REPUBLIC OF TÜRKİYE

YILDIZ TECHNICAL UNIVERSITY

GRADUATE SCHOOL OF SCIENCE AND ENGINEERING

TECHNOLOGY USE IN HUMANITARIAN CONSTRUCTION PROJECTS BASED ON PROJECT LIFE CYCLE STAGES AND PERFORMANCE DOMAINS

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MASTER OF SCIENCE THESIS

Department of Civil Engineering

Civil Engineering Program

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A thesis submitted by Ghada Hashim ABED in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE is approved by the committee on 25.10.2023 in Department of Civil Engineerning , Civil Engineering Program.

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Ghada Hashim ABED

Signature

Dedicated To

My Father

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LIST OF SYMBOLS

D1	Development approach and life cycle
D2	Planning
D3	Project work
D4	Delivery
D5	Measurement
D6	Uncertainty
L1	Feasibilty
L2	Design
L3	Build
L4	Test
L5	Deploy
L6	Close
N	Number of items
T1	Bim
T2	Blockchain / Smart contract
T3	Decision support systems
T4	Planning software
T5	Spatial Technologies (Geographic information system (GIS), Global Positioning System (GPS), Smart sensors, etc)
T6	Automatic identification technologies (Radio Frequency Identification technology (RFID), Ultra Wideband (UWB), Barcode, QRcode)]
T7	Mobile apps for phone / tablet
T8	Image capture technologies (Photogrammetry, Video Camera, Multimedia, Laser scanning, Laser-radar (LIDAR/LADAR))]
T9	Cloud computing technologies
T10	Augmented reality / Virtual reality / Mixed reality
T11	Internet of Things (IoT)
T12	Big Data Analytics
T13	Robotic applications (Autonomous vehicles, Unmanned aerial vehicle, 3D printer)
T14	Wearable technology (EEG, ECG/EKG sensors, UV light sensor, Stress control wristband, Smart helmet)

T15 Computer and software applications (ERP, EDI, XML, Database)

T16 Electronic document systems (E-commerce, E-procurement, E-commerce payment system, etc.)

T17 Wireless communication technologies (Bluetooth, wireless, WSN, WLAN)

T18 Advanced information technologies (Email, Voice, Handheld)

LIST OF ABBREVIATIONS

AEC	Architecture, Engineering, and Construction
CSF	critical success factors
ICT	Information and Communication Technology
IoT	Internet of Things
PHP	Prefabrication Housing Production
PM	Project Management
PMBOK	Project Management Body of Knowledge
Sig	P- value
SPESC	Specification Language for Smart Contract
SPSS	Statistical Package and Service Solutions
UNDP	United Nations Development Programme

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ABSTRACT

Technology Use In Humanıtarian Construction Projects Based On Project Life Cycle Stages And Performance Domains

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Department of Civil Engineering

Master of Science Thesis

Supervisor: Prof. Dr. Aslı Pelin GÜRGÜN

Use of technological means are increasing in construction sector to achieve the project objectives. There has always been a need to save effort, time and money in projects, and there is a lot of research in this field. Perhaps technology tools were one of the factors that helped previously and will continue to develop to serve their purpose in improving work efficiency in projects. Previous literature reviews examined the impact of these tools on the project as a whole or at a specific stage of the project. This research highlights the work of statistics to determine whether technological tools are involved in the work of humanitarian organizations and their impact, given that humanitarian organizations have noble goals in helping those affected by disasters and wars to develop their work by reducing time, preserving their funding, and ensuring that the product is delivered with the best quality. Integration of project management rules and technology is critical in this perspective. PMBOK 7th edition standards, which are published by Project Management Institute (PMI) refer to project management life cycle stages and project performance domains. In this study, technology use in humanitarian construction projects based on project life cycle stages and performance domains

are analyzed. For this purpose, a survey was prepared and administered to construction professionals who are experienced in humanitarian projects in Yemen, Ukraine, Iraq, Rome and South Sudan. The adoption and expected implications of recent technological tools are analyzed based on the responses collected from 176 participants to investigate the potential positive impacts of these tools on the project management lifecycle stages, and performance domains. The reliability of the responses were checked by Cronbach's alpha scale. The results showed that 52% of the answers said they have used technology tools in the project life cycle stages, while 55.8% of the answers said the have used it in project performance domains. 56.7% of the answers' evaluations was high between (5 and 7) and thinks the tools have benefits on project life cycle stages, and 18.8% of the answers were 4 (moderate). 55% of the answers' evaluations was high between (5 and 7) and thinks the tools have benefits on their work during project performance domains, and 21.4% of the answers gave answer 4 (moderate) benefit on project performance domains. These high ratings compared to the number of users show that there is a lack of support for organizations sponsoring humanitarian projects with technological tools.

Also, high ratings for technological tools show the intention of workers in the construction field to use these tools if they are available to them.

Keywords: Technology tools, survey, life cycle stages, project performance domains, PMBOK.

ÖZET

İnsani Yardım İnşaat Projelerinde Teknolojinin Proje Döngüsü ve Alanları Bazında Kullanımı

Ghada Hashim ABED

İnşaat Mühendisliği Anabilim Dalı

Yüksek Lisans Tezi

Danışman: Prof. Dr. Aslı Pelin GÜRGÜN

İnşaat sektöründe proje hedeflerine ulaşmak için teknolojik araçların kullanımı giderek artmaktadır. Projelerde her zaman emekten, zamandan ve paradan tasarruf etme ihtiyacı duyulmuştur ve bu alanda pek çok araştırma bulunmaktadır. Belki de teknoloji araçları, projelerde iş verimliliğinin arttırılmasında amacına hizmet etmek için daha önce yardımcı olan ve gelişmeye devam edecek olan faktörlerden biriydi. Önceki literatür taramaları, bu araçların projenin tamamına veya projenin belirli bir aşamasına olan etkisini inceledi. Bu araştırma, insani yardım kuruluşlarının afetlerden ve savaşlardan etkilenenlerin, zamanı kısaltarak ve fonlarını koruyarak işlerini geliştirmelerine yardımcı olma konusunda asil hedeflere sahip olduğu göz önüne alındığında, teknolojik araçların insani yardım kuruluşlarının çalışmalarında yer alıp almadığını ve bunların etkilerini belirlemeye yönelik istatistik çalışmalarını vurgulamaktadır. ve ürünün en iyi kalitede teslim edilmesini sağlamak. Proje yönetimi kurallarının ve teknolojinin entegrasyonu bu perspektifte kritik öneme sahiptir. Project Management Institute (PMI) tarafından yayınlanan PMBOK 7. basım standartları, proje yönetimi yaşam döngüsü aşamalarını ve proje performans alanlarını ifade etmektedir. Bu çalışmada insani inşaat projelerinde teknoloji kullanımı, proje yaşam döngüsü aşamaları ve performans alanlarına göre analiz edilmektedir. Bu amaçla Yemen, Ukrayna, Irak, Roma ve Güney Sudan'da insani

yardım projelerinde deneyimli inşaat profesyonellerine yönelik bir anket hazırlanarak uygulandı. Son teknolojik araçların benimsenmesi ve beklenen sonuçları, bu araçların proje yönetimi yaşam döngüsü aşamaları ve performans alanları üzerindeki potansiyel olumlu etkilerini araştırmak için 176 katılımcıdan toplanan yanıtlara dayanarak analiz ediliyor. Yanıtların güvenirliği Cronbach alfa ölçeği ile kontrol edildi. Sonuçlar, yanıtların %52'sinin proje yaşam döngüsü aşamalarında teknoloji araçlarını kullandıklarını, %55,8'inin ise bunu proje performans alanlarında kullandıklarını gösterdi. Cevapların %56,7'sinin değerlendirmeleri (5 ile 7) arasında yüksekti ve araçların proje yaşam döngüsü aşamalarında fayda sağladığını düşünüyor ve cevapların %18,8'i 4 (orta) idi. Cevapların %55'inin değerlendirmeleri (5 ile 7) arasında yüksekti ve araçların proje performans alanlarında çalışmalarına fayda sağladığını düşünüyor ve cevapların %21,4'ü proje performans alanlarında 4. cevapta (orta) fayda sağladı. Kullanıcı sayısına oranla bu yüksek puanlar, teknolojik araçlarla insani yardım projelerine sponsor olan kuruluşlara verilen desteğin eksikliğini gösteriyor. Ayrıca teknolojik araçlara yönelik yüksek puanlar, inşaat alanındaki işçilerin ellerinde mevcut olması halinde bu araçları kullanma niyetini göstermektedir.

Anahtar Kelimeler: Teknoloji araçları, anket, yaşam döngüsü aşamaları, proje performans alanları, PMBOK.

1
INTRODUCTION

1.1 Introduction

The historical significance of technology cannot be overstated. Various industries have reaped major benefits from developing technology advancements, which have resulted in significant gains in productivity, functionality, quality, and end-user comfort. The technology has used in the field of construction for humanitarian projects. The processes and technology used today are highly regarded of complexity and efficiency, and its productivity has increased dramatically over the years, many efforts had to make constantly. For successful implementation of emerging innovations in terms of organization, technology has played a major role [1].

In this research, the impacts of technological displays on project life cycle stages and performance domains, which are introduced by Project Management Body of Knowledge PMBOK 7th edition, which is a set of standard terminology and guidelines (a body of knowledge) for project management [2]. A survey was prepared based on an in-depth literature survey and a pilot study with few professionals for the finalization of the survey questions. Following that, it was distributed to skilled specialists in construction humanitarian initiatives. The responses gathered formed a dataset from several countries and areas, including Yemen, Ukraine, Iraq, Rome, and South Sudan. The corpus of knowledge has to be updated and shared frequently since practitioners' discoveries of new techniques or best practices lead to its continuous expansion. The Project Management Institute (PMI), a worldwide non-profit membership organization for project managers, is in charge of this endeavor [3].

1.2 Technological Tools in Construction Projects

The way that construction projects are planned and managed is expected to change as information technology advances. It is important to consider how the

advancement of computer technologies and the development of the construction industry as a whole are interconnected. The construction industry is currently utilizing computer technologies for its benefit along with other business sectors and industries. Beginning with the feasibility study stage and continuing through the planning, design, implementation, the maintenance, and finally the delivery and closing stages, the development of information technology plays a significant role in the life cycle of the construction project. Due to the increasing reliance on computer software for the planning and execution of construction engineering projects, various computer software programmes are now employed at every stage of the project, from concept to completion.

However, there have been gaps between the level of requirements in terms of cost, time, and technical specifications and the level of information and communication technology used in projects due to the rapid technological development in computer hardware and software as well as the changes that occur in the requirements of construction engineering projects [4].

An excellent step toward understanding the significance of IT and the technical reflection on management of the projects, to see its applications around the world, and to clarify the extent of this technology's capabilities to enhance project performance by assisting stakeholders in a variety of construction operations and activities [5].

