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The Role of Smartphone Applications in Enhancing Operational Efficiency in Construction Projects in Jordan

Tahseen Mansour Mansour [1] *, ***Husam Tahseen Mansour*** [2]

[1] Department of Journalism, Media, and Digital Communication, Jordan University, Amman, Jordan

[2]Corporate QA/QC Manager/Rawabi Specialized Contracting Co. KSA

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* *Corresponding author:*
t_mansour@ju.edu.jo

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Abstract

Objectives: This study aimed to identify the role of smartphone applications in improving communication, resource management, and decision-making in construction projects in Jordan. It also investigates their relationship with variables such as project size, geographic location, and technological infrastructure to identify opportunities and limitations in their application.

Methods: A descriptive research approach was employed, utilizing a survey methodology. Data was collected through a structured electronic questionnaire distributed to 210 engineers involved in construction projects across Jordan. Statistical analyses, including ANOVA, were conducted to evaluate the impact of smartphone applications on various aspects of project management.

Results: The study results showed that smartphone applications significantly enhance communication and accelerate decision-making, contributing to improved project performance. However, their effectiveness in managing resources, mitigating risks, and reducing errors was found to be limited. The findings highlight the influence of variables such as geographic location and technological readiness on the adoption and impact of these applications.

Conclusions: The study recommends that smartphone applications are valuable tools for improving efficiency and coordination in construction projects, particularly in communication and decision-making processes. However, challenges remain in fully leveraging their potential, especially in complex and large-scale projects. Recommendations include targeted training, IT infrastructure improvements, and integration with advanced technologies such as BIM and Digital Twin to optimize their utility.

Keywords: Smartphone applications, Construction projects, Communication, Decision-making, Jordan.

دور تطبيقات الهواتف الذكية في تعزيز الكفاءة التشغيلية في مشاريع البناء في الأردن

***تحسين منصور منصور*[1]*، حسام تحسين منصور*[2]

[1]قسم الصحافة والإعلام والاتصال الرقمي، الجامعة الأردنية، عمّان، الأردن

[2]مدير ضمان ومراقبة الجودة المؤسسي / شركة روابي للمقاولات المتخصصة، المملكة العربية السعودية

ملخّص

الأهداف: تهدف هذا الدراسة إلى فحص دور تطبيقات الهواتف الذكية في تحسين الاتصال، إدارة الموارد، واتخاذ القرارات في مشاريع البناء في الأردن. كما تستكشف العلاقة بين هذه التطبيقات ومتغيرات مثل حجم المشروع، الموقع الجغرافي، والبنية التحتية التكنولوجية لتحديد الفرص والقيود في تطبيقاتها.

الطرق: تم استخدام المنهج الوصفي التحليلي معتمدًا على أداة الاستبيان. تم جمع البيانات من خلال استبيان إلكتروني منظم وزّع على 210 مهندسين مشاركين في مشاريع البناء عبر الأردن، وتم إجراء تحليلات إحصائية، بما في ذلك تحليل التباين (ANOVA)، لتقييم تأثير تطبيقات الهواتف الذكية على جوانب مختلفة من إدارة المشاريع.

النتائج: أظهرت الدراسة أن تطبيقات الهواتف الذكية تعزز بشكل كبير الاتصال وتسريع اتخاذ القرارات، مما يساهم في تحسين أداء المشروع. ومع ذلك، وُجد أن فعاليتها في إدارة الموارد، التخفيف من المخاطر، وتقليل الأخطاء كانت محدودة. تبرز النتائج تأثير المتغيرات مثل الموقع الجغرافي وجاهزية التكنولوجيا على تبني هذه التطبيقات وتأثيرها.

الاستنتاجات: تعتبر تطبيقات الهواتف الذكية أدوات قيمة لتحسين الكفاءة والتنسيق في مشاريع البناء، خاصة في مجالات الاتصال واتخاذ القرارات. ومع ذلك، لا تزال هناك تحديات في الاستفادة الكاملة من إمكاناتها، خاصة في المشاريع الكبيرة والمعقدة. تشمل التوصيات التدريب المستهدف، تحسين البنية التحتية لتقنية المعلومات، والدمج مع تقنيات متقدمة مثل النمذجة المعلوماتية للبناء (BIM) والتوأم الرقمي (Digital Twin) لتحسين الاستفادة منها.

الكلمات المفتاحية: تطبيقات الهواتف الذكية؛ مشاريع البناء في الأردن؛ الاتصال؛ اتخاذ القرارات؛ الأردن.

