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Digitalization, Planning, and Sustainability in Project Management in Jordan's Construction Sector: Enhancing Project Success through Stakeholder Engagement and Virtual Work Dynamics

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ABSTRACT

Due to the growing client requirements for cost-effective solutions and environmentally friendly projects, the construction business remains pressured to deliver sustainable project results and objectives. Although the role of sustainability in project management has been widely explored and documented, there is growing research interest regarding integrating digitalized tools and sustainable project planning into sustainable project success; its relation to virtual teams is explicitly relatively unknown, especially within the developing world context such as Jordan. This research is intended to fill this gap by assessing the effect of sustainability in project management, Digitalization, and sustainable project planning on sustainable project success, with the virtue of the work environment acting as a moderator and stakeholder engagement as a mediator. To

meet this research aim, the structured questionnaire was distributed to one hundred project engineers, managers, and other project professionals in Jordan's construction industry. The gathered data were investigated to evaluate the claimed link using the Partial Least Squares (PLS) approach using the Smart PLS tool. The findings show that the success of a project mainly depends on digitization, environmentally friendly project design, and sustainable project management. Moreover, the virtual work environment and stakeholder engagement were recognized as the significant mediator and moderator of these relationships. The implications drawn from the study point to the critical need for construction firms to embrace integrated and sustainable project management models, incorporate technology in their execution, and be keen to involve stakeholders. Therefore, these concepts might be used to raise project-level organizational performance and help to meet more general sustainable development targets in the building sector.

Keywords: sustainability in project management, Digitalization, sustainable project planning, sustainable project success, virtuous work environment, stakeholder engagement.

INTRODUCTION

Sustainability is the ability to sustain a specific level. In this study, sustainability refers to project management's economic, environmental, and social advantages inside a construction organization. Sustainability must be included in project management strategies to secure future economic, environmental, and societal advantages [1]. The previously mentioned constraints—time, money, scope, and quality—have historically dominated the conventional perspective on project success. Recent studies indicate that a successful project nowadays consists of customer advantages, organizational learning, stakeholder engagement and enjoyment, and society well-being [2–6]. Academics have lately underlined the importance of substituting a more all-encompassing perspective that takes social, environmental, and financial issues as fundamental success determinants for projects for short-term measurements, including time, money, and quality. Complementing this long-term strategy is the Triple Bottom Line (TBL) concept, which has developed into a valuable tool for completely and environmentally friendly evaluation of project performance [7–11].

According to Rahim et al. [12], indicate that Sustainability in project management (SPM) significantly influences project outcomes by aligning with the Triple Bottom Line (TBL) approach, which incorporates financial, social, and environmental factors. Sustainable project management includes the strategic planning, supervision, and regulation of project execution and support mechanisms. This method considers the ecological, economic, and social aspects of the project's resource lifecycle, procedures, deliverables, and impacts. Its purpose is to promote openness, equity, ethical behavior, and active stakeholder engagement while providing advantages to stakeholders [13]. The Sustainability in Project Management is explained in figure 1.

