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Improving Project Performance Based on Information and Communication Technology

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ABSTRACT

Ict contributes to the establishment of deeper approaches to how to sustain major projects. On this basis, this research presents the impact of ICT-specific factors on performance indicators of major projects by utilizing a combination of surveys, expert opinions, interviews, and exploratory research, with the help of previous studies in the field of construction projects. The primary investigation assessed the impact of implementing risk management techniques on performance indicators by utilizing a combination of surveys, expert opinions, interviews, and exploratory research, drawing upon previous studies in the field of construction projects. The initial findings were obtained by calculating the factors effect. The identification of the relative importance index (RII) effect facilitated the determination of the consequences. The results of the RII analysis indicate a high level of resistance to change and a moderate level of effectiveness in scheduling and information and communication technology based job planning, with scores of the long payback periods factor and group decision making being made easier, respectively. Following the collection of data, the MCDM approach was employed to analyze it. It was discovered that two risk categories, inadequate rating systems and programs and financial management utilizing information and communication technology, more accurately represent the risk factors. The MCDM results yielded outcomes that were both more accurate and practical.

Keywords: MCDM, Building construction, Risk factors, ICT

1. INTRODUCTION

Meeting client expectations presents a continual challenge for the construction industry, requiring extensive data use and ongoing communication among project stakeholders. Consequently, the construction sector has lately experienced an increase in the utilization of information technology for project execution. The expansion of digital communication and information tools has initiated many "Industrial Revolutions" worldwide (ICT). The utilization of steam and hydraulic power to supplant manual work with mechanical labor

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initiated the first industrial revolution **(Jaafar et al., 2024)**. Camngca in 2024 investigated the effects and causes of the underutilization of ICT in the building sector of a municipality's public sector. The findings indicate that personnel in building technology lack comprehension of contemporary and emerging information and communication technology (ICT) software and hardware due to insufficient digitalization in construction project execution, inadequate system enhancements, limited ICT resources, financial constraints for internet and software application subscriptions, and a deficiency in ICT training. This transition adversely affects all authorities, particularly junior officials who have undergone training with advanced information and communication technologies **(Camngca, 2024)**. (**Saleh et al., 2024**) studied the contemporary technology and advanced knowledge such as information and communication technologies (ICT) which are utilized in smart,sustainable cities to meet the social, cultural, economic, and environmental requirements of current and future generations, thereby enhancing the quality of life. The results underscore the significance of building information modeling (BIM) in enhancing lean methodologies, offering experts a means to elevate the performance of the AEC sector through strategic integration of valuable information **(Saleh et al., 2024).** Also, the impact of human resource management and communication management on the efficiency of construction projects in Iraq has been investigated. Practitioners and politicians can get substantial insights into these issues via comprehension.

This knowledge may then be utilized to design solutions that surmount obstacles and enhance project efficiency. The quality of online communication significantly enhances worker productivity, but labor resource management has minimal to no impact. The importance of effective human resource management techniques in the construction industry is underscored by the role of high-quality internet communication in enhancing worker productivity on construction projects. Project managers and construction industry professionals can significantly benefit from the study's conclusions **(Al-Aloosy et al., 2024).** In order to assist the construction sector in enhancing decision-making via the examination of an integrated decision analysis framework for the investment case for the implementation of various logistical systems dependent on information and communication technology (ICT). Companies in the building industry may get the best results and success by putting strategic alignment into practice well. It gives companies new information about how apps and infrastructure for information and communication technology (ICT) can improve business results and efficiency. By looking at the problems that come with strategic ICT alignment, this study helps us understand how the building industry could use new technology **(Eliwa et al., 2024).** A quantitative survey of construction professionals was applied to show that the most influential factors are the owner's delay in paying for work, market price fluctuations, the lack of knowledge and inefficient use of current tools and technology, and the country's security. It shows that construction projects have cost showmanagement issues that delay or cease delivery, requiring immediate action. The implementation of new technologies in the construction business cost management systems **(Fadhil et al., 2021).** Due to construction industry considerations, project cost engineering is difficult. In construction management, accurate cost estimation affects project performance. Due to their ability to solve complicated problems, AI models have been successfully utilized in construction management research. The couples extreme gradient boosting, an advanced input selection approach, with three AI models—random forest (RF), artificial neural network (ANN), and support vector machine (SVM)—for cost estimation. A survey of 90 Iraqi building projects yielded datasets. The researchers found that all AI models predicted well on datasets with more than two parameters. Also, the optimistic