Introduction

Technologies have brought significant transformations in project management across various industries including the construction industry whether in Jordan or worldwide. The construction sector has been notably impacted by smart technologies that have shown great potential to enhance performance and increase efficiency (Sepasgozar, 2021; Hotový, 2018; Moshood et al., 2024). In the last decade, with the increasing complexity of projects and the labor shortage exacerbated by the COVID-19 pandemic. Smartphone technologies have improved operational efficiency and served the construction industry (Zhu et al., 2022). Smartphone applications are programs developed specifically to work on smart devices such as mobile phones and tablets. These applications are typically small software units designed to perform specific tasks, offering users a variety of services and a high-quality digital experience with outstanding performance. Compared to applications designed for desktop computers, mobile applications provide their own functionalities, such as games, calculators, and web browsers for mobile phones (Al Badr Systems, n.d.). However, studies focusing on the application of these technologies in project management remain relatively scarce, particularly in the Jordanian context. Although smartphone applications have become one of the most prominent developments in the construction industry in recent years, research on their specific impacts, especially with respect to variables such as experience, job roles, and project characteristics, is limited. The use of smartphone applications has become one of the most prominent developments in the construction industry in recent years. Recent statistics indicate that 90.9% of companies use smartphones daily for work purposes, reflecting the growing reliance on mobile devices to improve the daily performance of projects (ConTech Report, 2023). Additionally, 62.4% of companies use mobile devices on-site for daily reporting, which enhances the role of these applications in facilitating communication and improving workflow. Moreover, 21.4% of construction companies use three or more applications to manage their projects, reflecting the trend toward adopting multiple tools to meet diverse operational needs (ConTech Report, 2023).

Given the importance of technological development, His Majesty King Abdullah II instructed the Prime Minister on to form and chair a National Council for Future Technology. This directive highlights the significance of technological advancements to enhance Jordan's position as a technologically advanced nation. This vision underscores the importance of adopting modern technology such as smartphone applications to improve performance and increase efficiency in various sectors, including construction (Jordan.gove.jo, 2025). These applications today significantly contribute to improving organization, speeding up decision-making, and facilitating communication among teams. Studies have shown that these applications assist in real-time data management, which helps reduce errors and achieve better results (Zhu et al., 2022; Nisar, 2019; Hasan et al., 2019; Kim et al., 2013). Research has demonstrated that these applications effectively contribute to tracking the progress of projects in real-time, improving performance, and increasing efficiency.

On the other hand, the "State of Digital Adoption in Construction 2024" report published by Deloitte in collaboration with Autodesk highlights the continuous evolution in this field. The report addresses the challenges faced by the construction industry amid increasing disruptions such as rising costs, skill shortages, and sustainability pressures. Nevertheless, the report shows that companies investing in digital technologies, such as smartphone applications, have experienced significant improvements in efficiency. The report indicates that around 68% of companies have started or plan to use artificial intelligence in their future operations, reflecting the ongoing digital transformation in the sector (Deloitte, 2024). These applications are now essential tools in managing construction projects, as they contribute significantly to improving organization, enhancing communication, and speeding up decision-making among team members. According to multiple studies, using these applications can reduce stress levels and improve performance in work environments (Whelan & Turel, 2024). Furthermore, research by Shehab et al. (2009) emphasized the importance of barcode systems in accelerating processes and reducing errors on construction sites.

This study aims to bridge the research gap in the impact of smartphone applications on managing construction projects in Jordan. Specifically, the study will focus on how certain variables, such as years of experience, job role, engineering specialization, geographical location, and project size, influence the effectiveness of using these applications**.** By addressing this gap, the study seeks to better understand how these factors contribute to improving the use of smartphone applications

to achieve better outcomes in construction projects in Jordan. The growing trend toward adopting these technologies in the construction sector reflects the significant potential of smartphone applications to improve performance in the face of ongoing challenges, such as skill shortages and increasing economic pressures (Deloitte, 2024).

Theoretical Framework

From a theoretical perspective, the impact of smartphone applications in construction project management can be explained through three main theories: Network Theory, Complexity Theory, and the Technology Acceptance Model (TAM). These theories provide a framework for understanding how smartphone applications facilitate communication among different teams, improve system integration, and increase technology acceptance among individuals and organizations. These applications also help improve the performance of construction projects and increase the efficiency of related operations.