Sustainability

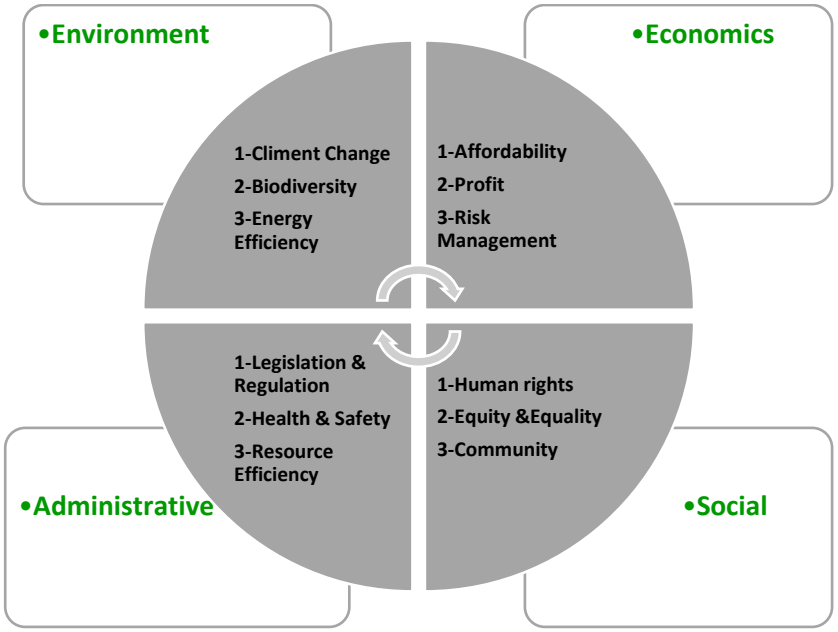

Figure 1: Sustainability in project management
Source: Developed by the researcher

Jordan's construction industry lacks labor-intensive industries, innovation, competitiveness, and enablers [14]. Shortages of raw materials, limitations in data storage capacity, unpredictability in handling, and the need for consistent streaming adversely affect the overall economic sustainability of organizations[15]. Triple bottom-line management is a term commonly used to define sustainable enterprises. According to Odeh and Mohammad [16], the construction sector gradually integrates sustainability managers' functions into standard operating practices. Many organizations in Jordan have chosen a sustainable strategy. Yet, there is still significant variance in how it is executed, and project planners and sustainability managers frequently encounter opposition, indifference, and misconceptions[17].

Effective project management throughout the life cycle relies heavily on project planning, which is crucial in achieving project success [18]. Sustainability measurement components must be included as a project success requirement to encourage sustainability in project management and planning.

To effectively integrate stakeholder demands and establish sustainable practices, it is essential to actively engage stakeholders in managing sustainable projects. This leads to better decision-making and project results [19]. Establishing a stable project environment has various benefits, including assuring project success, guaranteeing efficient knowledge acquisition and stakeholder participation, and thus enabling long-term project management practices[20–23]. Virtual tools and solutions for information and communication technology (ICT) can be negative or positive, depending on how effectively the infrastructure works, which applications are acceptable, and how well stakeholders adapt to new technologies[24–26]. However, the virtual collaborative environment is believed to be a more realistic and long-term means to manage project and general organizational tasks [19]. The introduction of virtual team settings

and their continuing transition has tested traditional concepts of project success and offered new areas for research into project success theory [27, 28].

Research Problem and Gap and Significance of the Study

The shift towards sustainability is gradually becoming inevitable for companies across the world. When creating and executing a project, sustainability integration is seen as an absolute must, not an optional extra[29]. However, the relevance of sustainability is beyond debate, and many project managers find it difficult to integrate sustainability requirements into the standard assessment of project success criteria, including cost, time, and scope[30]. Research into the impacts of digitalization on sustainability is still in the early stages; however, this technology demonstrates significant potential for enhancing transparency and efficiency in project management [27]. Moreover, another critical success factor, stakeholder engagement, becomes more problematic in virtual work environments. Since organizations have embraced remote and hybrid work models, understanding how these virtual spaces affect engagement stakeholders to achieve sustainable project outcomes is still relatively unknown. Therefore, the main objective of this research is to address the following question: what is the effect of sustainably managing projects, digitalizing projects, and planning sustainably about successful projects, and how are such relationships impacted by virtual work settings as a moderator and mediated by stakeholder involvement?

Previous research has separately focused on project management, sustainability, and Digitalization[31]. However, the combined understanding of these assumptions, especially regarding ideas connected with sustainability in project management, is still rather limited. For instance, although digitalization has received much attention regarding its efficiency and productivity antecedents, its work on sustaining a successful project has not been established enough[32]. Similarly, investigations of stakeholder engagement are largely grounded in face-to-face cooperation; there is little evidence on how technological advancement influences stakeholders' functions regarding sustainability[33]. Researchers draw attention to the lack of research looking at the combined impacts of these features on the feasibility of sustainable performance of the project[34]. This study aims to fill the existing information gap by examining the interactions involved in digitalization, virtual work environments, sustainable project planning, stakeholder engagement, and sustainability within project management.

