Key Factors Influencing Infrastructure Construction Project Completion in Egypt

العوامل الرئيسية المؤثرة في إتمام مشاريع البنية التحتية في مجال الإنشاءات في مصر

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Abstract

This research aims to explore the complex nature of infrastructure construction projects, particularly water treatment and pumping station projects in Egypt. It seeks to examine how various project performance factors influence the success of such projects.

Data collection is meticulously conducted through a questionnaire survey method, capturing stakeholders' perceptions on critical success factors, key performance indicators, and project performance metrics. A diverse sample of 385 respondents, including contractors, project managers, and project owners, is covered to give valuable insights into infrastructure project dynamics.

The findings reveal nuanced relationships between project performance factors and project success criteria. Site conditions,

project parties, and project features significantly influence project quality, while resource allocation emerges as a crucial determinant of project timeline adherence. Additionally, project parties play a pivotal role in cost management, and project features exert considerable influence on overall project costs.

This research underscores the importance of considering various project performance factors in infrastructure construction projects. It highlights the need for meticulous planning and effective resource allocation to ensure project success. By understanding the intricate interplay between these factors, stakeholders can enhance project outcomes and contribute to the sustainable development of infrastructure projects in Egypt.

Keywords: Infrastructure construction, Egypt, project performance factors, success criteria, stakeholders, project quality, project timeline, resource allocation, cost management, sustainable development.

الملخص :

يهدف البحث إلى استكشاف المشهد المعقد لمشاريع بناء البنية التحتية ، مع التركيز بشكل خاص على معالجة المياه ومشاريع محطة الضخ في مصر. كما يسعى إلى دراسة كيفية تأثير عوامل أداء المشروع المختلفة على نجاح مثل هذه المشاريع.

تم إجراء جمع البيانات بدقة من خلال طريقة مسح الاستبيان ، والتقاط تصورات أصحاب المصلحة حول عوامل النجاح ومؤشرات الأداء الرئيسية ومقاييس أداء المشروع. تمت تغطية عينة متنوعة من ٣٨٥ مشاركًا، بما في ذلك مقاولون ومديرو مشاريع وملاك مشاريع، لإعطاء رؤى قيمة حول ديناميكيات مشاريع البنية التحتية

تكشف نتائج البحث عن علاقات دقيقة بين عوامل أداء المشروع وبين معايير نجاحه ، وأن الظروف الموقعية ، والأطراف المشاركة بالمشروع ، والخصائص المتوفرة بالمشروع تؤثر بشكل كبير على مستوى جودة المشروع ، في حين يظهر أن تخصيص الموارد يبرز كمحدد حاسم للالتزام بالجدول الزمني للمشروع وإستكماله في الموعد المحدد. بالإضافة إلى ذلك ، تلعب الأطراف المشاركة بالمشروع دورًا محوريًا في إدارة التكاليف ، وتمارس الخصائص المتوفرة بالمشروع تأثيرًا كبيرًا على قيمة تكاليف المشروع الإجمالية.

الخاتمة: يؤكد البحث على أهمية النظر في عوامل أداء المشروع المختلفة في مشاريع بناء البنية التحتية. ويسلط الضوء على الحاجة إلى التخطيط الدقيق وتخصيص الموارد الفعالة لضمان نجاح المشروع من خلال فهم التفاعل المعقد بين هذه العوامل ، كما يمكن لأصحاب المصلحة تعزيز نتائج المشروع والمساهمة في التنمية المستدامة لمشاريع البنية التحتية في مصر.

الكلمات الرئيسية: *إنشاءات البنية التحتية ، مصر ، عوامل أداء المشروع ، معايير النجاح ، أصحاب المصلحة ، جودة المشروع ، الجدول الزمني للمشروع ، تخصيص الموارد ، إدارة التكاليف ، التنمية المستدامة.*

1) Introduction

1.1 Background

The construction business is vital to economic growth because it creates the infrastructure for other industries to flourish. This includes factories, warehouses, and transportation networks. Time, money, and quality are the three most prevalent measures of a project's success according to the triple constraint paradigm. The three measure are interrelated to each other, so that any two of them are sensitive to changes in the third. For instance, if the project's scope expands without commensurate increases in time and money, the result will be subpar work (Rohaniyati Salleh, 2009).

