[1] **Esraa S. Almaliki**

[2] **Meervat R. Altaay**

Conceptual Model for the Construction Risk Management Affecting Project Performance in Iraq

Abstract: - The construction projects stakeholders seek to complete projects within time, cost, and quality specified limits. Construction projects are exposed to numerous restrictions and risks that limit their accomplishment processes and usually have a major adverse effect on the whole project's performance because of its complex and dynamic nature. To conduct this study, interviews and a review of the literature were adopted to determine and rank the critical risk factors. The mean, standard deviation (std), relative importance index (RII), correlation analysis, and, regression analysis have been used as statistical analysis tools to identify critical risk factors and their ranking that represent an essential aspect in any construction project and to construct a conceptual model to research how risk factors affect projects performance in the context of the Iraqi construction industry. Understanding the influence of these factors is crucial for companies to risks management, exploit, and be concerned with chances. The study finds that risk factors for construction projects have a considerable impact on project performance, due to several factors, including delays in preparing, approving drawings, and the consultant's approval of significant project modifications, inflated cost estimates, and difficulties in financing the project during implementation, in addition to the delay in approving the type of materials required to complete the work by the owner work, as well as, low productivity of workers, machinery and other factors that must be highlighted and take appropriate strategies to risk management for early detection of these factors to reduce their impact. The study's results are foreseeable to be used by all project parties as a guide to assess risks and take appropriate solutions to reduce their impact on the project.

Keywords: Risk Management, Risk Factors, Project Performance, Conceptual model

I. INTRODUCTION

The construction projects are started in unpredictable and risky environments, with tight time restrictions, which requires a brief study in a wide context with emphasis on these aspects. [1-3]. Therefore, developing comprehensive and efficient risk management strategies may help to overcome and eliminate these issues, thus improving project performance [4]. Compared to other industries, building projects are more risky owing to varying construction practices and working circumstances [5]. Consistently poor building quality and high business failure rates indicate the construction industry is not managing risk well [6]. Risk management of construction is considered a significant process that must be implemented from the idea to the completion stage [7]. Project production is one of the most significant patterns of production, and its success depends on competent management for planning, monitoring, and scheduling project operations and taking appropriate steps to speed up its completion [8]. The three project goals of cost, time, and quality can be used to evaluate a construction project's overall success. As a result, these three elements should take into account the potential impact of any project risks [9,10]. Risk management (RM) is the complete and organized approach to achieving the project objectives in the context of construction management [11] and includes the reduction of the impact of the project risks by the management [12]. Because the project and the environment might change over time, risk management considers an essential part of the project life-cycle (PLC) [13]. Effective risk management requires that the risk associated with a project or activity be identified and quantified, as well as the implementation of some type of strategy for addressing those risks [14].

A. Review of Empirical Literature

Numerous research has been reviewed on the risk factors that impact the performance of construction projects and the development of conceptual models conducted by several researchers as follows: An earlier study [15] has developed a conceptual framework for studying the effect of PESTLE external factors on project performance in Iraq. The conceptual model was established to study the factors influencing the project success criteria that represent the independent variables and the project success criteria that represent the dependent variables [16] on the UAE aviation projects. On the other hand, [17] has developed a conceptual framework to study different variables that affect construction project performance in Kenya. The results showed that materials cost, time management, and quality management affect the construction project performance.

Therefore, this research contributes in develop a conceptual model to investigate various risk factors that affect the performance of construction projects. The independent variables of this study are management risk factors, consultant risk factors, owner risk factors, contractor risk factors, design risk factors, material risk factors, finance

[1,2] Department of Civil Engineering, University of Baghdad, Iraq. asraa1887met@gmail.com

risk factors, labor and equipment risk factors, and external risk management (MCOCDMFLE) factors which are identified according to categorizations of the risk factors contained within prior relevant studies shown in Table 1.

TABLE I. THE RISKS FACTORS CATEGORISATION

No.	Risk Categories	Reference
1	Management Risk	[18] [21][22]
2	Contractor Risk	[19] [20] [21] [22] [23]
3	Consultant Risk	[19] [20] [21] [22] [23]
4	Owner Risk	[21] [23]
5	Design Risk	[19] [20] [21] [22] [23]
6	Material Risk	[19] [20] [21] [22] [23]
7	Labor And Equipment Risk	[19] [20] [21] [22] [23]
8	Financial Risk	[18] [19] [22] [23]

Project performance measured using cost, time, and quality indicators is the study's dependent variable where these indicators represent the most common among researchers. The model will assist in illustrating the rapport between the risk factors and project performance as shown in Fig. 1. To study this relationship, a null hypothesis has been developed to test after the conduct regression analysis.