Sustainability in project management and technological advancements are two areas where the present literature makes significant contributions; however, there are scant few attempts to simultaneously incorporate all of the identified factors alongside sustainability to understand their effects on sustainable project delivery. Although managing sustainability is widely hyped as a strategic imperative, most of the extant works investigate the overall effects of sustainability on organizational performance or the environment[35]. According to the authors' understanding, there appears to be a limited amount of research addressing the connection between sustainable project management and the achievement of environmental objectives during both the planning and execution phases of these projects[20].

The literature review indicates that the majority of the current research is focused on the ways in which IT enhances the efficiency and effectiveness of project management. However, the potential of Digitalization to drive sustainability benefits – including resource use optimization,

emissions-cutting, and sustainable value creation – has not been studied enough [21]. Unfortunately, as in many studies on digitalization, the emphasis here is mainly on process improvement instead of connecting it to sustainability objectives.

New virtual work environments have developed, especially after the pandemic, changing the style of stakeholders' interaction in projects[36]. However, scant research has been done on how stakeholder engagement during these remote and hybrid environments affects the achievement of sustainable projects. External feedback is important for achieving project objectives to match stakeholder expectations regarding sustainability, but in virtual environments, communication, cooperation, and coordination may be disrupted [37]. The author is not aware of any past studies that have carefully examined the function of stakeholders' involvement as a mediator and virtual work environments as a moderator in the link between digitalization, sustainability, and the success of sustainable initiatives. This is a research gap because virtual environments and digital tools are becoming essential features in today's project management. This study, therefore, unlocks a new way of thinking by developing a comprehensive framework that combines the four dimensions of sustainable and digital project success: sustainability, digitalization, planning, and stakeholder engagement.

However, to the author's knowledge, very few have focused on the purpose of digitalization in project management in terms of sustainable outcomes[38]. This paper will explore how technology can assist in attaining further efficiencies and how technology can be used to achieve sustainability by promoting optimal resource utilization and the effective monitoring of organizational sustainability performance indicators. As the use of remote work environments rises, this study shall bring fresh knowledge regarding the effects of remote and hybrid environments on sustainable project achievement[39]. The use of virtual contexts to manage the interaction with stakeholders, as well as collaboration and decision-making on sustainability initiatives, is relatively unexplored in the literature studies. The implications of the study for project management and organizations suggest that both sectors may develop improved strategies to enhance the long-term success of their projects. It will be beneficial to ascertain how digital instruments can support sustainability initiatives, investigate the applicability of approaches to stakeholder engagement used in virtual spaces, and learn how sustainability can be integrated more efficiently into planning activities. This is especially significant to organizations prepared to ensure their projects meet international sustainable development goals.

LITERATURE REVIEW

Theoretical Framework

This study examines the impact of digitization on project management, the role of sustainability in project planning, and the factors contributing to project success, aligned with the Triple Bottom Line (TBL) Theory as outlined by Elkington [40]. TBL, the theoretical concept, deals with positive economic, environmental, and societal returns to ensure sustainability practices in organizations. In the context of this study, TBL is in concordance with the intention to examine how projects can generate economic value for the firm while also managing and maximizing the management of social and ecological costs/debts, especially regarding stakeholders[41]. By incorporating digitalization as one of the contextual factors for sustainable practices, the study contributes towards finding solutions to how one can attain

these three facets of sustainability. Further, the virtual work environment is analyzed as a moderating variable that influences stakeholder engagement and the sustainability impact of the project. TBL provides an integrated approach for evaluating projects' multi-dimensional performance and positioning stakeholders, digital innovation, and sustainability front and center, therefore enabling project management for long-term sustainability[42]. The Triple Bottom Line (TBL) Theory is explained in Figure 2.

