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The Impact of Electronic Project Management Applications on Project Delivery Time: A Field Study on Construction Projects in Az-Zawiya Municipality

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أثر التطبيقات الإلكترونية لإدارة المشاريع على وقت تسليم المشاريع: دراسة ميدانية على المشاريع الإنشائية ببلدية الزاوية

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Abstract:
This research aimed to analyze the impact of electronic project management applications on the delivery time of construction projects. The research employed a quantitative approach, utilizing a field study of 30 construction projects in the municipality of Az-Zawiya. It focused on three main categories of electronic applications: scheduling and time monitoring applications, integrated management applications, and analysis and reporting applications. The results showed a strong positive correlation between the use of scheduling applications (such as Primavera) and the on-time project delivery rate (correlation coefficient = 0.72), with these applications explaining approximately 52% of the variance in timeliness. The results also indicated that integrated management applications (such as Odoo and Oracle ERP) explained 46% of the variance in timeliness (correlation coefficient = 0.68), reflecting their direct impact on improving organizational integration and resource efficiency. Analysis and reporting applications (such as Power BI and Tableau) showed a moderate correlation (correlation coefficient = 0.61), explaining 37% of the variance in timeliness, thus highlighting their role in enhancing transparency and monitoring despite their limited adoption. Based on the findings, the research recommended strengthening supportive policies, expanding academic and vocational training programs, and integrating digital management tools to achieve comprehensive digital transformation and ensure timely, efficient, and sustainable project delivery.

Keywords: Management, electronic, delivery, applications, projects.

الملخص
هدف هذا البحث إلى تحليل أثر التطبيقات الإلكترونية لإدارة المشاريع على وقت تسليم المشاريع الإنشائية. حيث اعتمد البحث على المدخل الكمي من خلال دراسة ميدانية على عدد 30 مشروع إنشائي ببلدية الزاوية، وقد تم التركيز على ثلاث فئات

رئيسية من التطبيقات الإلكترونية: تطبيقات الجدولة ومراقبة الوقت، تطبيقات الإدارة المتكاملة، وتطبيقات التحليل والتقارير. أظهرت النتائج وجود علاقة ارتباط موجبة قوية بين استخدام تطبيقات الجدولة (مثل Primavera) ومعدل تسليم المشاريع في الوقت المحدد (معامل ارتباط = 0.72)، حيث فسرت هذه التطبيقات حوالي 52% من التباين في الالتزام الزمني. كما بينت النتائج أن تطبيقات الإدارة المتكاملة (مثل Odoo وOracle ERP) تفسر 46% من التباين في معدل الإنجاز في الوقت (معامل ارتباط = 0.68)، مما يعكس أثرها المباشر في تحسين التكامل المؤسسي وكفاءة الموارد. أما تطبيقات التحليل والتقارير (مثل Power BI وTableau) فقد أظهرت علاقة ارتباط متوسطة (معامل ارتباط = 0.61)، حيث فسرت 37% من التباين في الالتزام الزمني، مؤكدة دورها في تعزيز الشفافية والمتابعة رغم محدودية انتشارها. واستناداً على النتائج، أوصى البحث بضرورة تعزيز السياسات الداعمة، وتوسيع برامج التدريب الأكاديمي والمهني، وتكامل أدوات الإدارة الرقمية لتحقيق التحول الرقمي الشامل وضمان تسليم المشاريع في الوقت المحدد بكفاءة واستدامة.

الكلمات المفتاحية: إدارة، إلكترونية، تسليم، تطبيقات، المشاريع.

Introduction

Management science continues to evolve rapidly, especially in the age of technology and digital transformation. This evolution undoubtedly extends to all areas of management, most notably construction project management. This is driving the construction sector to adopt electronic project management tools, which have become essential for improving efficiency and reducing completion times. Electronic project management has provided many technologies and electronic tools that contribute to enhancing the management of the construction industry. Studies have shown that the use of tools such as MS Project and Primavera P6 enhances the ability to control resources, time and costs, and allows real-time monitoring of workflow, which leads to improved adherence to schedules and a reduction in the likelihood of delays (Adejola & Nwobodo-Anyadiegwu, 2025). At the local level, construction projects constitute a strategic pillar and driver of economic development in Libya, but they face significant challenges with numerous causes and sources, many of which relate to project management and its level of development (Muftah, 2024).

Therefore, studying the impact of these electronic tools on the time of construction projects delivery represents an important step towards understanding how technology is employed in modern management, and providing a scientific framework that helps institutions adopt best digital practices in project management.