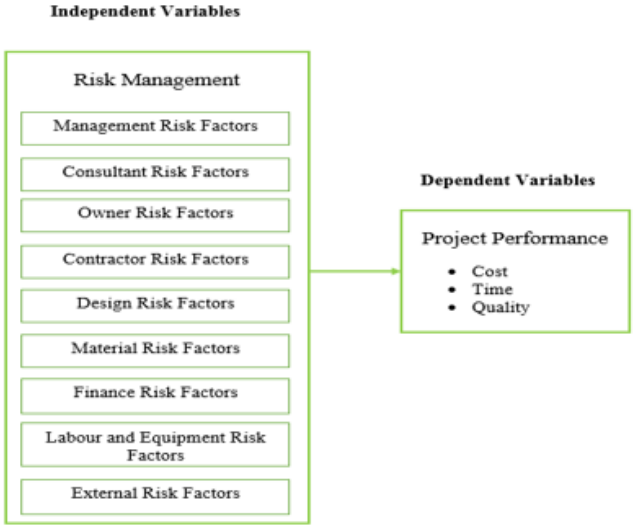

Fig. 1 Magnetization as a function of the applied field.

`II. MATERIALS AND METHODS

The choice of research technique is critical and is determined by the study objectives. It is critical to use a technique that suits the study objectives to collect accurate and trustworthy data. The general goal of this study is to conduct regression analysis to establish a conceptual model for the critical risk variables that impact project performance (time, cost, and quality) in Iraqi construction projects.

A. Research Design

The framework, plan, or strategy employed in research is known as the research design. For this study, an exploratory and descriptive quantitative research strategy was employed.

- By adopting an exploratory methodology, related literature is reviewed to support the problem's existence and related research in the field of risk management for building projects.
- Descriptive research involved gathering data regarding establishing the main risk factors and the extent of their influence on the project performance in Iraq through a questionnaire and methodically discussing it to present a comprehensive conclusion.
- The study has been separated into three parts so that the research's objectives can be fulfilled
- The first step involved a thorough analysis of the pertinent literature on the development of the project risk management approach.
- The second step examined pertinent studies and research on risk determination and evaluation, as well as identifying the most critical potential risk factors in any construction project and to any extent that affects project performance (cost, time, and quality).
- The third step involved conducting interviews with specialists to determine the risk factors (RF) to be examined, then a questionnaire has been constructed to fit the study goal.

B. Data Analysis Techniques

The data were analyzed by statistical tools including mean, RII, and inferential techniques were used as well. Multiple regression analysis was one of the inferential methods utilized in data analysis to assess the research's main hypothesis.

1) The Relative Importance Index (RII): The Relative Importance Index technique has been employed to examine the data and the relative importance of each factor was calculated using Equation (1) [22]:

$$RII\% = \frac{\sum_{1}^{n}(X1 * S1 + X2 * S2 + ... + Xn * Sn)}{A * N} \quad (1)$$

Where:

RII= Relative Importance Index

S = Weights are assigned to each element by respondents (range from 1 to 5)

X = Frequency with which each factor or choice is rated

N = The total of all respondents

A = The greatest weight (in this situation, 5)

2) Regression Analysis: The form of a mathematical model which will clarify the rapport between project performance criteria and main risk factors was determined through the use of multiple linear regression analysis, which has been also utilized to assess how strongly the variables are associated. Equation (2) may be used to compute it [23].

$$Y = \beta 0 + \beta iXi + ... + \beta nXn + \mu \quad (2)$$

Where:

Y= Dependent Variable

β0 = Constant term

βi = Beta coefficient of each predictor to the model

Xi= Predictor variable (Dependent variables)

μ = The error term

The replies to the questionnaire were obtained by adopting a five-point Likert scale ranging from 1 to 5 (5= extremely impact, to 1= not impact), as shown in Table 2 [24].