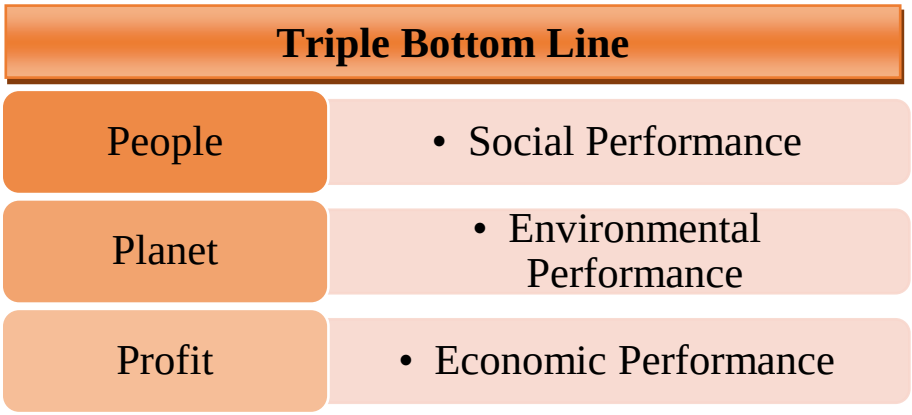

Figure 2: Triple Bottom Line (TBL) Theory
Source: Developed by the researcher

Sustainability in Project Management and Sustainable Project Success

Many authors in recent years have proposed the integration of sustainability considerations into project management approaches to ensure the successful execution and management of projects[19, 29, 33, 43]. Projects are vital for promoting sustainable development [44-47]. Furthermore, sustainability has a significant influence on project management (PM) in all areas, including project success (PS) [6, 37, 38, 48]. The evidence demonstrates that sustainable PM practices favorably influence PS when studied independently [49-50]. Project management is the method of planning and supervising the actions, data, and knowledge required to finish a project satisfactorily. A sustainable project manager aims to guarantee that a project is finished in a manner that not only helps the present generation but also the next one economically, environmentally, and socially[51]. The study evaluates sustainable project management considering the social, environmental, and financial benefits of the building sector. Decreasing energy usage, biodiversity, liquid pollution, and natural resources may all help with sustainable project management[52]. Numerous organizations are migrating to sustainability in project management, which may encompass long-term project planning and the firm's overall performance. [53]proposed that the project management process embraces the sustainability concept, which comprises the three TBL components (environmental, economic, and social), to enable sustainable project planning and increase organizational project performance. As a result, the first hypothesis was stated as follows:

- **H1:** Sustainable project management has a significant impact on sustainable project success.

Digitalization and Sustainable Project Success

The predominant body of literature regarding digital transformation in project management has focused on agile methodologies and the transformative capabilities of digital technologies

[54]. The integration of ICT tools, achieved via iterative and incremental development, successfully addresses technical complexity and frequent demand changes, increasing data and resource management and security[49].

The diversification and success of projects, particularly those focused on sustainability that encompass economic, social, and environmental dimensions, show a positive correlation with the adoption of digitalization methods and tools [55]. For instance, the flow of technology enhances the assessment of organizational impacts on environmental sustainability by using carbon footprints, energy usage and resource usage in projects undertaken by organizations [56]. It also assists in other collaborations involving the teams and other stakeholders, enhancing the communication and coordination processes essential to achieving sustainable goals[57]. Also, projects can enhance successful project operations through digital platforms as they can lead to time and cost-efficiency compliance with sustainability requirements and standards [58]. But whatever the case, the ability to advance Digitalization in sustainable projects needs the right structure, trained staff, and good use of digital tools to counter problems like data privacy issues, digital inclusion, and technological difficulties [59].This led to the development of the following hypothesis:

- **H2:** Digitalization has a significant impact on the success of sustainable projects.

Sustainable Project Planning and Sustainable Project Success

During the duration of the project, the planning phase encompasses activities, resources, time, and financial considerations [1]. This study emphasizes the importance of long-term project planning for construction organizations through the implementation of management control, risk response strategies, and fostering internal work consensus. This study indicates that organizations that excel in sustaining projects over long durations exhibit effectiveness, stakeholder engagement, teamwork, and preparedness for future commercial success. Effective project planning is crucial to project management as it guarantees the ongoing execution of projects within the organization[60].

According to Gunduz and Almuajebh [61], the success of a project-oriented organization is intrinsically tied to the project outputs, which include the company's basic competencies and important business. Competent project management is distinguished by its capacity to evaluate and organize performance[62]. Project metrics, as defined by the Project Management Institute, encompass budget, time, scope, quality, resources, and risk. These measurements are crucial in guaranteeing the organization's performance, as stated by Latiffi and Zulkiffli [63]. A few of the elements that have already been established and researched include customer impact, team dynamics, sustainability, future preparedness, company success, and project efficiency[45, 52], [64, 65].