Therefore, the delay could negatively impact the project duration, cost, and quality. The main causes of delay could be summarized as follows: technical issues, natural conditions, and problems related to the owner, contractor, or subcontractor (Kumar & Raj, 2015). The causes of delay must be well understood and analysed to take the necessary actions that prevent their occurrences in the first place (Kumar & Raj, 2015). So, this research aims to identify the primary sources of project delay in the construction sector and the remedial measures for delays. To narrow the search field to obtain accurate results, the search field will be limited to the infrastructure construction field, specifically in water treatment plants and pumping stations to reach the best project management strategies that effectively mitigate the effect of the construction project delay factors.

1.2 Research Objectives

This research has thee main objectives as follow:

- To explore the various factors that contribute to the successful completion of construction projects.
- To analyse the impact of these factors on project outcomes.
- To provide recommendations for project managers to enhance the likelihood of project success

2) Literature Review

This research explores the factors influencing the success of infrastructure construction projects from some or related precious researches as follow

Munyoki (2014) identified factors influencing the completion of construction projects in Nairobi. The research objectives included examining the influence of contract duration, project financing, planning, supervision/inspection of work, and the type of project delivery method on project completion. The research design was descriptive and explorative or correlative, seeking to establish relationships between various aspects of the identified problem. The findings of the study indicated that project cost increased by an average of 13.5%, while project duration increased by 33.6%. Respondents overwhelmingly believed that project financing and inspection/supervision significantly influenced project completion (98%).

Lamprou & Vagiona (2018) aimed to systematically compiled and identified project success criteria and critical success factors present in the literature, specifically focusing on academic journals. The most frequently encountered success criteria include time-schedule adherence, cost-budget management, user satisfaction, quality-performance standards, business and commercial performance, technical specifications, stakeholder satisfaction, achievement of strategic goals/objectives, competitiveness, functionality, project team satisfaction, and safety. Additionally, some researchers mention contractor satisfaction, future perspective, and environmental impact, while a minority highlight factors like effectiveness and suppliers' satisfaction as influencers of project success.

Yousuf & Mberesia (2018) investigated and documented successful strategies employed by project managers in construction projects, focusing on 21 schools out of the target population of 27 in Dagoretti South Sub-County (Nairobi – Kenya). The research utilized a mixed design approach, incorporating both qualitative and quantitative components. Data were collected from head teachers and teachers in charge, and a follow-up interview was planned with the Board of Management (BOM) at the school management level. The study found that several factors, namely project communication, project funding, project technical expertise, and project monitoring and

evaluation, had an impact on construction project completion in primary schools.

Ramiah et al. (2017) conducted a study examining the significance of project management knowledge assets throughout various stages of success in construction projects. Employing a quantitative research approach, they collected primary data from 370 construction firms and utilized the Structural Equation Modeling-Partial Least Squares (SEM-PLS) analytical technique for analysis. The findings indicated that for effective management of construction projects, construction firms must possess strategic knowledge assets. The study identified that relevant project management assets play a crucial role in enhancing success at each stage of a construction project. Successful construction companies are those capable of recognizing the importance of capturing project management knowledge as a means to gain competitive advantage.

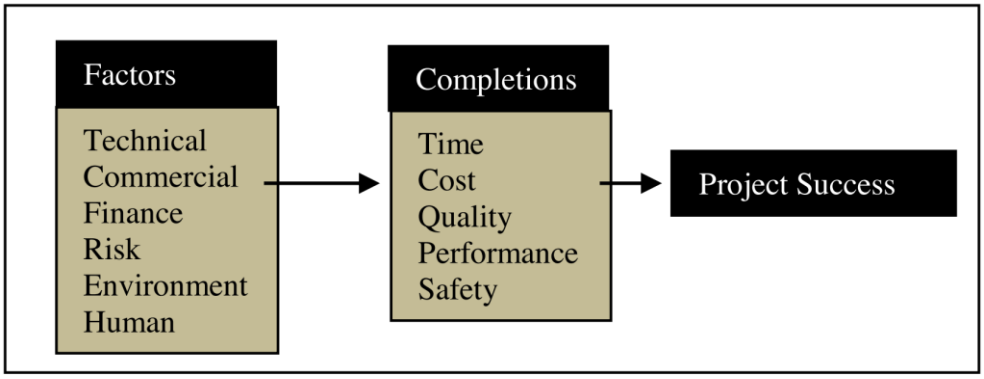
Amiril et al. (2014) endeavor to achieve two main objectives: firstly, to review sustainability factors and performance in transportation infrastructure projects, and secondly, to propose a relationship framework between sustainability factors and performance specifically tailored for Malaysia's railway infrastructure projects. Their literature review revealed that sustainability factors and performance in transportation infrastructure projects can be categorized into several key areas:

environment, economic, social, engineering/resource utilization, and project management.