TABLE 2. CRITERIA OF RESPONSE EVALUATION

No.	S	Level	Mean interval
1	1	Not Impact	1-1.5
2	2	Less Impact	1.5-2.5
3	3	Averagely Impact	2.5-3.5
4	4	Impact	3.5-4.5
5	5	Very Impact	4.5-5

3) Reliability Test (Cranach's Coefficient Alpha): Data consistency and stability are examined by using the coefficient of reliability. Before analysis, Cronbach's Alpha test coefficient has been employed in SPSS to verify the reliability of the questionnaire, have got the results range from 0.911 to 0.985 as shown in Table 3. This range is regarded as high since prior research has shown that if Cronbach's alpha is more than 0.7, the data's inner reliability is at a high level and may be extremely acceptable.

TABLE 3. COEFFICIENT OF RELIABILITY

No.	Risk Factor Groups	Cranach's Alpha	No. of items
1	Management Risk Factors	0.930	4
2	Consultant Risk Factors	0.949	3
3	Owner Risk Factors	0.911	3
4	Contractor Risk Factors	0.970	5
5	Design Risk Factors	0.985	7
6	Material Risk Factors	0.981	5
7	Finance Risk Factors	0.922	4
8	Labor and Equipment Risk Factors	0.962	4
9	External Risk Factors	0.957	6

III. RESULTS

1) Identifying Risks Factors in Construction Projects: After the data was collected from various sources, the most critical risk factors have been identified (RF) by the questionnaire based on the mean and relative importance index as displayed in Table 4.

TABLE 4. DETAILS OF QUESTIONNAIRE FOR RISK FACTOR CLASSIFICATIONS

No.	Risk Factor Groups	Number of Risk Factors	Mean	Std	RII	Rank
1	Management-related Risk Factors	4	3.90	0.68	0.78	7
2	Consultant-related Risk Factors	3	4.11	0.84	0.82	3
3	Owner-related Risk Factors	3	4.07	0.93	0.81	4
4	Contractor-related Risk Factors	5	3.99	0.87	0.79	6
5	Design-related Risk Factors	7	4.01	0.93	0.80	5
6	Material-related Risk Factors	5	3.92	0.95	0.78	7
7	Finance -related Risk Factors	4	4.22	0.85	0.84	1
8	Labor and equipment-related Risk Factors	4	4.00	0.78	0.80	5
9	External-related Risk Factors	6	4.16	0.83	0.83	2

The results in Table 4 & Fig. 2. displayed that the “Finance Risk Factors” risk source has got the first respondent’s priority among others with a percentage of (84%) followed by “External Risk Factors” with a percentage of (83%) and followed by “Consultant Risk Factors” with the percentage of (82%). The last priority was “Management Risk Factors” and “Material Risk Factors” with a percentage of (78%).

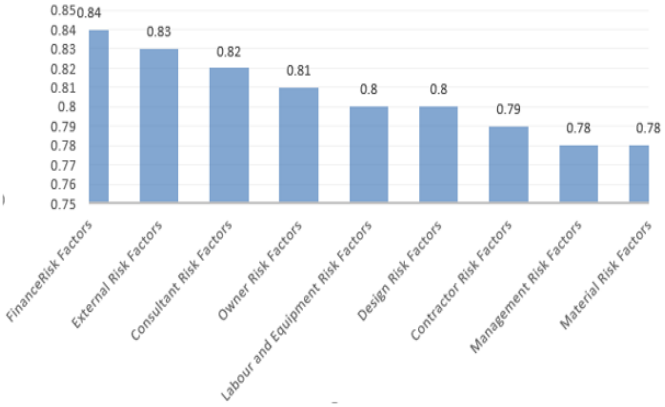

Fig. 2. Rank the group of risk according to the importance

2) Evaluated of the Project Performance Criteria: The results in Table 5 showed the degree of project performance in the research region is low. This is demonstrated by importance index values of 0.72 for quality, 0.7 for time, and 0.45 for time.

TABLE 5. DETAILS OF QUESTIONNAIRE FOR RISK FACTOR CLASSIFICATIONS

No.	Main Criteria	Sub-Criteria	Mean	Std	RII
1	Project performance	Project cost	3.53	0.91	0.70
		Project time	2.26	1.03	0.45
		Project Quality	3.60	0.91	0.72

3) Correlation Analysis: To examine the link between the critical risk factors, which were independent variables, and the project performance criteria, which were dependent variables, the Pearson correlation was used. According to Table 6 Pearson coefficient, the values of the independent variables were substantially connected with project performance as the dependent variable at a significance level of 0.01. Consequently, the null hypothesis, which was developed earlier and indicates that there is no relationship between the main risk factors and the project performance criteria, is not supported.

