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Influence of Digital Infrastructure on Project Management Success: Readiness, Fitness, and Tools as Moderators

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Abstract

In an era defined by rapid digital transformation, project-based organizations face increasing pressure to modernize and digitalize their operational frameworks to ensure competitive advantage and Project Management Success. However, only limited research has examined how foundational pillars of digital infrastructure interact and jointly influence project outcomes, leaving a gap in understanding the structural pathways that link digital infrastructure to Project Management Success and informed decision-making. This study investigates how the three pillars of digital infrastructure (Digital Readiness, Digital Fitness, and Digital Tools) jointly and individually influence Project Management Success through applying Partial Least Squares Structural Equation Modeling (PLS-SEM) to analyze survey data collected from experienced project management professionals who possess appreciable experience in digital technology systems and digital transformation leadership. The developed model captures both direct effects of the Digital Infrastructure Pillars on Project Management Success and the moderation effects between them. The results show that all three pillars significantly enhance Project Management Success, with Digital Readiness emerging as the most influential strategic enabler. Moreover, Digital Readiness positively moderates the effect of Digital Tools on Project Management Success, indicating that digital technology investments are more effective when supported by foundational digital preparedness. These findings offer a validated framework for assessing digital maturity in project environments and provide strategic and leadership guidance for organizations seeking to enhance project performance and achieve Project Management Success through balanced investment in digital infrastructure, integrated digital transformation strategies, digital technology adoption, and digital competencies.

Keywords:

Digital Transformation;
Digital Infrastructure;
Project Management;
Structural Equation Modeling (SEM);
Digital Readiness;
Digital Fitness;
Digital Tools;
Moderation Analysis;
Industry 4.0 Emerging Technologies.

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1- Introduction

The increasing industrial adoption of digital transformation requires new project management frameworks which recognize digital infrastructure as a fundamental factor for Project Management Success [1–3]. According to Hussain et al. [4], digital infrastructure is the set of digital servers, software, and physical networks that assist in organizing and delivering knowledge and information. Yang & Zhang [5] suggest that digital infrastructure refers to "the foundation for the development of digital technologies, providing the necessary production materials for the development of the digital economy and new types of productivity". A more comprehensive definition of digital infrastructure is presented by Khasawneh & Dweiri [6] who describe it as the prerequisites for the adoption of digital solutions and the implementation of Industry 4.0 technologies with their broad perspective and collective role in Project Management Success. Khasawneh & Dweiri [6] further refer to it as "the set of digital tools, combined with digital fitness and readiness required to achieve the project management goals and enable the project management practice". These three pillars represent the "main

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requirements for an organization to be entirely equipped with the necessary infrastructure for digitalization and industry 4.0 transformation" [6]. Digital infrastructure, which includes technology systems and competencies, functions as the fundamental support structure for contemporary project execution by providing agility, scalability, and data-driven decision capabilities [6]. The integration of artificial intelligence (AI) and quantum computing into digital infrastructure transforms conventional methods of resource allocation, risk mitigation, and schedule control for complex project environments [7]. Studies on AI in project management show that intelligent systems enhance predictive accuracy, operational efficiency, and decision-making throughout all key project phases [8]. The incorporation of digital infrastructure elements into project management can improve compliance with schedule, compliance with budget, and compliance with quality requirements and specifications [9]. Digital tools like AI can substantially improve cost estimation, scheduling, and risk management in project management [8]. These findings were emphasized by Fridgeirsson et al. [10], who highlighted the contribution of AI to enhancing cost, schedule, and risk management approaches throughout several project phases. Furthermore, the integration of Industry 4.0 Emerging Technologies significantly contributes to Project Management Success as these technologies can act as key enablers of enhanced project management effectiveness, particularly through improved process efficiency, real-time data utilization, and decision-making capabilities [11].

In this study, the foundations of digital infrastructure refer to the empirically validated pillars of organizational Digital Readiness, Digital Fitness of employees and teams, and enabling Digital Tools, as defined by Khasawneh & Dweiri [6]. Digital Readiness is defined by four enabling elements: Cybersecurity Systems, Real-time Data Access and Management, Technological Infrastructure, and Large Internet Network Capacity. Digital Fitness is defined by two enabling elements: Digital Teams and Digitally Competent Employees. The third pillar, Digital Tools, is defined by two enabling elements: Digital Transformation and Industry 4.0 Emerging Technologies [6].

This study addresses the gap represented in the inconsistent influence of digital infrastructure on project outcomes across industries, as well as the insufficiency of research examining the interactions between its pillars and how they collectively affect Project Management Success. Although prior studies have acknowledged the roles of digital tools, readiness, and fitness in enhancing project outcomes, most have treated these dimensions separately without analyzing their causal interdependencies. Existing research also remains fragmented across sectors such as construction, manufacturing, and education, with only a few attempts to develop a comprehensive multivariate framework. Only limited efforts, such as Chen et al. [12] and Naji et al. [13], have used structural modeling approaches, but these studies stopped short of linking the digital infrastructure pillars directly to project performance. Therefore, there is a need for an integrated model that empirically validates the direct and moderating effects of the digital infrastructure pillars on Project Management Success.

This research proposes a structural equation model whereby Project Management Success, Digital Readiness, Digital Fitness, and Digital Tools are conceptualized as latent constructs. For the digital pillars, the enabling elements of each digital pillar served as indicators, whereas Project Management Success was assessed through seven criteria-based indicators that acted as its variables in the analysis. These indicators were drawn from Khasawneh & Dweiri [6] as Compliance with the Budget, Compliance with the Schedule, Compliance with Quality Requirements and Specifications, Meeting the Scope of the Project, Ensuring Long-run Organizational Benefits, Achieving the Strategic Objectives of the Organization, and Sustainability of Solutions and Success.

1-1- Research Problem

In this era of technological disruption and rapid digitalization, project-based organizations face increasing pressure to modernize and digitalize their operational frameworks to ensure competitive advantage and enhanced project outcomes [6, 9, 11]. Organizations initiate these efforts by establishing a digital infrastructure based on pillars defined as Digital Readiness, Digital Tools, or Digital Fitness [6]. Although these pillars have been examined in past studies, there is insufficient research examining the interactions between these pillars and how they influence Project Management Success [6]. Most recent research focuses either on technology adoption or Project Management Success factors separately without considering the causal relationships or structural pathways between the foundations of digital infrastructure [13]. Prior studies have also explored digital technology adoption and project management separately, without empirically testing the digitalization of project management and the required organizational digital infrastructure [9]. Additionally, very few studies adopt a multivariate modeling approach that integrates the Digital Infrastructure Pillars into a causal framework predicting project outcomes [14, 15]. For example, Chen et al. [12] confirmed a PLS-SEM-based link between Digital Readiness and digital competence, but stopped short of assessing how this relationship affects project performance or outcomes. Similarly, Naji et al. [13] successfully validate factors influencing digital transformation potential using SEM, but their study failed in linking digital transformation or other Digital Infrastructure Pillars to project performance or outcomes. Other articles focused solely on traditional project management drivers, not digital infrastructure dimensions, such as Mirhosseini et al. [15] who apply PLS-SEM to study project cost accuracy as a driver of sustainable project management.

Additionally, most studies have fallen short of examining the uniformity of digital infrastructure adoption in project management across different industries. Prior studies have examined aspects of digital infrastructure in relation to project outcomes, but the existing literature lacks research that addresses the effect of the comprehensively defined digital infrastructure [6] on Project Management Success in a general sense across industries. For example, the work of Naji et al. [13] finds that strong digital infrastructure significantly enhances digital transformation readiness in building construction projects, which, in turn, improves project execution by enabling smoother data flows, better coordination, and more effective decision-making, thereby contributing to improved project outcomes. On the other hand, Machado et al. [16] identify digital infrastructure as a critical foundation for organizational readiness, whereby manufacturing firms with stronger digital infrastructure are better positioned to carry out successful digital transformation projects and, hence, more likely to achieve Project Management Success in manufacturing initiatives. Chounta et al. [17] address the effect of digital infrastructure on project outcomes in the education sector. They find that digital infrastructure enables higher education institutions to adopt and integrate hardware, software, and technical services more effectively, which supports greater efficiency in institutional processes and better educational outcomes, thereby contributing to improved project outcomes in educational change initiatives. Accordingly, a generic framework has to be identified to analyze the digital infrastructure pillars and factors affecting project outcomes, improving Project Management Success across different industries [3].

This paper closes the research gap and presents an integrated assessment of digital infrastructure for project-oriented companies by providing a structural equation model to test these relationships empirically. Digital infrastructure is defined in this study based on the work of Khasawneh & Dweiri [6], which is considered the most comprehensive definition involving digital technology and tools, organizational digital preparedness, and Digital Fitness of employees and teams enabling digitalization and Industry 4.0 transformation required to achieve Project Management Success. Therefore, this study uses a validated framework derived from Khasawneh & Dweiri [6] as a reference from which the Digital Infrastructure Pillars are inspired as latent constructs of the structural model, and the enabling elements of these pillars are integrated as indicators. The research gap is filled by considering all three defined pillars of digital infrastructure in the development of a structural model validated with a PLS-SEM approach to test the relationships in the model and explore the interdependencies of the latent constructs and their collective influence on Project Management Success. The aims is to confirm their direct and moderating effects in supporting the success of project management.

The significance of this research lies in its ability to provide strategic guidance on training, investment, infrastructure development opportunities, and digital capability enhancement from the identification of the interdependencies among the Digital Infrastructure Pillars and how they all work both independently and collectively to influence Project Management Success [16], whether directly or with a moderating effect.

1-2- Research Objectives

In this research, Structural Equation Modeling (SEM) was selected as a multivariate statistical analysis tool because of its powerful approach that enables multiple-indicator analysis of complex relationships between latent constructs and indicators [18]. Furthermore, SEM is able to compute measurement errors, offers a comprehensive evaluation of model fit, and can evaluate several interrelated relationships at once [19], which enhances the reliability of the findings in comparison to those from conventional regression models [20]. Most significantly, SEM is being used increasingly in research on digital transformation because of its ability to analyze complicated relationships and constructs [21, 22].

In developing the model for this research, the finalized set of three Digital Infrastructure Pillars as well as Project Management Success indicators proposed by Khasawneh & Dweiri [6] were adopted as foundational inputs. These four inputs were conceptualized as latent constructs in the SEM analysis, while the enabling elements of the three pillars as well as the criteria of Project Management Success were incorporated as indicators. Therefore, although this research builds upon the structured weights and rankings applied by by Khasawneh & Dweiri [6], it aims to advance the literature by transitioning from descriptive ranking approaches to predictive causal modeling of digital infrastructure impacts on Project Management Success. The study provides an integrated structural analysis that examines the structural relationships among the identified constructs. SEM is applied to empirically model and validate the causal pathways between Digital Readiness, Digital Fitness, Digital Tools, and Project Management Success. It also explores three potential moderating effects supported by the literature: the moderating effect of Digital Readiness on the relationship between Digital Tools and project outcomes; the moderating effect of Digital Readiness on the relationship between Digital Fitness and project outcomes; and the moderating effect of Digital Fitness on the relationship between Digital Tools and project outcomes. The results of this study should provide a validated framework for organizations seeking to enhance Project Management Success through digital initiatives. This framework will provide strategic recommendations for prioritizing digital infrastructure investments based on the empirical relationships between the digital infrastructure pillars and Project Management Success.

In summary, this study aims to address the following research questions:

- How do the pillars of digital infrastructure (Digital Readiness, Digital Fitness, and Digital Tools) individually and collectively impact Project Management Success?
- How does each pillar of Digital Infrastructure support and enhance the effectiveness of the other pillars to improve Project Management Success through its moderating effect?
- How can organizations strategically prioritize investments in digital infrastructure to maximize Project Management Success based on empirical evidence?

These research questions are addressed by achieving the following objectives:

- To examine the individual and collective effects of Digital Readiness, Digital Fitness, and Digital Tools on Project Management Success.
- To analyze the moderating role of each pillar of digital infrastructure in strengthening the relationship between the other pillars and Project Management Success.
- To provide strategic recommendations for prioritizing digital infrastructure investments based on the empirical relationships between Digital Readiness, Digital Fitness, Digital Tools, and Project Management Success.