Bisbey et al. (2020) shed light on the importance of focusing on public expenditure efficiency in infrastructure services delivery, particularly in the context of the large infrastructure needs in Asia and the Pacific. They argue that merely embarking on new constructions may not be the optimal solution, especially when governments face capital constraints. The authors highlight the global issue of delays and cost overruns in infrastructure projects, which result in the inefficient utilization of public resources. They identify key root causes including lack of transparency in project selection, insufficient project preparation, siloed approaches by public entities in assessing feasibility studies, and limited public sector capacity to develop a bankable pipeline of projects. To address these challenges, Bisbey et al. (2020) propose a "whole life cycle" (WLC) approach as a strategic solution. They define WLC to encompass the entire lifespan of an infrastructure asset, from need identification to disposal. This approach involves four phases: planning, preparation, procurement, and implementation. Throughout these phases, governments can enhance public service efficiency and improve access to finance by implementing various solutions.

Masrom et al. (2015) aimed to investigate potential success criteria for evaluating the overall performance of large

infrastructure implementation, particularly in developing countries. They utilized previous studies on successful criteria to develop a conceptual framework suitable for measuring the performance of large infrastructure projects. The findings of their research revealed that successful criteria for infrastructure project implementation could be categorized into several key elements that can be grouped into two categories namely the macro and micro viewpoints as show in the following figure



Anastasiu et al. (2023) conducted a study to evaluate the practical implications of employing **Critical Chain Project Management (CCPM)** in reducing the duration of a construction project. The research focused on utilizing **Critical Path Method (CPM)** for the planning phase and CCPM for the execution phase, specifically for finishing works such as drywalls, carpentry, and painting, across three identical blocks of flats. The outcome revealed a significant time savings of 36 days, equivalent to approximately 20%, with the project being completed in 151 days using CCPM

compared to the initially planned 187 days using CPM. The study emphasizes the importance of establishing ongoing collaboration between researchers and industry practitioners to ensure the effective implementation of research findings in real-world construction scenarios.

From other side, the critical success factors have been sorted out in line with project phases of project management, Financial aspects, and Timelines

Project Management: Various studies have confirmed that there is a wide range of characteristics and determinants of projects, especially construction projects. The first of these characteristics is project management, which carries a very important role. In the realm of Project Management theories within construction projects, various roles are defined, encompassing Building Owners, Design and Technology Managers, Planning Managers, Technical Assistants, Contractors, Project Managers, Supply Managers, Site Managers, and numerous subcontractors specializing in various services such as Mechanical, Fire, Transportation, and Electrical services. However, these roles can be consolidated into three main categories, allowing each actor to take on multiple roles as required (Shah et al., 2023).

1. **The Owner:** Whether public or private, the owner initiates the project by securing financing, overseeing the design, and managing the construction. Public owners, ranging from

federal to local entities, follow specific statutes and administrative directives for project execution. Private owners, which include individuals or corporations, may use the constructed facility for their own purposes or intend to lease or sell it (Shah et al., 2023).

2. **The Architect-Engineer (Design Professional):** Responsible for designing the project, the architect-engineer, or design professional, can be part of the owner's in-house team or an independent design firm contracted by the owner. In turnkey projects, where a single entity handles both design and construction, the architect-engineer may be a branch of the construction contractor (Shah et al., 2023).
3. **The General Contractor:** In a prime contract with the owner, the general contractor is tasked with constructing the entire project or a designated portion. Under a single-contract system, the contractor coordinates all aspects of construction and is accountable for subcontractors and other third parties. Alternatively, separate contracts may involve multiple independent contractors, each responsible for specific portions of the work.

Financial Aspects: The financial aspect of infrastructure construction projects plays a pivotal role in their success and sustainability. Project financing is a complex process that involves securing funding from various sources, including equity investors and lenders. Investors, known as Project Financing

Investors, contribute equity with the expectation of returns, shaping the financial structure of the project (Steffen, 2018). These financial arrangements are crucial in determining the feasibility and economic viability of the project.