Network Theory

Network Theory focuses on studying communication and relationships between elements within complex networks, including the flow of information and knowledge exchange among individuals and teams. In construction projects, smartphone applications play a significant role in improving the flow of information between different teams, such as engineers, contractors, and suppliers. This improvement in communication allows for faster and more effective collaboration, which is critical in large projects requiring constant coordination between many parties. According to Network Theory, smartphone applications can be considered tools that contribute to building new communication networks within organizations, creating strong connections between individuals, which enhances effective collaboration and decision-making (Borgatti & Halgin, 2011). In Jordan, where coordination between the various teams involved in construction projects requires substantial time and effort, applications such as Procore and Buildertrend are effective tools to improve this coordination by providing features for project management, task tracking, and document storage. In addition to these applications, other tools such as PlanGrid, Fieldwire, and eSUB Field Works contribute to enhancing coordination among on-site team members by providing real-time updates, document sharing, and precise task tracking.

The advent of mobile technology has made project management more flexible, allowing project managers and team members to access project information, update tasks, and communicate while on the move. Applications like AutoCAD and DWG FastView assist engineers in modifying and designing plans on mobile devices during site visits, enabling quick decision-making. This aligns with Monroy's (2021) article on the importance of mobile applications in enhancing efficiency and flexibility in construction project management. In the past, project management was confined to fixed office locations, which reduced flexibility and effective responsiveness. These findings are consistent with the study by Baryeh, Modie, and Petrovic (2021), which highlighted the role of mobile applications in improving coordination within the construction industry, thereby contributing to better decision-making processes and more accurate monitoring of work progress. According to Social Network Theory, these applications are part of the social networks created within an organization, which contributes to easier information flow between teams and aids in making more accurate and quicker decisions, consistent with the ideas presented by Wasserman & Faust (1994) about the importance of networks in facilitating resource exchange and decision-making within organizations.

Complexity Theory

Complexity Theory explores how systems adapt to continuous changes in their environments. In construction projects, multiple systems interact, such as human resources (engineers, workers), technical systems (equipment, software), and organizational systems (laws, permits) in unpredictable and dynamic environments. These interactions can be highly complex in large projects, where delays or unforeseen challenges can significantly impact workflow. According to Complexity Theory, these systems operate in an interconnected manner, where changes in one part can indirectly affect other parts (Miller & Page, 2007). Smartphone applications help manage these complexities by enabling teams to adapt better to changing conditions. For example, in large projects in Amman, these applications allow teams to track the project's progress in real-time, enabling them to compare actual performance with initial plans and make necessary adjustments in case of delays or unexpected challenges. This theory supports the study by Kim et al. (2013), which emphasized the role of

mobile computing in managing complex and changing work environments on construction sites, making smartphone applications a powerful tool in managing the dynamic nature of construction projects. In large-scale construction projects, the interdependence of various systems and the unpredictability of external factors make managing these projects complex. For instance, during the construction of several bridges in Jordan, project teams faced unpredictable delays due to weather conditions and labor shortages. Smartphone applications allowed project managers to adjust schedules in real time and track progress remotely, which was crucial in adapting to the changing conditions. This is an example of how Complexity Theory's emphasis on adaptability and real-time management applies to the construction sector.

Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM), developed by Davis (1989), focuses on understanding how individuals' perceptions of technology influence their willingness to adopt it. According to this model, individuals are more likely to adopt technology when they perceive it as useful and easy to use. In Jordan, the adoption of smartphone applications in managing construction projects has been gradual, with growing awareness among professionals of the benefits of these tools. As construction teams recognize the potential of these tools in improving efficiency and reducing costs, adoption rates are expected to rise. For example, applications like PlanGrid and Construct simplify documentation, track project progress accurately, and reduce errors, making them valuable tools in improving construction project management. This aligns with the findings of Venkatesh and Davis (2000), which confirmed that perceived usefulness and ease of use are the main factors driving technology adoption. Furthermore, a study by Na et al. (2022) confirms the application of the Technology Acceptance Model (TAM) in the context of artificial intelligence in the construction industry. The researchers found that technological factors, along with external and individual variables, positively affect users' perceptions of the usefulness and ease of using technology in construction companies. This indicates that the acceptance of new technologies, such as smartphone applications, can be enhanced when users perceive their benefits and ease of use in their construction projects. By integrating Network Theory, Complexity Theory, and the Technology Acceptance Model (TAM), we can better understand how smartphone applications contribute to improving the management of construction projects. Through enhancing communication between teams, improving system integration, and facilitating adaptation to continuous changes in complex work environments, these applications contribute to improving the overall performance of projects, increasing decision-making efficiency, reducing errors, and ultimately improving the quality of construction work.