technique helps early project management decision makers choose affecting parameters. Creating a high-precision prediction model can help project estimators reduce cost estimating errors **(Ali et al., 2022)**.
as a multi-objective optimization problem, the PSO algorithm usually yields multiple optimal solutions for five proposed pile types. The researcher evaluated and discussed the output results and found that pre-high tension spun (PHC) piles were best **(Lateef et al., 2019).**
The objective of this research is to identify the most essential element for identifying and enhancing the currently employed approaches for model construction and analysis. The problem lies in determining whether current methods are sufficient for constructing complex buildings employing ICT. In order to accomplish this objective, it is necessary to investigate the intricate elements of construction that are utilized to evaluate their effectiveness and create a model for decision-makers that analyzes the significance of different impacts of information and communication technology (ICT).

2. STRATEGY OF USING ICT IN CONSTRUCTION

Strategic Initiative Integration with Information and Communication Technology Infrastructure ICT must be linked with the company or corporate strategy to gain a competitive edge and increase ICT usage, which is where the concept of strategic alignment comes from **(Gransberg et al., 2018; Hussein et al., 2021).** The candidates are then organized hierarchically using the Rational Hierarchy Process, estimated weight training of criteria, and a fuzzy methodology for order achievement based on similarity to the great answer. The outcomes of the situation analysis are revealed to be acceptable **(Koç et al., 2020; Bari et al., 2012)**. Ethiopian construction projects have faced an average postponement risk of 38% points at a high and actual high-danger level. This work is expected to serve as a tool for donation managers in the planning and switching of schedule delays and cancellations in order to mitigate their risks (Mahmoudkelaye et al., 2018) . Because cost is more important, the cost of each activity is reduced from the highest to the lowest. The use of this method may open up new avenues for inquiry and expertise expansion in the field of building scheme planning **(Rashidv et al., 2023; Blackv et al., 2017).** To demonstrate the potential application and effectiveness of the future approach, a case study of the evaluation of contracting companies' competitive aptitude was used **(Polyankin et al., 2020).** An experiential study was led within the Malaysian construction industry to demonstrate the future method **(Rashid et al., 2016)**. Construction advancement of commercial and fun complex building schemes is one of many emerging countries' community desires. Meanwhile, while the application of these initiatives is typically very costly, identifying and evaluating their dangerous risk factors is of significant importance **(Sinaga et al., 2022; Supriyono et al., 2018; Marwa et al., 2022; Jalhoom et al., 2023).**

3. FACTORS ON ICT APPLICATION

In order to gauge the success of a project, it's important to track a number of quantifiable signs known as performance indicators. Measures are selected to represent the key success factors of a project and provide information to decision-makers so that they can evaluate progress and determine whether actual results are in line with expectations **(Rasheed et al., 2015)**. These theoretical works were chosen for review because of their

interconnectedness and relevance to the research at hand. The application of ICT factors presented by **(Paudyal et al., 2016)** are:

-Predesign / -Design / -Construction / -Operation / -Maintenance

According to the literature, the application of ICT mainly includes end-users, building owners, finance, intelligent building consultants, security, ICT consultants, and environmental compliance **(Mohammad et al., 2014).**

4. THE SYSTEM METHODOLOGY

In this research, the system methodology as shown in **Fig. 1.** Information and communication technologies (ICT) are a diverse collection of technological instruments and resources used for transmitting, storing, creating, sharing, or exchanging information**. Table 1** presents the independent ICT factors that have been used in the present study.