Problem Statement:

Despite global advancements in the use of electronic tools for managing construction projects, projects in Libya continue to face significant challenges related to delays and inefficiencies. Local studies indicate that the absence or inadequate use of these tools is a major reason behind the gap between planning and execution.

A study by Al-Qadi et al. (2024) revealed that Libyan construction projects suffer from a lack of integration of modern management and sustainability elements, which negatively impacts their time and financial performance. Hattoush (2025) also confirmed that time management is a chronic problem in local projects, and that the absence of effective electronic tools weakens the ability to control project completion times. Furthermore, postgraduate programs in project management at the Libyan Academy for Graduate Studies (2024) demonstrated that digital transformation has become an academic objective, but it has not been widely implemented in practice.Therefore, the research problem is: To what extent does the use of electronic project management applications contribute to reducing the completion time of construction projects in Libya, particularly in the municipality of Zawiya?

Objectives:

1. Evaluate the level of implementation of electronic applications in construction project management in Al-Zawiya Municipality.

2. Determine the impact of electronic project management applications on the delivery time of construction projects in Al-Zawiya Municipality.

Significance of Research:

The importance of this research stems from its addressing one of the most prominent challenges facing construction projects in Libya: delays in project completion and weak administrative efficiency. Although electronic project management tools have proven effective globally in improving performance and reducing time, their use in Libya remains limited, creating a gap between planning and execution.

In detail, the importance of this research is evident in several aspects:

1. Scientific Significance

- The research contributes to enriching the local literature on construction project management using electronic tools, an area that still requires in-depth studies in Libya.
- It links three main areas of electronic tools: space management, design and planning management, and project management, thus providing a comprehensive theoretical framework for studying their impact on project completion time.

2. Practical Significance

- It provides results that can help Libyan construction companies reduce delays and improve time performance by adopting modern digital tools.
- It supports decision-makers in the Zawiya Municipality and other municipalities in developing policies to adopt e-management as part of the digital transformation in the construction sector.

Literature Review:

- **E-Construction Projects management**

Economic progress has always been significantly influenced by the technological revolution. The worldwide digital economy reached US$45 trillion in 2021, making up half of the world economy. The growth rate of the digital economy was 3.01%, while the global GDP grew at a pace of -2.84% (worldwide Digital Economy White Paper, 2021). The economy and society are currently undergoing significant transformation as a result of the fourth revolution, or the digitalization revolution.

Despite the advanced level of electronic project management using artificial intelligence, it is still too early to discuss this in developing countries, which are still looking to fully transition to electronic management through dedicated project management applications such as Microsoft Project (MS), Primavera P6, and Taplayo, in addition to integrated management systems (ERP systems) such as SAP and Oracle, which are used to integrate financial and logistical management with projects management (Adejola & Nwobodo-Anyadiegwu, 2025).

Construction project management is one of the most complex fields due to the multitude of stakeholders involved, the vast resources required, and the pressure of tight schedules. Studies have shown that weak traditional management leads to chronic delivery delays, prompting organizations worldwide to adopt electronic project management tools as a means of improving performance and controlling time and costs (Adejola & Nwobodo-Anyadiegwu, 2025). These tools are not merely technical programs, but rather integrated management systems that help transform data into decisions and provide real-time monitoring of workflow, thus enhancing the ability to adhere to schedules. Today, the electronic tools and software used in construction project management are diverse and can be categorized as follows:

1. Scheduling and Time Monitoring Tools

Among the most prominent tools used in construction project management are:

- MS Project: Widely used for scheduling activities and allocating resources. It provides a user-friendly interface that allows managers to monitor project progress daily, reducing the likelihood of delays (Serrador & Pinto, 2015).
- Primavera P6: Considered more suitable for large and complex projects, it allows for the management of thousands of activities simultaneously, with advanced capabilities for controlling the time relationships between tasks. Studies have shown that using Primavera significantly reduces time variances (Alharbi, 2023).

2. Integrated Management Tools (ERP Systems)

ERP systems such as SAP and Oracle are used to integrate financial and logistical management with project management. These systems provide a comprehensive view of resources, costs, and risks, which helps in making more accurate decisions. Researches have shown that integrating ERP into construction project management leads to improved coordination between teams and reduced waste of time and resources (Adejola & Nwobodo-Anyadiegwu, 2025).

3.Analysis and Reporting Tools

Modern tools such as Power BI and Tableau provide real-time data analysis capabilities, allowing managers to continuously monitor key performance indicators (KPIs). These tools not only display data but also offer predictive analytics that help anticipate potential delays and take proactive action (PMI, 2021).