TABLE 6. CORRELATION BETWEEN CRITICAL RISK FACTORS AND PROJECT PERFORMANCE

Correlation			
No.			Project Performance
1	Management Risk Factors	Pearson Correlation	0.936**
		Sig. (2-tailed)	0.000
		N	15
2	Consultant Risk Factors	Pearson Correlation	0.926**
		Sig. (2-tailed)	0.000
		N	15

3	Owner Risk Factors	Pearson Correlation	0.909**
		Sig. (2-tailed)	0.000
		N	15
4	Contractor Risk Factors	Pearson Correlation	0.952**
		Sig. (2-tailed)	0.000
		N	15
5	Design Risk Factors	Pearson Correlation	0.920**
		Sig. (2-tailed)	0.000
		N	15
6	Material Risk Factors	Pearson Correlation	0.924**
		Sig. (2-tailed)	0.000
		N	15
7	Finance Risk Factors	Pearson Correlation	0.910**
		Sig. (2-tailed)	0.000
		N	15
8	Labor and Equipment Risk Factors	Pearson Correlation	0.953**
		Sig. (2-tailed)	0.000
		N	15
9	External Risk Factors	Pearson Correlation	0.941**
		Sig. (2-tailed)	0.000
		N	15

4) Conceptual Model: To determine how construction risk factors affected the fulfillment of construction projects in Baghdad, Iraq, Multiple Regression Analysis (MRA) was employed. Regression analysis predicts the value of project performance by developing a model to specify how key risk factors influence project performance. It will be tested using the enter technique, which is the regression test's standard approach and involves simultaneously entering all of the independent variables into the equation.

The model includes nine main risk factors with sub-risk factors and project performance criteria which include 3 items as we indicated previously. By utilizing SPSS data analysis, the proposed null hypothesis has been disproved and the results displayed an upward correlation between all the components and the project performance criteria as presented in the following Tables.

The R-value represents the simple correlation & R Square value denotes the percentage of the total variance in the dependent variable. Table 7 demonstrates the aggregated regression model summary. The R-value was 0.979 which indicates that positive association between the dependent and the independent variables. The performance of building projects in Iraq varied by 95.8%, according to the R Square value of 0.958, due to variations in the major risk variables.

TABLE 7. MODEL SUMMARY

Model	R	R Square	Adjusted R Square	Std. The error in the Estimate
1	0.979a	0.958	0.883	0.928
a. Predictors: (Constant), All factors				

Table 8 is presented the ANOVA outputs, as F-statistics was 12.791 which is significant at P≤0.05 where the p-value was 0.006, This demonstrates that the model as a whole was significant. As a result, the null hypothesis has been rejected, and accept the alternative hypothesis, which is that the regression is significant, that independent factors influence the dependent variable, and that the dependent variable can be predicted using these independent variables.

TABLE 8.THE RISKS FACTORS CATEGORISATION

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	99.287	9	11.032	12.791	0.006b
Residual	4.313	5	0.863		
Total	103.600	14			
a. Dependent Variable: Project Performance Criteria					
b. Predictors: (Constant), All factors					

The coefficients in Table 9 have been used to write the multiple regression model:

Y= 1.344+ 1.313 X1+ 2.392 X2+ 1.70 X3 + 0.766X4+0.273 X5+ 0.225 X6+ 1.445 X7 + 1.368X8+ 0.760X9

Where:

Y= Project Performance X1= Management Risk Factors X2= Consultant Risk Factors

X3= Owner Risk Factors X4= Contractor Risk Factors X5= Design Risk Factors
X6= Material Risk Factors X7= Finance Risk Factors X8= Labour and equipment Risk Factors
X9= External Risk Factors

TABLE 9
REGRESSION COEFFICIENTS

	Un standardized Coefficients		Standardized Coefficients			Collinearity Statistics	
Model	B	Std. Error	Beta	t	Sig.	Tolerance	VIF
(Constant)	1.344	6.682		4.663	0.000		
Management risk factors	1.313	1.751	1.206	3.495	0.001	0.624	1.603
Consultant risk factors	2.392	1.766	2.120	3.544	0.004	0.651	1.537
Owner risk factors	1.700	2.203	1.656	2.995	0.010	0.574	1.742
Contractor risk factors	0.766	0.902	1.168	3.321	0.005	0.497	2.010
Design risk factors	0.273	0.795	0.628	3.126	0.006	0.500	1.999
Material risk factors	0.225	0.691	0.384	3.767	0.001	0.567	1.765
Finance risk factors	1.445	1.962	1.713	3.292	0.005	0.577	1.745
Labor and equipment risk factors	1.368	0.764	1.497	2.865	0.020	0.632	1.633
External risk factors	0.760	0.601	1.313	2.543	0.040	0.511	1.458