Accordingly, the following research hypotheses are proposed to be tested using the developed model:

H1: *Digital Readiness positively influences Project Management Success.*

H2: *Digital Fitness positively influences Project Management Success.*

H3: *Digital Tools positively influence Project Management Success.*

H4: *Digital Readiness moderates the effect of Digital Tools on Project Management Success.*

H5: *Digital Readiness moderates the effect of Digital Fitness on Project Management Success.*

H6: *Digital Tools moderates the effect of Digital Fitness on Project Management Success.*

Figure 1 shows how the six proposed hypotheses attempt to explain the direct and moderating effects between the main pillars of digital infrastructure, in pursuit of a comprehensive understanding of how these pillars affect Project Management Success. Each pillar of digital infrastructure is examined in terms of its direct effect on Project Management Success (H1, H2, and H3) as well as its moderating role in improving the effect of each of the other pillars on Project Management Success (H4, H5, and H6).

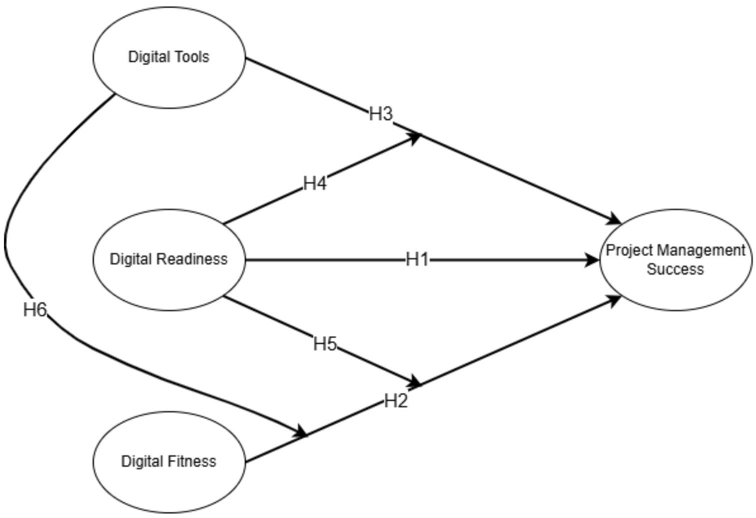

Figure 1. Research Hypotheses Development

1-3- Theoretical Contributions and Practical Relevance

This research significantly contributes to existing literature by providing a comprehensive and empirically tested structural equation model that assesses the integrated and interactive effects of the digital infrastructure pillars on Project Management Success. Prior research has predominantly addressed these pillars independently, rarely considering their synergistic interactions and moderating relationships within a cohesive framework [6, 9, 12–15]. By bridging this gap, the current study extends theoretical understanding by employing the Technology–Organization–Environment (TOE) framework and the Resource-Based View (RBV) theory to explain how these digital infrastructure components collectively constitute strategic organizational resources, capable of driving an organization's competitive advantage and enhancing project outcomes. This integrated theoretical approach broadens the scope of existing scholarly work and establishes a robust foundation for future research exploring the comprehensive impacts of digital infrastructure.

The theoretical approach of this study integrates the TOE framework with the RBV to establish a comprehensive lens for analyzing digital infrastructure in project management. TOE clarifies how environmental conditions, technological innovations, and organizational capacities act as drivers of digital infrastructure adoption. On the other hand, the RBV positions the pillars of digital infrastructure as valuable, rare, inimitable, and non-substitutable resources that generate competitive advantage. This combined perspective moves beyond prior research that often adopts these frameworks in isolation, with some studies relying exclusively on the TOE framework [23] and some others focusing solely on the RBV to highlight internal resource advantage [24]. Given that the current study develops a structural equation model that captures both the direct and moderating effects of the digital infrastructure pillars on Project Management Success, this theoretical approach explains why organizations adopt digital infrastructure and how these resources interact to achieve successful project outcomes.

Practically, this study aims to guide project-based organizations on strategic and effective use of digital transformation to improve project management outcomes. By empirically validating the direct and moderating relationships among the digital infrastructure pillars, the research identifies those that organizations should prioritize for investment and development. Furthermore, the findings of the study enable managers to understand how enhancing one pillar, such as Digital Readiness, can amplify the effectiveness of Digital Tools and Digital Fitness, thereby optimizing resource allocation and achieving maximum impact on Project Management Success. Ultimately, this research aims to equip organizations with an evidence-based strategic framework, facilitating informed decisions that align digital initiatives with organizational objectives and market competitiveness.

1-4- Paper Structure

The following sections of the paper begin with a comprehensive literature review that establishes the theoretical framework by drawing on key theories such as TOE and the RBV to support the development of the study's constructs. It then clearly defines each construct and develops hypotheses for the direct effects, providing theoretical justifications for the proposed relationships. The review also explores the moderating role of each of the digital infrastructure pillars, supported by prior studies and conceptual reasoning to justify the moderation hypotheses. The methodology section then outlines the study design and theoretical model development, followed by a detailed description of the data collection process and sampling techniques. It explains the development and validation of the survey instrument, including the construct measures, and addresses potential common method bias. The analytical approach is based on SEM, covering both the measurement model assessment to confirm construct validity and reliability, and the structural model evaluation to test hypothesized relationships. Following this, the results section presents findings from the measurement model, structural model, and moderation analyses, offering evidence for both direct and moderating effects. The discussion interprets these results in relation to the theoretical framework, highlighting their implications for both research and practice, particularly in enhancing Project Management Success through digital infrastructure. Finally, the paper concludes by summarizing the key findings, outlining theoretical and practical contributions, acknowledging limitations, and suggesting potential directions for future research.

2- Literature Review

2-1- Theoretical Framework

This study presents the foundations of digital infrastructure as the empirically validated pillars of organizational Digital Readiness, Digital Fitness of employees and teams, and enabling Digital Tools, as defined by Khasawneh & Dweiri [6]. The conceptualization of these three foundational pillars of digital infrastructure is supported by the TOE framework introduced by Tornatzky & Fleischer [25] as a theoretical framework which suggests that three dimensions—technology, organization, and environment—individually and collectively enable the adoption of technological innovations in an organization. According to Baker [26], the TOE framework effectively identifies critical determinants across its three dimensions. The Digital Tools pillar clearly aligns with the *technological* dimension, representing the adoption and effective utilization of digital innovations such as Industry 4.0 enabling technologies and digital transformation. Digital Fitness aligns with the *organizational* dimension, emphasizing internal human capabilities, digital competencies, and effective team collaboration, crucial for innovation implementation and organizational effectiveness. Digital Readiness best aligns with the *environmental* dimension, encapsulating infrastructural aspects such as technological infrastructure quality, cybersecurity measures, and network connectivity, driven by industry standards and pressures external to the organizational workflow.

Building on this, the RBV further supports the theoretical foundation of this study by emphasizing the importance of internal resources and capabilities in achieving sustained competitive advantage [27]. Under the RBV lens, the three pillars of digital infrastructure are understood as strategic organizational resources that collectively constitute Valuable, Rare, Inimitable, and Non-substitutable (VRIN) resources which reinforce project execution quality and project management initiatives. Digital Readiness represents foundational enablers that are valuable and often difficult to replicate. It is also non-substitutable, as no human or procedural alternative can replace robust digital infrastructure [28]. Digital Fitness reflects unique human capital capabilities that enhance adaptability and innovation. This pillar is considered rare because of the scarcity of digitally competent and collaborative employees in many industries, and inimitable because team culture and embedded skills are deeply rooted and not easily replicated [29]. The Digital Tools pillar aligns strongly with the valuable dimension due to its transformative impact on project execution and operations. They are also inimitable when tailored or embedded in organizational contexts [30]. Therefore, the RBV supports the view that strategically developing and integrating these digital resources significantly contributes to enhanced Project Management Success. The RBV also indicates that sophisticated Digital Tools may not achieve optimal performance without sufficient Digital Readiness or digitally competent teams, highlighting the necessity of adopting a comprehensive VRIN approach to digital infrastructure development.

2-2-Construct Definitions

In this study, four key constructs are used: Digital Readiness, Digital Fitness, Digital Tools, and Project Management Success. Each construct is conceptualized as a formative construct, meaning that it is shaped exclusively by its associated indicators rather than reflecting a latent trait that causes the indicators. As such, the constructs do not exist independently of their indicators and are fully defined by them.

According to Khasawneh & Dweiri [6], Digital Readiness is formed by four indicators: Cybersecurity Systems, Real-time Data Access and Management, Technological Infrastructure, and Large Internet Network Capacity [6, 16, 31-33]. The work of Khasawneh & Dweiri [6] has initially identified seven enabling elements of Digital Readiness that were shortlisted to four during the weighing and ranking process which utilized the results of an expert survey to deduce a shortlist of the most effective and important elements. These elements reflect the foundational systems and capabilities that comprehensively and adequately enable an organization to support digital initiatives and ensure operational resilience. The enabling elements of Digital Readiness are supported by the work of Nadhifah et al. [34] who find that robust cybersecurity systems significantly enhance Digital Readiness and transformation effectiveness within organizations. Furthermore, Berlilana et al. [35] integrate technology readiness into their TOE-based framework, identifying it as a core enabler of organizational readiness and overall organizational performance. The role of real-time data access and management in Digital Readiness has also been supported by Chounta et al. [17], who emphasize the impartial significance of data-informed capabilities in their framework for assessing institutional Digital Readiness. Accordingly, Digital Readiness is best understood as a formative construct built upon four critical enablers, each representing a distinct dimension essential for an organization’s preparedness to engage in digital transformation initiatives.

Digital Fitness consists of two indicators: Digital Teams and Digitally Competent Employees [6, 32, 36], fully representing the human capital elements critical for implementing and adapting to digital technologies within project environments. Digital Fitness is described by Khasawneh & Dweiri [6] as the ability of an organization to learn, train, adapt, and evolve with new Digital Tools, and its capacity to develop and maintain the digital capabilities of its people and teams. This definition positions digitally skilled individuals and collaborative digital teams at its core, which aligns closely with the definition of Oberländer et al. [37] who highlight Digital Fitness as the aggregate of employee digital competencies and ongoing learning practices, emphasizing the significant contribution of individual digital skills to digital fitness [37]. Moreover, effective digital teams, supported by digital competencies, are essential for implementing and sustaining digital initiatives within organizations [38]. Accordingly, several resources from the body of literature affirm that Digital Fitness is entirely and comprehensively captured through the development of digitally competent employees and well-functioning digital teams.

The Digital Tools pillar is defined by two indicators: Digital Transformation Initiatives and Industry 4.0 Emerging Technologies [6, 39, 40], reflecting the complete set of advanced technological solutions that organizations adopt to automate processes, enhance decision-making, and drive innovation. Digital Tools can be conceptualized as a formative construct that is entirely and sufficiently defined by its two enabling elements, with no additional dimensions required. This view is reinforced by Yaqub & Alsabban [41], who recognize digital transformation as a primary outcome and driver of Industry 4.0 implementation, shaping how Digital Tools impact business models and operational and management processes. Similarly, Zamora Iribarren et al. [42] highlight the central role of enabling technologies (such as IoT, AI, Big Data analytics, and cloud computing) in defining digital transformation maturity, positioning them as essential operational components of Digital Tools. Together, these studies affirm that digital transformation and Industry 4.0 technologies together fully define the Digital Tools construct, with no additional elements needed to represent its conceptual or operational boundaries.

Finally, Project Management Success is represented by seven criteria-based indicators: Compliance with the Budget, Compliance with the Schedule, Compliance with Quality Requirements and Specifications, Meeting the Scope of the Project, Ensuring Long-run Organizational Benefits, Achieving the Strategic Objectives of the Organization, and

Sustainability of Solutions and Success [6, 11]. Khasawneh & Dweiri [6] initially identified 11 Project Management Success criteria that were later shortlisted to the seven most relevant and important criteria used as indicators for Project Management Success, defined as a latent construct in this study. These indicators collectively and sufficiently define the success outcomes that project-based organizations aim to achieve. This finding is also supported by other studies that list Project Management Success criteria and define the most relevant and important of them based on different contexts [43–45].

In conclusion, each of these four constructs is adequately determined by its respective indicators and, hence, is considered as a formative construct. No additional external factors are presumed to influence these constructs directly [6]. Instead, the full meaning and measurement of each construct are captured by the complete set of its associated indicators.