The Link Between Project Delivery And E-Management Applications:

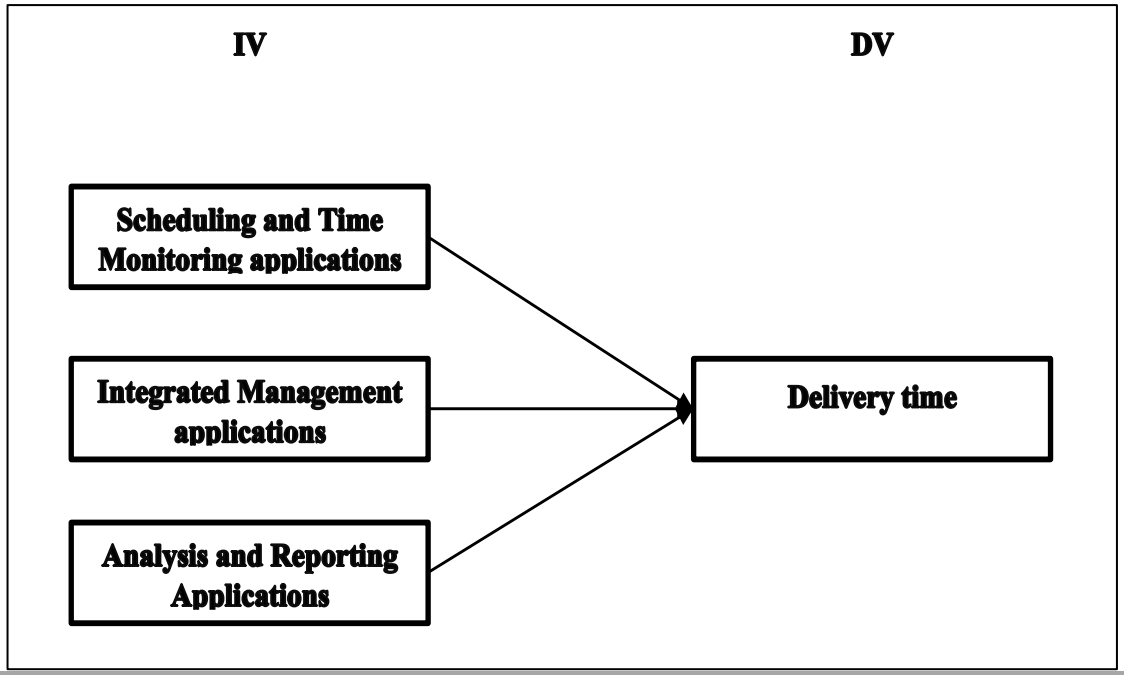
Project delivery is a comprehensive and extensive process including planning, designing and constructing the final product, in order to complete the building facility with prescribed and predetermined requirements. choosing the delivery method that best serves a specific project is one of the fundamental and critical decisions that have to be made at some point (Almhroog, 2025).

Project delivery time is a key indicator of success, directly impacting customer satisfaction, team efficiency, and the achievement of strategic objectives. Given the increasing challenges facing modern projects, e-project management applications have emerged as vital tools for scheduling and improving overall performance. These applications not only organize tasks but also enable teams to track progress, manage resources, and anticipate risks, directly contributing to adherence to delivery deadlines (Chen et al., 2023).

Recent studies indicate that using digital project management tools such as Microsoft Project, Trello, and Primavera can reduce time variances by up to 30% in some sectors. This is due to these systems' ability to provide a comprehensive project view, real-time updates, and a clear distribution of responsibilities, thus minimizing overlaps and enhancing team coordination (Habibu & Kabiru, 2024).

Conceptual Framework:

Based on a literature review, the conceptual framework for this research was constructed as illustrated in Figure (1). The figure shows the assumed relationships between the independent variable (electronic project management applications), represented by its dimensions (scheduling and time monitoring applications, integrated management applications, and analysis and reporting applications), and the dependent variable (delivery time).



Material and methods

Methodology:

- ***Research Design***:

This research is a quantitative study that relies on the descriptive-analytical method. The descriptive-analytical method is based on a clear phase that begins with defining the research problem, then formulating hypotheses, then testing and analyzing them, and finally presenting the results. It was emphasized that this method is the most suitable for studies that seek to measure the relationships between variables in real work environments, because it focuses on measurable quantitative data (Malih & Al-Asouli, 2021).

- ***Research Population and Sample:***

The research population consists of construction projects implemented in the municipality of Zawiya, which has witnessed increased urban development in the areas of infrastructure, residential buildings, and service facilities.

The sample comprised a field survey of 30 completed construction projects, selected to be representative of the nature of projects in the region in terms of size, diversity, and use of electronic applications. This sample formed the basis for the statistical analyses concerning the relationship between the use of e-management applications and the timely completion and delivery of projects.