According to the findings, all independent factors was a positive and significant impact on the performance of construction projects in Baghdad, Iraq, as shown by t-values. The relations ($p < 0.05$) are all significant with management risk factors (3.495, $p< 0.05$), consultant risk factors (3.544, $p< 0.05$), owner risk factors (2.995, $p< 0.05$), contractor risk factors (3.321, $p< 0.05$), design risk factors (3.126, $p< 0.05$), material risk factors (3.767, $p< 0.05$), finance risk factors (3.292, $p< 0.05$), labor and equipment risk factors (2.865, $p< 0.05$) and external risk factors (2.543, $p< 0.05$).

The consultant risk factors have the maximum impact on project performance as shown by a standardized beta coefficient of (2.120), followed by finance risk factors (1.713), owner risk factors (1.656), labor and equipment risk factors (1.497) external risk factors (1.313), management risk factors (1.206), contractor risk factors (1.168), design risk factors (0.628) and material risk factors (0.384).

Tolerance and variance inflation factors (VIF) also indicated significant values. As a result, the study variables satisfied the correlation test and are appropriate for multi-regression analysis when (VIF) values were less than (3).

IV. CONCLUSIONS

Any project failure is usually associated with performance problems. The implications can be costly and time-consuming, with the majority of outcomes resulting in adverse legal arrangements. The cost, time, and quality criteria are considered into evaluated the project's performance. These criteria are essential to measure the progress of any project and cannot be indispensable.

The construction sector in Iraq has long been associated with poor performance in terms of cost, schedule, and quality due to the influence of risk factors on the project. Despite this, Efforts to identify and manage construction risks were insufficient, in addition to an absence of interest in and understanding of risk management strategies. Consequently, this study evaluated the performance of building projects in Baghdad, Iraq, as well as the risk factors that inhibit their performance.

Lastly, the study shows that risk variables in construction projects have a considerable impact on project performance. As a result, project performance may be enhanced by improving risk management, especially consultant, finance, owner, and labor and equipment risk factors.

Finally, the research concludes that construction project risk factors have a significant influence on project performance, due to several factors, including delays in preparing, approving drawings, and approving major changes in the project by the consultant, inflated cost estimates, and difficulties in financing the project during implementation, in addition to the delay in approving the type of materials required to complete the work by the owner work, as well as, low productivity of workers, machinery and other factors that must be highlighted and take appropriate strategies for early detection of these factors.

To reduce the impact of these factors, the research recommended several necessary strategies, which include the following:

- Employ several engineers with experience in risk management.
- Promote awareness of the need to understand and apply risk management in construction projects.
- The establishment of a training curriculum for the Rehabilitation and development of engineering cadres, contractors, workers, and all stakeholders involved in construction work in the field of risk analysis and

management to be able to visualize emerging risks and use the necessary methods and techniques in the early stages to reduce their impact, which helps to complete the project within the specified goals.

It is expected that the regression model can be appropriate to a widespread of engineering projects for risk management. Consequently, project performance can therefore be enhanced by improving risk management, it will be a critical component of any organization's path toward peak performance.

The results of the research include future suggestions for researchers, such as including a wider group of respondents in construction projects from both the public and private sectors, and making a comparison between them. In addition, similar research can be conducted using a broader set of project performance criteria. Also, each category of identified risks can be studied independently and a conceptual model can be created for each category.

Future researchers must know that there are many previous studies have been conducted on building a conceptual model between risk factors and project performance. However, there are differences in terms of studying the number of major risk categories and project performance criteria.

REFERENCES

[1] Abdulrahman, R. S., Ibrahim, A. D., Kolo, B. A., & Ahmadu, H. A. Review of risk management studies: towards a frame of reference for large projects. In Built Environment Research Conference, West Africa, Accra, Ghana, 9-11 August 2021.

[2] Adedokun, O. A., Egbelakin, T., Adedokun, D. O., & Adafin, J. Success criteria-based impacts of risk factors on education building projects in southwestern Nigeria. Journal of Engineering, Design, and Technology, 2021. DOI: 10.1108/JEDT-09-2021-0458.