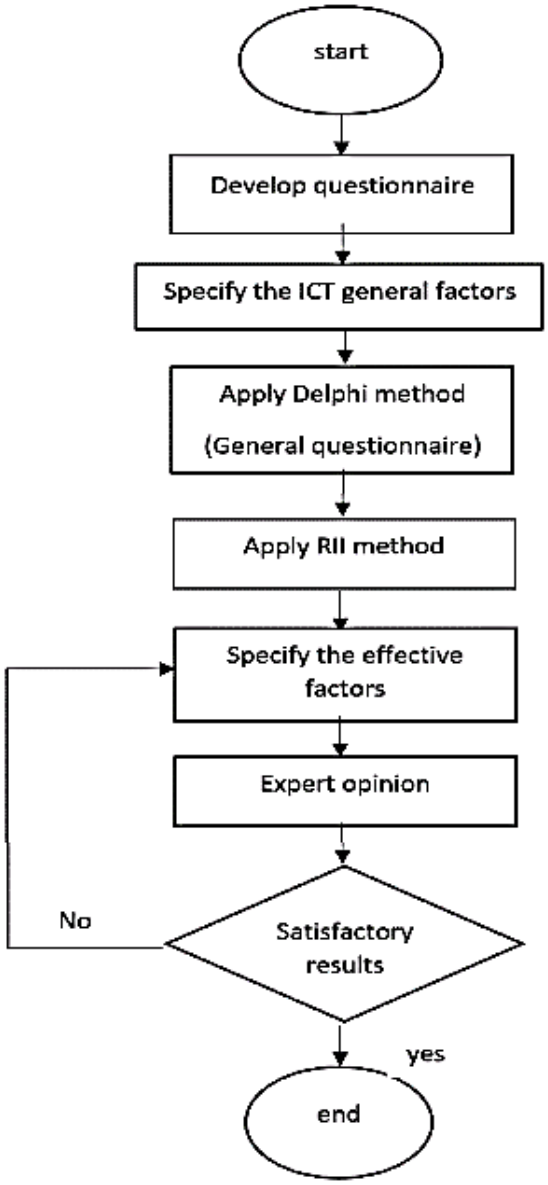

Figure 1. The system methodology of the present research

Table 1. Independent ICT factors **(Paudyal et al., 2016)**

Symbol	ICT factors
CF1	Enhance cooperation, coordination and collaboration levels.
CF2	Improves the performance of construction processes in terms of cost, time, quality, and client satisfaction.
CF3	Works as a catalyst in development processes.
CF4	It helps complete the project in an estimated time and budget.
CF5	Lower financial risk
CF6	Effective communication between project participants.
CF7	Group decision-making is made easier.
CF8	The possibility of error is minimized.
CF9	Change in design can be made efficiently.
CF10	Information flow is accurate

Information and communications technology, or ICT for short, is a broad word that al to all networking tools and software. Information technology (IT) is the integration of computers, software, and information processing techniques like information storing, retrieval, and access. This word, also referred to as ICT, describes telecommunications-based information access tools. This encompasses networked devices, the Internet, wireless networks, mobile phones, and other means of contact.

5. MANAGEMENT FACTORS

The management roles are influenced by numerous variables. The planning, organizing, leading, and regulating processes make up the managerial responsibilities. Key elements include the internal and external, globalization, technology, creativity, variety, and ethics. It has seen a variety of management methods, whether in energy, financial services, or healthcare, but the fundamentals of successful management stay the same. Various variables influencing the construction productivity of university lecturers have been the subject of numerous studies. Nevertheless, these studies have mainly looked at how administrative and/or individual factors **(Alfahad et al., 2024; Rashid et al., 2023)**. **Table 2** presents the independent management factors that have been used in this study.