Financial planning, including feasibility studies, is conducted during the project initiation phase. These studies assess various economic factors, market conditions, and potential risks to inform decision-making and attract financing (Winch, 2010). Rigorous financial planning contributes to the project's overall success and aligns with the interests of Project Financing Investors seeking favorable returns on their investment.

Timelines: The Theory of Constraints emphasizes the need for a holistic consideration of all limiting factors within a system. In the context of project management, key performance indicators (KPIs) are significantly influenced by the constraints of scope, time, and budget (Mellado et al, 2020). If any of these constraints deviate from the plan, it can lead to imbalances affecting the other elements of the project. Efficient management of constraints, particularly in the early stages, is essential for project success. Human resources play a central role in addressing these constraints, as they are responsible for delivering the project's products or services (Irfan et al, 2019).

Implementing CCPM in construction projects can result in significant time savings, estimated at 20–35%, according to statistics. The project manager monitors progress and can allocate additional

time from the project's buffer if needed. However, resistance to change in the construction industry has limited the adoption of innovative methods (Shah et al., 2023). The paper proposes applying CCPM to improve project timelines, comparing it with the traditional Critical Path Method (CPM) in the execution of residential blocks. The results suggest approximately 20-time savings with CCPM, emphasizing the potential benefits of modern approaches in construction project management.

In addressing the critical need for infrastructure improvement in Egypt, various resources, and strategic priorities have been identified to enhance the quality of life, increase access to basic services, create employment opportunities, and stimulate economic growth. As of 2015, Egypt was ranked 118 out of 148 countries in terms of infrastructure by the World Bank (Mohamed Bahgat Moussa, 2018).

A) Government Allocation:

The Government of Egypt, recognizing the importance of infrastructure, plans to allocate EGP 135.4 billion of the General State Budget for the fiscal year 2017/2018 for infrastructure investments (Mohamed Bahgat Moussa, 2018).

b) World Bank's Strategic Priorities:

Energy & Power:

Diversification of energy sources through sustainable renewable technologies. Expansion of energy infrastructure to reduce power outages and support industrial development.

c) Healthcare:

Targeting the lowest 40% of the population for proper healthcare coverage with a focus on service quality.

d) Irrigation and Agriculture:

Addressing food security concerns, improving income, and enhancing the quality of life in Egyptian villages (Mohamed Bahgat Moussa, 2018).

e) Wastewater and Sanitation:

Encouraging decentralization and enhancing the capacity of implementing agencies. Vital improvements in wastewater management to tackle water pollution issues (Mohamed Bahgat Moussa, 2018).

f) Development Partners and Financing:

The Egyptian government collaborates with various development partners to secure funds for infrastructure development. According to the Central Bank of Egypt, 25.5% of Egypt's external debt is owed to multilateral international entities, with significant contributions from the World Bank, African Development Bank group, and the European Investment Bank (Mohamed Bahgat Moussa, 2018).

3) Research Model & Hypothesis

Based on the collected and selected factors that are influencing the project success (Independent Variables X's) as well as the success criteria of success factor (Dependent variables

Y's) as collected in the following table, which has been used also for data survey questionnaire and research model:

Factors effect levels on project performance																				
Independent Variable X's			Dependent Variable Y's																	
Criteria	Sub-criteria	Attributes - Factors	Quality					Cost					Time				
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Site conditions	Environmental	Earthquake															
		Precipitation /flood															
		Unpredicted Weather conditions															
		Pollution															
	Site location	Construction area (rural/urban)															
		Access conditions															
		On-site congestion															
		Delay in permits and licenses															
		Security requirements															
		Safety regulation															
		Differing site conditions															
Resources	Labor	Labor skills level															
		Labor availability															
		Drop in Labor productivity															
		Labor accidents															
		Human resource planning															
		Working hours restrictions															
	Equipment	Equipment quality															
		Equipment breakdown															
		Equipment maintenance															
		Equipment malfunctions															

	Material	Material delivery															
		Material storage															
		Material theft & damage															
		Material procurement															
		Non-conforming material															
		Material monopoly															
		Nominated vendors															
Project parties	Owner	Owner type															
		management strategy															
		organization structure															
		Work/labour permits															
		on-site access															
	Engineering and Design	Team experience															
		Project goal															
		Complexity of design															
		Ad-hoc consultants															
		Design error															
	Contractor	Contractor pre-qualified															
		New technology															
		Defective work															
		Rework															
		no of subcontractors															
		Contractor Reputation															
		Nominated sub-contractors															
		no. of current projects															
Project features	Project management	Management experience															
		Owner quality assurance															
		Scope definition															
		quality control process															
		Type of contract															
		availability of variations															