Risk management helps to reduce high-risk activities, and project risk is assessed throughout the planning process[66]. As a result, planning can help to resolve project uncertainties [7]. Furthermore, full planning enables a project team to comprehend project objectives and direct project conduct properly, hence improving execution efficiency. Previous studies focused on sustainable project planning strategies that impact project success [67]. There is a dearth of studies aimed at elucidating how sustainability affects the effectiveness of sustainable projects

and how best to include it into project design and execution. Therefore, the researcher proposed that:

- **H3:** Implementing sustainable project planning practices has a significant impact on the project success.

The Moderating Effect of Virtual Work Environment

Using virtual teams in projects significantly benefits businesses in terms of operational efficiency and long-term objectives [19]. Even for a single day, videoconferencing decreases travel time (hence, carbon emissions) while enhancing resource conservation [20, 68, 69]. Virtual work solutions provide significant societal advantages by lowering dependency on real workplaces and contributing to cost savings on tangible assets. This is accomplished by allowing people to live in more reasonable cities. Placing housing zones and offices promotes sustainable property and space use [70]. According to research, implementing sustainable practices in virtual worlds considering economic, social, and environmental concerns can improve project success [71].

Scholars, such as Dzandu et al. [72], showed that a virtual work environment based on the remote use of digital technologies for work collaboration impinges on how sustainability and digitalization measures are accomplished for project management. In sustainability, virtual work settings facilitate and increase communication media technology's effectiveness in supporting sustainable project development and engagement processes [73]. On the same note, face-to-face communication is not possible. Hence, virtual circumstances can also hinder the successful implementation of sustainability practices, implying that virtual circumstances can support and challenge sustainable project success [74].

If Digitalization is incorporated into virtual work environments. In that case, chances are high for sustainable project success since the tools make real-time cooperation possible, effective resource management, and close monitoring of sustainability metrics [75]. Yet, it is necessary to notice that the structure of the virtual context, communicational procedures, and management highly condition these tools' efficiency. A virtual context that is not well managed may negatively affect digitization's potential for improving sustainability performance by disrupting team dynamics and focusing on sustainability objectives altogether[76]. This paper addresses sustainable project planning in online environments, digitalization's probable benefits and drawbacks, and sustainable project management in general. Good virtual work environments foster real-time collaboration on work projects by project teams and can help deliver sustainable project plans [77].Therefore, the following hypothesis was formulated:

- **H4:** Virtual teams (VTs) significantly moderate the influence of sustainability in project management (SPM)**,** Digitalization, sustainable project planning on project success.

The Mediating Effect of Stakeholders 'Engagement

Three areas where active stakeholders are absolutely essential to the success of sustainable improvement initiatives are digitalization, sustainable project development, and the integration of sustainability into project management. Relations refer to individuals or companies with a stake in a project and may include team members, clients, regulatory bodies, and various communities of interest [19]. Stakeholder engagement, therefore, is a mediator between sustainability practices and the adopted digital tools and the eventual outcomes of the

sustainable initiatives because its principal role involves making sure that everyone's needs and concerns are met and that sustainable initiatives are in tune with stakeholder aspirations [78]. Early stage participation of stakeholders in a project's life cycle raises its long-term success likelihood by raising its sensitivity to environmental, social, and economic sustainability challenges[20].

In digitalization, stakeholder engagement is a key moderating variable that defines how organizations incorporate and leverage technology to deliver sustainable value. The initiatives taken with the help of digital technologies include sharing information and ideas with various stakeholders and making project implementation more transparent and accountable [33]. Where stakeholders are engaged in a project's digital processes, it is possible for their inputs to inform the optimization of improved projects digital and sustainability objectives to ensure technology is a force for sustainability improvement and enhanced project effectiveness [79]. On the other hand, a non-important engagement of the stakeholders coordinated to the implementation of the change may result in resistance to change, underutilization of tools, or incongruence of the digital strategies formulated with the sustainability goals necessary for sustainability project advancement; these may compromise a project's successes [10].