2-3- Hypotheses for Direct and Moderating Effects

The conceptual and empirical findings of the most recent literature served as the foundation for the development and formulation of the research hypotheses. Khasawneh & Dweiri [6] identify and empirically validate the three foundational pillars of organizational digital infrastructure as critical enablers of Project Management Success. Their study applied a multi-criteria decision-making approach to rank the enabling elements of each pillar and demonstrated that these components significantly influence key project outcomes. They conclude that, when organizations are digitally ready, have digitally fit employees and teams, and implement effective Digital Tools, they are better positioned to achieve Project Management Success in terms of compliance with budget, schedule, and quality requirements, as well as meeting strategic objectives and ensuring sustainability. The enabling elements of Digital Readiness provide the essential digital environment required for effective project execution [6]. Digitally ready organizations exhibit better adaptability, communication, and data security, contributing to project resilience and responsiveness, and making organizations more capable of achieving project goals related to cost, time, and quality due to enhanced operational stability, information flow, and system responsiveness [6]. This is supported by Bugarčić & Slavković [46] who use SEM on survey data from project teams to examine how Digital Readiness influences project management effectiveness; accordingly, they find that Digital Readiness directly improves project outcomes including efficiency, communication, scope, schedule, and cost performance. Moreover, this finding was confirmed by Chen et al. [12] who conclude that Digital Readiness leads to improved project execution and project management performance. Based on this, the first hypothesis (H1) was developed positing that Digital Readiness positively impacts Project Management Success.

The second hypothesis (H2) was developed based on the work of Chang & Octoyuda [47], who conclude that digitally fit teams and employees with high digital literacy and cross-functional capabilities have been found to deliver projects with greater agility and better innovative outcomes. Digital Fitness comprises digital teams and digitally competent employees [6], reflecting an organization's human capacity to operate and innovate within digital environments [39, 40]. Organizations with high Digital Fitness demonstrate improved agility, adaptability, and collaboration, which are essential qualities for successful project delivery [6]. Marnewick & Marnewick [48] explore individual-level digital competency among project managers and demonstrate its direct impact on Project Management Success and overall project delivery. Furthermore, key digital skills for project managers were identified by Marhraoui [49], who establish that higher digital competence of project managers leads directly to enhanced project management performance and efficiency, and, hence, better chances of Project Management Success. Accordingly, H2 was formulated on these premises assuming that Digital Fitness positively influences Project Management Success.

The development of the third hypothesis (H3) was inspired from the work of Bugarčić & Slavković [46] who find that the adoption and implementation of advanced Digital Tools including AI and IoT technologies enhances project monitoring, resource optimization, and planning accuracy. The framework developed by Khasawneh & Dweiri [6] emphasizes that the Digital Tools pillar consists of digital transformation initiatives and Industry 4.0 Emerging Technologies [32, 36]. Their analysis highlights the significant role that these tools play in enabling data-driven decisions, process automation, and enhanced coordination. The study concluded that organizations effectively deploying such tools are better equipped to improve project risk management and resource allocation, ultimately contributing to Project Management Success. Kanski & Pizon [11] confirm these findings and report that selected Industry 4.0 components such as IoT, AI, and Big Data analytics directly improve project management performance indicators and act as significant predictors of Project Management Success. In support of the role of digital transformation in project management, a study by Kozarkiewicz [50] reveals that digital transformation directly enhances project management effectiveness through digital platforms, agile methodologies, and IT-enabled coordination**.** Moreover**,** Zhang et al. [51] conclude that digital transformation initiatives such as data-driven processes and sustainability-aligned digital solutions directly contribute to project management efficiency and effectiveness**.**

The development of the moderating hypotheses in this study (H4, H5, and H6) is based on recent empirical findings in the field of digital transformation and infrastructure. The fourth hypothesis (H4) was developed based on the findings of Wadi et al. [52], who emphasize that, in infrastructure projects, digital technologies are often introduced as “ready-made tools that lack flexibility” (p. 293) without adequate readiness, leading to limited effectiveness [52]. This suggests that Digital Readiness plays a role in enabling Digital Tools to effectively contribute to project outcomes [53]. According to Guinan et al. [36], a good set of Digital Tools does not perform optimally without sufficient Digital Readiness or Digital Fitness. Additionally, the combination of tools and readiness is essential for the resilience and sustainability of project systems [53]. Moreover, using a hybrid FAHP–FTOPSIS approach, Khasawneh & Dweiri [6] demonstrate that Digital Tools have the highest closeness coefficient for enabling Project Management Success when their impact was evaluated in relation to Digital Readiness and Digital Fitness pillars, indicating that Digital Tools are most effective when foundational readiness is present. Furthermore, Aleca & Mihai [54] indicate that organizations with robust digital infrastructure readiness are more capable of maximizing the benefits of deploying advanced Digital Tools, such as cloud technologies and Industry 4.0 systems. In contrast, inadequate readiness can limit the potential productivity and operational gains offered by such Digital Tools. A PLS-SEM model was developed by Bugarčić & Slavković [46] to empirically demonstrate that digital transformation readiness strengthens the effectiveness of digital tools on project management outcomes such as cost, schedule, and quality, indicating a significant interaction that supports H4.

The fifth hypothesis (H5) posits that Digital Readiness moderates the effect of Digital Fitness on Project Management Success. This hypothesis draws on Naji et al. [13], who introduce critical infrastructure factors into their Digital Transformation Readiness Framework and emphasize that these factors are essential for successful digital outcomes. Their findings affirm that Digital Readiness forms the necessary foundation for capabilities like digitally competent employees and teams to be effectively leveraged. Moreover, this is corroborated by Khasawneh & Dweiri [6] who rank digital fitness elements behind Digital Tools—yet, point out that Digital Fitness delivers its benefits primarily in organizational contexts with adequate readiness [6]. In further support of the development of H5, the PLS-SEM analysis conducted by Chen et al. [12] confirms the positive correlation between the Digital Readiness of an organization and its competence towards seven types of DT, including "immersive technologies, sensing technology, robotics, 3D printing, digital fabrication, artificial intelligence and big data" (p. 905). The work of Chen et al. [12] has validated H5 using SEM and ANN and confirms a significant moderating effect of Digital Readiness on the relationship between digital competence and project management and execution success. According to Aleca & Mihai [54], the potential productivity improvements driven by digital skills and competencies are notably diminished without sufficient digital infrastructure readiness.

The sixth and last hypothesis (H6) was supported by research indicating that advanced Digital Tools significantly amplify the capabilities of digitally competent teams, supporting the development and performance of employees [41, 55]. For instance, Yaqub & Alsabban [41] concluded that Industry 4.0 emerging technologies such as IoT, AI, Big Data analytics, and cloud computing serve as crucial drivers of digital transformation, directly enhancing workforce digital skills, collaboration, and innovation outcomes across organizational units. Similarly, Eversberg & Lambrecht [55] highlight that, as Digital Tools become integrated into project environments, teams composed of digitally proficient individuals experience faster task completion, reduced errors, and improved collaborative efficiency. Therefore, aligned with Hypothesis 6, these findings illustrate that, when digital teams and digitally competent employees are equipped with effective Digital Tools, their project performance improves considerably, indicating a moderating effect of tools on Digital Fitness.

Acknowledging the symmetrical interaction term of the reversed moderation relationship direction of H6 in PLS-SEM, the literature highlighting the consideration of Digital Fitness as the moderator in the relationship is also explored to support the plausibility of this interaction effect. This exploration revealed results supporting the interaction, such as the work of Obradović et al. [56] which finds that project manager competencies are more fully realized when supported by Digital Tools, and the work of Kozarkiewicz [50] which concludes that digital maturity, comprising digital skills, enables more effective use of Digital Tools for improved project processes and project management outcomes. Such findings enhance the broader theoretical expectation that Digital Tools and Digital Fitness interact in influencing project management performance, even when the directional framing varies across different studies.

3- Research Methodology

The methodological process of this study followed a structured sequence of phases as shown in Figure 2. The first phase involved the identification and conceptualization of latent constructs and their respective observed indicators through the literature review. The second phase entailed designing a quantitative theory-driven research methodology based on purposive sampling to target respondents who are experienced project management professionals with digital technology experience. In the third phase, the structural model was specified by defining the hypothesized relationship among the identified latent constructs. Following this, a PLS-SEM analysis was conducted using SmartPLS 4 software. The measurement model was validated by examining the outer weights of formative indicators, further confirmed by assessing the outer loadings. Multicollinearity among indicators was evaluated using the Variance Inflation Factor (VIF). Subsequently, the path coefficients were tested, and their statistical significance was tested through corresponding p-values. The explanatory power and predictive relevance of the model were assessed using R-squared (R^2), effect size (f^2), and predictive relevance (Q^2). Finally, the study conducted a moderation analysis to evaluate the statistical significance and relevance of hypothesized moderating effects (H4, H5, and H6) within the proposed structural relationships.

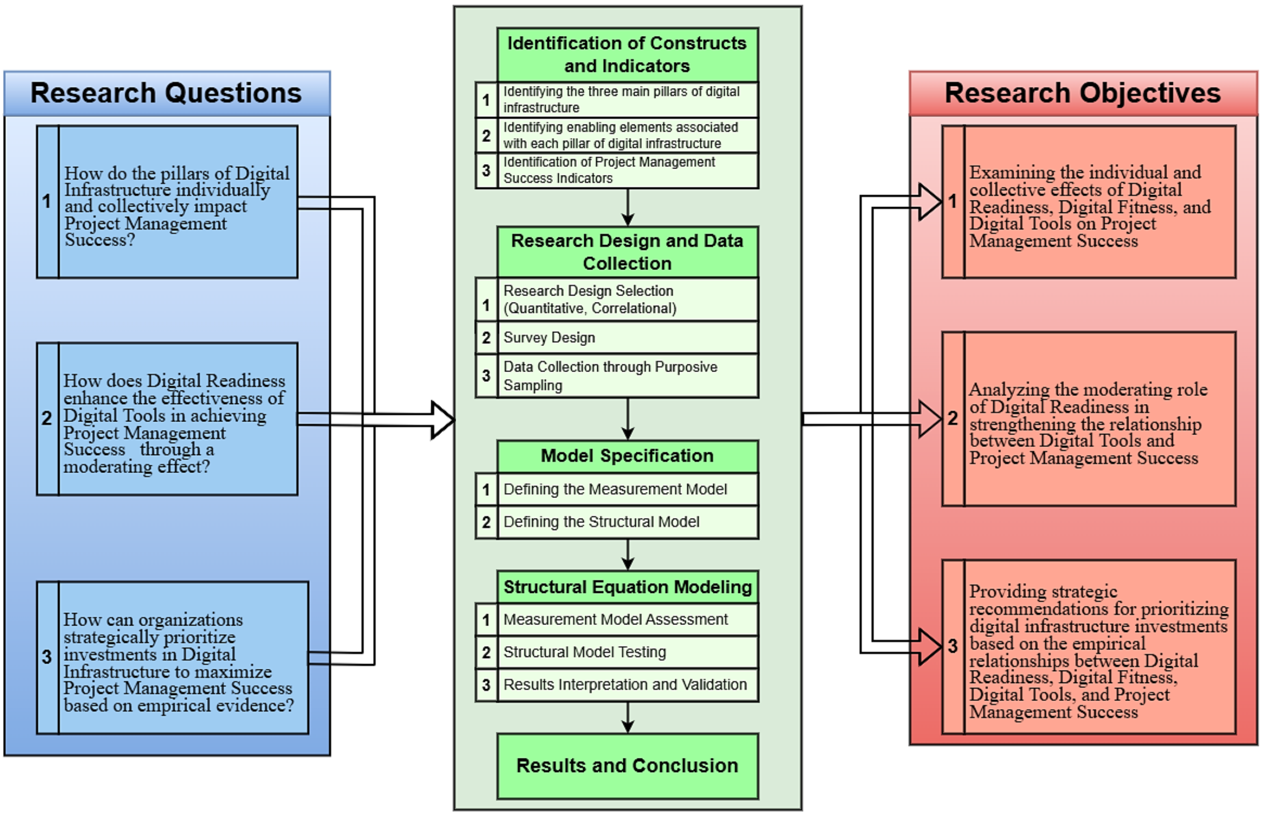

Figure 2. Research Methodology and its Connection to Research Questions and Objectives

SmartPLS was used because it fits the goals and structure of the research. The model includes four formative constructs (Digital Readiness, Digital Fitness, Digital Tools, and Project Management Success), which are better handled by PLS-SEM than by traditional covariance-based SEM [57, 58]. PLS-SEM is also preferred for predictive models, complex relationships, and when the data do not meet normality assumptions [59]. These advantages make it well-suited for studying the effects of digital infrastructure on Project Management Success. In addition, PLS-SEM is widely used in management and strategic research dealing with similar models [60]. For the analysis of the collected data, SmartPLS 4 was used, which is a variance-based SEM software. The fact that SmartPLS 4 is effective with formative constructs and moderate sample sizes [61] made it an ideal choice of software for the analysis in this research.

