



Digital Transformation in Capital Construction Projects

A Case Study in the Digital Transformation of Saudi Arabia,
Eastern Region

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التحول الرقمي في إدارة مشاريع البناء الحديثة

دراسة حالة التحول الرقمي في المملكة العربية السعودية المنطقة الشرقية

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1. Research Background:

1.1• Acknowledgement:

I Would Like to express my Heartfelt Gratitude to my Family for their Unwavering Support, Love and Encouragement Throughout this Project. Their Understanding, Patience, and Belief in me have been the Cornerstone of my Success.

Thank you for Being my Constant Source of Inspiration and Motivation.

I also Want to Thanks my Advisor, **Mr. Nasser Al-Muhaimid**, for Providing this Opportunity to Complete my University Studies.

1.2• Dedication:

I Dedicate This Project to my Wife, Whose Support, and Encouragement have been my Guiding Light. Your Belief in me and your Sacrifices have made this Journey Possible. Thank you for Being my Confidant, and my Source of Strength.

1.3• Introduction:

The history of project management presents ample examples of technological needs-driven management innovations on projects (Sankaran et al., 2021). Industry 4.0 is now well understood as a fundamental anchor for digital transformation. Industry 4.0, while radically addressing many challenges of the conventional delivery models and bringing manifold benefits in terms of productivity, cost, quality, time, resource efficiency, collaboration and communication, safety, and sustainability (Craveiro et al., 2019; Oesterreich and Teuteberg, 2016), has brought about a certain degree of ambiguity and lack of clarity, especially in its adoption and adaptation (Karmakar and Delhi, 2021; Muñoz-La Rivera et al., 2021; Winfield, 2020), even to an extent to say that we are not in a position to even understand the readiness of construction sector for industry 4.0 (Maskuriy et al., 2019). For instance, industry 4.0 in the construction sector has caused productivity gains when lean construction concepts based on integrated project delivery methods are coupled with building information modelling (BIM) based digital twin technologies. Nevertheless, the data transfer's reliability and interoperability impede and challenge the wider application. Digital transformation has become a cornerstone in the evolution of capital projects, reshaping the way infrastructure is developed, constructed, and managed. In an era defined by rapid technological advancement, the integration of digital tools and methodologies has emerged as a key strategy for driving efficiency, collaboration, and innovation in the capital project landscape. Capital projects encompass a wide range of endeavors, from building bridges and highways to constructing energy facilities and urban developments. Traditionally, these projects have been characterized by complex workflows, disparate stakeholders, and inherent risks. However, the advent of digital transformation has ushered in a new era of possibility, enabling stakeholders to overcome traditional challenges and unlock new opportunities for success. At the heart of digital transformation in capital projects lies the

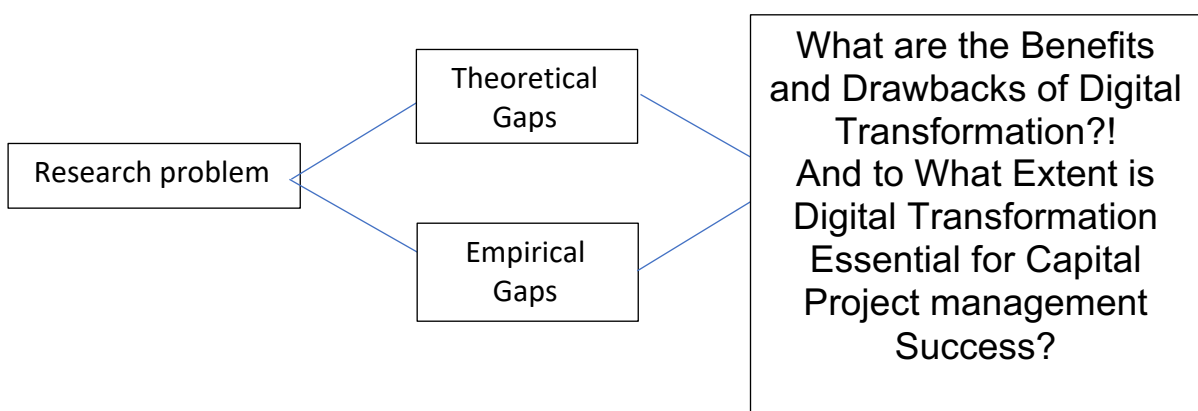
convergence of various technologies, including Building Information Modeling (BIM), Internet of Things (IoT), Artificial Intelligence (AI), and Augmented Reality (AR). These technologies, when integrated effectively, empower project teams to streamline processes, enhance decision-making, and optimize project outcomes. This introduction explores the profound impact of digital transformation on capital projects, examining key trends, challenges, and opportunities shaping the industry. From improving collaboration and productivity to mitigating risks and enhancing sustainability, digital transformation promises to revolutionize the way capital projects are conceived, executed, and delivered in the 21st century. Digital transformation and adoption hinge on several dimensions spanning organisational and stakeholder spaces. This is critical since research revealed that local stakeholders had varying views about localised digital solutions in projects (Wang and Lu, 2021). According to Alaimo & Kallinikos (2021), organisations can no longer be framed as separate from the technologies they deploy. Thus, there is a need to understand the dynamics of digital transformation with the organisational processes and project participants, especially in the construction industry. It is crucial to understand whether digital technologies impact project management approaches (will) and how they would impact (how). Thus, it became imperative to inquire about the 'will' and 'how' of the construction sector's journey on the industry 4.0 path.