1.3 Technology Tools in Humanitarian Organizations

Humanitarian organizations often embark on (re)-construction projects after destructions caused by a natural disaster or due to humanitarian needs created by conflict. Therefore, the use of technology tools in construction projects for those affected by disasters and wars is necessary in particular because of their positive impact on the stages of the project and its performance and related matters such as the use of these tools to facilitate access to dangerous places for workers in this field and their impact on the speed of completion and the preservation of funds that are In fact, it could be a donation.[6]

Modern technology have impacts on the effectiveness of organizations and businesses, as these advanced technological industries exhibited the traits of innovation, development, and flexibility in dealing. This development enabled numerous businesses and organizations to manage multiple departments and levels in a variety of contexts. The business is doing better, and the majority of these businesses now base all of their administrative plans on information technology, to the point that no organization can keep up with the rapid speed of change. the necessity of learning how to make use of this technology in a way that fulfils the required objectives.[7]

By enabling earlier, quicker, and perhaps even more effective humanitarian intervention, new and developing technologies can promote the paradigm transition from reaction to anticipating. In order to improve forecasts and decision-making, artificial intelligence can simplify the processing and understanding of large-scale, complex humanitarian datasets. Social media, chatbots, and mobile applications all enable quick feedback loops with those impacted by humanitarian situations.[8]

1.4 Objective of the Thesis

Non-governmental organizations have a long history of participating in identifying refugee cases and assisting them in resettlement. Because technology has facilitated innovation in many fields, this research aims to know the impact of this technology and its contribution to facilitating the work of construction projects affiliated with these organizations at every stage of the project life cycle and its performance domains. The current study deals with a questionnaire filled out by a segment of engineers and workers in construction projects affiliated with humanitarian organizations. It is expected that this study will give a clear vision from those working in these organizations and be useful for improving and facilitating their work, especially in countries affected by disasters.

2
LITERATURE REVIEW

2.1 Literature Review

Construction projects in humanitarian organizations were and are still attempted to innovate solutions bearing supported by digitalization, innovation and development finance, are accelerating the impact and scale of UNDP in the world [9].

This research will shed light on the impact of technological tools on construction projects in humanitarian organizations. It will attempt to determine the impact of these tools on the stages of the project's life cycle stages and on the project performance domains. There has been a lot of research on this regard, and this literature review will highlight the researches conducted in recent years.

Elcin Tas et al. (2007) [10] conducted a survey on the present and planned usage of information technology (IT) and its impact on the Turkish construction sector to aid in the selection of building materials. The survey was administered to two distinct groups. The supply side (manufacturers) produces or imports building products in Turkey, while the demand side (architects) selects construction products. The characteristics and significance of these items while providing information, as well as the criteria for selecting building products, are analyzed. The survey revealed the ways and motives for giving and receiving building product information in Turkey for both parties. It was discovered that Turkey has recently experienced a surge in the use of building product information systems, both in terms of current usage and aspirations for the future. Even if the project's architects are highly skilled designers, they still need to put in a lot of effort and utilize a variety of techniques to gather information. It is challenging to obtain information that is accurate, timely, and up-to-date when information systems are not used efficiently. Therefore, it is believed that creating building product information systems—which gather all data from a single source, classify and transform it through recording and processing, and then distribute it precisely and on schedule—is a crucial first step toward resolving a number of issues in this industry.

Oladapo et al. (2006) [11] In order to illustrate the extent of ICT penetration, its influence on the sector, and the barriers to its acceptance, he looked into the situation of ICT in Nigeria's construction sector. The research determined which factors—internal and external to the industry—have a substantial impact on the amount of ICT use. Empirical data for the investigation was contributed by 136 respondents to a questionnaire survey, including academic researchers, contractors, and consultants. The findings demonstrated a significant correlation between the degree of ICT use in the industry and a number of internal factors, including the nature of the business (contracting, consulting, or academic), the perception of the benefits of ICT by chief executive officers (CEOs) and senior managers, and the number of years that these executives had spent computer literate. Nonetheless, there was no significant correlation found between the level of ICT use and any of the external factors. In the industry, word processing, Internet connectivity, costing, and job scheduling are the primary uses of ICT. The top five factors preventing businesses from using ICT are: low job orders; fear of virus attacks; high cost of ICT software and hardware; insufficient or irregular power supply; and a high rate of obsolescence of ICT software and hardware.

Tracy Harwood et al. (2017) [12] researched on emerging technologies, including Big Data, drones and the so-called “Internet of Things” (IoT). The top prediction, named by 65.3 per cent of respondents, is that virtual reality applications will used much more in the future to experience a building’s design before it is built. The research finds that the future of the AEC industry will also characterized by the absence of paper (38.1 %) and the use of virtual technology to address not only two-dimensional drawing and three-dimensional modelling but also for project sequencing, cost estimating, sustainability, and facilities management, often referred to as a “7D” building process. Projects will be easier to visualize (51.9 %). Projects will be completed faster (48.3%). Projects will require fewer workers (42.2%). Projects will require less material (40.8%). Paper removals such as Mobile/tablet technologies have replaced printed sets of drawings (43.5 %). The Building Information Model (BIM) helps design and construction teams resolve building problems without having to print numerous drawings (27.2%). Project teams are more environmentally conscious (25.2%). Better communication

between workers (58.5%). Outdated data will no longer be shared (55.8%). Changes will be easier to see as made (54.4%)

Global Construction Survey (2015) [13] harnessing technology's potential to improve major projects' performance, they found the industry is yet to embrace technology fully, data volume is rising exponentially — but many are struggling to make sense of information. Integrated, real-time project reporting is still a dream rather than a reality. There is more to come from mobile. There is still room for improvement in project management basics.

JB Knowledge-Construction-Technology-Report (2021) (14) make a survey, the main takeaway about this year's ConTech Report is 2021's participants are a mature group, with 54.6% of all respondents between the ages of 42 to 61 years old. The Millennials (those born between 1980 to 1995) experienced a 1% increase since 2020, while the first generation to be born after the invention of the internet, Generation Z (1996- 2000) entered the construction industry 1.3% more in 2021. The culprit behind 2021's very minimal changes from 2020 versus 2021 could be the product of the construction hiring slowdowns in 2021 among other issues. The research ask about the most limiting factor in trying and/or adopting new technology at the firms, they found that 35.4% Employee hesitance, 35.2% Budget, 28% Lack of knowledge about new technology, 27.8% Management hesitance, 19.5% Maturity of technology available.

Ibrahim Wuni et al. (2020) [15] in his research, he found and evaluated the success factors required for the initial stages, visualization, planning, and design of the life cycle of a construction project. In it, he relied on a multi-stage framework to identify and evaluate the critical success factors for managing the initial stages of the construction project life cycle. He relied on an international questionnaire, and the critical success factors affecting the life cycle were measured. The important initial stages of the project. The research also found connections between success factors and proposed a conceptual framework for managing the early stages of the project life cycle.

Long Li et al. (2018) [16] research covers the critical success elements for organizing and tracking prefabrication housing production PHP projects. A

literature review, in-depth interviews and empirical studies with construction industry professionals led to the identification of total of 23 standards. Chinese designers, producers and builders participated in the survey. According to the results, the five most critical elements for success are:

(1) Designers' experience with PHP.

(2) The manufacturer's experience with PHP.

(3) The project manager's problem-solving skills.

(4) Maturity of the technology used in the detailed design phase.

(5) Ongoing policies and incentives.

Through exploratory factor analysis, the 23 important success variables divided into five groups: technologies and method, information, communication, and cooperation, external environment, experience and knowledge, and project manager competency. "Technology and method" in particular assumed a starring role. By using a comprehensive methodology to evaluate CSFs of PHP, this study adds to the body of knowledge by focusing on the major PHP actors, including designers, manufacturers, and contractors. These conclusions helped to facilitate the successful implementation of PHP by giving designers and project managers a set of important criteria for the efficient planning and management in planning phase of project life cycle stage of PHP projects.

Leonore van del et al. (2014) [17] in his study focused on ceremonial changes in projects. Gaining an understanding of the use and importance of transition rituals in the project life cycle is the stated goal. To achieve this, the research draw on fieldwork in the infrastructure sector, where 58 participants interviewed and participant-observed eight rituals of change in four Dutch construction projects. The discussion of transition organizing by PM adds value by understanding transition rituals as powerful symbolic and strategic practices across the project life cycle and by providing a summary of how transition rituals are used to facilitate transitions and integrate the project into its surroundings, and how transition rituals are used to enhance our understanding of the project life cycle.

Klaus-Rosinska et al. (2023) [18] in their research discuss the managing research and development projects in the early stages of the project life cycle. The research subjects selected for the study were representatives of research and development organizations, commercial enterprises and academic institutions. Their interviews focused on the management of research and development projects. Based on discussions with participants and an evaluation of the literature, suggestions and best practices for managing R&D projects in the early stages of the life cycle i.e., initiation and planning – were developed.

Regarding technological tools, there has been a lot of research that shows the impact of these tools on construction projects. Yue Pan et al. (2020) [19] explained in their research that BIM and the developing IoT are being integrated more and more. To be more precise, the Internet of Things (IoT) may think of as a network of physical things with strong capability of data collecting and communication on the internet. They created as-built event log using new IoT and connect it with BIM to talk about actual delays. This is helpful to discover operational insights and make precise predictions in a fully automated and affordable method in the projects.

Aneetha Vilventhan et al. (2021) [20] in their research found that the 4D simulation of the BIM model made it possible to track the actual progress of the relocation activities and, as a result, assisted in taking the required steps to reduce impending delays. The evaluation of the created model revealed that the use of 4D BIM during utility relocation activities enhanced collaboration and communication.

As for the Block chain/ Smart contract tool, Miao Li et al. (2021) [21] concentrated on the shortcomings in project management, investigated new generation mechanisms, and set up the core structure of the mechanisms that block chains and smart contracts found in both the physical and virtual worlds. To mitigate the aforementioned risks, real records from the real world compared to records stored in block chains and secure smart contracts; they created the project's parallel management contract and offered module contracts in SPESC. This technique successfully strengthens the bonds between the project manager, contractor, and investors and keeps everyone operating within the principles of justice and equity.

As for the Decision support systems, Garcia, G. R., Michau et al. (2021)[22], suggested a comprehensive framework for the creation of a system to assist projects operators in making decisions regarding how to change control parameters in response to quickly altering conditions, demonstrating excellent promise for the suggested approach.

For planning software tool, Karim M.Aljebory et al. (2019)[23], by using an expert system that facilitates the automatic development of project plan scheduling charts for project control functions, he connected the Revit software to Primavera for his research. This obviated some of the time-consuming and onerous tasks involved in developing a building project schedule.