3-1- Study Design and Theoretical Model Development

To explore the relationships among the pillars of digital infrastructure and their effect on Project Management Success, this study employed a quantitative, theory-driven research design. This approach is particularly appropriate when analyzing complex structural equation models, which are rooted in theoretically derived latent constructs and their respective indicators [62]. The theory-based design enabled the examination of hypothesized relationships among variables derived from literature, ensuring a robust theoretical basis that supports construct validity, ensures model coherence, enhances explanatory power, and guides meaningful interpretation of the findings.

Building upon the theoretical and empirical insights outlined in the introduction, the research model was designed by synthesizing key findings from Khasawneh & Dweiri [6], alongside additional peer-reviewed sources in the body of literature. These works collectively provided the conceptual foundation for identifying Digital Readiness, Digital Fitness, and Digital Tools as the three foundational pillars of digital infrastructure. Each of these constructs was treated as a latent variable, with their associated enabling elements adopted as indicators. The formulation of the structural model was guided by validated frameworks and supported by theoretical foundations including the TOE framework and the RBV model [25, 27]. These perspectives reinforced the appropriateness of the selected constructs and justified their inclusion in the SEM analysis to empirically assess their impact on Project Management Success. In parallel, Project Management Success was conceptualized as the fourth formative latent construct, with its corresponding indicators such as budget compliance, schedule adherence, and scope alignment adopted based on prior literature [6].

3-2- Data Collection and Sampling

3-2-1- Population and Sampling

The research study targeted experienced project managers and project management professionals who have spent at least five years in the field and possess appreciable experience in digital technology systems and digital transformation applications. The target sample of the research ensures that participants possess the required qualifications to assess the effect of the digital infrastructure pillars on project management outcomes. To make sure that a wider range of respondents was covered, the survey was distributed in both online and paper-based modes.

3-2-2- Data Collection Method

Data were gathered using both online and paper-based modes to increase accessibility and response rates. The purposive selection of respondents was further justified to ensure relevance, meaning that only individuals meeting the specified inclusion criteria were invited to participate. This approach enhanced the validity of the collected data by aligning the expertise of the respondents with the objectives of the study. The survey was administered to around 400 subjects over a set time period and ensured respondent confidentiality and voluntary participation. The first section of the survey collected demographic and professional background data, including industry, country, years of experience in project management, digital technology experience, and organizational seniority level. This ensured the alignment of survey respondents with the research criteria. Completed surveys were stored digitally and reviewed for completeness and consistency before analysis.

Data were gathered through a structured survey. The first section of the survey collected demographic and professional background data, including industry, country, years of experience in project management, digital technology experience, and organizational seniority level. Despite the fact that the survey was purposive, this section of the survey ensured the alignment of survey respondents with the requirements. The second section of the survey comprised a 56-cell evaluation matrix which contained eight digital infrastructure enabling elements (rows) across seven Project Management Success indicators (columns). A 10-point Likert-type scale was used, ranging from 1 (no impact) to 10 (very high impact). Each cell in the matrix answered the following question in relation to the effect of each digital infrastructure enabling element on each Project Management Success indicator:

"To assess the role of digital infrastructure in Project Management Success, please evaluate the significance of the following digital infrastructure enabling elements in relation to the Project Management Success indicators, using a scale of 1 (no impact) to 10 (very high impact)."

3-3- Survey Instrument and Construct Measures

The survey consisted of two parts: (1) the background/demographic section and (2) a structured 56-cell evaluation matrix. The matrix included eight enabling elements of digital infrastructure (rows) evaluated across seven Project Management Success indicators (columns).

A 10-point Likert-type scale was used for each cell, ranging from 1 (no impact) to 10 (very high impact). This structure allowed respondents to evaluate the degree to which each enabling element influenced Project Management Success in terms of a specific Project Management Success criterion (indicator). This evaluation matrix served as the basis for operationalizing the constructs of the structural model (Digital Readiness, Digital Fitness, Digital Tools, and Project Management Success). The matrix format was selected instead of a traditional 56-question survey to streamline data collection, reduce respondent fatigue, enhance the quality of responses, and expedite the process of completing the survey. It allowed for the simultaneous evaluation of all element–indicator combinations, which was essential for the multidimensional nature of the SEM analysis. Additionally, the use of a 10-point Likert-type scale supported the PLS-SEM methodology by providing continuous data suitable for assessing the strength and direction of relationships among constructs to improve the statistical reliability of the resulting path coefficients. A 10-point response format enhances construct validity by capturing a wider range of perceptions, making it especially effective for measuring complex or multidimensional concepts, allowing for a more comprehensive representation of the constructs being measured [63].

3-4- Common Method Bias

Given that data for all constructs were collected from the same respondents using a structured questionnaire, the potential for common method bias (CMB) was carefully considered. However, traditional methods such as Harman's single-factor test were not suitable because all constructs in this study are formative in nature [64]. Instead, VIF values were assessed for all formative indicators to detect any signs of multicollinearity that could suggest CMB. As recommended by Kock [65], VIF values below 3.3 indicate that common method bias is not a significant concern in PLS-SEM models. Although VIF values below 5 are considered acceptable [66], values below 3.3 are preferable. In this study, only indicators with VIF values below the threshold of 5 were retained in the analysis, suggesting that CMB was not likely to bias the results. In addition to statistical checks, respondent anonymity was ensured as a procedural remedy during the survey design. This approach helped to reduce social desirability bias and evaluation apprehension, thereby improving data quality and helping to mitigate potential sources of common method bias.

3-5- Structural Equation Modeling Approach

In developing the model for this research, the finalized set of three Digital Infrastructure Pillars as well as Project Management Success indicators proposed by Khasawneh & Dweiri [6] were adopted as foundational inputs. Other peer-reviewed studies have also confirmed the content validity of the proposed model by reinforcing and emphasizing the collective and individual effects of these pillars on Project Management Success [12, 13, 36, 41, 46, 47, 52–55]. Digital Readiness, Digital Fitness, Digital Tools, and Project Management Success were the four inputs conceptualized as latent constructs in the SEM analysis

3-5-1- Measurement Model Assessment

All four latent constructs studied in this research were formative constructs that are caused by their indicators. The indicators of Project Management Success include compliance with the budget (PMS1), compliance with the schedule (PMS2), compliance with quality requirements and specifications (PMS3), meeting the scope of the project (PMS4), ensuring long-run organizational benefits (PMS5), achieving the strategic objectives of the organization (PMS6), and sustainability of solutions and success (PMS7) [6, 11, 43–45]. These dimensions represent distinct yet complementary outcomes that collectively define the construct of Project Management Success. As such, they are modeled formatively, since changes in one indicator may not necessarily imply changes in the others, but each contributes uniquely to the overall conceptualization of Project Management Success.

Digital Readiness, Digital Fitness, and Digital Tools are also formative constructs in this study because their indicators are distinct determinants that define the corresponding construct but are not interchangeable. The enabling elements of Digital Readiness (technological infrastructure, real-time data access and management, large internet network capacity, and cybersecurity systems) [6, 16, 31–33] were considered as the indicators of the Digital Readiness latent construct in the structural model (DR1, DR2, DR3, and DR4). For Digital Tools, the enabling elements included digital transformation initiatives and Industry 4.0 Emerging Technologies [6, 39, 40], both of which served as indicators of the Digital Tools latent construct (DT1 and DT2). Similarly, digitally competent employees and digital teams were identified as the enabling elements of Digital Fitness [6, 32, 36], and were used as the indicators of the Digital Fitness latent construct in the model (DF1 and DF2). Each set of indicators was selected based on prior literature to reflect the theoretical and empirical relevance of these dimensions to their respective constructs. Table 1 lists the latent constructs and indicators included in the study.

Table 1. Latent Constructs and Indicators of the SEM Analysis

Latent Construct	Indicator	Abbreviation
Project Management Success	Compliance with the Budget	PMS1
	Compliance with the Schedule	PMS2
	Compliance with Quality Requirements and Specifications	PMS3
	Meeting the Scope of the Project	PMS4
	Ensuring Long-run Organizational Benefits	PMS5
	Achieving the Strategic Objectives of the Organization	PMS6
	Sustainability of Solutions and Success	PMS7
Digital Readiness	Cybersecurity Systems	DR1
	Real-time Data Access and Management	DR2
	Technological Infrastructure	DR3
	Large Internet Network Capacity	DR4
Digital Fitness	Digital Teams	DF1
	Digitally Competent Employees	DF2
Digital Tools	Digital Transformation	DT1
	Industry 4.0 Emerging Technologies	DT2

For the four formative constructs defined in this study, indicators were assessed for multicollinearity using VIF to check for redundancy among indicators. Traditional criteria for discriminant validity such as the Heterotrait–Monotrait (HTMT) ratio of correlations are not applicable, because such methods are designed for reflective measurement models where indicators are expected to be highly correlated. Accordingly, the VIF values were compared to a threshold of 3.3 indicating ideal multicollinearity and a threshold of 5 indicating acceptable multicollinearity. The significance of outer weights was then assessed using bootstrapping on SmartPLS 4 to check whether the indicator contributes meaningfully to the construct. If any of the outer weights is statistically insignificant for any indicator, the outer loadings are checked and the indicator is retained in case its outer loading is more than 0.5, as it would be considered contributing to content validity.

3-5-2- Structural Model Evaluation

The structural model evaluation process involved checking the path coefficients by testing standardized regression weights (β) for hypothesized paths to validate the strength and direction of the relationships between latent constructs.

Checking the path coefficients and their statistical significance enabled the testing of H1, H2, and H3. A positive and significant path coefficient means that the relationship is supported, whereas non-significant paths suggest that the effect is weak or absent.

R^2 values were then checked to explain how much variance in the dependent construct (Project Management Success) is explained by the independent constructs (Digital Readiness, Digital Fitness, and Digital Tools). R^2 is checked to assess the predictive power of the model with values above 0.75 indicating substantial predictive power. Hair et al. [61] note that R^2 values beyond 0.90 might indicate overfit, and recommend using Q^2 as part of a broader model validation strategy. f^2 was then checked to measure the contribution of an individual predictor to the R^2 of the dependent variable, helping to determine the relative importance of each predictor construct. Effect sizes larger than 0.35 indicate higher relative importance of constructs [67]. Q^2 is finally checked to test the predictive accuracy of the model through a technique that assesses whether the model has predictive power beyond just fitting the data. Any positive Q^2 value suggests predictive relevance, with higher Q^2 values indicating better prediction [68]. According to Lin & Hyunh [69], positive Q^2 values are evidence of non-overfitting when R^2 is suspiciously high. Shmueli et al. [70] support this by stating that relying solely on R^2 and f^2 is insufficient, whereby predictive validity metrics like Q^2 ensure that the findings of the model are not limited to the sample data but can be reliably applied to similar real-world situations.

The last step of the Structural Model Evaluation is to check the moderation effects to test interactions involving the effect of one construct on another depending on a third construct. A statistically significant interaction means that the moderator changes the strength or direction of the relationship. This step aims to test H4, H5, and H6 in this study.

4- Results

A total of 136 responses were collected through the survey, whereby 118 responses were submitted online through SurveyMonkey and 18 were submitted through paper-based surveys. The purposive sampling technique followed in this research has ensured that all survey respondents were experienced project management professionals with appreciable exposure to technology applications and digital-based projects. More than 58% of respondents had more than 10 years of project management-related experience, and around 46% of them had more than 10 years of technology and digital technology experience. Table 2 outlines the demographics of the survey respondents.

Table 2. Demographic Profile of the Survey Respondents

Characteristics	Categories	N%
Survey Type	Online	86.76%
	Paper	13.24%
Industry	Construction	34.56%
	Educational Services	18.38%
	Technology	12.50%
	Professional, Scientific, and Technical Services	7.35%
	Engineering, Infrastructure, and Contractors	5.88%
	Other	21.32%
Country	United Arab Emirates	36.03%
	Jordan	30.15%
	China	7.35%
	Egypt	6.62%
	Other	19.85%
Project Management Experience	Up to 10 Years	41.91%
	10–20 Years	44.12%
	More than 20 years	13.97%
Technology and Digital Technology Experience	Up to 10 Years	53.68%
	10–20 Years	33.82%
	More than 20 years	12.50%
Seniority Level	Junior Level	1.47%
	Mid-Level	22.06%
	Senior Level	52.21%
	Top Management Level	24.26%

4-1- Measurement Model Results

Based on the proposed hypotheses in this research, a path model was structured (Figure 3) and a PLS-SEM algorithm was calculated.