In this study, the objective is to understand the dynamics of the project participants in enabling the adoption of industry 4.0 in the construction sector in a holistic approach. As indicated earlier, the study looks at the 'will' and 'how' to understand the stated dynamics.

2• Research Problem:

Identifying research problems in digital transformation, particularly in the context of capital construction projects, can help guide future studies and improve both theoretical understanding and practical applications.

How can different digital technologies be effectively integrated to work seamlessly together in construction projects?



2.1• Research significant:

2.2-Theoretical Significant:

Digital transformation in capital construction projects holds significant theoretical implications across various domains. Digital tools can enhance the sustainability of construction projects by optimizing resource use, reducing waste, and improving energy efficiency. Theoretical models of lifecycle analysis can be enhanced with digital data, providing more accurate assessments of a project's environmental footprint over its entire lifecycle. By integrating these perspectives, the theoretical significance of digital transformation in capital construction projects can be comprehensively understood, offering valuable insights for both academic research and practical application.

2.3-Empirical Significance:

The empirical significance of digital transformation in capital construction projects is well-documented, showcasing improvements in efficiency, cost management, risk mitigation, quality, sustainability, and stakeholder satisfaction. These benefits underscore the importance of continued investment and research in digital technologies within the construction industry. Digital transformation is crucial because it enables organizations to adapt to the rapidly changing technological landscape, improve efficiency, enhance customer experiences, stay competitive, and innovate. By leveraging digital technologies, businesses can streamline operations, gain insights from data analytics, reach new markets, and create new revenue streams. Additionally, digital transformation fosters agility and resilience, allowing organizations to better respond to market shifts and customer demands.

3. Research Questions:

Research sub-question are specific questions that are derived from the main research question.

- What are the best practices for integrating digital transformation into traditional project management methodologies in capital construction?
- How dose digital transformation impact the overall quality and durability of constructed assets in capital projects?
- What are the most effective digital tools and technologies for enhancing efficiency in capital construction projects?
- What are the barriers and challenges to implementing digital transformation in capital construction project?

The researcher is conducting a study entitled “Digital Transformation in Capital Construction Projects: A Field Study in Engineering Consulting Companies in the Kingdom of Saudi Arabia,” which is part of the requirements for obtaining a Bachelor’s degree in Business Administration from Midocean University.

Therefore, the success of this study depends on the extent of your contribution in reading it carefully and then Answer its paragraphs by placing a mark (X) in the box that agrees with your opinion.

I thank you for your cooperation in reaching the results of this study.

I would like to inform you that the information contained in the questionnaire will be used exclusively for scientific research purposes and will be treated with complete confidentiality.

With high respect and appreciation.

Supervisor.

Researcher's name.