The main argument is more specific and goes as follows: sustainable project planning also gains from stakeholder engagement since the main advantages include increased sustainability and improved meeting of stakeholders' needs [80]. Stakeholder involvement effectively provides a perception of the social and environmental ramifications of the mission plans and makes adaptations to conform to sustainable practices [81]. In this way, the sustainability goals provide mediators because stakeholders assist in explaining sustainable objectives and their plans while considering all the interested parties. Thus, mediation of stakeholder engagement ensures improved communication and cooperation and increased commitment towards sustainable project objectives, which will be instrumental to project success in the long run [82]. Hence, stakeholders' participation is crucial in assuring sustainable development, digitization, and project planning mechanisms towards successful project delivery. Therefore, the following hypotheses were formulated:

- **H5:** Stakeholder engagement has a positive mediating effect on the influence of sustainability in project management (SPM)**,** Digitalization, and sustainable project planning and project success
- **H6:** Stakeholder engagement (SE) is significantly related to sustainability in project management (SPM).
- **H7:** Digitalization has a significant relationship with Stakeholders 'Engagement.
- **H8:** Sustainable Project planning has a significant relationship with Stakeholders 'Engagement.

Stakeholders' Engagement and Sustainable Project Success

Depending on their interests and motives, project success (PS)criteria might differ between one stakeholder and another. It is critical to understand that PS is not only controlled by the iron triangle's outmoded measurements [33]. Stakeholder engagement (SE) is the active involvement of stakeholders in the assignment, allowing them to effect policymaking and stay up to date on project developments. As a result, the extent of stakeholder participation may

influence their appraisal of PS [79]. To make sure that stakeholders are involved in decision-making processes, Systems Engineers engage with them and build ties with them throughout the project lifetime [8]. Stakeholder engagement can be broadly divided into two levels: involvement, which entails providing information and advice, and participation, which entails a more active role in resolving conflicts [19]. SE enables stakeholders to convey their thoughts, influence project planning, and stay informed about project choices [83]. The major purpose of SE is to guarantee that stakeholders agree with the decisions taken, resulting in transparent decision-making [84].

Long-term success of the project depends on shifting our focus from transient KPIs to a more sustainable framework including SE [85]. According to research, SE is a crucial component of PS [86–88]. Early and early participation of internal and outside stakeholders helps to avoid or lessen the effects of unexpected events. Active communication and participation throughout the planning stages help to lower the possibility of conflicts in the later phases of the project [89–92]. Suboptimal planning, defined by poor stakeholder expectation communication and management methods, can cause noteworthy project matters, sometimes leading to project termination [93]. The subsequent hypothesis is based on the literature and proposes that:

- **H9:** Stakeholder engagement (SE) has a significant relationship with project success (PS)

RESEARCH METHODOLOGY

Data Collection and Sampling Method

The researcher utilized an online survey form to distribute a self-administered questionnaire to the participants. The online survey technique [94] facilitates the distribution of questionnaires to respondents over the Internet. Responses to this research were limited to Jordanian construction company employees. The researcher used a convenience sample strategy to collect data. From the firm's website, the researcher gathered the names and email addresses of the project management experts at the building company—including the CEO, director, project manager, engineer, and others. The researcher sent the respondents a consent form and a questionnaire meant to seek their involvement in the study. The researcher underlined to the subjects that their responses would remain confidential and that the study was done purely for intellectual interests. Every personally identifiable piece of data was also under assurance in terms of security. Given managers at different levels have diverse opinions on project management, researchers prudently used a survey method to collect data for this study [95]. There were three tiers of management surveyed from Jordanian construction firms: entry-level (Project Engineer, for example), middle-level (Project Manager, for example), and executive-level (Managing Director, for example, and CEO). Social media sites such as LinkedIn and WhatsApp groups were used to distribute links to the online survey questions. Participants received one hundred fifty questionnaires with survey URLs. The researcher collected 100 completed questionnaires out of a total of 150 circulated.