	Financial	Type of Funds															
		Fluctuation in prices															
		Invoices delay															
		Change in currency rate															
		Owner financial capacity															
		Progress payment															
		rate of interest															
		tax rate															
		foreign currency															
		project size															
	Political	Bribery and Corruption															
		Wars and revolutions															
		Changes in laws and regulations															
	Schedule	Fast track schedule															
		Project duration															

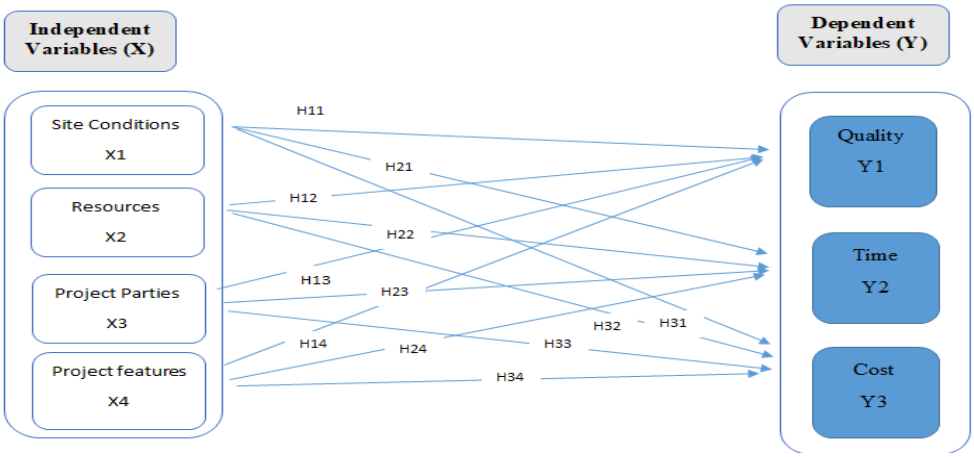


Figure 3: Research Model

Quality of Infrastructure Construction Projects

H11: The Site conditions have a significant effect on the quality of the infrastructure construction projects.

H12: Resources do not have a significant effect on the quality of the infrastructure construction projects.

H13: Project parties have a significant effect on the quality of the infrastructure construction projects.

H14: Project features have a significant effect on the quality of the infrastructure construction projects.

Time of Infrastructure Construction Projects:

H21: The Site conditions do not have a significant effect on the time of the infrastructure construction projects.

H22: Resources have a significant effect on the time of the infrastructure construction projects.

H23: Project parties have a significant effect on the time of the infrastructure construction projects.
H24: Project features have a significant effect on the time of the infrastructure construction projects.

Cost of Infrastructure Construction Projects:
H31: The Site conditions do not have a significant effect on the cost of the infrastructure construction projects.
H32: Resources do not have a significant effect on the cost of the infrastructure construction projects.
H33: Project parties have a significant effect on the cost of the infrastructure construction projects.
H34: Project features have a significant effect on the cost of the infrastructure construction projects.

4) Case Study: Analyzing Success Factors in Major Construction Projects

4.1Selection the case study

The case study focuses on a major construction project undertaken by a well-established company known for its successful completion of complex projects. The project selected for this study is the construction of a large commercial complex, which was completed on time and within budget, receiving high praise from all stakeholder. To achieve the study objective, the study population includes the following categories Contractor, Project Manager, and Project owner. The study population for this research would consist

of stakeholders involved in public-sector construction projects in Egypt. These stakeholders include:

1. Project Managers: Project managers play a crucial role in overseeing and coordinating construction projects.
2. Contractors and Subcontractors: Contractors and subcontractors are involved in the actual execution of construction projects.
3. Project Owners/Clients: Project owners or clients are the entities or individuals who initiate and fund construction projects. Their perspectives on project success factors, expectations, and satisfaction levels are essential in assessing the overall success of projects.

4.2 **Research Method**

The research methodology involves employing a questionnaire survey to gather primary data from stakeholders involved in public-sector construction projects in Egypt, supplemented by secondary data from official documents. The study population consists of contractors, project managers, and project owners, with a sample size of 385 respondents. Data analysis includes various statistical tests such as Cronbach's Alpha. The validity and reliability of the questionnaire are assessed, ensuring consistent and accurate measurement of constructs. Ethical considerations prioritize informed consent, privacy, confidentiality, and data protection, with adherence to

ethical principles and legal requirements. Overall, the research aims to comprehensively understand the impact of Project Performance Factors on the success of construction infrastructure projects in Egypt, employing robust methodologies while upholding ethical standards.