R. Rajadurai et al. (2021) [24] in their research, to aid in the early detection of utilities and efficient coordination during utility relocation in infrastructure projects, they created integrated road information modeling (RIM) and geographic information system (GIS) models. The models created evaluated, and the results demonstrate that the RIM-GIS model technique permitted early planning and coordination and facilitated efficient administration of facility relocations.

Sudarsan, J.S. et al. (2023)[25] He discovered through his research that mobile applications help track project and employee performance and enhance coordination and communication by putting all team members on the same platform.

Cloud computing system is another technological tool used by Qiu-yi li et al. (2021) [26] in their research, based on cloud computing technology has been demonstrated through studies to have improved accuracy and timeliness in the real application process, fully satisfying the research criteria.

Patrick Dallasega et al. (2020)[27] focused in their research on the implementation of BIM, augmented and virtual reality on construction projects, they found that these tools can be applied to aid lean construction. These technologies showed promise for enhancing Key Performance Indicators (KPIs) such overall construction time, reduced downtime on the job site, higher levels of quality, and sustainability in terms of less material waste.

Alak,H. et al. (2019)[28], Miglena Stoyanova (2022)[29] in their research found an approach to perform a big data analytics to keep up with the escalating demands of customers for complicated, quick projects, and to develop new techniques for data structuring and analysis in order to raise output and performance generally.

Kambiz Radman et al. (2021)[30], Moneer Bhih et al. (2021)[32], Chengke Wu et al. (2021)[33] and Mariam Elazhary et al. (2021)[34] used computer software like Primavera and MS project to track delays in construction projects, comparing these procedures to using the strategies separately, they demonstrate encouraging outcomes.

Jayasree,V. et al. (2020)[35], searched about smart helmet as a wearable technology tool. The research found these helmets continuously monitor the employees and protect them from any health risks while they are working in the field.

According to Sudharsan.K et al. (2019) [38], effective communication among those involved on the job sites was identified as a crucial element in the administration of construction projects. He has developed a smartphone app platform to help manage and interact in construction sites, increasing the efficiency of projects. This is made possible by the rapid transmission of project data. The mobile application's specification enables users to access helpful features like online guidance, requests for interpretation, and project information. Android was used after emulators to test the framework. The apparatus was subsequently tested on a roadway rehabilitation project. Users of mobile devices can get in touch with field offices and mobile workers who can help them look up project specifics.

Bo-Christer Björk et al (2002) [40] made their research on four building projects from Finland, Sweden, United Kingdom, and the United States that utilised the electronic document management system were used. The projects ranged in size from 25 million euros to smaller ones. The readily apparent advantages included lower managing expenses, reduced trips to events, etc., and in the example of Finland, these savings totaled 17300 Euros (which represents about 0.1 percent of the overall project expenditure). This is comparable to the 8500 Euro expense of employing the electronic document management system. The distribution of documents was completed in 1700 fewer working days, among other quantitative

advantages. The simplicity of using the electronic site diary, that became a component of the specific electronic document management technologies deployed, was one of those most significant positive advantages, and the encouragement of remote work.

Table 2.1 shows a summary of available past studies on technology tools in construction projects.

Table 2.1 A Summary of Available Past Studies on Technology tools in construction projects

No.	Technological Tool Name	References
1	BIM	Yue Pan et al. (2021) [19], Aneetha Vilventhan et al. (2020) [20], Patrick Dallasega et al. (2020) [27].
2	Blockchain / Smart contract	Ali RezaHoseini et al. (2021) [37],
3	Decision support systems	Garcia, G. R., Michau et al. (2021) [22], G.C. Koseoglu et al. (2021) [36],
4	Planning software	Karim M. Aljebory et al. (2019) [23]
5	Spatial Technologies (Geographic information system (GIS), Global Positioning System (GPS), Smart sensors, etc.)	R. Rajadurai et al. (2021) [24]
6	Automatic identification technologies (Radio Frequency Identification technology (RFID), Ultra Wideband (UWB), Barcode, QRcode)]	Arsalan Mahmoodzadeh et al. (2020) [34],
7	Mobile apps for phone / tablet	Sudarsan, J.S. et al. (2023) [25], Sudharsan.K et al. (2019) [38]

Table 2.1 A Summary of Available Past Studies on Technology tools in construction projects (continued…)

8	Image capture technologies (Photogrammetry, Video Camera, Multimedia, Laser scanning, Laser-radar(LIDAR/LADAR))]	Surya S. C., Anand J. et al. (2019) [41].
9	Cloud computing technologies	Qiu-yi li et al. (2021) [26]
10	Augmented reality / Virtual reality / Mixed reality	Patrick Dallasega et al. (2020) [27]
11	Internet of Things (IoT)	Yue Pan et al. (2021) [19],
12	Big Data Analytics	Alak, H. et al. (2019) [28], Miglena Stoyanova (2022) [29]
13	Robotic applications (Autonomous vehicles, Unmanned aerial vehicle, 3D printer)	None
14	Wearable technology (EEG, ECG/EKG sensors, UV light sensor, Stress control wristband, Smart helmet)	Jayasree, v. et al. (2020) [35],
15	Computer and software applications (ERP, EDI, XML, Database)	Kambiz et al. (2021) [31], Moneer et al. (2021) [32], Chengke Wu et al. (2021) [33], Mariam Elazhary et al. (2021) [34]
16	Electronic document systems (E-commerce, E-procurement, E-commerce payment system, etc.)	Bo-Christer Björk et al (2002) [40]
17	Wireless communication technologies (Bluetooth, wireless, WSN, WLAN)	Agarwal, D. et al. (2023) [39]
18	Advanced information technologies (Email, Voice, Handheld)	None

3
METHODOLOGY

3.1 Introduction

Many studies looked at the impact of at least one of these tools on the project or at a specific stage of the project, mostly on the planning and design stage. Also, the studies was limited in research into the impact of technology tools on project performance domains. From previous literature reviews, technology tools that have shown an impact on construction projects were collected, therefore this project seeks to collect the opinions of engineers and specialists in the field of construction in humanitarian organizations on the extent of the impact of these tools at each stage of the project and in each domain of the project.

3.2 Research Methodology

The research methodology depends on the techniques used in collecting and analyzing data in accordance with the variables, objectives, and the nature of the data on which the research will be conducted in light of the problem and objectives and the research model and hypotheses that the study will answer. Collecting and analyzing data through the study tool represented by the questionnaire to reach the final results and conclusions, to reveal the type of relationship between the dimensions for the purpose of interpreting the results and presenting the conclusions and recommendations that came out of the study.

3.3 SPSS Software

Statistical Package and Service Solutions (SPSS) is a prominent statistical tool capable of performing highly complicated data manipulation and analysis. This tool will be used to analyze the questionnaire data collected for this study.

3.4 Questionnaire Construction

the first part of the questionnaire was developed to capture the background of the reviewer, the second was divided into two sections:

1- Have you ever use these tools in each stage of project life cycle (yes\no), then, on scale (1-7) give your opinion about its usefulness for each stage.

2- Have you ever use these tools in each domain of project life performance domains (yes\no), then, on scale (1-7) give your opinion about its usefulness for each domain. (1= very little, 7= extremely useful). Figure 3.1 shows a flow chart of the survey conducted in this study.

Figure 3.1 Survey Flowchart

3.4.1 Technological Tools used in Survey Construction

Based on the literature reviews, technology tools that have shown an impact on construction projects were selected, as shown in Table 3.1.

Table 3.1 Technological Tools Used in This Study

Technology tool	Definition
BIM	It is the procedure through which 3D digital project data is created, managed, and used for tasks including conflict detection, site layout design, project planning, project coordination, construction monitoring, prefabrication, and security.
Blockchain / Smart contract	A distributed network of computers, people, and data are recorded, shared, and synced in this particular form of database. Computer software or a transaction protocol called a "smart contract" is designed to automatically execute, manage, or record legally significant events.
decision support systems	By applying gathered data at a decision stage, these computer-based solutions facilitate decision-making.
Planning software	It is a method for scheduling, overseeing, and carrying out projects and programs. Like MS Project, Primavera P6.

Table 3.1 Technological Tools Used in This Study (continued…)

Spatial Technologies (Geographic information system (GIS), Global Positioning System (GPS), Smart sensors, etc)	GIS: It is a type of information system that combines tasks including gathering, storing, analyzing, and showing users earth-related data. Using signal exchanges, GPS: It provides the ability to pinpoint a person's location inside an orbit. Intelligent sensor: This device is utilized to transform environmental inputs (such as humidity, temperature, smoke, and water leaks) into readable data and then transmits that data to a central warehouse. It is crucial to the dissemination of data.
Automatic identification technologies (Radio Frequency Identification technology (RFID), Ultra Wideband (UWB), Barcode, QRcode)]	RFID is a data collecting, automatic verification, and spatial archive technique. UWB: This form of communication uses radio frequencies to communicate over short distances. Barcode: This robotic data gathering technique makes it possible to read data from a distance.
Mobile apps for phone / tablet	They are programs that make it easier to go to different locations and carry out job while doing so. Applications that allow viewing, producing, and altering AUTOCAD designs include DWG viewer, e-invoice, and concrete calculators, for instance.

Table 3.1 Technological Tools Used in This Study (continued…)

Image capture technologies (Photogrammetry, Video Camera, Multimedia, Laser scanning, Laser-radar (LIDAR/LADAR))	Laser scanning: It's critical to take precise three-dimensional measures of structures or areas while reducing measurement-based mistakes. LIDAR is a method of remote observation that employs laser radiation to determine the separation from items and measurement equipment.
cloud computing technologies	Numerous data are kept and real-time access is made available no matter the place with internet-based apps that do not need installation.
Augmented reality / Virtual reality / Mixed reality	Virtual things are combined with real visuals in augmented reality, which modifies and enriches inputs that appeal to and activate the senses of humans. Virtual reality: A digital depiction created by computers using three-dimensional modeling or 360-degree camera footage that is completely detached from real. Actual and artificial elements coexist in a setting known as hybrid reality.
Internet of Things (IoT)	It speaks of a collection of tangible items connected to one another via the global web and equipped with software, sensors, and various other techniques.

