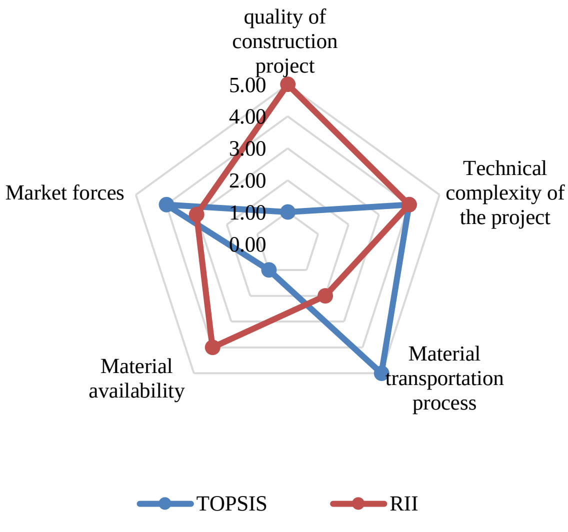

Figure 5. The most effective parameters result of steel building construction

5. CONCLUSIONS

Construction is a complex process that happens in an unregulated setting. The many people (clients, contractors, designers, suppliers, etc.) involved in a construction project, the many tasks (design, operation, planning, maintenance), the many materials (concrete, wood, cement, steel), and the many resources (time, manpower, money,) all combine to make construction projects diverse and critical. This study analyzed the factors that influence the construction of steel structural buildings. By taking precautionary measures, construction delay and building costs can be reduced. A questionnaire survey was performed following Delphi method. The *RII* value was calculated to discover the most influential factor.

The TOPSIS technique was also used in a system management framework to investigate and reduce the rate of inconsistencies detected by specialists. The TOPSIS technique's qualitative and quantitative impact detection and prioritization capabilities have been demonstrated. Model development for *RII* and TOPSIS began with the selection of the software to be used to create the models. Because of their ability and ease of application, the MATLAB TOPSIS risk evaluation algorithm and Microsoft Excel software were chosen. The results revealed that according to the participants who joined the survey the most significant factors are the quality of the building project, the complexity of the construction project, the transportation procedure of materials, and the availability of materials.

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BIOGRAPHIES

Name: **Karrar**
Surname: **Albohameedi**
Birthday: 19.11.1982
Birth Place: Najaf, Iraq
Bachelor: Department of Civil Engineering, College of Engineering, University of Kufa, Najaf, Iraq, 2008
Masters: Department of Civil Engineering, Altinbas University, Istanbul, Turkey, 2022
Research Interests: Road Construction, Concrete Construction, Building construction, Additives in Concrete
Scientific Memberships: Iraqi Engineers Syndicate

Name: **Sepanta**
Surname: **Naimi**
Birthday: 12.06.1976
Birth Place: Esfahan, Iran
Bachelor: Mechanical Engineering Department, Islamic Azad University, Isfahan, Iran, 2001
Bachelor: Civil Engineering Department, Beykent University, Istanbul, Turkey, 2010
Master: Mechanical Engineering Department, Eastern Mediterranean University, Gazimagusa, Northern Cyprus, 2007
Doctorate: Civil Engineering Department, Eastern Mediterranean University, Gazimagusa, Northern Cyprus, 2013
The Last Scientific Position: Assoc. Prof., Department of Civil Engineering, Altinbas University, Istanbul, Turkey, Since 2019
Research Interests: Steel Structures, Finite Element Analysis, Construction Management
Scientific Publications: 34 Papers, 1 Book, 35 Theses
Scientific Memberships: Union of Chambers of Turkish Engineers