4.3Project outcomes

4.3.1 Testing Research Hypotheses

The association between the Project performance Factors and success of construction infrastructure

Table 1 checks the hypothesis that "There is no significant association between Project performance factors and success of construction infrastructure"

Table (1) Matrix correlation coefficients between the basic Variables (X & Y)

	Statistics	Project Performance Factors (X)	the success of construction infrastructure (Y)
Project Performance Factors (X)	Correlation coefficient (Spearman)	1	.401**
	Significance level	1	0.000
Success of construction infrastructure (Y)	Correlation coefficient (Spearman)	.401**	1
	Significance level	0.000	1

Table (1) illustrates the strong positive correlation between the basic variables (X, Y) (Project performance Factors and success of construction infrastructure), as the correlation coefficient is (.401**) according to the correlation of Person, and at a significance level of (0.000). It is also noted that there is an assurance related to the validity of the statements that can be used to measure the study variables, therefore the basic variables (X, Y) are correlated.

Table (2) Correlation matrix values between sub-variables of the study

	The quality(Y1)	The time (Y2)	The cost(Y3)
Site conditions (X1)	.174**	.585**	.529**
Sig. (2-tailed)	0.007	0.000	0.000
Resources (X2)	-0.070	.456**	.530**
Sig. (2-tailed)	0.281	0.000	0.000
Project parties (X3)	0.043	.501**	.437**
Sig. (2-tailed)	0.510	0.000	0.000
Project features (X4)	.215**	.173**	.305**
Sig. (2-tailed)	0.001	0.007	0.000

Table (2) indicates the correlation coefficient with the two stars (**) can express the strong relationship at a 1% significance level, Such as a lot of variables for example:

- **The quality with** Site conditions (.174**), which represents a positive correlation between the two variables. In the same context, the quality has a positive significant correlation with Project features with a correlation coefficient (.215**). **The time with** all independent variables Site conditions, Resources, Project parties, and Project features, with positive significant correlation coefficient .585**, .456**, .501**, .173**, .458**, and .431**, respectively. **The cost** with all independent variables Site conditions, Resources, Project parties, and Project features, with positive significant correlation coefficient .529**, .530**, .437**, .479**, .551**, respectively. It is noted from previous correlation results that the second hypothesis "There is no significant relationship between Project performance Factors on and success of construction infrastructure" can be rejected and accept alternative hypothesis that there is a significant relationship between Project performance Factors and success of construction infrastructure.

- **Impact of Project Performance Factors and Success of construction infrastructure (quality)**

"There is no significant impact of Project performance Factors on the success of construction infrastructure (quality)". The table (3) illustrates the results of multiple regression analysis as follows:

Table (3) The results of multiple regression test related to the most important variables affecting the success of construction infrastructure (quality)

Symbol	Variables	Unstandardized coefficients		Standardized Coefficients	T	P-value	TOL	VIF
		B	Std. Error					
X1	Site conditions	0.130	0.037	0.171	3.542	0.000	0.76	1.32
X2	Resources	0.076	0.055	0.075	1.379	0.169	0.43	2.33
X3	Project parties	0.173	0.059	0.171	2.955	0.003	0.51	1.98
X4	Project features	0.294	0.056	0.284	5.258	0.000	0.52	1.93
Constant				1.460				
Correlation coefficient (R)				.544				
Determination Coefficient (R2)				0.296				
Adjusted determination coefficient (Adj.R2)				0.289				
F-test				40.006				
P-value				.000				

Table (3) explains the significance of the model in testing the most important variables affecting the dependent variable (Y), as (F-test) is (**40.006**) and (P-value) is (**<.001**[b]), which shows that the model is valid for predicting the value of (Y) and the results have a statistical significance as the significance level

is (0.000) less than (5%), which helps us in making the decision. Moreover, the variance inflation factor (VIF) for each variable is less than (10), and tolerance (T) is greater than (0.1) for each variable, meaning that there is no multi-collinearity among the explanatory variables so the researcher can rely on the results of this model. There is a high correlation (**.370**[a]) between the independent variables in the previous table and the dependent variable (Y: the success of construction infrastructure), and the determination coefficient (R2) reveals that the explanatory variables contribute to explain **0.296** % of the variation in (Y) dependent variable. The results show that the variables (Site conditions, Project parties, Project features) have a positive impact on the dependent variable (Y: success of construction infrastructure (quality) at a 5% significance level.