Table 2. Independent management factors **(Bendi, 2017)**

Symbol	Management factors
F1	Economic state
F2	Higher costs of building technologies
F3	Lack of market demand
F4	Risks involved in implementing new technologies
F5	Lack of government support
F6	Lack of knowledge
F7	Long pay-back periods
F8	Conflicts of interest among stakeholders
F9	Resistance to change
F10	Longer construction period
F11	Lack of reliable research and education

F12	Lack of skilled/experienced staff
F13	Lack of databases and information
F14	High cost of sustainable materials
F15	Lack of available suppliers
F16	Complexity and rigid requirements
F17	Insufficient rating systems and available programs
F18	Fewer regulations available

6. THE DELPHI METHOD

The Delphi technique consists of a series of written queries sent to field-specific experts. After all of the experts have completed a series of questionnaires, the facilitator will consolidate the responses and provide each of them with a summary report **(Shadhar et al., 2018)**. The talent then reviews the executive summary of the report and determines whether or not they agree with the presented conclusions. Participants are asked to complete a second questionnaire in which they can elaborate on their most recent thoughts after perusing the summary report. Using the Delphi method, when a consensus is reached on forecasts, it is deemed a success **(Skulmoski et al., 2007; Khairullah et al., 2023).**

7. MCDM METHOD

MCDA (Multi-Criteria Decision Analysis) and MCDM (Multi-Criteria Decision Making) are two approaches used to make judgments by considering several criteria. MCDA/MCDM approaches often yield a limited selection of options, where each alternative is defined by a distinct set of criteria. To evaluate each selection choice, calculate numerous ratios that represent different criteria for picking. These ratios can then be multiplied together for comparison. The relative importance of each criterion is multiplied by its corresponding ratio. The WPM can be applied to MCDA/MCDM problems in both one and two dimensions. For instance, when the decision-making alternatives have distinct units of measurement.
An important advantage of this method is that it enables the utilization of relative values rather than absolute ones. The subsequent numerical illustration demonstrates the computations of this technique in a comprehensible style. can employ identical numerical values from the weighted sum model's numerical example for our dataset **(Mohammed et al., 2024; Sawsan et al., 2014; Ahmed et al., 2014)**:

$$W_J^- = \frac{W_J}{\sum_{J=1}^{N} W_J} \quad (1)$$

$$where \quad \sum_{J=1}^{N} W_J = 1$$

Calculate the preference value of every i -the alternative using Eq. (2).

$$S_i = \prod_{j=1}^{N} x_{ij}^{W_J^-} \quad (2)$$

Where the value of w is positive if the criteria is a benefit otherwise its value is negative.

Calculate relative preference value of each alternative to all alternatives using Eq. (3).

$$V_i = \frac{S_i}{\sum_{i=1}^{M} S_i} \quad (3)$$

The higher V value means the better the alternative. Where W is weighted sum model, S_i is the i-preference value, V is relative preference value

8. RELATIVE IMPORTANCE INDEX (RII)

The degree and gravity of the expense, the decision-makers' risk tolerance, and other relevant factors all play a role in the decisions made during risk factor management. Therefore, it is necessary to determine the level of permission following the assessment of the risks. The amount of risk that a person, client, or society is willing to take determines the decision-maker's willingness to make a decision. Choosing an appropriate amount of acceptable risk is essential when deciding on the construction methods, technical solutions, budget, and schedule. Early in a project, decisions can be made with greater information and clarity if the degree of acceptable risk factor is determined early on. The risk considerations policy for the project should provide a precisely defined limit for the amount of risk that is considered acceptable. The willingness and ability of a decision-maker to identify and reduce related risks determines whether or not certain factors are acceptable. The adoption of risk factors is influenced by a number of factors, including decision criteria, past knowledge and experience with comparable choice scenarios, and how individuals or organizations perceive risk factors. The certainty equivalent, which stands for the guaranteed or projected worth of assets connected to a risky circumstance, is the basis for determining each of them. The source is credited with using the RII test to determine how risk factors affected survey responses. This was made possible by giving each variable's degree of risk a precise numerical representation. The purpose of this study was to use the following equation to calculate the Relative Importance Index (RII):

$$RII = \sum (PiUi)/Nn \quad (4)$$

RII = relative importance index, Pi = respondent's rating of risk factors, Ui = number of respondents placing identical weighting/rating on the factor, N = sample size people responded to the survey, n = the highest attainable score for each factor.