[3] Deng, X., Low, S. P., Zhao, X., & Chang, T. Identifying micro variables contributing to political risks in international construction projects. Engineering, Construction and Architectural Management 2018.

[4] Odimabo, O., & Oduoza, C. F. Guidelines to aid project managers in conceptualizing and implementing risk management in building projects. Procedia Manufacturing 2018, 17, 515-522.

[5] Chatterjee, K., Zavadskas, E. K., Tamošaitienė, J., Adhikari, K., & Kar, S. A Hybrid MCDM technique for risk management in construction projects. Symmetry 2018, 10(2), 46. doi:10.3390/sym10020046

[6] Chang-Richards, A., Brown, C., & Smith, N. Building risk management strategies into the vertical construction sector. Report ER59, BRANZ 2019, Wellington, ISSN, 2423-0839.

[7] Gitahi, S. M., & Tumuti, J. Management of contracting risks on performance of construction projects in Kilifi county, Kenya. International Academic Journal of Information Sciences and Project Management 2019, 3(3), 105-130.

[8] Keshk, A. M., Maarouf, I., & Annany, Y. Special studies in the management of construction project risks, risk concept, plan building, risk quantitative and qualitative analysis, risk response strategies. Alexandria Engineering Journal 2018, 57(4), 3179-3187.

[9] Tavakolan, M., & Etemadinia, H. Fuzzy weighted interpretive structural modeling: an improved method for identification of risk interactions in construction projects. Journal of Construction Engineering and Management 2017, 143(11), 04017084.

[10] Tepeli, E., Taillandier, F., & Breysse, D. Multidimensional modeling of complex and strategic construction projects for more effective risk management. International Journal of Construction Management 2021, 21(12), 1218-1239.

[11] Boateng, A., Ameyaw, C., & Mensah, S. Assessment of systematic risk management practices on building construction projects in Ghana. International Journal of Construction Management 2020, 1-10. DOI 10.1080/15623599.2020.1842962.

[12] Fariala, A., & Awolusi, O. D. An Assessment of key success factors for construction projects in the democratic republic of Congo. Information Management and Business Review2021, 13(2 (I)), 16-34.

[13] Abdelmageid, M. A. S. Application of risk management and Monte Carlo simulation on a construction project (Case Study). PhD Thesis, Politecnico di Torino, 2020.

[14] Aarthipriya, V., Chitra, G., & Poomozhi, J. Risk and its impacts on time and cost in construction projects. Journal of Project Management 2020, 5(4), 245-254.

[15] Khalid, L. S., & Rahman, I. A. Conceptual model for the external factors affecting project performance using pestle factors. Journal of Advanced Research in Dynamical and Control Systems 2019, 11(3), 246-250.

[16] AlQassem, S. The Factors affecting project success criteria–aviation projects. PhD Thesis, The British University, Dubai, 2017.

[17] Auma, E. Factors affecting the performance of construction projects in Kenya: a survey of low-rise buildings in Nairobi central business district. The International Journal of Business & Management 2014, 2(12), 115.

[18] Altoryman, A. (2014). Identification and assessment of risk factors affecting construction projects in the Gulf region: Kuwait and Bahrain. Ph.D. Thesis, The University of Manchester, United Kingdom, 2014.

[19] Arya, A., & Kansal, R. Analysing delays of construction projects in India: causes and effects. International Journal of Science Technology & Engineering 2016, 3, 66-74.

[20] Gebrehiwet, T., & Luo, H. Risk level evaluation on construction project lifecycle using fuzzy comprehensive evaluation and TOPSIS. Symmetry 2019, 11(1), 12.
[21] Salleh, R. Critical success factors of project management for Brunei construction projects: improving project performance. Ph.D. Thesis, Queensland University of Technology, 2009.
[22] Muneeswaran, G., Manoharan, P., Awoyera, P. O., & Adesina, A. A Statistical approach to assess the schedule delays and risks in the Indian construction industry. International Journal of Construction Management 2020, 20(5), 450-461.
[23] Youssef, W. M. (2014). Probabilistic models for construction projects' durations in the middle east. Ph.D. Thesis, Cairo University, GIZA, EGYPT, 2014.
[24] Hassan, B., Waziri, A. Y., Usman, H., & Ibrahim, Y. The Influence of construction project team effectiveness in higher institutions' building projects: a case from Nigeria. International Journal of Real Estate Studies 2022, 16(1), 37-50.