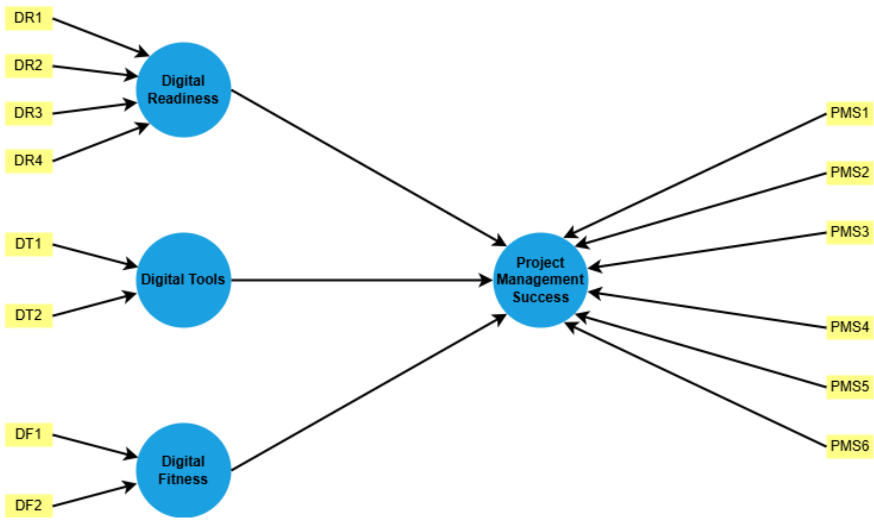

Figure 3. The Hypothesized Structural Path Model

To test the validity of indicators in the model, the bootstrapping test conducted using SmartPLS 4 showed that the outer weights for all indicators were statistically significant. Table 3 shows the outer weights of the indicators and the corresponding p-values. The outer weights ranged from 0.119 (DR2) to 0.723 (DT2). All weights were statistically significant, indicating that all indicators had a confirmed contribution to their corresponding formative construct. DT2 contributed very strongly to Digital Tools with an outer weight of 0.723, and DF2 contributed strongly to Digital Fitness with an outer weight of 0.611. On the other hand, all Project Management Success indicators contributed weakly but meaningfully (due to statistical significance) to Project Management Success, in addition to DR2 which also contributed weakly to Digital Readiness. The rest of indicators (DF1, DR1, DR3, DR4, and DT1) had a moderate contribution to their corresponding formative constructs.

Table 3. Outer Weights

Path	Outer Weight	P-Value	Contribution to Formative Construct
DF1 → Digital Fitness	0.441	<0.001	Moderate
DF2 → Digital Fitness	0.611	<0.001	Strong
DR1 → Digital Readiness	0.371	<0.001	Moderate
DR2 → Digital Readiness	0.119	0.002	Meaningful
DR3 → Digital Readiness	0.311	<0.001	Moderate
DR4 → Digital Readiness	0.393	<0.001	Moderate
DT1 → Digital Tools	0.476	<0.001	Moderate
DT2 → Digital Tools	0.723	<0.001	Very Strong
PMS1 → Project Management Success	0.157	<0.001	Meaningful
PMS2 → Project Management Success	0.148	<0.001	Meaningful
PMS3 → Project Management Success	0.155	<0.001	Meaningful
PMS4 → Project Management Success	0.207	<0.001	Meaningful
PMS5 → Project Management Success	0.124	<0.001	Meaningful
PMS6 → Project Management Success	0.154	<0.001	Meaningful
PMS7 → Project Management Success	0.151	<0.001	Meaningful

These results indicate that Digital Tools (especially DT2: Industry 4.0 Emerging Technologies) and Digital Fitness (especially DF2: digitally competent employees) are the strongest contributors among the pillars. Therefore, advanced technologies and skilled human resources provide the most direct support to Project Management Success. On the other hand, Project Management Success indicators showed a weaker contribution, which indicates that Project Management Success is multidimensional and not explained by a single indicator.

To further justify the validity of the indicators of the model and their contribution to formative constructs, the outer loadings were tested and it was found that all of them exceeded the 0.70 threshold except for DR2, with values ranging from 0.739 (DT1) to 0.965 (DF2). The outer loading for DR2 stood at 0.687, which is an acceptable value given its close proximity to the 0.7 threshold and the prioritization of outer weights over outer loadings to justify the retention of the indicator as a contributor to its formative construct [58]. Therefore, DR2 was retained due to its statistically significant outer weight as a major validation criterion. Table 4 shows the outer loadings of the indicators.

Table 4. Outer Loadings Matrix

Indicator	Digital Fitness	Digital Readiness	Digital Tools	Project Management Success
DF1	0.931			
DF2	0.965			
DR1		0.893		
DR2		0.687		
DR3		0.812		
DR4		0.848		
DT1			0.739	
DT2			0.896	
PMS1				0.897
PMS2				0.906
PMS3				0.949
PMS4				0.916
PMS5				0.870
PMS6				0.943
PMS7				0.901

To assess the multicollinearity in formative constructs, VIF is tested to test the unique contribution of each indicator on its associated formative construct. Table 5 shows the VIF values for each one of the indicators.

Table 5. Variance Inflation Factor

Indicator	VIF
DF1	2.799
DF2	2.799
DR1	2.354
DR2	1.781
DR3	2.078
DR4	1.859
DT1	1.152
DT2	1.152
PMS1	5.135
PMS2	5.362
PMS3	8.680
PMS4	7.700
PMS5	6.082
PMS6	9.555
PMS7	5.374

The VIF values for the indicators of Digital Fitness, Digital Readiness, and Digital Tools were all less than the ideal threshold of 3.3. On the other hand, all seven indicators of Project Management Success had values above 5, indicating high collinearity with each other. The collinearity statistics in such case should be recalculated to lower down the VIF values below the acceptable threshold of 5 after excluding the highly correlated indicators one by one. Because PMS6 had the highest VIF value (9.555), it was excluded from the analysis and the VIF values were recalculated after its exclusion, as shown in Table 6. The exclusion of PMS6 has lowered down the VIF values for all indicators except for

PMS3 to below or around the threshold of 5. The VIF of PMS3 stood at a critical value of 8.65 and, hence, it was also excluded and the VIF values were recalculated once again. The second recalculation of VIF values yielded values below 5 for all Project Management Success indicators except PMS7 which stood at 5.026; a slightly higher value than the acceptable threshold of 5. Despite being able to tolerate slightly higher VIF values in case of strong theoretical reasoning, PMS7 was excluded from the analysis to only retain strong indicators in the study with minimum chances of collinearity. The recalculation of collinearity statistics showed lower VIF values that were acceptable (between 3.3 and 5) for PMS1, PMS2, and PMS4, and an ideal VIF value (below 3.3) for PMS5.

Table 6. Variance Inflation Factor Values After Excluding PMS3, PMS6, and PMS7

Indicator	VIF (Excluding PMS6)	VIF (Excluding PMS3)	VIF (Excluding PMS7)
DF1	2.799	2.799	2.799
DF2	2.799	2.799	2.799
DR1	2.354	2.354	2.354
DR2	1.781	1.781	1.781
DR3	2.078	2.078	2.078
DR4	1.859	1.859	1.859
DT1	1.152	1.152	1.152
DT2	1.152	1.152	1.152
PMS1	5.132	4.802	4.687
PMS2	5.249	4.208	4.058
PMS3	8.650	Excluded	Excluded
PMS4	4.778	4.432	4.391
PMS5	5.104	4.350	2.746
PMS6	Excluded	Excluded	Excluded
PMS7	5.026	5.026	Excluded

This step demonstrates that, despite the conceptual broadness of the Project Management Success construct, refinement was required to avoid redundancy among highly correlated indicators. The retained indicators shown in Table 6 continued to cover the core of Project Management Success criteria such as budget compliance, schedule compliance, and long-term organizational benefits. Therefore, the Project Management Success construct remains theoretically valid while statistically reliable.

After removing indicators with high multicollinearity (VIF > 5), the measurement model was re-estimated to obtain updated outer weights and to test the statistical relevance of the remaining indicators. This step ensures that the construct is accurately specified and validated [71]. Table 7 shows the updated outer weights after the exclusion of PMS3, PMS6, and PMS7.

Table 7. Updated Outer Weights After Excluding PMS3, PMS6, and PMS7

Path	Outer Weight	P-Value	Contribution to Formative Construct
DF1 → Digital Fitness	0.476	<0.001	Moderate
DF2 → Digital Fitness	0.577	<0.001	Strong
DR1 → Digital Readiness	0.369	<0.001	Moderate
DR2→ Digital Readiness	0.104	0.012	Meaningful
DR3→ Digital Readiness	0.292	<0.001	Meaningful
DR4→Digital Readiness	0.427	<0.001	Moderate
DT1→ Digital Tools	0.466	<0.001	Moderate
DT2-> Digital Tools	0.731	<0.001	Very Strong
PMS1→Project Management Success	0.222	<0.001	Meaningful
PMS2 → Project Management Success	0.215	<0.001	Meaningful
PMS4 →Project Management Success	0.370	<0.001	Moderate
PMS5 → Project Management Success	0.300	<0.001	Moderate

The outer weights reported in Table 7 indicate that the outer weights for all indicators were statistically significant as they all had p-values less than 0.05. The updated outer weights ranged from 0.104 (DR2) to 0.731 (DT2). The statistical significance of all outer weights demonstrates that all indicators had a confirmed contribution to their corresponding formative construct. DT2 contributed very strongly to Digital Tools, and DF2 contributed strongly to Digital Fitness. After excluding the three Project Management Success indicators, PMS4 and PMS5 have now become moderate contributors to Project Management Success, while PMS1 and PMS2 stayed as weak contributors. DR2 and DR3 were also reported as weak contributors as their outer weights fell below 0.3. Nevertheless, all weak contributors (PMS4, PMS5, DR2, and DR3) were considered as meaningful contributors and were retained in the analysis due to their statistical significance proven by p-values below 0.05. to Project Management Success, in addition to DR2 which also contributed weakly to Digital Readiness. The rest of indicators (DF1, DR1, DR3, DR4, and DT1) had a moderate contribution to their corresponding formative constructs.

The outer loadings were tested again to confirm the validity of the indicators of the model and their contribution to formative constructs after eliminating three of the indicators of Project Management Success. Similar to the case before eliminating the three indicators, all of the outer loadings exceeded the 0.70 threshold except for DR2, with values ranging from 0.732 (DT1) to 0.959 (DF2). The outer loading for DR2 stood at 0.673, which is an acceptable value given its close proximity to the 0.7 threshold, and the prioritization of outer weights over outer loadings to justify the retention of the indicator as a contributor to its formative construct [58]. Therefore, DR2 was retained due to its statistically significant outer weight as a major validation criterion. Table 8 shows the updated outer loadings of the indicators.

Table 8. Updated Outer Loadings Matrix

Indicator	Digital Fitness	Digital Readiness	Digital Tools	Project Management Success
DF1	0.939			
DF2	0.959			
DR1		0.893		
DR2		0.673		
DR3		0.798		
DR4		0.863		
DT1			0.732	
DT2			0.901	
PMS1				0.907
PMS2				0.908
PMS4				0.929
PMS5				0.865

4-2- Structural Model Results

Upon running the PLS-SEM analysis on the path model in SmartPLS 4, all proposed relationships between the latent constructs were found to be statistically significant, as shown in Table 9. These results confirm the direct effects hypothesized in the structural path model.

Table 9. Hypothesized Path Relationships Between Latent Constructs with Coefficients, P-values, and Statistical Significance

Hypothesis	β	P-Value	Statistical Significance
H1: Digital Readiness → Project Management Success	0.538	< 0.001	Statistically Significant
H2: Digital Fitness → Project Management Success	0.309	< 0.001	Statistically Significant
H3: Digital Tools → Project Management Success	0.218	< 0.001	Statistically Significant

Among the three digital infrastructure pillars, Digital Readiness had the strongest effect on Project Management Success. This highlights its impartial role in improving project outcomes and driving successful project management. On the other hand, Digital Fitness and Digital Tools showed relatively smaller—yet still significant—coefficients, indicating meaningful individual effects on Project Management Success.

Figure 4 depicts the structural path model with path coefficients (β) indicating the strength of the path relationship between the latent constructs, and outer loadings (λ) indicating the strength of effect of an indicator on its associated latent variable.