Dr. Mona Moustafa Elashry

Ali Almuslem

DATE

JUN.25.2024

<https://forms.gle/4DFF61d2f4cjL49LA>

3.1. Research Objectives:

Assess the current state and environmental sustainability benefits of digital adoption within capital construction projects.

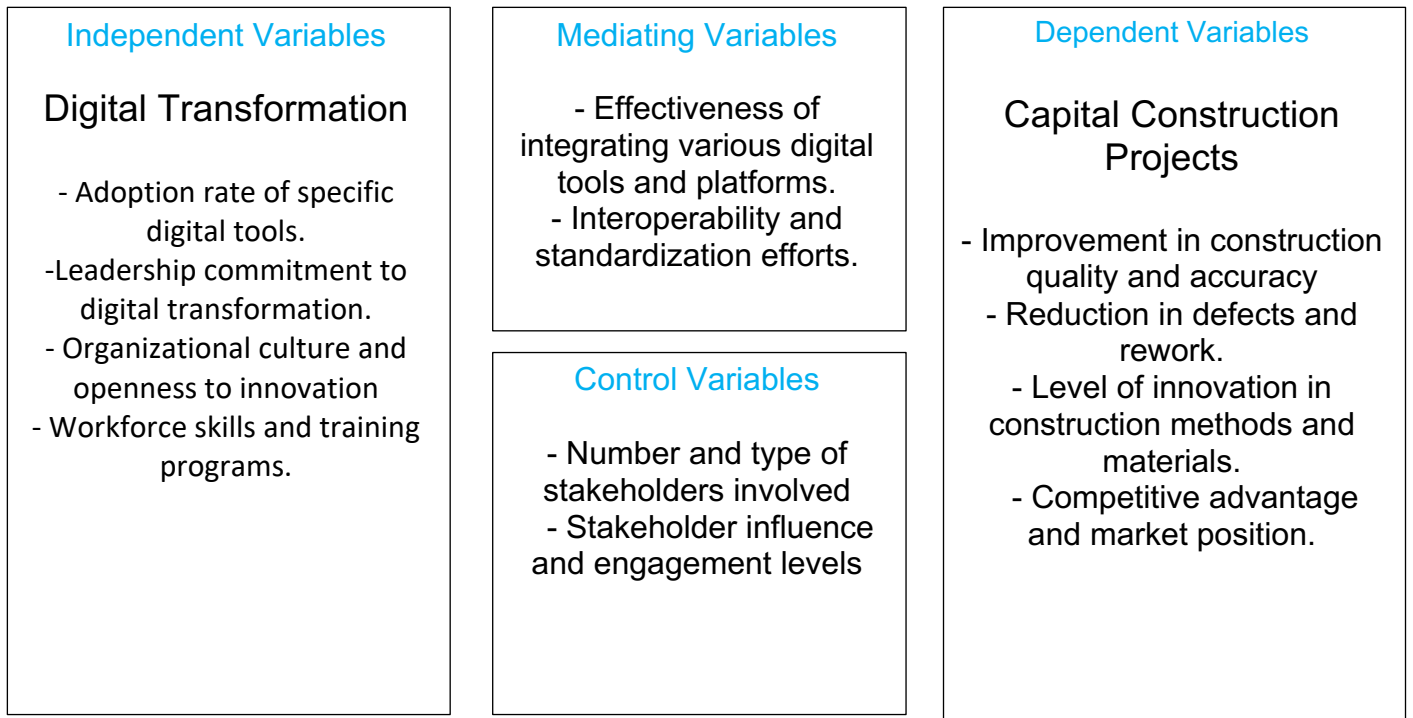
Develop recommendation and best practices for integrating digital transformation into existing project management frameworks in capital construction.

Evaluate the effectiveness of various digital tools and technologies in streamlining project management processes.