The integration of Network Theory, Complexity Theory, and Technology Acceptance Model (TAM) provides a multifaceted lens through which the adoption of smartphone applications in construction projects can be understood. Network Theory highlights the improvement of communication between teams, Complexity Theory addresses the adaptation of systems in dynamic construction environments, and TAM explains the perceived usefulness and ease of use that influence adoption. These theories collectively show how smartphone applications are important in improving collaboration, managing the complexities of projects, and driving technology adoption. However, challenges such as resistance to digital tools must also be considered, as they affect the effective use of these applications. In addition, it is important to consider the cultural and organizational factors that could influence the adoption of smartphone applications in Jordan's construction industry. Resistance to new technologies, particularly in traditionally conservative industries like construction, can limit the potential of smartphone applications. This resistance may be compounded by factors such as a lack of technological infrastructure, limited training, and financial constraints, which further challenge the smooth integration of these tools into everyday project management activities.

Smartphone Applications in Construction Project Management: Theoretical Literature

In the construction industry, digital transformation has become crucial for improving various processes, including project management, team communication, and reducing errors. Many studies highlight the role of mobile applications in improving efficiency and communication on construction sites. For instance, a study by Hasan et al. (2019) illustrate how these applications contribute to facilitating information exchange between teams and reducing reliance on paper documents, which enhances decision-making speed and reduces human errors. These findings align with the study by Johari et al. (2024), which emphasizes improved communication between teams through digital tools like mobile applications, and with

the study by Yankah et al. (2022), which highlighted the role of applications such as Autodesk Sketchbook and MagicPlan in speeding up modeling and planning. Regarding Digital Twin and BIM (Building Information Modeling) technologies, numerous studies emphasize the importance of these tools in improving the construction industry's efficiency. Studies by Lu et al. (2020) and Min Ding et al. (2021) suggest that using digital twins enhances effectiveness during various project phases. Additionally, Damström's (2020) study explains how tools like BIM improve team communication and increase efficiency, which is consistent with the findings of Yankah et al. (2022) and Kozarkiewicz (2020), both of which focus on the digital transformation in construction and the use of tools like BIM to accelerate planning and execution processes.

Despite these benefits, some studies point to challenges in implementing these technologies. For example, the study by Al-Azizi et al. (2017) on challenges facing mobile applications in the public sector reveals resistance from some employees to adopt these technologies within the regulatory environment. Likewise, the findings of the studies by Hassamo and Hosamo. (2022) overlap with these results, as they noted difficulties in adopting advanced technologies such as digital twins and 3D laser scanning in bridge maintenance, reflecting challenges in the integration between technology and teams' efficiency in adapting to these tools. On the other hand, digital decision-making tools play a key role in improving project management. In this context, the study by Naeem et al. (2023) underscores the importance of these systems in the real estate industry, where they aid in improving decision-making by supporting real-time data analysis. These findings overlap with the study by PlanRadar (2023), which focuses on how modern technologies, such as project management platforms, improve decision-making in construction projects, contributing to faster operations and fewer errors.

Additionally, the study by Al-Bustanji (2024) on digital engineering in municipalities highlights the importance of digitization in improving project management efficiency, which aligns with the results of Redden et al. (2017), who pointed out that introducing digital tools in construction management academic programs helps develop team skills and organize projects more effectively, thereby enhancing project management efficiency. The acceleration of digital transformation reflects a significant impact on productivity and team collaboration. The study by Tairov & Donchev (2022) suggests that mobile applications contribute to enhancing productivity and increasing collaboration between different teams, a result that aligns with the study by Johari et al. (2024), which confirms the role of digital technology in improving communication among teams in construction projects. The study by Kim et al. (2017) highlights the effective role of digital tools such as drones in enhancing collaboration and site monitoring, reflecting the positive impact of digital transformation on the performance efficiency of teams on construction sites.

A comprehensive review of these studies clearly shows that mobile applications play a pivotal role in improving construction project management performance, as they help enhance real-time communication between teams and improve data exchange. Many recent studies, such as those by Johari et al. (2024) and Yankah et al. (2022), emphasize the importance of these applications in accelerating processes and providing accurate real-time information, which boosts efficiency and work quality on construction sites. These digital tools help reduce human errors and foster collaboration among the various parties involved in the project, which is a key benefit given the increasing complexities in construction projects. Moreover, studies such as those by Naeem et al. (2023) and Damström (2020) highlight the significance of integrating technologies like BIM and digital twins in improving management and monitoring, as these tools provide a digital environment that supports rapid and accurate decision-making. According to studies like PlanRadar (2023), these technologies can enhance teams' ability to communicate and coordinate more efficiently, leading to improved productivity and cost reduction. However, studies also indicate challenges related to adopting these technologies. As shown in the study by Al-Azizi et al. (2017), which addressed the challenges of mobile applications in the public sector, it is crucial for teams and organizations to be prepared to adopt these digital tools effectively. It is expected that these applications will continue to positively impact the construction industry, as they contribute to improving execution accuracy and increasing the competitiveness of construction projects. In the future, reliance on these technologies will continue to enhance effectiveness and efficiency in managing construction projects.