Table 3.1 Technological Tools Used in This Study (continued…)

Big data analytics	It is information that can't be managed, saved, or analyzed using conventional database systems. Big data is the gathering of useful information that can be used for analysis and improved productivity.
Robotic applications (Autonomous vehicles, Unmanned aerial vehicle, 3D printer)	For example, driverless dozers, brick-laying robots, etc. Unmanned aerial vehicles (UAVs) or drones: Virtual designs and construction are important in streamlining workflows. it can plan and manage large-scale projects in a shorter time and at a lower cost. 3D printer: It is the technology that transforms products and objects designed in virtual environment into solid objects.
Wearable technology (EEG, ECG/EKG sensors, UV light sensor, Stress control wristband, Smart helmet).	EEG: These devices, which track a user's brainwaves as transmit the results to a smart device, also offer data on how well they sleep. A rhythm monitor with ECG. Smart wristband: Monitors beats to determine level of stress and offers recipient advice for meditation.
Computer and software applications (ERP, EDI, XML, Database)	Data transmissions guarantee data interchange among multiple components.
Electronic document systems (E-commerce, E-procurement, E-commerce payment system, etc.)	By organizing standards and processes, it aims to standardize the creation of papers and boost productivity while avoiding or limiting possible mistakes.

Table 3.1 Technological Tools Used in This Study (continued…)

Wireless communication technologies (Bluetooth, wireless, WSN, WLAN)	Wireless methods use electromagnetic radiation to transmit data among equipment.
Advanced information technologies (Email, Voice, Handheld)	These innovations serve as a tool for engagement.

3.4.2 Project Life Cycle's Stages

Wasting money, time and resources can be avoided by effective management, which is important in construction projects, especially in humanitarian organizations. The stages of the project life cycle represent a high level of processes that lead to the formation of a successful project. Project life cycle stages as defined in PMBOK 7th edition is a structure made up of a number of discrete high-level phases needed to effectively and methodically turn an idea into reality.

In this study project life cycle's stages one of the axes of the survey that are carried out to try to find the impact of technology tools on each stage. These stages are:

- **Feasibility**: The probability that the project will be productive as well as the way to get through any potential challenges.
- **Design**: the initial stage of a project's lifespan, during which ideas, procedures, supplies, and deliveries are prepared.
- **Build**: it is the stage when the group is assembled. Scheduling is based on time estimations. Budgets are created from cost estimations. The supplies were gathered.
- **Test**: means ensuring that the system was developed effectively and adhered to all specifications and design guidelines
- **Deploy**: The outcomes of the project have been fulfilled, and transition-related tasks for sustainability, gain realization, and organizational change management are completed (e.g., dissemination of the approach to beneficiaries).

- **Close**: The impact during closing of the project, project knowledge and artifacts archiving, project team members releasing, and contracts closing.

3.4.3 Project Prformance Domains

The PMBOK 7th edition defines project performance domains as "a group of associated tasks which are essential to the efficient execution of the task results." One of the axes of the survey used to determine the impact of technology tools on each domain in these studies is project performance domains. These domains are:

- **Development approach and life cycle**: During the project life cycle, a method such as predictive, iterative, incremental, adaptive, or hybrid is used to generate and evolve the product, service, or outcome.
- **Planning**: is the part that entails deciding on a plan of action for reaching goals and setting them.
- **Project work**: is concerned with building processes and carrying out tasks that will allow the project team to deliver the required deliverables and outcomes. This term includes controlling the flow of existing work, new work, and work modifications. interacting with stakeholders Material and equipment management.
- **Delivery**: focuses on fulfilling criteria, scope, and quality expectations in order to provide the expected deliverables that will drive the desired results.
- **Measurement**: Assessing achievement in relation to plan and tracking resource use, job performed, budget used, and so on.
- **Uncertainty**: presents threats and opportunities that project teams explore, assess, and decide how to handle.

3.5 Theoretical Side

Secondary data will be obtained through sources, books, references, doctoral dissertations, master's theses, and various scientific journals, depending on Arabic and foreign literature on the theoretical side, and the Internet.

3.6 Practical Side

The questionnaire: It is a scientific research tool that was employed to collect quantitative data, which consists of a set of questions divided into axes to achieve the goal according to the subject of the research or study, in order to collect data on the research sample. The questionnaire is often characterized by simplicity, low cost, and does not take a long time to answer it because it is characterized by short answers or by marking the choice that the person believes is correct, and after collecting the information, the answers from which the sample information was obtained are summarized for the purpose of statistical analysis or questionnaires that achieve the purpose of the study. A software called SPSS used to test and analyze the data of this study survey.

4
RESULTS AND DISCUSSION

4.1 Introduction

This chapter includes a description of the most important procedure to achieve the main objective of the study, through the standard deviations and arithmetic averages of the variables in the study. Also examines the testing of the study hypotheses and the special statistical indications for each hypothesis and the most important statistical methods used in analyzing and interpreting the results by using statistical program SPSS version 21. The study sample included engineers and employees of humanitarian organizations in Iraq, Yemen, Italy, Ukraine, South Sudan, Turkey and Mozambique. The number of valid forms was 176.

4.2 The Research Sample

The research sample consists of (176) reviewers distributed unevenly across seven countries, as shown in Table 4.1.

Table 4.1 Distribution of the reviewers countries of the survey

Yemen	South Sudan	Iraq	Mozambique	Italy	Ukraine	Turkey
51	17	72	6	7	22	1

Where Iraq occupied the largest number of the sample (72) and Turkey occupied the least number (1) of reviewers. The questionnaire form was distributed by hand in both Iraq and Yemen. As for the rest of the countries in which the survey conducted, the questionnaire was distributed and the data obtained via email, due to the difficulty of access.

4.3 Tests and Analysis of Data

The SPSS program package used to conduct statistical analysis of the data, which included unequal samples taken from (7) countries to conduct the questionnaire evaluation. The questionnaire included two parts the first part project life stages and the second part is th project performance domains.

Each of these two parts contains (6) stages for the purpose of testing. A set of technological tools consisting of (18) tools as shown in Table (4.2), which included answering the questionnaire to the item on using the tool for two cases (yes or no) and evaluating the level of interest, which took (7) cases divided from (1-7) from the lowest level to the highest according to the order.

The data was entered into the SPSS (as shown in Figure 4.1 and Figure 4.2) program, and then the necessary tests and analyses required to complete this study were conducted.

Figure 4.1 Data inputs (data view) in SPSS

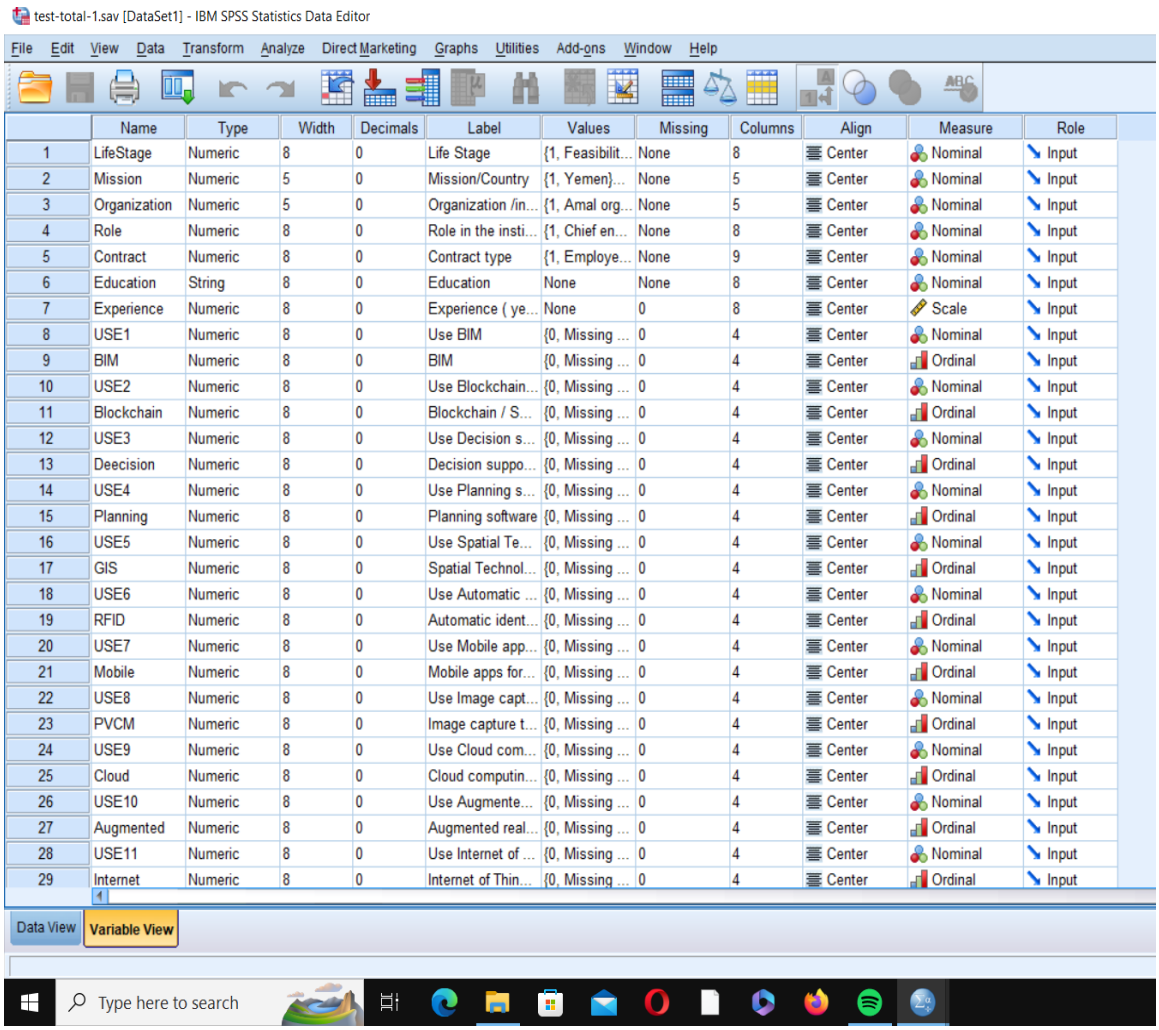


Figure 4.2 Data inputs (Variable View) in SPSS

4.4 Statistical Analysis

The statistical analysis of the collected data included frequencies and descriptive statistics and tests.

4.4.1 Reliability of Study Data

It is a simple way to measure whether or not a result is reliable. Reliability refers to the amount of true variance that can be accounted for by the observed variance in a measurement. Several coefficients have been proposed to estimate reliability from internal consistency, Cronbach's alpha being the most popular. Cronbach's alpha is one of the most widely used reliability measures in the social and organizational sciences.

The test performed and the alpha value extracted is shown in Table 4.2.

Table 4.2 Cronbach's alpha coefficient for life cycle stages

Cronbach's Alpha	N of Items
0.898	18

Through the Table 4.2, it is clear that the alpha ratio is equal to (0.898) that can make the questionnaire method gives good results and can indicates the existence of honesty and stability in these results.

In the same way, the test performed for project performance domains data and the alpha value extracted as shown in Table 4.3

Table 4.3 Cronbach's alpha coefficient for project performance domains

Cronbach's Alpha	N of Items
0.889	18

Through the Table 4.3, it is clear that the alpha ratio is equal to (0.889), which is a good ratio that can make the questionnaire method gives good results and can indicates the existence of honesty and stability in these results.