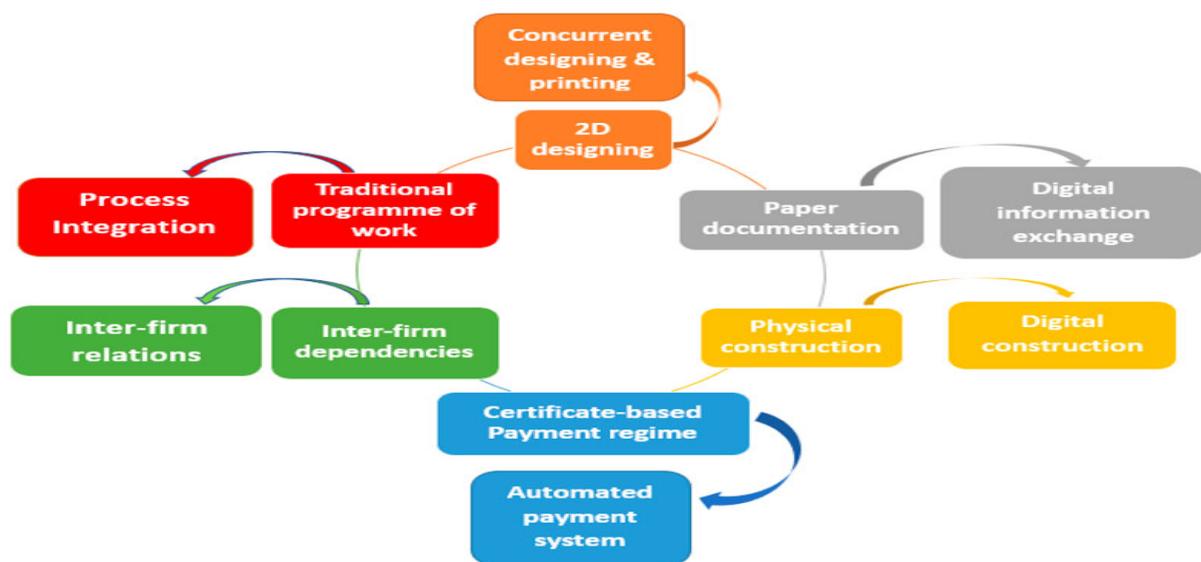
Analyze the barriers and challenges hindering the successful implementation of digital transformation in capital construction projects.

- Digital transformation in capital construction project leads to increased productivity and efficiency in the construction process.
- Digital transformation improves the accuracy and efficiency of project management.

4. Mediating Variables:



4.1. Research Model:



4.2. Scope of study:

Kingdome of Saudi Arabia – Capital Construction Projects (Roads, Bridges).

4.3. Project structure:

- - Introduction.
- - Literature Review.
- - Statistical Analysis.
- - Finding ‘Discussion and Conclusion.

5. Literature Review:

5.1- Introduction

Digital transformation has become a cornerstone in the evolution of capital projects, reshaping the way infrastructure is developed, constructed, and managed. In an era defined by rapid technological advancement, the integration of digital tools and methodologies has emerged as a key strategy for driving efficiency, collaboration, and innovation in the capital project landscape. Capital projects encompass a wide range of endeavors, from building bridges and highways to constructing energy facilities and urban developments.

5.2 Research Variable (Digital Transformation)

Digital transformation refers to the integration of digital technology into all areas of business, fundamentally changing how organizations operate and deliver value to customers. In the context of capital construction projects, digital transformation involves the adoption of technologies such as Building Information Modeling (BIM), Internet of Things (IoT), artificial intelligence (AI), cloud computing, and blockchain to enhance various aspects of construction processes.

5.3 Benefits of Digital Transformation in Construction

Increased Efficiency and Productivity:

- Digital tools streamline processes, reduce manual tasks, and improve workflow automation.
- Enhanced planning and resource management lead to faster project completion.

Cost Reduction:

- Optimized resource use and reduced waste lower overall project costs.
- Improved accuracy and early detection of issues minimize costly rework.

Enhanced Quality and Safety:

- Digital monitoring and analytics improve quality control and safety standards.
- Real-time data and predictive maintenance reduce the likelihood of accidents and defects.

Better Collaboration and Communication:

- Digital platforms facilitate seamless communication among stakeholders.
- Collaborative tools enhance coordination and reduce misunderstandings.

Sustainability and Environmental Impact:

- Digital tools help optimize energy use and minimize environmental impact.
- Improved planning and monitoring support sustainable construction practices.