Research Hypotheses

H 1: There are no significant differences in the role of smartphone applications in improving planning effectiveness in construction projects in Jordan based on job role and years of experience.

H 2: There are no significant differences in the role of smartphone applications in managing project resources and reducing time and cost wastage based on years of experience and engineering specialization.

H 3: There are no significant differences in the role of smartphone applications in improving communication between teams based on geographic location and years of experience.

H 4: There are no significant differences in the role of smartphone applications in improving quality control and reducing errors based on engineering specialization.

H 5: There are no significant differences in the role of smartphone applications in risk management and reducing accidents based on project size and job role.

Methodology

This descriptive study employed a survey method, using a questionnaire designed for participants in construction projects in Jordan. The questionnaire comprises two main sections: the first section gathers demographic data about the sample members, including years of experience, job role, engineering specialization, geographic location, and project size, while the second section consists of 20 items addressing the study's research questions, measured on a three-point Likert scale with options of "Agree" (3 points), "Neutral" (2 points), and "Disagree" (1 point).

Study Population and Sample

The study population consists of engineers working in construction projects in Jordan. This population includes engineers from various engineering specializations, such as civil, architectural, electrical, mechanical engineering, and others. Engineers were chosen as the primary sample for this study because they are directly involved in managing, executing, and overseeing construction projects, and their role in planning, resource management, communication, quality control, and risk management processes makes them key stakeholders in the context of smartphone applications' usage and their impact on project effectiveness. Given that engineers are distributed across various projects and geographic regions, it was difficult to identify them using traditional methods. To overcome this challenge, the study tool (an electronic questionnaire via Google Forms) was used to reach participants across different work environments. The questionnaire was distributed to engineers working in construction projects, with 210 engineers responding to participate in the study, forming the study sample. This sample is considered adequate for the size of the study, as it is sufficient to analyze the relationship between independent variables and the role of smartphone applications in improving process effectiveness in construction projects.

Table 1. Characteristics of the Sample Members

Variable	Category	Number	Percentage (%)
Years of Experience	Less than 5 years	87	41.4%
	5-10 years	56	26.7%
	More than 10 years	67	31.9%
Job Role	Engineer	125	59.5%
	Project Manager	33	15.7%
	Field Supervisor	25	11.9%
	Administrative Staff	27	12.9%
Engineering Specialization	Civil Engineering	93	44.3%
	Mechanical Engineering	27	12.9%
	Electrical Engineering	25	11.9%
	Architectural Engineering	28	13.3%

Variable	Category	Number	Percentage (%)
	Other Specialization	37	17.6%
Geographic Location	Amman	156	74.3%
	Irbid	22	10.5%
	Zarqa	12	5.7%
	Other Cities	20	9.5%
Project Size	Small Projects	60	28.6%
	Medium Projects	79	37.6%
	Large Projects	71	33.8%

Validity and Reliability: The questionnaire was reviewed by a group of professors in engineering and media to evaluate its validity. Some minor adjustments were made to ensure its applicability. As for reliability, Cronbach's Alpha coefficient was used to test reliability, and the results showed a value of 95.5%, reflecting a high level of reliability and confirming the tool's ability to measure what the study aims to evaluate.

Results

First

Table 2 shows the mean values, standard deviations, percentages, and rankings for each area of the role of smartphone applications in improving project management processes.

Area	Mean	Standard Deviation	Percentage	Rank
Improving Planning Effectiveness	2.63	0.470	87.6%	3rd
Managing Project Resources & Reducing Time & Money Waste	2.66	0.501	88.7%	2nd
Communication Between Teams	2.80	0.427	93.3%	1st
Quality Control & Reducing Errors	2.55	0.512	85%	4th
Risk Management & Reducing Accidents	2.46	0.546	82%	5th
All Areas	2.62	3.99	87.3%	-

The table presents the means, standard deviations, percentages, and rankings for each area of the role of smartphone applications in improving project management processes. In the area of improving planning effectiveness, the mean was 2.63 with a standard deviation of 0.470, and a percentage of 87.6%, ranking 3rd. In managing project resources and reducing time and money waste, the mean was 2.66 with a standard deviation of 0.501, and a percentage of 88.7%, ranking 2nd. In communication between teams, the mean was 2.80 with a standard deviation of 0.427, and a percentage of 93.3%, ranking 1st. In quality control and reducing errors, the mean was 2.55 with a standard deviation of 0.512, and a percentage of 85%, ranking 4th. In risk management and reducing accidents, the mean was 2.46 with a standard deviation of 0.546, and a percentage of 82%, ranking 5th. Across all areas, the mean was 2.62 with a standard deviation of 3.99, and a percentage of 87.3%.