4.4.2 Differences in Perceptions and Evaluations Between Civil Engineering Reviewers and other Engineering Fields in Project Life Cycle Stages and Performance Domains.

In this case the following tests are used:

1- Spearman's Rank Correlation (Rs): This test has been put in place to gauge how well the civil engineering group and others agree. The correlation results from SPSS software show in Table 4.4 that there is a strong correlation and agreement between the two groups (civil engineers and other reviewer fields) in life cycle stages evaluations, since the calculated (Rs) for the technological tools is = 0.963 with a considerable level of 0.000.

As for the evaluations in project performance domains, the correlation results from SPSS software show in Table 4.5 that there is a strong correlation and agreement between the two groups (civil engineers and other reviewer fields) in performance domains evaluations, since the calculated (Rs) for the technological tools is = 0.933 with a considerable level of 0.000.

Table 4.4 Spearman's Rank Correlation between civil engineerings and other reviewer's field in life cycle stages

			CivilEL	Others EL
Spearman's rho	CivilEL	Correlation Coefficient	1.000	.963**
		Sig. (2-tailed)	.	.000
		N	18	18
	OthersEL	Correlation Coefficient	.963**	1.000
		Sig. (2-tailed)	.000	.
		N	18	18

Table 4.5 Spearman's Rank Correlation between civil engineerings and other reviewer's field in Project Performance Domains

			CivilED	OthersED
Spearman's rho	CivilED	Correlation Coefficient	1.000	.933
		Sig. (2-tailed)	.	.000
		N	18	18
	OthersED	Correlation Coefficient	.933**	1.000
		Sig. (2-tailed)	.000	.
		N	18	18

2- ANOVA Test

An anova test is used to determine whether survey or experiment results are important. In other words, these assist you in determining whether you should reject the null hypothesis or embrace a different theory. Inferential tests will provide you with a ‘p-value’. The p-value indicates the likelihood that any association or difference (depending upon the test) was down to chance or not. A p-value of 0.05 indicates that in 95 cases out of 100 you could be confident that there was an actual difference or association, rather than a chance difference or association. In this research these hypothsis are:

a- Null Hypothesis (Ho): There is no significant difference in variance of evaluations of these tools between civil engineers and other group’s fields.

b- Alternative Hypothesis (HA): There is a significant difference between variance for evaluation between civil engineers and other groups.

The results in Table 4.6 shows that sig > 0.05 (sig.=0.949 in project life cycle stages) and (sig.=0.735 in project performance domains) that means the null hypothesis will accepted which states (there has no significant difference in variance of evaluations of these these tools between civil engineering and other engineering fields who works for the humanitarian organizations.

Table 4.6 ANOVA Test Values for Technology tools in life cycle Stages and Domains for civil engineers and other fields

		Sum of Squares	df	Mean Square	F	Sig.
LifeStage	Between Groups	.002	1	.002	.004	.949
	Within Groups	13.115	34	.386		
	Total	13.116	35			
Domains	Between Groups	.043	1	.043	.116	.735
	Within Groups	12.674	34	.373		
	Total	12.718	35			

4.4.3 Differences in Perceptions and Evaluations Between Iraq Reviewers and other Missions in Project Life Cycle Stages and Performance Domains.

1- Spearman's Rank Correlation (Rs): This test has been put in place to gauge how well the Iraqi mission group and others agree. The correlation results from SPSS software show in Table 4.7 that there is a strong correlation and agreement between the two groups (Iraqi mission and other reviewer missions) in life cycle stages evaluations, since the calculated (Rs) for the technological tools is = 0.958 with a considerable level of 0.000.

As for the evaluations in project performance domains, the correlation results from SPSS software show in Table 4.8 that there is a strong correlation and agreement between the two groups (Iraqi mission and other reviewer missions) in performance domains evaluations, since the calculated (Rs) for the technological tools is = 0.954 with a considerable level of 0.000.

Table 4.7 Spearman's Rank Correlation between Iraq missions and other reviewer's missions in life cycle stages

			IraqML	OthersML
Spearman's rho	IraqML	Correlation Coefficient	1.000	.958**
		Sig. (2-tailed)	.	.000
		N	18	18
	OthersML	Correlation Coefficient	.958**	1.000
		Sig. (2-tailed)	.000	.
		N	18	18

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4.8 Spearman's Rank Correlation between Iraq missions and other reviewer's missions in Project Performance Domains

			IraqMD	OthersMD
Spearman's rho	IraqMD	Correlation Coefficient	1.000	.954**
		Sig. (2-tailed)	.	.000
		N	18	18
	OthersMD	Correlation Coefficient	.954**	1.000
		Sig. (2-tailed)	.000	.
		N	18	18

2- **ANOVA Test:** This test was used again for another factor that could affect the results, which was (Mission). The research suggested making the comparison of the two groups between Iraq and others, considering that the sample from Iraq was the largest sample in this survey. In the same way the hypothesis was stated and the results in Table 4.9 showed that sig. values were greater than 0.05 for both axis (sig.=0.635 in life cycle stages evaluations) and (sig.=0.708 in project performance domains evaluations), that means there was no significant differences in perceptions of reviewers from Iraq and other Missions.

Table 4.9 ANOVA Test Values for Technology tools in life cycle Stages and Domains for mission from Iraq and others

		Sum of Squares	df	Mean Square	F	Sig.
LifeStage	Between Groups	.107	1	.107	.229	.635
	Within Groups	15.845	34	.466		
	Total	15.952	35			
Domains	Between Groups	.054	1	.054	.143	.708
	Within Groups	12.930	34	.380		
	Total	12.985	35			

4.5 Results of Using Technology Tools

Although the construction industry is yet to embrace technology fully [13], the result of this study showed that all stages of the life of the project used at least one of the technology tools, which is as shown in Table 4.10.

Table 4.10 and Figure 4.3 shows the stages that received the highest answer (yes) for each technology tool and in any country. It can be noted that (2: Design) received the highest answer (yes) for most of the technological tools, meaning that the (design) stage is the stage in which technology tools are used the most in organizations, and because most of the sample is from Iraq, it received the highest number of users for these tools in humanitarian organizations.

Table 4.11 and Figure 4.4 show the domains that received the highest answer (yes) for each technology tool and in any country. It can be noted that (D2: Planning) received the highest answer (yes) for most of the technological tools, meaning that (Planning) is the domain in which technology tools are most used in organizations, and because most of

the sample is from Iraq, it received the highest number of users for these tools in humanitarian organizations. This result is in one line with Long Li et al. (2018) [16] his results suggested in his research that. "Technology and method" in particular assumed a starring role to facilitate the successful implementation of PHP by giving designers and project managers a set of important criteria for the efficient planning and management in planning phase.

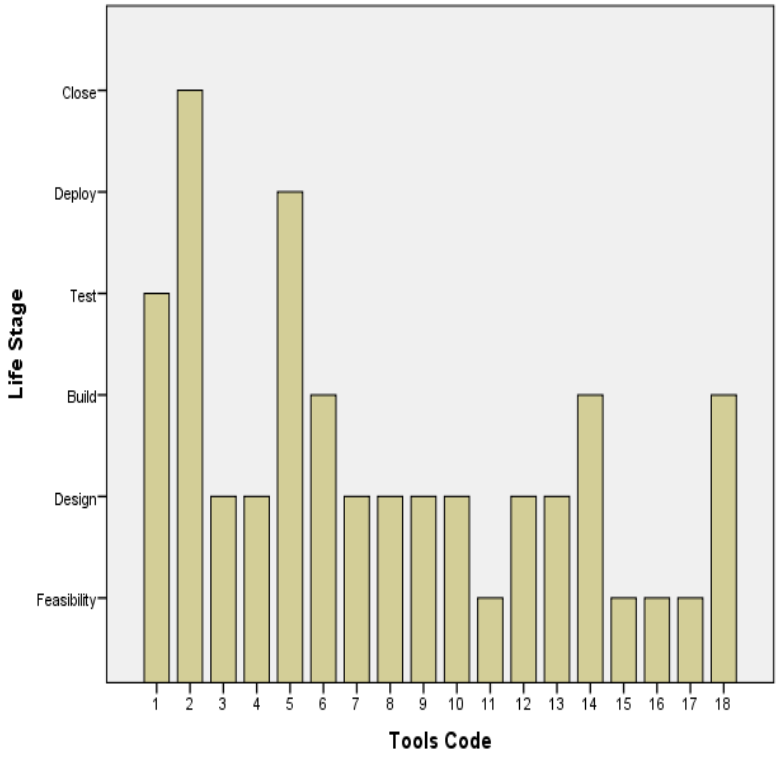


Figure 4.3 Maximum frequency of using tools as a function of life stage and mission

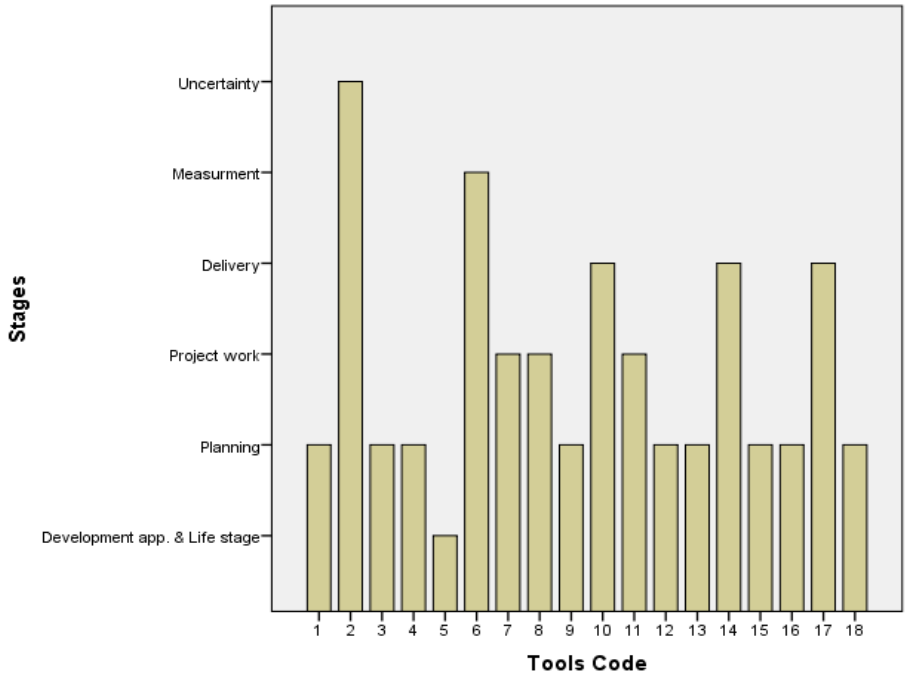


Figure 4.4 Maximum frequency of using tools as a function of Domains and Mission

Table 4.10 Maximum frequency of Using tools as a function of life stage and mission