5.4 Challenges of Digital Transformation in Construction

Resistance to Change:

- Organizations may face resistance from employees accustomed to traditional methods.
- Effective change management and training programs are essential.

High Initial Investment:

- Implementing digital technologies can require substantial initial investment.
- Long-term benefits need to be clearly communicated to justify costs.

Data Security and Privacy:

- Increased reliance on digital tools raises concerns about data security and privacy.
- Robust cybersecurity measures and policies are necessary.

Interoperability Issues:

- Different digital tools and platforms need to work seamlessly together.
- Standardization and integration efforts are critical for successful implementation.

Skill Gaps:

- The workforce may lack the necessary skills to effectively use new technologies.
- Continuous training and upskilling programs are required.

5.5 Research Variable (Capital Construction projects)

Capital construction projects are crucial for economic development and societal advancement. By embracing digital transformation and innovative practices, the construction industry can overcome challenges and deliver projects that are efficient, cost-effective, and sustainable.

Capital construction projects refer to large-scale construction endeavors aimed at creating significant physical infrastructure or facilities that have long-term value and use. These projects are often substantial in scope, cost, and duration, involving a wide array of stakeholders including governments, private enterprises, and the public.

5.6 Future Trends in Capital Construction Projects**Green and Sustainable Construction**

- 5.7 Emphasis on eco-friendly materials, energy-efficient designs, and sustainable construction practices.

Smart Infrastructure

- 5.8 Integration of IoT and smart technologies to create intelligent infrastructure that can monitor and manage itself.

Advanced Construction Technologies

- 5.9 Use of robotics, 3D printing, and modular construction techniques to improve efficiency and reduce labor costs.

Data-Driven Decision Making

- 5.10 Leveraging big data and analytics to inform decision-making and improve project outcomes.

Resilient Design

Designing infrastructure to withstand natural disasters, climate change, and other unforeseen challenges.

5.7 Relationship between Digital Transformation and Capital Construction Projects

The relationship between digital transformation and capital construction projects is multifaceted and deeply impactful. Digital transformation involves integrating advanced digital technologies into various aspects of construction projects, thereby enhancing efficiency, quality, and sustainability.

5.8 Challenges in the Relationship:

- **Resistance to Change**

Organizations may face resistance from employees accustomed to traditional methods. Effective change management and training programs are essential.

- **Interoperability Issues**

Different digital tools and platforms need to work seamlessly together. Standardization and integration efforts are critical for successful implementation.

- **Skill Gaps**

The workforce may lack the necessary skills to effectively use new technologies. Continuous training and upskilling programs are required.

5.9 Conclusion

The relationship between digital transformation and capital construction projects is characterized by significant enhancements in efficiency, quality, and sustainability. By integrating advanced digital technologies into planning, design, execution, and management processes, construction projects can achieve better outcomes, reduce costs, and improve stakeholder satisfaction. Despite challenges, the ongoing evolution of digital tools and practices promises to further transform the construction industry, driving innovation and long-term success.

5.10 Definition of Digital Transformation:

- Digital transformation is the combined effects of several
- digital innovations bringing about novel actors (and actor constellations), structures, practices,
- values, and beliefs that change, threaten, replace, or complement existing rules of the game
- within organizations, ecosystems, industries, or fields.
- Hinings B., Gegenhuber T., Greenwood R. (2018). Digital innovation and transformation: An institutional perspective. *Information and Organization*, 28(1), 52–61.
- Definition of Capital Construction Projects:
- Zhang, Yang;Li, Hui;Yao, Zeliang
Engineering, construction, and architectural management, 12 Dec 2023,

- 6. Findings

The study's results reveal that the performance of construction firms greatly depends on intellectual capital and its components. Furthermore, digital transformation plays a vital moderating role between intellectual capital and its components and construction firm performance.

often measured the effect that specific inputs have on project success. However, the Project management researchers have concept of project success is complicated and there is no consensus as to how it should be measured. The research community and project management practitioners need a simple and direct measurement for project success that is based on objective 5.10.1 measurements and can be used on projects of different types and sizes.

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