Second

First Hypothesis: There are no differences in the role of smartphone applications in improving planning effectiveness in construction projects based on job role and years of experience.

To test this hypothesis, an Analysis of Variance (ANOVA) was conducted to determine whether years of experience or job role significantly influence the use of smartphone applications in improving planning effectiveness in construction projects.

ANOVA Results:

Variable	F-Value	Sig-Value	Conclusion
Years of Experience	1.05	0.351	Fail to reject H0 (No significant effect)
Job Role	0.586	0.625	Fail to reject H0 (No significant effect)

Analysis and Results:

- **Years of Experience**: The F-value of 1.05 and Sig-value of 0.351 (greater than 0.05) indicate that years of experience do not have a statistically significant impact on the role of smartphone applications in improving planning effectiveness. Thus, we conclude that years of experience do not significantly influence the use of smartphone applications for planning purposes.
- **Job Role**: Similarly, the F-value of 0.586 and Sig-value of 0.625 (greater than 0.05) show that job role does not significantly affect the use of smartphone applications in improving planning. Therefore, the type of job role (e.g., project manager, site engineer) does not impact how smartphone applications are used for planning.

Additionally, the R Squared value of -0.006 suggests that years of experience and job role explain very little of the variance in improving planning effectiveness.

Conclusion:

Based on the ANOVA results, we fail to reject the null hypothesis (H0), concluding that there are no significant differences in the role of smartphone applications in improving planning effectiveness based on either years of experience or job role.

Second Hypothesis: There are no differences in the role of smartphone applications in managing project resources and reducing time and cost wastage based on years of experience and engineering specialization."

To test this hypothesis, an Analysis of Variance (ANOVA) was conducted to examine whether years of experience or engineering specialty significantly influences the role of smartphone applications in managing project resources and reducing time and cost wastage.

ANOVA Results:

Variable	F-Value	Sig-Value	Conclusion
Years of Experience	0.452	0.501	Fail to reject H0 (No significant effect)
Engineering Specialty	1.246	0.249	Fail to reject H0 (No significant effect)

- **Years of Experience:** The F-value of 0.452 and Sig-value of 0.501 (greater than 0.05) indicate that years of experience do not have a statistically significant impact on the role of smartphone applications in resource management and reducing wastage.
- **Engineering Specialty:** Similarly, the F-value of 1.246 and Sig-value of 0.249 (greater than 0.05) show that engineering specialization does not have a significant effect on the use of smartphone applications for managing project resources and reducing time and cost wastage.

Additionally, the R Squared value of 0.028 suggests that only 2.8% of the variance in resource management can be explained by these two variables.

Conclusion: Based on the ANOVA results, we fail to reject the null hypothesis (H0). Neither years of experience nor engineering specialization have a significant impact on the role of smartphone applications in managing project resources and reducing time and cost wastage.

Third Hypothesis: There are no differences in the role of smartphone applications in improving communication between teams based on geographic location and years of experience."

To test this hypothesis, an Analysis of Variance (ANOVA) was conducted to assess whether geographic location or years of experience significantly influences the role of smartphone applications in improving communication between teams.

Analysis and Results:

Variable	F-Value	Sig-Value	Conclusion
Years of Experience	-	0.117	Fail to reject H0 (No significant effect)
Geographic Location	2.792	0.042	Reject H0 (Significant effect of location)

- **Years of Experience:** The Sig-value of 0.117 is greater than 0.05, meaning there were no statistically significant differences based on years of experience in improving communication between teams using smartphone applications.
- **Geographic Location:** The F-value of 2.792 and Sig-value of 0.042 (less than 0.05) indicate that geographic location significantly influences communication between teams using smartphone applications.

Additionally, the R Squared value of 0.053 suggests that 5.3% of the variance in communication effectiveness can be explained by these two variables.

Conclusion: We reject the null hypothesis for geographic location, as it significantly affects communication between teams. However, we fail to reject the null hypothesis for years of experience, as it does not have a significant impact on communication.

Fourth Hypothesis: There are no differences in the role of smartphone applications in improving quality control and reducing errors based on engineering specialization."