Name Of Technological Tool	Life Stage			Mission		
	Stages	YES	NO	Mission	YES	NO
BIM	L4	170	0	Iraq	192	240
Blockchain / Smart contract	L6	66	102	Iraq	110	319
Decision support systems	L2	144	32	Iraq	248	182
Planning software	L2	139	37	Iraq	274	156
Spatial Technologies (Geographic information system (GIS), Global Positioning System (GPS), Smart sensors, etc)	L5	148	24	Iraq	275	152
Automatic identification technologies (Radio Frequency Identification technology (RFID), Ultra Wideband (UWB), Barcode, QRcode)]	L3	86	89	Iraq	184	243
Mobile apps for phone / tablet	L2	157	19	Iraq	390	40
Image capture technologies (Photogrammetry, Video Camera, Multimedia, Laser scanning, Laser-radar(LIDAR/LADAR))]	L2	125	51	Iraq	301	127
Cloud computing technologies	L2	116	60	Iraq	288	140
Augmented reality/Virtual reality / Mixed reality	L2	63	113	Iraq	34	396
Internet of Things (IoT)	L1	114	62	Iraq	274	156
Big Data Analytics	L2	91	85	Iraq	228	202
Robotic applications (Autonomous vehicles, Unmanned aerial vehicle, 3D printer)	L2	71	105	Iraq	62	368
Wearable technology (EEG, ECG/EKG sensors, UV light sensor, Stress control wristband, Smart helmet)	L3	48	128	Iraq	43	386
Computer and software applications (ERP, EDI, XML, Database)	L1	158	18	Iraq	390	39
Electronic document systems (E-commerce, E-procurement, E-commerce payment system, etc.)	L1	151	25	Iraq	377	52
Wireless communication technologies (Bluetooth, wireless, WSN, WLAN)	L1	81	95	Iraq	184	246
Advanced information technologies (Email, Voice, Handheld)	L3	173	3	Iraq	416	14

Table 4.11 Maximum Frequency of Using tools as a function of Domains and Mission

Name of technological tool	Domains			Mission		
	Stages	Yes	No	Mission	Yes	No
BIM	D2	85	84	Iraq	167	242
Blockchain / Smart contract	D6	54	114	Iraq	95	314
Decision support systems	D2	139	29	Iraq	298	110
Planning software	D2	134	34	Iraq	230	177
Spatial Technologies (Geographic information system (GIS), Global Positioning System (GPS), Smart sensors, etc)	D1	137	31	Iraq	243	164
Automatic identification technologies (Radio Frequency Identification technology (RFID), Ultra Wideband (UWB), Barcode, QRcode)]	D5	144	24	Iraq	282	125
Mobile apps for phone / tablet	D3	156	12	Iraq	335	73
Image capture technologies (Photogrammetry, Video Camera, Multimedia, Laser scanning, Laser-radar(LIDAR/LADAR))]	D3	120	48	Iraq	280	128
Cloud computing technologies	D2	112	56	Iraq	146	261
Augmented reality/Virtual reality/ Mixed reality	D4	107	61	Iraq	153	255
Internet of Things (IoT)	D3	110	58	Iraq	238	168
Big Data Analytics	D2	89	79	Iraq	135	272
Robotic applications (Autonomous vehicles,Unmanned aerial vehicle, 3D printer)	D2	71	97	Iraq	53	356
Wearable technology (EEG, ECG/EKG sensors, UV light sensor, Stress control wristband, Smart helmet)	D4	143	25	Iraq	214	195
Computer and software applications (ERP, EDI, XML, Database)	D2	152	16	Iraq	367	41

Table 4.11 Maximum Frequency of Using tools as a function of Domains and Mission (continued..)

Electronic document systems (E-commerce, E-procurement, E-commerce payment system, etc.)	D2	143	25	Iraq	265	142
Wireless communication technologies (Bluetooth, wireless, WSN, WLAN)	D4	159	9	Iraq	282	128
Advanced information technologies (Email, Voice, Handheld)	D2	165	3	Iraq	397	11

4.6 Results of Evaluations of Technology Tools

Table 4.12 shows more details of the technological tools evaluations during the project life cycle stages and the country in which the reviewers work. It was noted that tool (Advanced information technologies (Email, Voice, Handheld)) received the highest evaluation in the "Feasibility" phase of the project, Ibrahim Wuni et al (2020)[15] in his research suggested the critical success factors affecting the life cycle stages, he found that one of these major factors was involving technology tools in the initial stages of the projects. Also, the tools (Planning software, Mobile apps for phone/ tablet, Cloud computing technologies, Augmented reality/ Virtual reality/ Mixed reality, and Electronic document systems) received the highest evaluation in the “Design” phase of the project. This results are similar to Long Li et al (2018)[16] and Ibrahim Wuni et al (2020)[15] results about the importance of technology tools in "design" stages of project life cycle stages. In their research, they identified maturity of the technology used in the detailed design phase as one of the most critical elements for success. The tools (Internet of Things (IoT) and Computer and software applications (ERP, EDI, XML, Database)) received the highest rating in the “Build” phase of the project. While the tools (BIM, Image capture technologies (Photogrammetry, Video Camera, Multimedia, Laser scanning, Laser-radar (LIDAR/LADAR)), Robotic applications (Autonomous vehicles, Unmanned aerial vehicle, 3D printer)) received the highest evaluations in the "Test"

phase of the project. The tools (BIM and Decision support systems) received the highest rating in the "Deploy" phase of the project. The tools (Blockchain/ Smart contract, Spatial Technologies (Geographic information system (GIS), Global Positioning System (GPS), Smart sensors, etc), Automatic identification technologies (Radio Frequency Identification technology (RFID), Ultra Wideband (UWB), Barcode, QRcode), Internet of Things (IoT), and Wireless communication technologies (Bluetooth, wireless, WSN, WLAN)), received a high rating in the Close stage of the project. The tool (Wearable technology (EEG, ECG/EKG sensors, UV light sensor, Stress control wristband, Smart helmet)) was the only one that received a weak rating in most stages, ranging from "less" to "Moderate". As for the country in which the reviewers worked, it was noted from the Table 4.12 that most of these high ratings were from the reviewers who work on missions for humanitarian organizations in Iraq. This is because most of the samples was from Iraq.

Likewise, with regard to project performance domains, each domain received the highest rating for at least one of the tools as shown in Table 4.13. Although the results of the questionnaire regarding the use of these tools show that most of the users of these tools were in "Design" stage regarding the project life cycle stages, and it was in the "Planning" domain in relation to the domains of the project's performance. The tendency of workers in the construction field to use technology tools in certain stages and not others shows a lack of knowledge about the benefits of these tools, and the lack of research in this regard. Also, has an impact on the involvement of these tools in all stages of the project and its management.

Table 4.12 Maximum frequency of evaluation for all technological tools as a function of life cycle stage and mission

Technological tool	Life Stage							Mission						
	Evaluation	Feasibility	Design	Build	Test	Deploy	Close	Yemen	South Sudan	Iraq	Mozambique	Rome	Ukraine	Turkey
BIM	5	43	37	37	59	59	55	71	34	129	7	12	35	2
Blockchain / Smart contract	4	36	48	39	39	37	50	66	23	109	11	9	31	0
Decision support systems	5	45	46	46	28	49	30	75	21	104	8	7	27	2
Planning software	5	39	59	39	48	30	44	81	18	107	8	8	31	1
Spatial Technologies (Geographic information system (GIS), Global Positioning System (GPS), Smart sensors, etc)	4	44	46	34	35	37	56	68	25	107	8	9	34	1
Automatic identification technologies (Radio Frequency Identification technology (RFID), Ultra Wideband (UWB), Barcode, QRcode)]	5	41	45	44	27	38	51	70	20	101	10	15	29	1
Mobile apps for phone / tablet	7	49	61	41	45	35	42	86	25	101	5	18	36	2
Image capture technologies (Photogrammetry, Video Camera, Multimedia, Laser scanning, Laser-radar(LIDAR/LADAR))]	5	43	42	41	56	48	48	65	27	121	13	9	40	3
Cloud computing technologies	7	35	55	38	39	48	34	75	22	89	12	16	35	0
Augmented reality / Virtual reality / Mixed reality	5	34	52	37	40	40	36	63	25	92	9	5	42	3
Internet of Things (IoT)	5	34	38	35	45	43	47	60	26	103	6	10	36	1
Big Data Analytics	5	38	38	47	46	43	42	70	27	106	5	12	34	0
Robotic applications (Autonomous vehicles, Unmanned aerial vehicle, 3D printer)	3	43	31	16	44	39	31	58	26	87	4	6	20	3
Wearable technology (EEG, ECG/EKG sensors, UV light sensor, Stress control wristband, Smart helmet)	2	61	42	32	56	38	29	75	26	107	11	12	27	0
Computer and software applications (ERP, EDI, XML, Database)	5	43	37	53	44	42	46	78	26	115	4	8	34	0
Electronic document systems (E-commerce, E-procurement, E-commerce payment system, etc.)	5	55	63	36	49	44	35	79	27	116	11	8	41	0
Wireless communication technologies (Bluetooth, wireless, WSN, WLAN)	6	40	42	41	45	49	54	70	23	119	8	10	38	3
Advanced information technologies (Email, Voice, Handheld)	7	74	57	39	55	65	52	98	35	130	18	19	41	1

Table 4.13 Maximum frequency of evaluations for all technological tools as a function of domains and mission

Technological tool	Project Performance Domains							Mission						
	Evaluation	Development approach and life stage	Planning	Project work	Delivery	Measurement.	Uncertainty	Yemen	South Sudan	Iraq	Mozambique	Rome	Ukraine	Turkey
BIM	7	11	71	62	66	66	67	104	25	121	11	18	60	4
Blockchain / Smart contract	4	37	42	50	45	43	43	67	13	126	11	7	36	0
Decision support systems	4	48	49	43	40	37	33	81	24	105	3	7	30	0
Planning software	4	55	46	38	37	38	35	85	20	82	8	10	44	0
Spatial Technologies (Geographic information system (GIS), Global Positioning System (GPS), Smart sensors, etc)	5	53	41	39	40	37	41	86	23	96	6	9	31	0
Automatic identification technologies (Radio Frequency Identification technology (RFID), Ultra Wideband (UWB), Barcode, QRcode)]	5	42	41	46	44	47	47	81	32	98	14	10	32	0
Mobile apps for phone / tablet	6	51	47	48	49	51	43	82	29	118	13	12	34	1
Image capture technologies (Photogrammetry, Video Camera, Multimedia, Laser scanning, Laser-radar(LIDAR/LADAR))]	4	35	32	44	42	40	42	71	35	99	4	4	22	0
Cloud computing technologies	4	26	17	44	50	47	45	74	29	75	8	9	33	1
Augmented reality / Virtual reality / Mixed reality	4	35	39	53	46	45	44	86	20	106	3	14	33	0
Internet of Things (IoT)	4	34	35	49	52	49	49	66	32	119	0	13	37	1
Big Data Analytics	5	39	38	48	47	49	51	75	23	109	10	14	41	0
Robotic applications (Autonomous vehicles, Unmanned aerial vehicle, 3D printer)	5	20	41	50	48	51	55	85	32	103	10	8	26	1
Wearable technology (EEG, ECG/ EKG sensors, UV light sensor, Stress control wristband, Smart helmet)	4	23	33	45	45	42	44	81	29	78	8	6	30	0
Computer and software applications (ERP, EDI, XML, Database)	5	44	37	46	44	44	44	84	25	100	7	7	35	1
Electronic document systems (E-commerce, E-procurement, E-commerce payment system, etc.)	5	51	60	46	43	42	43	67	38	134	3	6	37	0
Wireless communication technologies (Bluetooth, wireless, WSN, WLAN)	5	43	38	59	56	61	59	104	26	114	12	15	45	0
Advanced information technologies (Email, Voice, Handheld)	7	66	53	53	54	51	54	105	19	135	10	20	39	3

4.6.1 Ranking of Technology Tools

The classification of technological tools was extracted using Mean and Standard diviation method. Table 4.14, the Normalized Value shows that 10 tools are critical tools, and the average ratings for all tools are mostly more than 4.