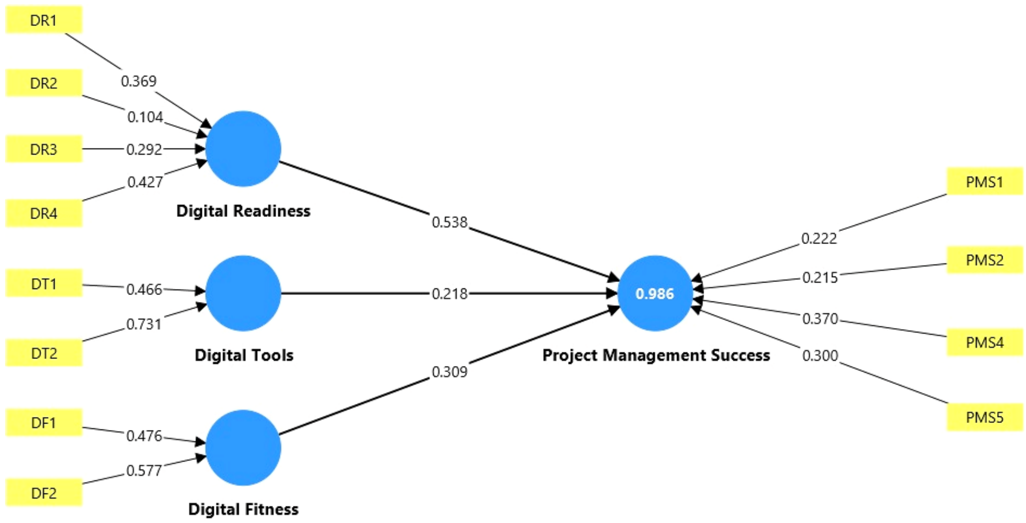

Figure 4. **Structural Path Model with Path Coefficients, Outer Loadings, and P-values**

According to Kock [65], R^2, f^2, and Q^2 together form the core quality criteria for evaluating a structural model. As shown in Table 10, the R^2 value for Project Management Success is 0.986, indicating high explanatory power of Digital Readiness, Digital Fitness, and Digital Tools, which explain 98.6% of the variance in Project Management Success. Table 11 supports these findings as it reports an identical adjusted R^2 value for Project Management Success. Moreover, Table 12 presents the f^2 values for Digital Readiness (5.158), Digital Fitness (2.449), and Digital Tools (1.089), all statistically significant at $p < 0.05$. These values indicate that all paths are significant with large effects of the three latent constructs (Digital Fitness, Digital Readiness, and Digital Tools) on Project Management Success given the effect sizes being above the conventional standard of 0.35.

Table 10. **R-square for Project Management Success**

Latent Constructs	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
Project Management Success	0.986	0.986	0.003	382.707	<0.001

Table 11. **R-square Adjusted for Project Management Success**

Latent Constructs	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
Project Management Success	0.986	0.986	0.003	374.085	<0.001

Table 12. **f-square Values for Path Relationships**

Structural Path	Original sample (O)	P values
Digital Fitness → Project Management Success	2.449	<0.001
Digital Readiness → Project Management Success	5.158	<0.001
Digital Tools → Project Management Success	1.089	<0.001

Predictive relevance was also tested to further support the proposed model and validate its structural relationships and effect sizes within the model. Predictive relevance proved to be strong based on the fact that all four indicators of Project Management Success exhibited positive Q^2 values, ranging from 0.732 (PMS5) and 0.845 (PMS4), as shown in Table 13. RMSE and MAE were not reported because this study adopts an explanatory modeling approach, not predictive benchmarking**.** Therefore, the focus of the study remains on testing theoretically based relationships between digital infrastructure pillars and Project Management Success.

Table 13. **Predictive Relevance for Project Management Success Indicators**

Indicator	Q^2
PMS1	0.809
PMS2	0.812
PMS4	0.845
PMS5	0.732

The fact that the structural model explains over 98% of the variance in Project Management Success can signal potential overfitting of the model, but it is justifiable based on several factors that ensure the robustness and validity of the model. The first factor is multicollinearity, which was addressed by calculating VIF values and ensuring that all indicators had values below 5, which indicates that there is no problematic multicollinearity affecting the relationships in the model. Second, the high F^2 values for the path relationships (2.449, 5.158, and 1.089) point to large effect sizes, suggesting that the constructs in the model have a substantial influence on the dependent variables. According to Cohen [67], an F^2 value above 0.35 represents a large effect, and, as F^2 values far exceed the aforementioned threshold, this confirms the strong influence of the path and suggests that the constructs in the model have a substantial influence on the dependent variables. Finally, the high Q^2 values also support the credibility of high individual f^2 values, showing that those large individual effects are not just statistical noise as they translate into a meaningful explanation of Project Management Success at the indicator level. Additionally, the high Q^2 values also confirm the validity of the explanatory power indicated by the high R^2 values, signaling that this explanatory power is real and that the indicators can truly explain Project Management Success not only by explaining its variance but also but also by predicting it accurately.

The careful handling of multicollinearity (VIF), the large effect sizes (F^2), and the strong predictive relevance (Q^2) of the model all contribute to the justification of the high R^2. This is consistent with studies such as that by Hair et al. [66], where high R^2 values were observed in models with strong path relationships and were justified through the use of proper model validation techniques, including testing for multicollinearity, examining effect sizes, and assessing predictive relevance. Furthermore, Henseler et al. [60] demonstrate in their study that, when predictive relevance (Q^2) is high and VIF values are controlled to ensure there is no high multicollinearity, high R^2 values are plausible and do not suggest overfitting. These references support the conclusion that the high R^2 is credible and reflects well-specified meaningful relationships rather than overfitting.

4-3- Moderation Analysis

To test the moderation role of Digital Readiness in the effect of Digital Tools on Project Management Success, the path model was reconstructed based on this hypothesis as shown in Figure 5, and a bootstrapping analysis was conducted on the software.

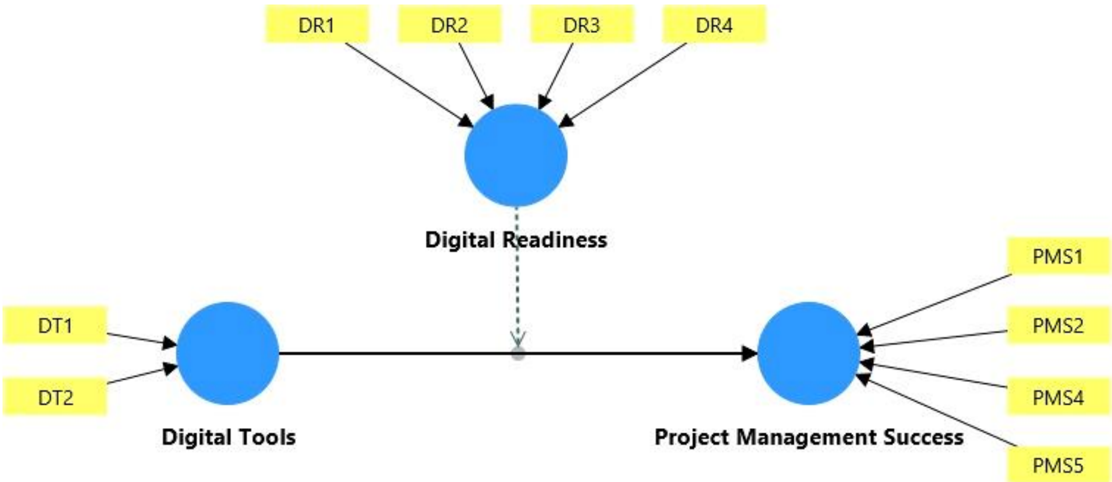

Figure 5. Hypothesis 4 Path Model Reconstructed to Test the Moderation Role of Digital Readiness in the Effect of Digital Tools on Project Management Success

Accordingly, the path coefficient was found as a statistically significant positive value (0.046) at a P-value less than 0.05, as shown in Table 14. The path coefficient value supported H4 and indicated that Digital Readiness enhances the effect of Digital Tools on Project Management Success. The 95% confidence intervals (0.018 to 0.067) confirmed the robustness of the findings. Accordingly, this highlights the role of Digital Readiness in leveraging Digital Tools. Organizations with strong Digital Readiness are, therefore, more capable of translating the adoption of Digital Tools into improved project outcomes.

Table 14. Path Coefficient for Digital Readiness Moderation of the Effect of Digital Tools on Project Management Success

Structural Path	Original sample (O)	Sample mean	2.5 %	97.5%	Standard deviation	P-value
Digital Readiness → Project Management Success	0.665	0.667	0.583	0.742	0.040	<0.001
Digital Readiness x Digital Tools → Project Management Success	0.046	0.044	0.018	0.067	0.012	<0.001
Digital Tools → Project Management Success	0.388	0.384	0.298	0.475	0.045	<0.001

To test the moderation role of Digital Readiness in the effect of Digital Fitness on Project Management Success, the path model was reconstructed based on this hypothesis as shown in Figure 6, and a bootstrapping analysis was conducted using the software.

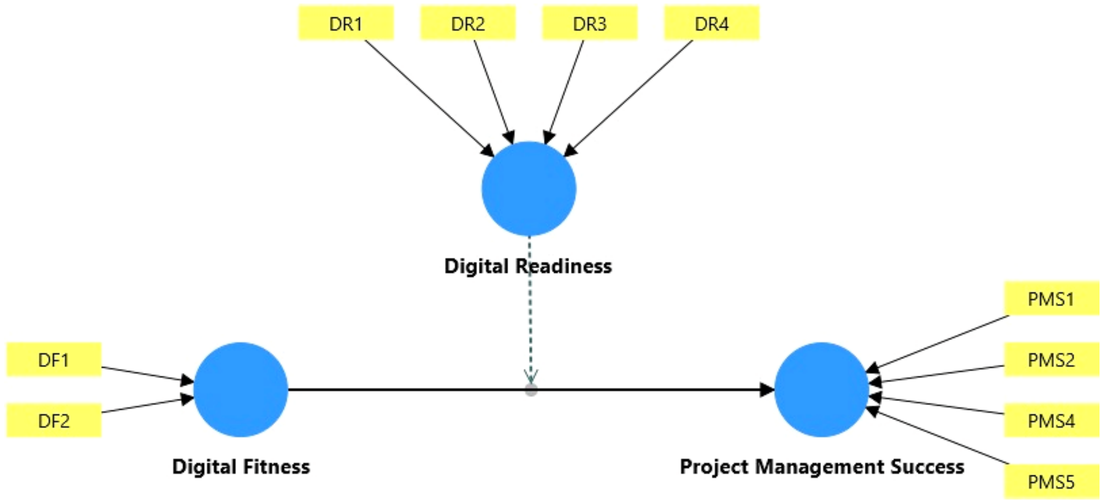

Figure 6. Hypothesis 5 Path Model Reconstructed to Test the Moderation Role of Digital Readiness in the Effect of Digital Fitness on Project Management Success

Accordingly, the results reported in Table 15 show that the path coefficient was found as a positive value (0.015) but at a P-value greater than 0.05. This indicates that the moderation effect is not statistically significant. The statistical rejection of the path coefficient does not support H5 and indicates that Digital Readiness does not enhance the effect of Digital Fitness on Project Management Success. This conclusion can be interpreted based on the assumption that Digital Readiness is related to the existence of hardware and software, which does not directly support the digital skills of employees and the formation of digital teams. This also implies that improving Digital Readiness does not automatically strengthen the contribution of Digital Fitness. In other words, it can be concluded that digitally competent employees and digital teams are not dependent on the level of Digital Readiness in the organization or on decisions to invest in it.

Table 15. Path Coefficient for Digital Readiness Moderation of the Effect of Digital Fitness on Project Management Success

Structural Path	Original sample (O)	Sample mean	2.5 %	97.5%	Standard deviation	P-value
Digital Readiness → Project Management Success	0.668	0.666	0.602	0.705	0.032	<0.001
Digital Readiness x Digital Fitness → Project Management Success	0.015	0.017	-.008	0.043	0.013	0.258
Digital Fitness → Project Management Success	0.373	0.372	0.308	0.438	0.033	<0.001

H6 was tested by investigating the moderation role of Digital Tools in the effect of Digital Fitness on Project Management Success. Therefore, the path model was reconstructed based on this hypothesis and a bootstrapping analysis was conducted using the software. Figure 7 shows the reconstructed path model based on H6.