9. RESULTS AND DISCUSSION

Effectively mitigating the risks connected with a project poses a significant challenge for developing nations during its implementation. The objective of this corporate strategy is to maximize profits while simultaneously creating a beneficial influence on society, the environment, and the government. The main objective of sustainability risk management is to achieve a balanced approach that minimizes negative outcomes while promoting positive outcomes. This article highlights certain hazards that have the potential to impede or even stop construction operations in Iraq. By implementing this approach, the probability of supply chain disruptions resulting from occurrences such as natural catastrophes or labor

conflicts is diminished. The average risk assessment serves as the initial stage for conducting any inquiry into road risks. Begin by calculating the standard deviation. Gaining an understanding of the variability of the dataset is an essential prerequisite in the field of statistics and data analysis. Utilizing this tool enables individuals to gain enhanced comprehension of patterns, anomalies, dependability, comparability of datasets, and potential hazards. The primary benefit of the standard deviation is its consistent and precisely defined value. Standard deviation enables the feasibility of statistical and mathematical investigations. **Table 3** presents the STD of the factors.

The next step is to investigate the effective risk factors. Ranking the variables elucidates the criteria employed for assessing them in order to assess the risk variables based on their risk outcomes. Ranking variables may be determined by the adoption of technology, the presence of risk content, or other significant attributes. In order to optimize factors efficiently, it is necessary to have a comprehensive understanding of ranking factors. An efficient approach is necessary to assess the risk associated with third parties. In essence, it is impractical to anticipate that a compliance program's risk ranking system will consider every individual element. While there may be other factors to examine, these two are likely to be the most significant and reliable. **Figs. 2 and 3** depict the Relative Importance Index (RII) ranking of risk factors in this study.

Table 3. The STD of the factors

Factor	STD	Factor	STD	Factor	STD
F1	0.793	**F10**	0.689	**CF1**	0.858
F2	0.912	**F11**	0.961	**CF2**	1.028
F3	0.664	**F12**	0.716	**CF3**	1.021
F4	0.858	**F13**	0.961	**CF4**	0.858
F5	1.063	**F14**	0.850	**CF5**	0.907
F6	1.075	**F15**	1.123	**CF6**	0.857
F7	0.874	**F16**	1.124	**CF7**	0.619
F8	0.703	**F17**	1.077	**CF8**	1.026
F9	0.792	**F18**	1.167	**CF9**	0.920
				CF10	0.858