Table 4.14 Ranking Technology Tools Evaluation Using Mean and Standard Deviation Method

Tool's code	Mean	Std. deviation	Rank	Normalized value
T18	5.74	1.175	1	1
T7	5.51	1.238	2	0.907
T17	5.34	1.372	3	0.839
T16	5.25	1.404	4	0.802
T9	5.22	1.440	5	0.790
T1	5.18	1.377	6	0.774
T12	5.04	1.458	7	0.718
T15	5	1.585	8	0.702
T8	4.88	1.490	9	0.653
T11	4.72	1.602	10	0.588
T5	4.46	1.458	11	0.484
T3	4.41	1.499	12	0.463
T4	4.41	1.462	12	0.463
T10	4.41	1.520	12	0.463
T6	4.2	1.431	13	0.379
T2	4.18	1.499	14	0.370
T13	3.84	1.716	15	0.234
T14	3.26	1.585	16	0

Normalized value= (mean - minimum mean)/ (maximum mean - minimum mean); if the normalized value was equal or greater than 0.50, this mean that the technology tool is a critical tool.

This, in general, shows that these tools are important for the work of construction projects for reviewers. From the results of the survey, it appeared that the tool (Advanced information technologies (Email, Voice, Handheld)) was ranked first, and this means that this tool had the most impact on the progress of work in construction projects in organizations. The second ranked was for the tool (Mobile apps for phone / tablet) with median= 5.51, it demonstrated its importance regarding the project stages. This result is similar to Sudharsan. K et al. (2019) [38] results, according to, effective communication among those involved on the job sites was

identified as a crucial element in the administration of construction projects. The mobile application's specification enables users to access helpful features like online guidance, requests for interpretation, and project information. Users of mobile devices can get in touch with field offices and mobile workers who can help them look up project specifics. The third rank was for the Wireless communication technologies (Bluetooth, wireless, WSN, WLAN) tool with median=5.34, this finding was supported by Deepesh Agarwal's research (2023) [39], which concentrated on the issue of Low Power Wide Area Networking (LPWAN) and the use of Long RangeWAN (LoRa) technology to track and monitor construction equipment to boost productivity and complete projects more quickly. Fourd rank was electronic document systems (E-commerce, E-procurement, E-commerce payment system, etc.) tool with median=5.25, The importance of this tool also appeared in Bo-Christer Björk et al (2002) [40] research, they explained in their research that the advantages that could be measured immediately included lower coping costs, less travel to meetings, etc. Other measurable advantages were a decrease in the number of working days required for document delivery. The simplicity of using the electronic site diary was one of the most significant qualitative advantages. Also using electronic documents system enhanced searching and less time wasted on outdated document versions. The fifth rank was Cloud computing technologies Augmented reality / Virtual reality / Mixed reality tool with median=5.22, This result is in line with the results of the Qiu-yi li et al. (2021) [26] search, his research based on cloud computing technology has been demonstrated through studies have improved accuracy and timeliness in the real application process. The sixth rank was BIM tool with median=5.18, the researchers highlited the importance of BIM in construction projects and how it is helpful to discover operational insights and make precise predictions in a fully automated and affordable method in the projects, and enhanced collaboration and communication, and showed promise for enhancing Key Performance Indicators (KPIs) such overall construction time, reduced downtime on the job site, higher levels of quality, and sustainability in terms of less material waste. [21][22][27]. The seventh rank was for Big Data Analytics tool with median=5.04, This high rating supports the results of Alak, H. et al. (2019) [28], Miglena Stoyanova (2022) [29] in their research found an approach to perform big data analytics to keep up with the escalating demands

of customers for complicated, quick projects, and to develop new techniques for data structuring and analysis and that raise output and performance generally. The eighth rank was for Computer and software applications (ERP, EDI, XML, Database) with median=5, this rating supports by Kambiz Radman et al. (2021) [30], Moneer Bhih et al. (2021) [32], Chengke Wu et al. (2021) [33] and Mariam Elazhary et al. (2021) [34], in their research they used computer software like Primavera and MS project to track delays in construction projects, they demonstrate encouraging outcomes. Image capture technologies (Photogrammetry, Video Camera, Multimedia, Laser scanning, Laser-radar (LIDAR/LADAR)) was the ninth rank in this survey with median=4.88, The respondents in this questionnaire believe that this tool is useful in their construction projects affiliated with women's organizations, and Surya S. C. et al. (2019) [41] agrees with them. The findings of their research showed an outstanding align, demonstrating that this close-range photogrammetry technology might be a helpful instrument for establishing infrastructure operations and reduce related delays. The last critical tool according to this survey was Internet of Things (IoT), with median=4.72, Yue Pan et al. (2021) [19] shows its benefits in their research, they created as-built event log using new IoT and connect it with BIM to talk about actual delays. This is helpful to discover operational insights and make precise predictions in a fully automated and affordable method in the projects.

Tools that shown to be inconclusive in influencing construction projects are Augmented reality/ Virtual reality/ Mixed reality, Robotic applications (Autonomous vehicles, Unmanned aerial vehicle, 3D printer) and Wearable technology (EEG, ECG/EKG sensors, UV light sensor, Stress control wristband, Smart helmet) despite good evaluations of it. This is not in agreement with a lot of research that finds it important for better performance of construction projects, reduced downtime on the job site, higher levels of quality, and sustainability in terms of less material waste, and continuously monitor the employees [27][35], this can be interpreted as a lack of knowledge about these tools and because some of them may be expensive in relation to the funding that humanitarian organizations receive.

5
CONCLUSIONS

5.1 Conclusions

1- Most of the technology tools received a high rating, regardless of the reviewers' background (country, project life cycle stages, and domains).

2- The results of the research show that most of the researchers use or have previously used technological tools in the design stage, although it received good reviews in the rest of the project's life stages. This show that the user may not have sufficient knowledge of these tools, their usefulness and their optimal use, or that there is difficulty in accessing these tools in some stages of the project or the institution supporting the completion of the project does not provide them.

3- Likewise, with regard to the project performance domains, most reviewers use or have used these tools in the planning stage in particular, and this shows a lack of knowledge about using these tools in other stages or their lack of provision by institutions.

4- Tables show that most of the technology tools received an evaluation ranging between 4 and 5 in relation to the stages of the project life and its performance domains. BIM obtained the largest number of high evaluations, while (Wearable technology (EEG, ECG/EKG sensors, UV light sensor, Stress control wristband, Smart helmet)) tool received the largest number of poor evaluations.

5- Results show that 52% of the answers said they have used technology tools in the project life cycle stages, while 55.8% of the answers said they have used it in project performance domains.

6- Results show that 56.7% of the answers' evaluations was high between (5 and 7) and thinks the tools have benefits on project life cycle stages, and 18.8% of the answers were 4 (moderate).

7- Results show that 55% of the answers' evaluations was high between (5 and 7) and thinks the tools have benefits on their work during project

performance domains, and 21.4% of the answers gave answer 4 (moderate) benefit on project performance domains.

8- These high ratings compared to the number of users show that there is a lack of support for organizations sponsoring humanitarian projects with technological tools.

9- In addition, high ratings for technological tools show the intention of workers in the construction field to use these tools if it was available to them.

10- This study showed that tools in sequence

- (Advanced information technologies (Email, Voice, Handheld).
- Mobile apps for phone / tablet.
- Wireless communication technologies (Bluetooth, wireless, WSN, WLAN).
- Electronic document systems (E-commerce, E-procurement, E-commerce payment system, etc.).
- Cloud computing technologies.
- BIM.
- Big Data Analytics.
- Computer and software applications (ERP, EDI, XML, Database).

have the greatest impact on improving work performance during the project life cycle stages and on performance domains on construction projects in humanitarian organizations, so the use of these tools leads to greater smoothness in the work of these organizations and in completing their tasks, which are often urgent.

11- Through the results of the study and by direct interviews with the reviewers, we believe that the tools: Wireless Communication, Electronic Document systems, Cloud Computing technologies, BIM, Image Capture, and Internet of Things will have a better future in the coming years in the field of construction because they have received good reviews from specialists as well as their desire to use these tools, as they only have sufficient knowledge

of these tools, but they lack the appropriate experience to use them in work sites.

5.2 Recommendations

For the future researches, although the sample number is sufficient, but increasing the number of samples will lead to more results that are accurate. As well as, diversifying the sample from different countries will lead to knowing the countries that have introduced technology to their construction projects. Also, although the sample of this research includes several countries, most of the sample was from one country due to the difficulty of convincing the target group to fill out the questionnaire by e-mail. Therefore, it is recommended to do the survey face to face.

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A

A QUESTIONAIRE FORM

Overview:

In this study, the effects of technological tools used in construction projects will be examined in terms of project stages and project performance domains.

After finalizing all the questions, kindly share via: Email

If you prefer whatsapp

EVALUATION OF PROJECT LIFE CYCLE STAGES

This part of the study, it is desired to evaluate the need of the technological tools at project lifecycle stages,

a 1-7 scale. On this scale, 1=very little; 2=less, 3=moderate-less, 4=moderate, 5=moderate-high, 6=very, 7=very extreme.

- Check the box if you think you need the tool in this stage, then evaluate the need on a scale (1-7) on the next sub column, if not , leave it blank, Please see the example below.