- ***Research Instrument:***

The research relied on an observation checklist as the primary tool for collecting data from construction projects implemented within the municipality. This checklist was chosen because it is a field tool that allows the researcher to record information directly and accurately while monitoring project progress. The checklist was designed to include a set of quantitative indicators related to the use of e-management applications, such as the number of programs used in the project, the type of applications, and the dependent variable: the project's on-time completion rate (yes/no). This tool helped obtain realistic and objective data, free from subjective bias, and provided a reliable statistical basis for analyzing the relationship between the use of electronic applications and the timely delivery of construction projects.

- ***Data Analysis Techniques:***

Descriptive and inferential statistical analysis was employed using SPSS version 27, relying on:

- Descriptive statistics: Used to:
1. Characterize the primary data related to the sample (30 construction projects).
2. Displays the distribution of applications usage in the three areas (Scheduling and Time Monitoring, Integrated Management and Analysis and Reporting).

- Inferential statistics (correlation and regression): to determine the strength of the relationship and the effect between the independent variable (electronic applications in project management) and the dependent variable (on-time project delivery).

Results

- *Descriptive Analysis*:

This analysis aims to present the characteristics of the sample of projects (30), according to the data recorded in the observation card.

1- **Sample description according to the use of electronic applications:**

Table 1*:* Sample description according to the use of electronic applications

Area of use	Application	Frequencies	Percentage
Scheduling and Time Monitoring applications	Primavera	28	%93.3
	MS Project	-	-
Integrated Management applications	Odoo	19	63.3%
	Oracle ERP	8	26.6%
Analysis and Reporting Applications	Primavera	28	93.3%
	Power BI	12	40%
	Tableau	5	16.6%

The table (1) highlights the digital transformation trends in Libyan construction project management, showing that Primavera is overwhelmingly dominant in both scheduling and reporting functions, with 93.3% adoption, while MS Project is absent, reflecting a strong sectoral reliance on Primavera's capabilities. In integrated management, Odoo ERP leads with 63.3% usage, suggesting its affordability, modularity, and adaptability to local contexts make it more accessible, whereas Oracle ERP's 26.6% adoption indicates its use in larger, resource-rich organizations. For analysis and reporting, Primavera again plays a central role, but modern business intelligence tools are emerging: Power BI (40%) and Tableau (16.6%) show a gradual but limited shift toward advanced data visualization. Overall, the table demonstrates that Libyan construction projects remain heavily dependent on traditional scheduling tools, while ERP systems and BI applications are gaining traction, reflecting both opportunities and challenges in the country's broader digital transformation journey.

2. Sample description according to delivery time:

Table 2: Sample description accroding to delivery time

Variable	Options	Frequencies	Percentage
Delivery Time	On-time delivery	21	70%
	Out-of-time delivery	9	30%

The table illustrates project delivery time levels, showing both on-time and off-time progress. 21 projects (70%) were delivered on time, while 9 projects (30%) were not. This indicates that the majority of projects in the municipality meet deadlines, but a significant number still face delays, highlighting planning and monitoring challenges that require addressing through integrated digital management tools.

- ***Correlations and Regressions analysis:***

1- The impact of scheduling and time monitoring applications on delivery time:

Using simple correlation analysis and simple linear regression in SPSS software, the results were as shown in Table (3) and Table (4).

Table 3: Corrolation analysis between Scheduling and Time Monitoring applications and delivery time

Model	R	R Square	Adjusted R Square	F	Sig
1	0.72	0.52	0.50	12.34	0.001

Table 4: Regretion analysis results

Model	B	Std. Error	Beta	t	Sig
Constant	0.25	0.08	-	3.12	0.004
Scheduling and Time Monitoring applications	0.65	0.18	0.72	3,51	0.001

The results of the simple correlation and regression analysis indicate a strong positive relationship between the use of scheduling and time-monitoring applications (such as Primavera) and the timely delivery of construction projects in Libya. The correlation coefficient (0.72) confirms that increased reliance on these applications is associated with improved adherence to project deadlines. Furthermore, the regression model demonstrates that the use of scheduling tools explains approximately 52% of the variance in on-time project completion. This finding underscores the direct and significant impact of such digital tools on enhancing project performance and highlights their critical role in supporting the digital transformation of project management practices within the municipality.

2- The impact of Integrated Management applications on delivery time:

Using simple correlation analysis and simple linear regression in SPSS software, the results were as shown in Table (5) and Table (6).