We can use the following equation to illustrate the main result obviously:

Y1= 31.460+0.130X1+ 0.076X2+0.173X3+0.294X4

Therefore, we can refuse conclude that:

The hypothesis H_{11} is approved that The Site conditions have a significant effect on the quality of the infrastructure construction projects.

Hypothesis H_{12} is approved that Resources do not have a significant effect on the quality of the infrastructure construction projects.

The hypothesis H_{13} is approved that Project parties have a significant effect on the quality of the infrastructure construction projects.

Hypothesis H_{14} is approved that Project features have a significant effect on the quality of the infrastructure construction projects.

Impact of Project Performance Factors and Success of construction infrastructure (time)

"There is no significant impact of Project performance Factors on the success of construction infrastructure (time)". The table (5/22) illustrates the results of multiple regression analysis as follows:

Table (4) The results of multiple regression test related to the most important variables affecting the success of construction infrastructure (time)

Symbol	Variables	Unstandardized coefficients		Standardized Coefficients	T	P-value	TOL	VIF
		B	Std. Error					
X1	Site conditions	0.026	0.044	0.030	0.597	0.551	0.76	1.32
X2	Resources	0.161	0.066	0.139	2.444	0.015	0.43	2.33
X3	Project parties	0.229	0.070	0.199	3.273	0.001	0.51	1.98
X4	Project features	0.241	0.067	0.206	3.613	0.000	0.52	1.93
Constant					1.490			
Correlation coefficient (R)					.467			
Determination Coefficient (R2)					0.218			
Adjusted determination coefficient (Adj.R2)					0.210			
F-test					26.554			
P-value					.000			

Table (4) explains the significance of the model in testing the most important variables affecting the dependent variable (Y), as (F-test) is (**26.554**) and (P-value) is (**<.001**[b]), which shows that the model is valid for predicting the value of (Y) and the results have a statistical significance as the significance level is (0.000) less than (5%), which helps us in making the decision. Moreover, the variance inflation factor (VIF) for each variable is less than (10), and tolerance (T) is greater than (0.1) for each variable, meaning that there is no multi-collinearity among the explanatory variables so the researcher can rely on the results of this model. There is a high correlation (**.467**) between the independent variables in the previous table and the dependent variable (Y: the success of construction infrastructure (time), and the determination coefficient (R2) reveals that the explanatory variables are contributing to explain **0.22** % of the variation in (Y) dependent variable. The results show that the variables (Resources, Project parties, Project features) have a positive impact on the dependent variable (Y: success of construction infrastructure (time) at a 5% significance level.

We can use the following equation to illustrate the main result obviously:

$$Y2= 1.490+0.026X1+ 0.161X2+0.229X3+0.241X4$$

Therefore, we can refuse to conclude that:

Hypothesis H_{21} is approved that The Site conditions do not have a significant effect on the time of the infrastructure construction projects.
Hypothesis H_{22} is approved that Resources have a significant effect on the time of the infrastructure construction projects.
Hypothesis H_{23} is approved that Project parties have a significant effect on the time of the infrastructure construction projects.
Hypothesis H_{24} is approved that Project features have a significant effect on the time of the infrastructure construction projects.

Impact of Project Performance Factors and Success of construction infrastructure (cost)

"There is no significant impact of Project performance Factors on the success of construction infrastructure (cost)". The table (5) illustrates the results of multiple regression analysis as follows:

Table (5) The results of multiple regression test related to the most important variables affecting the success of construction infrastructure (cost)

Symbol	Variables	Unstandardized coefficients		Standardized Coefficients	T	P-value	TOL	VIF
		B	Std. Error					
X1	Site conditions	0.053	0.043	0.063	1.235	0.218	0.76	1.32
X2	Resources	0.084	0.064	0.075	1.307	0.192	0.43	2.33
X3	Project parties	0.211	0.068	0.191	3.093	0.002	0.51	1.98
X4	Project features	0.253	0.065	0.224	3.888	0.000	0.52	1.93
Constant				1.793				
Correlation coefficient (R)				.446a				
Determination Coefficient (R2)				0.199				
Adjusted determination coefficient (Adj.R2)				0.190				
F-test				23.564				
P-value				.000b				