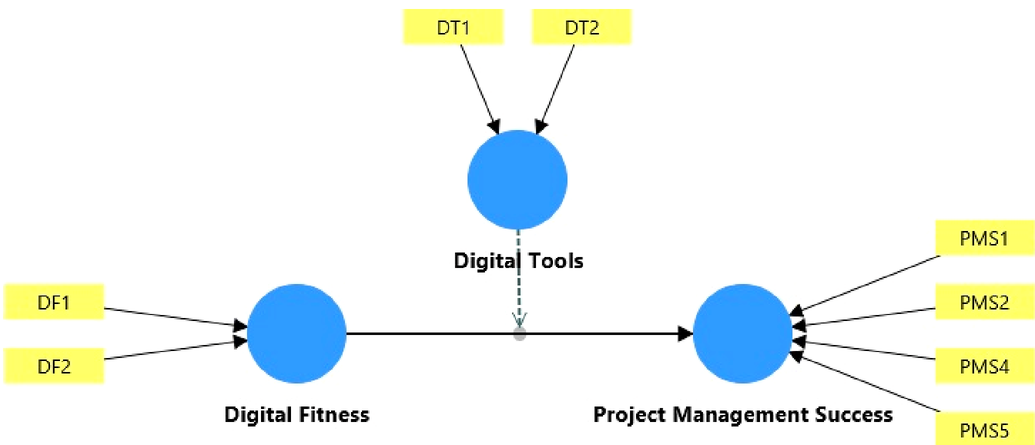

Figure 7. Hypothesis 6 Path Model Reconstructed to Test the Moderation Role of Digital Tools in the Effect of Digital Fitness on Project Management Success

The results shown in Table 16 indicate that the path coefficient is not statistically significant despite exhibiting a positive value. Therefore, the p-value being more than 0.05 does not support the claim made in H6 regarding the moderation role of Digital Tools of the effect of Digital Fitness on Project Management Success. This suggests that, despite the direct effect of Digital Tools on Project Management Success, the role of Digital Fitness in Project Management Success is not improved by the adoption of Digital Tools. Therefore, it can be concluded that digitally competent employees and digital teams are not only not dependent on Digital Readiness but also not dependent on Digital Tools or the decision to invest in them.

Table 16. Path Coefficient for Digital Tools Moderation of the Effect of Digital Fitness on Project Management Success

Structural Path	Original sample (O)	Sample mean	2.5%	97.5%	Standard deviation	P-value
Digital Tools → Project Management Success	0.556	0.546	0.435	0.634	0.051	<0.001
Digital Tools x Digital Fitness → Project Management Success	0.042	0.049	-0.002	0.124	0.033	0.198
Digital Fitness → Project Management Success	0.495	0.503	0.413	0.611	0.050	<0.001

5- Discussion

The purpose of this study was to examine how the three pillars of digital infrastructure affect Project Management Success at individual and collective levels. The use of SEM paved the way for a comprehensive testing of the hypothesized direct relationships (H1, H2, and H3) and moderated effects (H4, H5, and H6).

A radar chart mapping the path coefficients of the latent constructs and the outer loadings of the observed variables within the suggested structural equation model is shown in Figure 8. The radar chart is divided into four quadrants whereby each represents one of the four latent constructs. Based on the number of indicators associated with each construct, a quadrant is proportionally divided to accommodate these indicators. The outer weights are shown as solid blue lines that indicate the contribution of each indicator in forming its corresponding latent construct. The outer loadings are shown as solid dark red lines that indicate how strongly each indicator correlates with its corresponding latent construct. A dotted dark green line joining the corresponding path coefficients (0.309, 0.538, and 0.218) of the latent constructs (Digital Fitness, Digital Readiness, and Digital Tools) further illustrates the relative impact of these digital infrastructure pillars on Project Management Success.

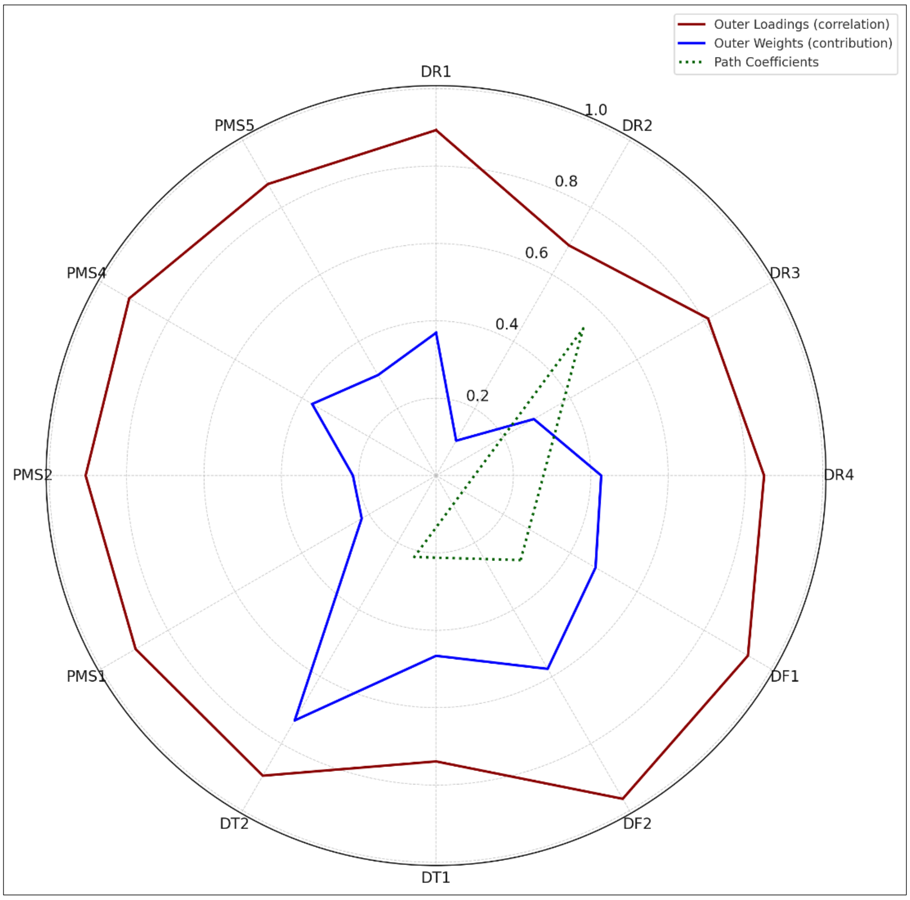

Figure 8. Radar Chart Depicting Path Coefficients of Latent Constructs Outer Weights, and Outer Loadings of Indicators

This study confirmed that each of the three pillars of digital infrastructure (Digital Readiness, Digital Fitness, and Digital Tools**)** demonstrated statistically significant effects on various aspects of Project Management Success. These findings support the theoretical proposition that digital infrastructure is a composite of interdependent capabilities that operate collectively to influence Project Management Success. The results align with the structural model and indicate strong empirical support for the conceptual framework adopted in this study. The use of formative constructs and the PLS-SEM methodology further strengthened these findings by enabling the analysis of interrelationships and moderation effects among constructs that reflect multidimensional real-world phenomena.

Digital Readiness emerged as the most influential construct, both as a direct contributor to Project Management Success and as a moderator that enhances the effect of Digital Tools. Digital Readiness had the strongest direct effect on Project Management Success through the individual and collective roles of its four enabling elements acting as indicators in the analysis. The enabling elements (Cybersecurity, Technological Infrastructure, Real-time Data Access and Management, and Large Internet Network Capacity) allow project managers to meet the identified Project Management Success criteria.

The individual positive effects of the four enabling elements were confirmed by their outer weights (0.369, 0.104, 0.292, and 0.427, respectively), while their collective positive effect was confirmed through the path coefficient (0.538). This conclusion is supported by statistical significance indicated by low P-values for the path coefficient and outer weights, which support the first hypothesis (H1) in this research. The conclusion also aligns with previous findings in the literature indicating that a robust digital organizational readiness enhances processes, systems automation, and data collection and analysis in project-oriented organizations leading to Project Management Success [6, 16]. For example, Khasawneh & Dweiri [6] apply a hybrid FAHP–FTOPSIS approach to rank digital infrastructure enablers for Project Management Success and found that Digital Readiness factors such as cybersecurity and large internet network capacity ranked highest, ensuring that such Digital Readiness initiatives are translated into improved project outcomes. Similarly, Machado et al. [16] demonstrate that manufacturing companies with higher levels of organizational Digital Readiness were more capable of leveraging real-time data to improve performance and adaptability. Collectively, these studies support the finding of this paper that Digital Readiness is the most influential driver of successful project outcomes across different sectors. This finding also reinforces the critical role of Digital Readiness in shaping a robust digital environment. According to the TOE framework, Digital Readiness aligns with the environmental dimension and reflects pressures and technological enablers such as the quality of technological infrastructure, cybersecurity systems, real-time data access, and large network capacity. This study validates these enabling components as essential foundations for Project Management Success that support technological execution and enable resilience, communication, and operational continuity, all of which are vital in complex project environments**.**

Digital Fitness also showed a strong positive effect on Project Management Success through a statistically significant path coefficient resulting from the analysis (0.309), supporting its role within the organizational dimension of the TOE framework and its recognition as a valuable inimitable resource within the RBV. This positive effect was confirmed through the individual effects of the two Digital Fitness indicators: Digital Teams and Digitally Competent Employees. Both indicators had statistically significant outer weights (0.476, and 0.577, respectively), which confirmed their individual positive effects. The predicting power of Digital Fitness supports the second hypothesis made in this research (H2) and supports the existing literature emphasizing that digital infrastructure is not only based on digital technology, but also on a people-centric evolution requiring skill development and organizational cultural alignment [2, 6, 39, 40, 47]. This finding is consistent with Gonçalves et al. [2], who show that digital transformation outcomes are strongly dependent on workforce skills and organizational learning, reinforcing the idea that digital competence is as critical as digital technology in driving Project Management Success. Similarly, Dou & Gao [40] highlight the role of workforce capabilities in translating digital initiatives into innovation outcomes, while Chang & Octoyuda [47] address the contribution of digital competencies specifically to organizational performance.

The results of this study also revealed that Digital Tools had a significant positive impact on Project Management Success, despite being the weakest predictor of Project Management Success among the three pillars of digital infrastructure. Digital Tools collectively affected Project Management Success positively with a statistically significant path coefficient of 0.218, and outer weights of 0.466 and 0.731, respectively, for its two enabling elements: Digital Transformation and Industry 4.0 Emerging Technologies. This finding supports the third hypothesis of the research (H3) and the literature indicating the profound implications for project management caused by digital transformation and Industry 4.0 Emerging Technologies [6, 32, 36, 46]. For example, de Sousa Jabbour et al. [32] shows that Industry 4.0 technologies are critical success factors for improving organizational performance when integrated effectively in projects. In a more related work, Bugarčić & Slavković [46] provide empirical evidence that digitalization significantly enhances project management effectiveness. These studies support the finding of this paper that, despite the smaller contribution of Digital Tools in Project Management Success compared to Digital Readiness and Digital Fitness, it remains an impartial pillar of digital infrastructure that drives Project Management Success when effectively adopted.

This study further examined the moderating effects proposed in the model (H4, H5, and H6). Digital Readiness was found to significantly strengthen the influence of Digital Tools on Project Management Success, while the expected moderation effects involving Digital Fitness were not supported. H4 was tested to explore whether the positive effect of Digital Tools on Project Management Success was moderated by Digital Readiness. Accordingly, Digital Tools was found to be particularly impactful on Project Management Success when complemented by strong Digital Readiness. The fourth hypothesis proposed in this research (H4) was confirmed through a moderation analysis which showed a statistically significant path coefficient of 0.046 at a P-value less than 0.05. These results supporting H4 confirm the literature which proposes that Digital Transformation practices as well as Industry 4.0 Emerging Technologies such as AI, IoT, and Big Data Analytics have higher effectiveness in organizations with solid Digital Readiness foundations and digital organizational capabilities [6, 37-40]. In the literature, it was emphasized that Digital Tools are most effective when organizations have the necessary infrastructure and readiness to embed them in work practices [37]. In line with this, Aoun et al. [39] stress that emerging Industry 4.0 technologies, including blockchain and IoT, require robust readiness foundations to overcome integration challenges and achieve performance gains. Therefore, the Digital Tools pillar is not a standalone enabler of Project Management Success, as its role is amplified when strong Digital Readiness elements are in place. Accordingly, a project-oriented organization that enforces the adoption of robust Digital Readiness enabling elements is more capable of fostering an encouraging environment for the implementation of Digital Tools in a manner that serves into achieving Project Management Success.