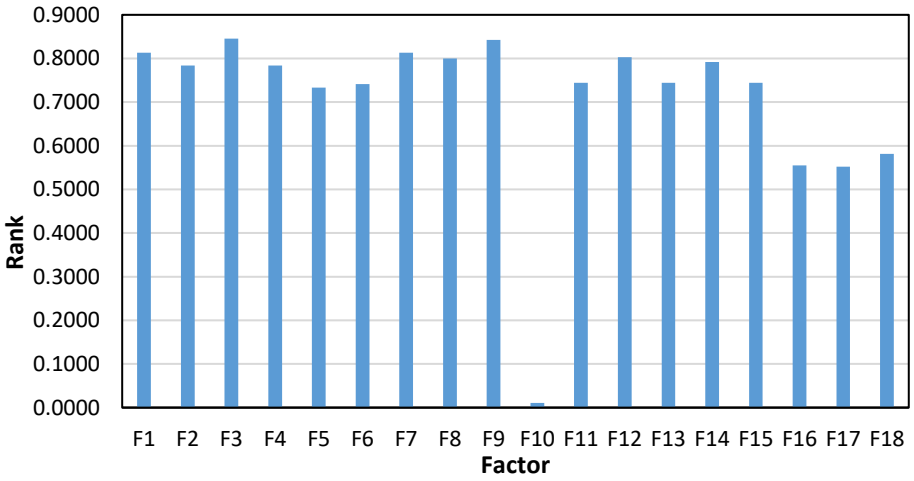

Figure 2. The RII results of the management factors

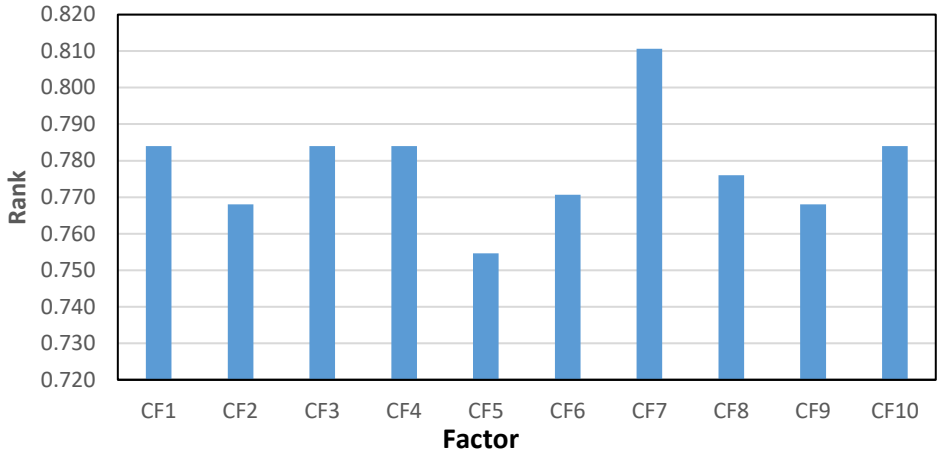

Figure 3. The RII results of the ICT factors

The results observed two effective factors. The factors are F9 (0.8427) and CF7 (0.81067), which represent resistance to change and scheduling and work planning using ICT, respectively. In order to investigate the accurate risk factors, the MCDM present another opinion. **Figs. 4 and 5** present other effective factors.