To test this hypothesis, an Analysis of Variance (ANOVA) was conducted to assess whether engineering specialization significantly affects the use of smartphone applications in improving quality control and reducing errors.

Analysis and Results:

Variable	F-Value	Sig-Value	Conclusion
Engineering Specialty	0.347	0.846	Fail to reject H0 (No significant effect)

- **Engineering Specialty:** The F-value of 0.347 and Sig-value of 0.846 (greater than 0.05) indicate that engineering specialization does not significantly affect the use of smartphone applications in improving quality control and reducing errors.

Conclusion: Based on the results, we fail to reject the null hypothesis (H0). Engineering specialization does not significantly affect the use of smartphone applications for quality control and error reduction.

Fifth Hypothesis:

H0: "There are no differences in the role of smartphone applications in managing risks and reducing accidents based on job role or project size."

To test this hypothesis, an Analysis of Variance (ANOVA) was conducted to determine whether job role or project size significantly influences the use of smartphone applications in managing risks and reducing accidents.

Analysis and Results:

Variable	F-Value	Sig-Value	Conclusion
Job Role	0.732	0.534	Fail to reject H0 (No significant effect)
Project Size	0.472	0.625	Fail to reject H0 (No significant effect)

- **Job Role:** The F-value of 0.732 and Sig-value of 0.534 (greater than 0.05) indicate that job role does not significantly influence the role of smartphone applications in managing risks and reducing accidents.
- **Project Size:** The F-value of 0.472 and Sig-value of 0.625 (greater than 0.05) also suggest that project size does not have a significant effect on the use of smartphone applications for risk management and accident reduction.

Additionally, the R Squared value of 0.020 suggests that only 2% of the variance in risk management and accident reduction can be explained by these variables.

Conclusion: Based on the results, we fail to reject the null hypothesis (H0). Neither job role nor project size have a significant impact on the role of smartphone applications in managing risks and reducing accidents.

Discussion

After presenting the statistical analysis results for each of the study questions, the following discussion will interpret these results in light of the previous literature to clarify how the findings align with prior studies and analyze the challenges

smartphone applications might face in construction projects. The results of the study indicate that smartphone applications play a pivotal role in improving various aspects of construction projects, particularly in facilitating communication between teams. This finding is consistent with many previous studies that emphasize the importance of these applications in enhancing the flow of information and facilitating collaboration among different project parties. For example, studies by Abdel Latif (2019) and Ghanem et al. (2015) highlighted the effective role of these applications in accelerating communication and reducing reliance on paper documents, which contributes to faster decision-making and reduces human errors. Similarly, the study by Johari et al. (2024) supports this idea, demonstrating the significance of digital applications in speeding up the flow of information between teams and facilitating effective collaboration.

Despite the clear impact on improving communication, the results showed that the role of smartphone applications in managing resources and reducing time and money waste was less pronounced in some cases. This aligns with the study by Hassan et al. (2019), which emphasized that smart applications contribute to improving resource allocation efficiency but may face challenges when complex or detailed analyses are required, limiting their impact on more complicated aspects of resource management. Regarding quality control and reducing errors, the study found that the impact of applications was limited in this area. This could be due to challenges associated with implementing these tools in complex work environments such as construction sites. Studies like Al-Azizi et al. (2017) and Hosamo and Hosamo (2022) showed that these applications may face resistance to adaptation from the teams working on construction sites, which negatively impacts their effectiveness in improving quality. Additionally, some applications may not provide full integration with more specialized systems like Digital Twins or BIM (Building Information Modeling), hindering the achievement of better results in quality control.

On the other hand, the study also found that smartphone applications do not have a significant impact on risk management and accident reduction in construction projects. This is consistent with the findings of Kim et al. (2017), which pointed out that risk management requires advanced tools and techniques like drones or specialized analytics that smartphone applications do not fully offer. Likewise, Naeem et al. (2023) examined the impact of digital tools in the real estate industry and confirmed the need for a suitable regulatory and technological environment to effectively adopt these tools in construction projects. Despite these challenges, the results of the study indicated that smartphone applications significantly contribute to speeding up decision-making. By enabling teams to access accurate real-time information, these applications facilitate immediate decisions based on updated data, enhancing process efficiency and reducing delays. This aligns with the findings of Venkatesh and Davis (2000), which confirmed that the ease of use of technology and its usefulness in speeding up processes are the main factors driving the effective adoption of new technologies like these applications.