The positive effect of Digital Fitness on Project Management Success was also explored in terms of whether it is moderated by Digital Readiness (H5) and Digital Tools (H6). However, the two hypotheses were not statistically significant and, hence, were rejected. The rejection of H5 and H6 provides a useful boundary for interpreting the interactions between digital infrastructure components. It shows that not all enabling elements of digital pillars necessarily interact in harmony with one another, and some (like those associated with Digital Fitness) may operate as independent drivers of Project Management Success. This also indicates that Digital Fitness is a stable pillar of digital infrastructure across varying levels of Digital Readiness and Digital Tools deployment, meaning that organizations can benefit from workforce digital competencies even when other digital pillars are underdeveloped. The rejection of H5 and H6 is consistent with prior literature indicating that Digital Fitness often functions as a self-sufficient driver of project outcomes without relying on digital infrastructural moderators. For example, Oberländer et al [37] emphasize that digital competencies represent foundational capabilities that organizations can leverage independently of readiness conditions. Additionally, Guinan et al. [36] note that the effectiveness of Digital Tools depends on how employees and teams are empowered to adopt them, rather than their interaction with the competencies of those employees. These results provide nuance to the RBV by indicating that not all valuable resources function interdependently, as some would function independently.

The validated direct effects (H1–H3) and significant moderation effect (H4) offer practical insights for strategic planning. Organizations aiming to improve Project Management Success must not only adopt Digital Tools but also invest in foundational infrastructure and human capital, even if their effects may not be strongly interlinked. These insights are consistent with the integrated resource perspective advanced by the RBV, suggesting that competitive advantage in digital project management can emerge from both individual and collective resource contributions, arising from coordinated investments across all pillars. They also signal that an investment imbalance among these pillars can limit digital infrastructure outcomes, compromise Project Management Success, and reduce return on investment.

From a theoretical standpoint, this study reinforces the view of digital infrastructure as a multi-pillar concept whereby structural (Digital Readiness), human (Digital Fitness), and technological (Digital Tools) elements collectively drive project performance to achieve Project Management Success. The SEM framework developed in this research has utilized formative constructs that highlighted detailed interconnections between the constructs and their associated indicators. With reference to six identified research hypotheses, the exploration of these interconnections provided an in-depth dive into the complexity of digital infrastructure and its critical role in project-oriented organizations in their pursuit of Project Management Success.

These results advance existing research by offering a causal, SEM-based evaluation of how digital infrastructure operates as a system. This approach moves beyond descriptive analysis and allows for clearer strategic recommendations in digital transformation planning for project-based organizations. It contributes to the literature by offering empirical evidence of not only the individual impacts of each pillar but also their interaction effects, highlighting the value of integrated digital infrastructure planning over independent and disconnected initiatives.

The findings of this study also present important recommendations for project managers who seek to leverage digital infrastructure more effectively. First, organizations should prioritize Digital Readiness by ensuring that the enabling elements of technological infrastructure, cybersecurity, real-time data access, and large internet network capacity are firmly established. Without these elements, the adoption of Digital Tools may be less effective in driving Project Management Success. Second, project managers should recognize that Digital Fitness is not a secondary consideration but a central pillar of digital infrastructure, because digitally competent employees and well-structured digital teams can directly improve project outcomes. Therefore, investments in training, digital skills refinement, change management, and cultural alignment are critical. Third, the choice and deployment of Digital Tools such as digital transformation initiatives and Industry 4.0 Emerging Technologies should be aligned with project goals and supported by strong readiness and fitness.

Despite these recommendations, several barriers may hinder digital infrastructure adoption. For example, high costs of implementation and continuous upgrades may burden organizations [72]; resistance to change can slow down or disrupt digital initiatives [73]; cybersecurity risks may undermine trust in digital systems [72]; vendor lock-in and technological dependency may limit flexibility [74]; and skill gaps among employees can restrict the effectiveness of newly adopted Digital Tools. These challenges highlight that Project Management Success in the digital era requires investment in the three pillars of digital infrastructure, and, more importantly, the enforcing of proactive strategies to overcome the obstacles that accompany their adoption.

Practically, the findings of this research pose a strategic framework for organizations aiming to improve project outcomes and achieve Project Management Success through the construction of a solid well-structured digital infrastructure. This research proves that none of the three pillars of digital infrastructure is a standalone pillar that is sufficient to support project performance and achieve Project Management Success. Against the common belief that the adoption and implementation of Digital Tools such as Digital Transformation and Industry 4.0 Emerging Technologies are sufficient to drive the performance and success of project-oriented organizations, this research has shown that Digital Tools as a pillar of digital infrastructure must be complemented by Digital Readiness and Digital Fitness for optimal project outcomes.

In future research, the findings of this study can be extended to evaluate how the path relationships can change by comparing sector-specific or region-specific input. Additionally, qualitative studies might explore the contextual factors that may influence the path relationships, such as leadership support or organizational culture. Given that these contextual factors are known to influence Project Management Success, the lack of their direct inclusion in the analysis constitutes a limitation. However, although such factors were not directly measured, elements of these factors may have been indirectly reflected within the three pillars of digital infrastructure. For example, Digital Fitness may have implicitly captured aspects of workforce adaptability and leadership-driven investments in the refinement of digital skills and formation of digital teams. Despite this limitation, the purpose of this study is to highlight the significant, yet underexplored, standalone role of digital infrastructure in Project Management Success. Accordingly, the absence of contextual factors does not invalidate the results of this study because demonstrating the standalone role of digital infrastructure, even without explicitly incorporating contextual factors, still contributes to the development of a comprehensive, validated, and unique framework that can steer organizations seeking to enhance their project performance and achieve Project Management Success through digital initiatives.

Another potential limitation of this study is the possibility of reverse causality—namely, that Project Management Success may itself encourage organizations to invest further in digital infrastructure rather than digital infrastructure driving success. While this possibility cannot be fully ruled out, prior research has shown that digital infrastructure tends to precede project outcomes. Several studies showed that digital infrastructure investment was planned and implemented before subsequent improvements in project performance were observed [75, 76]. These findings suggest that digital infrastructure acts as a precursor to and enabler of Project Management Success rather than merely a by-product of it. Nevertheless, to provide stronger evidence of directionality, future research should adapt longitudinal or quasi-experimental designs that allow for temporal ordering and more robust control of confounding variables.

A further limitation of this study is that it does not consider the long-term implications of heavy reliance on digital infrastructure for Project Management Success. Such reliance may increase exposure to cybersecurity vulnerabilities and impose high costs for securing, maintaining, and updating the integrated digital systems [72]. Additionally, heavily relying on digital infrastructure can lead to technological dependency or vendor lock-in [74]. Future research should empirically investigate these risks to clarify the broader implications of digital infrastructure for project outcomes, and guide organizations in making more informed digital decisions to achieve Project Management Success.

6- Conclusion

This study examined how the three key pillars of digital infrastructure individually and collectively influence Project Management Success in project-oriented organizations. The research proposed a conceptual model and empirically validated it using Partial Least Squares Structural Equation Modeling (PLS-SEM). With empirical support, this research confirms that Digital Readiness, Digital Fitness, and Digital Tools are interdependent pillars of digital infrastructure that play essential roles in driving project performance and achieving Project Management Success. Four out of the six proposed research hypotheses are emphasized by the structural and functional interconnections between these three pillars. Digital Readiness has particularly emerged as the strongest predictor, indicating that foundational Digital Readiness must precede or accompany any attempts of digital technology adoption. Notably, the study confirmed that Digital Readiness significantly moderates the relationship between Digital Tools and Project Management Success. This highlights that the benefits of digital transformation adoption and Industry 4.0 enabling technologies implementation are amplified in well-prepared digital environments where foundational digital preparedness is already in place.

Digital Fitness did not exhibit significant moderation effects, but showed strong direct influence on Project Management Success, reinforcing the critical role of human capital and digitally competent teams. Digital Tools, although the weakest predictor of the three, still contributed significantly. The significance of Digital Fitness and Digital Tools highlights the urgent need for organizations to balance technical investment with workforce capability development in relation to digital technology.

The use of PLS-SEM in this research enabled the decomposition of each construct into its formative indicators, providing a modular view of how each element contributes to the broader framework. This study validated the theory-driven constructs proposed and proved four of the six hypothesized relationships (H1–H4). Outer weights and loadings validated the individual and collective impact of enabling elements, and a clear representation of the interplay between constructs was visualized.

Using a versatile well-structured analysis tool like SEM has also enabled the development of a comprehensive framework that can assess the required digital maturity in project-based organizations that aim to improve its project performance and efficiency and achieve Project Management Success.

The results of this paper highlight the importance of strategic prioritization of investments in Digital Readiness by organizations aiming to improve their project outcomes, pursue project success, and achieve Project Management Success. With reference to rigorous and well-structured Project Management Success indicators, Digital Readiness has demonstrated the strongest direct and moderating effects on project management. Therefore, organizations are advised to first establish robust technological infrastructure, cybersecurity systems, and real-time data management capabilities. Subsequently, investment should be made in an organization in enhancing Digital Fitness through the development of digitally skilled teams and employees, and in acquiring advanced Digital Tools such as Industry 4.0 Emerging Technologies. Securing a strong Digital Readiness can ensure that the adoption and implementation of Digital Tools is more effective towards the improvement of project outcomes and success of project management.

This paper presents a contribution to the research field of project management in the digital era and provides an integrated structural analysis that empirically models and validates the causal pathways between Digital Readiness, Digital Fitness, Digital Tools, and Project Management Success. A validated framework is formulated in this research to steer organizations seeking to enhance their project performance towards achieving Project Management Success through digital initiatives.

Future research should explore sector-specific and region-specific applications of this model and investigate the roles of contextual factors such as organizational culture and leadership in moderating the observed relationships. Potential assessment of the practical effectiveness of the model can also be investigated upon the adoption and implementation of the model in a project-oriented organization. Future studies can test this model using longitudinal designs to validate the causal relationships, and to assess the risks associated with long-term reliance on digital infrastructure.

Overall, this study demonstrates that Digital Readiness amplifies Digital Tools, Digital Fitness contributes independently, and all three Digital Infrastructure Pillars individually and collectively shape Project Management Success. In doing so, this paper advances theoretical understanding by clarifying the distinct and joint pathways through which infrastructural, human, and technological resources interact to conceptualize digital infrastructure in project-based organizations.

7- Declarations

7-1- Author Contributions

Conceptualization, M.A.K. and F.D.; methodology, M.A.K. and F.D.; software, M.A.K.; validation, M.A.K. and F.D.; formal analysis, M.A.K.; investigation, M.A.K.; resources, M.A.K. and F.D.; data curation, M.A.K. and F.D.; writing—original draft preparation, M.A.K.; writing—review and editing, M.A.K. and F.D.; visualization, M.A.K. and F.D.; supervision, F.D. All authors have read and agreed to the published version of the manuscript.

7-2- Data Availability Statement

The data presented in this study are available in the article.

7-3- Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

7-4- Institutional Review Board Statement

Not applicable.

7-5- Informed Consent Statement

Not applicable.

7-6- Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

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Appendix I: Questionnaire

All items were measured using a 10-point Likert scale ranging from 1 = No Impact to 5 = Very High Impact.

1. **What is your name? (Optional)**

**You do not have to answer this question. You can either provide your full name, initials of your first and last names, or leave the question empty.*

* 2.
What industry does your organization operate in?

* 3. **In which country is your organization located?**

* 4.
How many years of experience do you have in the field of project management?

- ◯ 0-5 Years
- ◯ 5-10 Years
- ◯ 10-20 years
- ◯ More than 20 years

* 5.
How many years of experience do you have in technological or digital related fields of work?

- ◯ 0-5 Years
- ◯ 5-10 Years
- ◯ 10-20 years
- ◯ More than 20 years

* 6.

What is your seniority level in the organization you work at?

◯ Junior Level

◯ Mid Level

◯ Senior Level

◯ Top Management Level

* 7.

To assess the role of digital infrastructure in project management success, please evaluate the significance of the following digital infrastructure enabling elements (rows) in relation to the project management success indicators (Columns), using a scale of 1 (no impact) to 10 (very high impact).

**Kindly provide a rating from 1 to 10 for each one of the 56 cells in the table below.*

	Compliance with the budget	Compliance with the schedule	Compliance with quality requirements and specifications	Meeting the scope of the project	Ensuring long-run organizational benefits	Achieving the strategic objectives of the organization	Sustainability of solutions and success
Cybersecurity Systems							
Real-time Data Access and Management							
Technological Infrastructure							
Large Internet Capacity							
Digital Transformation							
Industry 4.0 Enabling Technologies							
Digital Teams							
Digitally Competent Employees							