* Feasibility: This process is the starting point when the organization requests new capability delivered through a new project by filing a business case (e.g., brainstorming, worst possible idea.)

* Test: Final quality review and inspection of deliverables are carried out before transition, go-live, or acceptance by the customer.(e.g., validate the methodology against the organization requirements.)

* Deploy: Project deliverables are put into use and transitional activities required for sustainment, benefits realization, and organizational change management are completed.(e.g., release the methodology to the beneficiaries).

* Close: The impact during closing of the project, project knowledge and artifacts archiving, project team members releasing, and contracts closing.

After finalizing all the questions, kindly share via:

Email

If you prefer whatsapp

Reviewers

Mission Country	Organization / institution:	Role in the institution	Role of the institution in the contract	Experience in the Sector	Education
		☐ Employer ☐ Contractor ☐ Designer ☐ Consultant ☐ Subcontractor ☐ Supplier			

Technological Tools	Project Lifecycle Stages											
	Feasibility *		Design		Build		Test*		Deploy*		Close*	
Ex: software	☒	3	☒	7	☐	7	☐	7	☒	3	☐	5
BIM	☐		☐		☐		☐		☐		☐	
Blockchain / Smart contract	☐		☐		☐		☐		☐		☐	
decision support systems	☐		☐		☐		☐		☐		☐	
Planning software	☐		☐		☐		☐		☐		☐	
Spatial technologies (Geographic information system (GIS), Global Positioning System (GPS), Smart sensors, etc.)	☐		☐		☐		☐		☐		☐	
Automatic identification technologies (Radio Frequency Identification technology (RFID), Ultra Wideband (UWB), Barcode, QRcode)	☐		☐		☐		☐		☐		☒	
Mobile apps for phone / tablet	☐		☐		☐		☐		☐		☐	
Image capture technologies (Photogrammetry, Video Camera, Multimedia, Laser scanning, Laser-radar(LIDAR/LADAR))	☐		☐		☐		☐		☐		☐	
cloud computing technologies	☐		☐		☐		☐		☐		☐	
Augmented reality / Virtual reality / Mixed reality	☐		☐		☐		☐		☐		☐	
Internet of Things (IoT)	☐		☐		☐		☐		☐		☐	
Big data analytics	☐		☐		☐		☐		☐		☐	
Robotic applications (Autonomous vehicles, Unmanned aerial vehicle, 3D printer)	☐		☐		☐		☐		☐		☐	
Wearable technology (EEG, ECG/EKG sensors, UV light sensor, Stress control wristband, Smart helmet)	☐		☐		☐		☐		☐		☐	
Computer and software applications (ERP, EDI, XML, Database)	☐		☐		☐		☐		☐		☐	
Electronic document systems (E-commerce, E-procurement,	☐		☐		☐		☐		☐		☐	

E-commerce payment system, etc.)												
Wireless communication technologies (Bluetooth, wireless, WSN, WLAN)	☐		☐		☐		☐		☐		☐	
Advanced information technologies (Email, Voice, Handheld)	☐		☐		☐		☐		☐		☐	

VALUATION OF PROJECT PERFORMANCE DOMAINS

In this part of the study, the need of technological tools to performance domains were evaluated on a 1-7 scale.

On this scale, 1=very little; 2=less, 3=moderate-less, 4=moderate, 5=moderate-high, 6=very, 7=very extreme.

- Check the box if you think you need the tool in this stage. evaluate the need on a scale (1-7) on the next sub column. If not, leave it blank. Please see the example below.

*Development Approach: A method used to create and evolve the product, service, or result during the project life cycle, such as a predictive, iterative, incremental, adaptive, or hybrid method.

* Project work is associated with establishing the processes and performing the work to enable the project team to deliver the expected deliverables and outcomes. This definition includes managing the flow of existing work, new work, changes to work, Communicating with stakeholders; Managing material, equipment

* Project delivery focuses on meeting requirements, scope, and quality expectations to produce the expected deliverables that will drive the intended outcomes.

* Measurement , ex: Evaluating performance compared to plan, and Tracking the utilization of resources, work completed, budget expended, etc.

* Uncertainty presents threats and opportunities that project teams explore, assess, and decide how to handle.

Technological Tools	Project performance domains											
	Development Approach and Life Cycle*		Planning		Project Work*		Delivery*		Measurement*		Uncertainty *	
Ex: software	☒	6	☒	4	☐	6	☐	5	☒	7	☒	7
BIM	☐		☐		☐		☐		☐		☐	
Blockchain / Smart contract	☐		☐		☐		☐		☐		☐	
decision support systems	☐		☒		☐		☐		☐		☐	
Planning software	☐		☐		☐		☐		☐		☐	
Special technologies (Geographic information system (GIS), Global Positioning System (GPS), Smart sensors, etc.)	☐		☐		☐		☐		☐		☐	
Automatic identification technologies (Radio Frequency Identification technology (RFID), Ultra Wideband (UWB), Barcode, QRcode)	☐		☐		☐		☐		☐		☐	
Mobile apps for phone / tablet	☐		☐		☐		☐		☐		☐	
Image capture technologies (Photogrammetry, Video Camera, Multimedia, Laser scanning, Laser-radar(LIDAR/LADAR))	☐		☐		☐		☒		☐		☐	
cloud computing technologies	☐		☐		☐		☐		☐		☐	
Augmented reality / Virtual reality / Mixed reality	☐		☐		☐		☐		☐		☐	
Internet of Things (IoT)	☐		☐		☐		☐		☐		☐	
Big data analytics	☐		☐		☐		☐		☐		☐	
Robotic applications (Autonomous vehicles, Unmanned aerial vehicle, 3D printer)	☐		☐		☐		☐		☐		☐	
Wearable technology (EEG, ECG/EKG sensors, UV light sensor, Stress control wristband, Smart helmet)	☐		☐		☐		☐		☒		☐	
Computer and software applications (ERP, EDI, XML, Database)	☒		☐		☐		☐		☐		☐	

Electronic document systems (E-commerce, E-procurement, E-commerce payment system, etc.)	☐		☐		☐		☐		☐		☐	
Wireless communication technologies (Bluetooth, wireless, WSN, WLAN)	☐		☐		☐		☐		☐		☐	
Advanced information technologies (Email, Voice, Handheld)	☐		☐		☐		☐		☐		☐	

TECHNOLOGICAL TOOLS AND THEIR DEFINITIONS

BIM	It is the process in which the project data is created and managed digitally in 3D, and activities such as conflict detection, site layout planning, project planning, project coordination, construction monitoring, prefabrication, and security are carried out.
Blockchain / Smart contract	It is a specific type of database where data, computers or participants are recorded, shared and synchronized in a distributed network. Smart contract: A computer program or transaction protocol that is intended to automatically execute, control, or document legally relevant events
decision support systems	They are computer-based systems that facilitate decision-making by utilizing collected information at a decision stage.
Planning software	It is a solution for planning, managing, and executing projects and programs. Like Primavera P6, MS Project.
Special technologies (Geographic information system (GIS), Global Positioning System (GPS), Smart sensors, etc.)	GIS: It is an information system that integrates functions such as collecting, storing, analyzing and presenting data belonging to the earth to the user. GPS: It provides the determination of the location of the people in the orbit in signal exchanges. Intelligent sensor: It is used to convert environmental inputs (eg humidity, temperature, smoke, water leakage) into readable data and then transmit it to a central warehouse and plays a very important role in data distribution.
Automatic identification technologies (Radio	RFID: It is the technology of automatic identification, data collection and spatial data storage. UWB: It is a

Frequency Identification technology (RFID), Ultra-Wideband (UWB), Barcode, QRcode)	short-range, wireless communication protocol that works through radio waves. Barcode: It is an automatic data collection tool that enables data reading from a long distance
Mobile apps for phone / tablet	They are applications that facilitate site visits and enable work to be completed on the go. For example, Such as DWG viewer application, e-invoice, concrete calculator applications that allow viewing, creating and editing AUTOCAD drawings.
Image capture technologies (Photogrammetry, Video Camera, Multimedia, Laser scanning, Laser-radar (LIDAR/LADAR))	Laser scanning: It is important to take 3-dimensional measurements of buildings or lands accurately and by minimizing measurement-based errors. LIDAR: It is a remote sensing technology that uses laser beams to measure the distance between objects and measuring instruments.
cloud computing technologies	With web-based applications that do not require installation, many data are stored and real-time access is provided regardless of location, with operational convenience.
Augmented reality / Virtual reality / Mixed reality	Augmented reality: Inputs that will appeal to the human senses and stimulate their senses are modified and enriched by the computer, virtual objects are blended with real images. Virtual reality: Completely freed and abstracted from real life, in a computer-designed digital representation to create a simulated environment by 3D modeling or 360-degree video

	capture Mixed reality: It is the environment where real and virtual environment objects are together.
Internet of Things (IoT)	It describes the network of physical objects embedded with sensors, software and other technologies for data connection and sharing with other devices and systems over the Internet.
Big data analytics	It is data that cannot be stored, managed and analyzed with traditional database systems. Big data is the collection of meaningful and actionable data that is collected to be analyzed and increased efficiency.
Robotic applications (Autonomous vehicles, Unmanned aerial vehicle, 3D printer)	For example, driverless dozers, brick-laying robots, etc. Unmanned aerial vehicles (UAVs) or drones: Virtual designs and construction are important in streamlining workflows. Thanks to high resolution photos, videos and maps taken from the air, it can plan and manage large-scale projects in a shorter time and at a lower cost. 3D printer: It is the technology that transforms products and objects designed in virtual environment into solid objects.
Wearable technology (EEG, ECG/EKG sensors, UV light sensor, Stress control wristband, Smart helmet)	EEG: These bands, which record the user's brain activity and transfer the data to a smart device, also provide information about sleep quality. ECG sensor: Heart rate sensor. Smart wristband: Measures stress level by monitoring heartbeats and gives relaxation suggestions to the user.
Computer and software applications (ERP, EDI, XML, Database)	With data transfers, data exchange between different units is ensured.

Electronic document systems (E-commerce, E-procurement, E-commerce payment system, etc.)	It is aimed to increase efficiency by standardizing document production by arranging standards and procedures, preventing or minimizing errors that may occur during this time.
Wireless communication technologies (Bluetooth, wireless, WSN, WLAN)	Wireless technologies carry information between devices using electromagnetic waves.
Advanced information technologies (Email, Voice, Handheld)	These technologies contribute as a communication tool

PUBLICATIONS FROM THE THESIS

Conference Papers

1. Abed G., Gürgün A. " The Effect of Technology On Construction Projects In Humanitarian sector", 3rd International Conference on Access to Recent Advances in Engineering and Digitalization, Turkey, 15 - 17 March 2023.