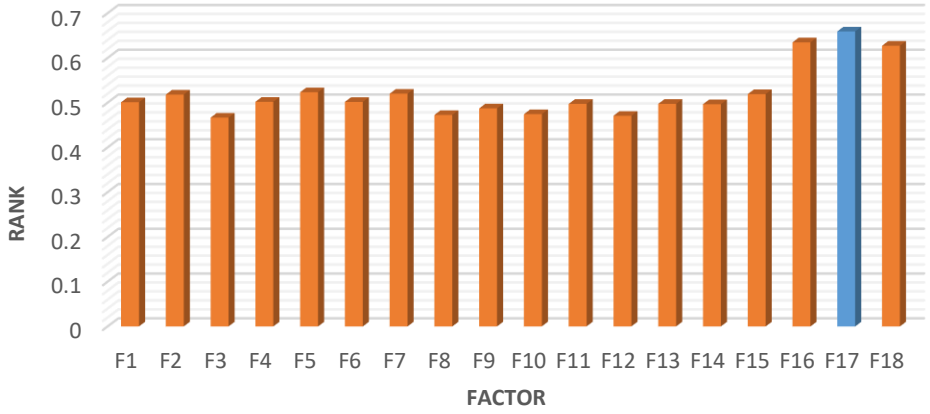

Figure 4. The MCDM results of the management factors

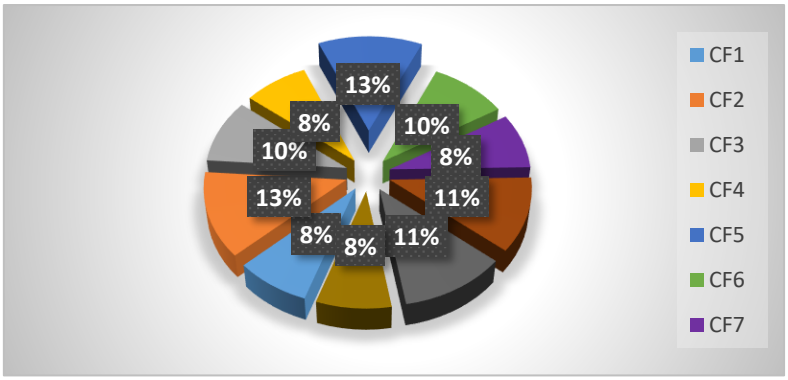

Figure 5. The MCDM results of the ICT factors

(F17),which represents the insufficient rating systems and available programs and (CF5),which represents financial management using ICT,represent more accurate risk factors. The results observed more reasonable risk factors.

10. CONCLUSIONS

The building construction industry in Iraq has a longstanding history of contempt for management procedures and budgetary limitations. The daily visual simulation of the building process conducted by researchers represents a substantial advancement toward design excellence. It presents a challenge to existing review methods, which are often more arduous and time-intensive. Motivated by the successes of their colleagues in rich nations, academics in developing countries such as Iraq have shown interest in the benefits of using ICTs in construction processes. Construction technology provides advanced and costly solutions. In the long run, the integration of ICT into the construction process provides several advantages, notwithstanding the higher initial costs. Consequently, emerging nations such as ours must acknowledge the importance of modern information and communication technologies in civil engineering to address technological challenges.
The identification of the RII impact was crucial in ascertaining the results. The RII scores for resistance to change (F9) and group decision making is made easier (CF7). According to the data collected, the MCDM technique identified two more precise risk factors: (F17), which pertains to insufficient rating systems and programs, and (CF5), which refers to the use of ICT in financial management. The results of the Multiple Criteria Decision Making (MCDM) were characterized by a greater emphasis on realism and pragmatism.

Credit Authorship Contribution Statement

Maytham B. Abdulhussain: Writing – original draft, Validation, Methodology. Abbas M. Burhan: Proofreading, Validation, and Methodology.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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تحسين أداء المشروع باستخدام تكنولوجيا المعلومات والاتصالات

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الخلاصة

تساهم تكنولوجيا المعلومات والاتصالات في ترسيخ اساليب أعمق لكيفية ديمومة المشريع الكبرى. على هذا الاساس يقدم هذا البحث تأثير العوامل الخاصة بتكنولوجيا المعلومات والاتصالات على مؤشرات الأداء للمشاريع الكبرى من خلال الاستفادة من مجموعة من المسوحات وآراء الخبراء والمقابلات والبحوث الاستكشافية، بالاستعانة بدراسات سابقة في مجال مشاريع البناء. تم الحصول على النتائج الأولية من خلال حساب تأثير العوامل. سهّل تحديد مؤشر الأهمية النسبية RII تحديد العواقب. تشير نتائج تحليل RII إلى مستوى عالٍ من مقاومة التغيير ومستوى معتدل من الفعالية في الجدولة والتخطيط الوظيفي القائم على تكنولوجيا المعلومات والاتصالات، مع تسهيل اتخاذ القرارات الجماعية وعشرات فترات الاسترداد الطويلة على التوالي. بعد جمع البيانات، تم استخدام نهج MCDM لتحليلها. وقد تم اكتشاف أن فئتين من المخاطر، أنظمة وبرامج التصنيف غير الكافية والإدارة المالية باستخدام تكنولوجيا المعلومات والاتصالات، تمثلان عوامل الخطر بشكل أكثر دقة. أسفرت نتائج MCDM عن نتائج كانت أكثر دقة وعملية.

الكلمات المفتاحية: طرق اتخاذ القرار، تشييد المباني، العوامل المؤثرة، تكنولوجيا المعلومات والاتصالات