Table (5) explains the significance of the model in testing the most important variables affecting the dependent variable (Y), as (F-test) is (**23.564**) and (P-value) is (**<.001[b]**), which shows that the model is valid for predicting the value of (Y) and the results have a statistical significance as the significance level is (0.000) less than (5%), which helps us in making the decision. Moreover, the variance inflation factor (VIF) for each variable is less than (10), and tolerance (T) is greater than (0.1) for each variable, meaning that there is no multi-collinearity among the explanatory variables so the researcher can rely on the results of this model. There is a high correlation (**.446**) between the independent variables in the previous table and the dependent

variable (Y: the success of construction infrastructure (cost), and the determination coefficient (R2) reveals that the explanatory variables are contributing to explain **0.199** % of the variation in (Y) dependent variable.

The results show that the variables (Project parties, Project features) have a positive impact on the dependent variable (Y: success of construction infrastructure (cost) at a 5% significance level.

We can use the following equation to illustrate the main result obviously:

$$Y3= 1.793+0.053X1+ 0.048X2+0.048X3+0.211X4$$

Therefore, we can refuse to conclude that:

Hypothesis H_{31} is approved that The Site conditions do not have a significant effect on the time of the infrastructure construction projects.

Hypothesis H_{32} is approved that Resources do not have a significant effect on the cost of the infrastructure construction projects.

Hypothesis H_{33} is approved that Project parties have a significant effect on the cost of the infrastructure construction projects.

The hypothesis H_{34} is approved that Project features have a significant effect on the cost of the infrastructure construction projects.

5) Discussion Findings

The research findings challenge the hypothesis of no significant association between project performance factors and the success of construction infrastructure. A strong positive correlation (0.401**) indicates that factors like quality, time, and cost significantly impact project success. The correlation analysis further elucidates relationships between these factors, highlighting the importance of site conditions, resources, and project features in determining project outcomes. The study's emphasis on interdisciplinary collaboration aligns with previous research, emphasizing the role of diverse stakeholders in achieving project success. Additionally, the multiple regression analysis validates the model's ability to predict project success, with coefficients indicating the positive impact of resources, project parties, and project features on success metrics such as quality, time, and cost. However, adverse site conditions were found to significantly impact project timelines, underscoring the need for proactive risk management and planning. The discussion on project success nuances, considering factors beyond traditional metrics like time and cost, echoes the evolving understanding of project management success. In the context of Egypt's construction industry, efficient project management is crucial for driving economic growth, as outlined in Vision 2030. Despite challenges, the sector benefits from factors like low-cost labor and supportive ecosystems, emphasizing the importance of timely project delivery. Overall, the research contributes to understanding the multifaceted dynamics of

construction project success, informing evidence-based decision-making and enhancing project outcomes in Egypt's infrastructure development.

6) Implications for Project Managers:

1. Prioritize project performance factors like quality, time, and cost to ensure successful water treatment and pumping station projects.
2. Foster effective collaboration among stakeholders to align project objectives with local needs and ensure regulatory compliance.
3. Optimize resource allocation strategies to minimize wastage and maximize productivity, leveraging innovative technologies and sustainable practices.
4. Conduct comprehensive risk assessments and implement proactive mitigation strategies to minimize disruptions.
5. Embrace best practices and innovative technologies to enhance project efficiency, quality, and sustainability

7) Limitations:

1. Study's focus on the Egyptian context may limit generalizability.
2. Limited data availability may have constrained depth of analysis.
3. Short-term timeframe may not capture long-term project effects and dynamics.

4. Methodological biases or sampling constraints could affect results.
5. External factors like government policies and economic conditions were not fully explored.

8) Future Research Directions:

1. Comparative studies across regions to understand variations in project outcomes.
2. Future studies to track long-term project effects and sustainability.
3. Incorporation of qualitative research methods to explore stakeholders' perspectives.
4. Development of comprehensive risk assessment frameworks.
5. Analysis of government policies' effectiveness in promoting infrastructure development.
6. Investigation of emerging technologies' impact on project efficiency and sustainability.

9) Conclusion:

This research emphasizes the importance of considering multiple factors in evaluating project success, offering insights to inform decision-making and enhance outcomes in construction infrastructure projects, particularly in water treatment and pumping station construction in Egypt. By addressing limitations and exploring future research directions, stakeholders can contribute to sustainable infrastructure development.

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