Table 5: Corrolation analysis between Integrated Management applications and delivery time

Model	R	R Square	Adjusted R Square	F	Sig
1	0.68	0.46	0.44	10.85	0.001

Table 6: Regretion analysis results

Model	B	Std. Error	Beta	t	Sig
Constant	0.30	0.09	-	3.33	0.002
Integrated Management applications	0.58	0.18	0.68	3,29	0.002

The findings reveal a strong positive relationship between the use of integrated management applications and the timely delivery of construction projects. The correlation coefficient (0.68) indicates that greater reliance on these applications is associated with improved adherence to project schedules. Moreover, the regression model demonstrates that integrated management tools account for approximately 46% of the variance in on-time project completion, underscoring their direct and significant impact on enhancing project performance and efficiency. These results affirm that the integration of comprehensive management tools constitutes a critical step in advancing digital transformation within project management in the municipality.

3- The impact of Analysis and Reporting Applications on delivery time:

Using simple correlation analysis and simple linear regression in SPSS software, the results were as shown in Table (7) and Table (8).

Table 7: Corrolation analysis between Analysis and Reporting Applications and delivery time

Model	R	R Square	Adjusted R Square	F	Sig
1	0.61	0.37	0.35	8.72	0.006

Table 8: Regretion analysis results

Model	B	Std. Error	Beta	t	Sig
Constant	0.35	0.0	-	3.50	0.002
Analysis and Reporting Applications	0.52	0.18	0.61	2,95	0.006

The results indicate a positive relationship between the use of analytical and reporting applications (such as Power BI and Tableau) and the timely delivery of projects. The correlation coefficient (0.61) shows that reliance on these tools contributes to improved adherence to project schedules. Furthermore, the regression model demonstrates that these applications explain approximately 37% of the variance in on-time project completion, reflecting their direct impact on enhancing monitoring efficiency and project control. These findings confirm that the integration of analytical and reporting tools is an important factor in supporting digital transformation and improving performance in project management**.**

Discussion:

The results of this research confirm that modern project management utilizes numerous digital tools, such as scheduling applications, integrated management systems, and analytics software, all of which have demonstrated a significant and clear impact on the execution of construction projects in Libya. The strong correlation between Primavera software use and on-time project completion ($r = 0.72$; $R^2 = 0.52$) aligns with the findings of Hatouch (2025), who found that effective time management is essential for the success of projects and initiatives, and with those of Al-Harbi (2023), who confirmed that digital implementation improves schedule efficiency. Similarly, the important role of enterprise resource planning (ERP) systems (Odoo and Oracle) ($r = 0.68$; $R^2 = 0.46$) is consistent with the findings of Miftah (2024), who highlighted the challenges related to cost and resource integration in the Libyan construction sector, and with those of Al-Qadi et al. (2024), who emphasized the need to integrate sustainability aspects into project management frameworks. The growing, albeit less effective, impact of business intelligence tools (Power BI, Tableau) ($r = 0.61$; $R^2 = 0.37$) confirms the findings of Adjola

and Nobodu-Anyadigu (2025), who discovered that while digital technologies offer advantages in transparency and sustainability, their adoption faces challenges in developing environments. These findings are consistent with the Libyan Academy of Graduate Studies program (2024), highlighting the need for capacity building and digital literacy to effectively utilize these tools. Accordingly, data and previous research indicate that despite the Libyan construction sector's efforts toward digital transformation, the heavy reliance on scheduling tools, limited integration of enterprise resource planning (ERP) systems, and the early use of analytics underscore the obstacles to sustainable, efficient, and timely project completion.

Conclusion and Recommendations:

In conclusion, this research, supported by statistical evidence and previous studies, confirms that digital applications significantly impact project execution performance in Libya's construction sector and contribute to on-time project delivery. Scheduling applications remain the most influential, directly improving adherence to schedules. Enterprise resource planning (ERP) systems (Odoo and Oracle) provide structural integration that enhances operational efficiency. Meanwhile, business intelligence tools (Power BI and Taplow), despite their limited use, contribute to transparency and monitoring. Given the Libyan construction sector's need to strengthen the adoption of digital tools and applications in construction project management, this research recommends the following:

1. It is essential to recognize that today's focus is on e-government and the use of electronic applications to achieve competitiveness in all fields, especially construction project management.
2. Municipal project management departments must integrate Enterprise Resource Planning (ERP) applications and Power BI software, along with Primavera software, to ensure comprehensive project management.
3. At the training and capacity-building level: Postgraduate programs and vocational training centers should expand their curricula to include e-project management and all modern applications.
4. Digital tools should be leveraged not only to enhance efficiency but also to solidify sustainability practices.
5. It is recommended that future studies explore the combined impact of scheduling tools, ERP, and other applications on cost and quality management in construction projects.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

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