Additionally, some challenges associated with adopting smartphone applications in construction projects were identified. The study by Al-Azizi et al. (2017) highlighted that resistance from teams to adapt to these technologies was one of the main barriers. Moreover, some applications may not meet the needs of large or complex projects, such as those requiring integration with more specialized systems. Studies like Haider et al. (2022) have shown these challenges in integrating digital tools like Digital Twins with smartphone applications. Regarding the competitive advantage of construction projects, the study results showed that smartphone applications help improve efficiency and reduce costs. By accelerating communication, enhancing resource management, and reducing errors, projects become more competitive in the market. These results align with the study by Tairov and Donchev (2022), which confirmed that digital transformation, including the use of smartphone applications, contributes to improving collaboration between different teams, thus increasing the competitiveness of projects.

Moreover, these results can be linked to network theory, where improving communication between teams enhances the flow of information and decision-making in a faster and more accurate manner, reflecting the importance of networks in promoting collaboration and knowledge sharing among individuals, as pointed out by Borgatti & Halgin (2011). As for areas like "risk management" and "quality control," the limited impact of these applications can be explained by the complexity of construction work environments, as noted by Miller & Page (2007), who emphasized the need for integrated

tools to address the complex interactions between systems in construction projects. In relation to the Technology Acceptance Model (TAM), the results showed that applications offering greater benefits and ease of use were more accepted by users. This supports the effective use of these applications to improve project processes and aligns with the findings of Venkatesh and Davis (2000), which highlighted that usefulness and ease of use are key factors in motivating technology adoption.

The role of smartphone applications can be further amplified when integrated with broader project management systems such as Building Information Modeling (BIM) and Geographic Information Systems (GIS). These integrations enable a seamless flow of information, providing real-time updates and enhancing coordination across teams. By using applications that are connected to centralized platforms, stakeholders can access and share project data instantly, improving decision-making, reducing errors, and ultimately contributing to the efficiency of construction projects. The integration with systems like BIM also offers a digital representation of the physical project, aiding in the visualization of progress and potential issues in real time, thus increasing the potential for timely interventions and smoother project execution.

Conclusion

This study has demonstrated that smartphone applications play a significant role in improving communication, enhancing resource management, and facilitating decision-making in construction projects in Jordan. Smartphone applications have the ability to provide real-time updates, streamline communication among teams, and reduce human errors. They have emerged as tools which are necessary for addressing the complexities of construction project management. The study findings align with global trends and reinforce the importance of integrating modern technologies into the construction sector to overcome challenges such as skill shortages, economic pressures, and increasing project complexities. The study found that smartphone applications are particularly effective in improving team communication and accelerating decision-making processes. These improvements contribute to better collaboration and coordination among project stakeholders, thereby enhancing overall project performance. Such benefits underscore the relevance of Network Theory, which highlights the critical role of information flow and connectivity in achieving organizational goals. The study also identified limitations in the applications' effectiveness in managing resources, reducing errors, and mitigating risks. These limitations suggest that while smartphone applications are valuable, they are not standalone solutions for addressing all aspects of construction project management. The adoption and impact of these applications depend on various factors, including project size, geographic location, and the technological infrastructure available on construction sites.

Recommendations

Based on the findings, several recommendations can be made to improve the use of smartphone applications in construction projects in Jordan:

1. **Increase Training and Awareness**: Providing training programs for engineers, contractors, and other project stakeholders to encourage more effective use of applications.
2. **Encourage Use in Small and Medium-Sized Projects**: It is important to activate the use of smartphone applications in small and medium-sized projects to increase efficiency and reduce costs.
3. **Enhance BIM and Digital Twin Technologies**: Adopt technologies like BIM and Digital Twins in large projects to facilitate team coordination and reduce errors.
4. **Improve IT Infrastructure**: Ensure strong internet and mobile device infrastructure at work sites to support the effective use of applications.
5. **Integrate These Applications with Other Systems**: It is recommended to integrate smartphone applications with advanced project management systems such as BIM and GIS. This integration would provide a unified platform that enhances real-time communication, better resource allocation, and more efficient management of construction projects. Companies should prioritize ensuring that their smartphone applications are compatible with existing project management tools to maximize the benefits of both.
6. **Conduct Future Studies**: Further research is needed to understand the impact of smartphone applications in the context of Jordanian construction projects to support more tailored decisions and policies.

Smartphone applications significantly contribute to improving communication and coordination between teams in construction projects. Adopting these technologies can enhance overall efficiency and reduce errors in various stages of the project. However, challenges related to teams' adaptation to these technologies and their use in complex work environments remain, which necessitates continued research to improve the integration of these tools in construction projects.

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