Operationalization of Construct

The research questions were derived from previously completed studies that had been properly examined. As a result, the framework became more credible and authentic. A questionnaire was employed, with each item assessed utilizing a five-point Likert scale that ranges from one ("strongly disagree") to five ("strongly agree"). The questions presented here

were derived from earlier studies. Before the final data collection commenced, the questionnaire underwent a review by field specialists and management team members to confirm its grammatical accuracy, relevance to the measurements, and clarity. Respondents rated the questionnaire and proposed many changes. Input from the participants of the pilot research helped the instrument to be changed and enhanced before being assigned to the target group for data collecting.

The basis for the intended and altered measuring tools utilized in this investigation was the body of literature on Saunder et al. [95] define "sustainable project management" as a method of handling projects with an eye towards their effects on the environment, society, and economy. Sustainable project planning is assessed using questions modified from [96]. These questions assess three scopes: risk response, managerial control, and workplace agreement. The sustainability project's success was measured using items derived from [2], which included five dimensions: efficiency, stakeholder involvement, team performance, business success, and future preparation, in addition to sustainability.

The items selected for digitization were sourced from [3]. Questionnaire items were created from two complimentary references [8], [9] to assess the first-order stakeholder engagement construct. The key aspects of virtual team development guided the choice of questions for VT moderation[4]–[7]. The questionnaire selection procedure took a modern approach to assessing PS criteria methods [19].

Data Analysis

To achieve the research objective, inferential statistics were employed to analyze the data for this study. Inferential statistics were employed to characterize the concentrations and the interrelationships among the variables. The objective was effectively achieved through the application of Smart-PLS (partial least squares) statistical methods. Ideal for PLS-SEM, Smart-PLS clarifies the inferential statistics of the model [97–99]. SEM is a very versatile process because of its low requirements for data normality, measurement scale, and sample size [100]. PLS improves analysis, and the researchers used it to evaluate the moderating impact of their model [101–103]. PLS-SEM outperforms other techniques, such as regression and LISREL, in managing high and low loadings in complicated models [104–106]. Smart PLS may be applied to both formative and reflective measuring approaches.

Structural Equation Modelling (SEM) is a statistical approach that employs factor analysis and multiple regression techniques to analyze the relationships among variables. This investigation employed the structural equation modelling method referred to as Partial Least Squares (PLS). Due to its reduced reliance on assumptions about data distribution, this methodology is well-suited to complex models with small sample numbers [107, 108]. Intricate models and small sample sizes make Partial Least Squares (PLS) ideal for evaluating several variable interrelations simultaneously [109, 110].

Conceptual Framework

The conceptual model of the study is illustrated in Figure 3:

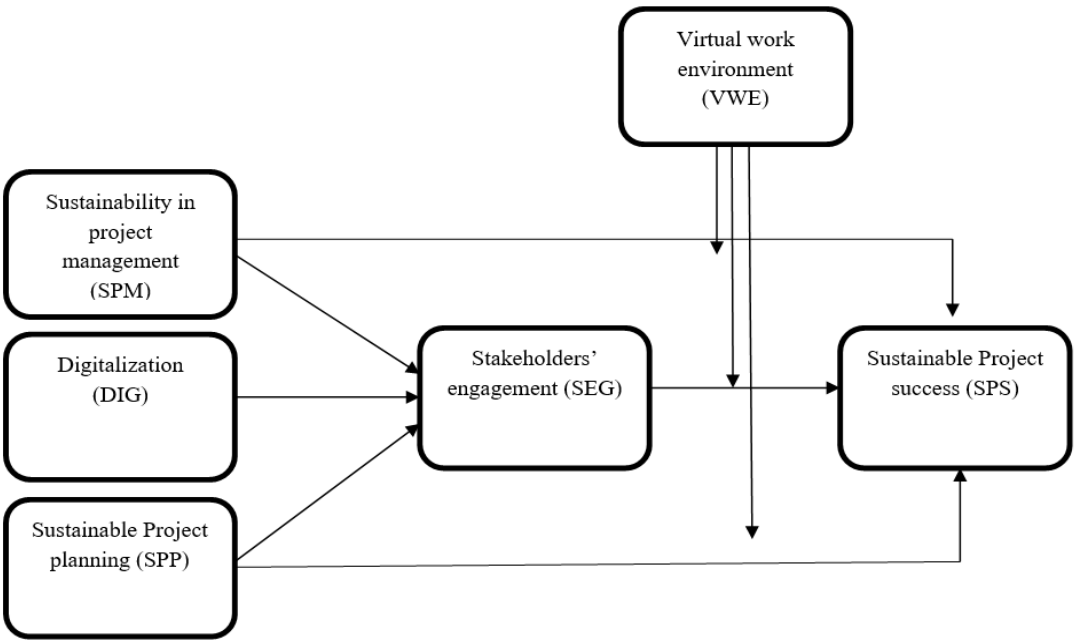

Figure 3: Conceptual Framework
Source: Developed by the researcher

DATA ANALYSIS

Demographic Data

Table 1: Demographic data

Variables	Description	Percentage (%)
Gender	Male	73%
	Female	27%
Age Group	25 – 30 Years	15%
	30 – 35 Years	45%
	35 – 40 Years	30%
	40 and Above	10%
Qualification	Bachelor degree	30%
	Master degree	50%
	PhD degree	20%
Designation	Low-Level Management (Executives)	25%
	Middle Level Management	40%
	Top Level Management (Owner, CEO, MD, GM, Director etc.)	35%

Regarding the gender distribution of the sample in table 1, 73% are male and 27% female. The age distribution shows that the largest group is the 30-35 years (45%) while the second largest group is 35-40 (30%), implying young workers dominate the sector. Majority of the respondent had postgraduate education level 50% had master degree, 30% had Bachelor's degree and 20% had doctorate degree. According to the posts, 40% of the employees are middle managers and 35% are upper/down line managers and the remaining 25% is lower level managers. This indicates that the authors have attempted to take a sample that is well educated and has a fair amount of experience and majority of them occupies middle to senior managerial posts.

Descriptive Statistics

Table 2: Descriptive statistics

	N	Mean	Min	Max	Standard Deviation
Sustainability in project management	5	4.2	1	5	1.20
Digitalization	5	3.8	1	5	1.15
Sustainable Project Planning	5	4.0	1	5	1.10
Virtual Work Environment	5	4.5	1	5	0.80
Stakeholders' Engagement	6	3.5	1	5	1.30
Sustainable Project Success	5	4.3	1	5	1.05

The descriptive statistics for the study variables in table 2 reveal key insights into respondents' perceptions of sustainability and project success. The average ratings indicate that both sustainable project success (4.3) and sustainability in project management (4.2) are well-respected, demonstrating a strong recognition of their importance. Digitalization (3.8) and sustainable project planning (4.0) also received favorable ratings, though slightly lower than the sustainability and success variables, reflecting a solid understanding of these concepts among respondents. The virtual work environment, with a mean score of 4.5, is viewed positively, indicating its significance in facilitating project management practices. In contrast, stakeholders' Engagement received the lowest mean score (3.5), suggesting that while stakeholders are recognized as important, there may be room for improvement in their involvement. The standard deviations across all variables indicate moderate variability in responses, with the highest variability observed in stakeholders' Engagement (1.30), highlighting diverse perceptions among respondents regarding this aspect.

Outer Loading:

Table 3: Outer loadings

Constructs	Items	Outer Loading
Sustainability in project management	SPM1	0.762
	SPM2	0.816
	SPM3	0.772
	SPM4	0.817
	SPM5	0.709
Digitalization	DIG1	0.767
	DIG2	0.716
	DIG3	0.890
	DIG4	0.811
	DIG5	0.819
Sustainable Project Planning	SPP1	0.798
	SPP2	0.890
	SPP3	0.682
	SPP4	0.907
	SPP5	0.712
Virtual Work Environment	VWE1	0.784
	VWE2	0.715
	VWE3	0.801
	VWE4	0.829
	VWE5	0.792

Stakeholders' Engagement	SEG1	0.836
	SEG2	0.702
	SEG3	0.876
	SEG4	0.745
	SEG5	0.732
	SEG6	0.760
Sustainable Project Success	SPS1	0.851
	SPS2	0.843
	SPS3	0.887
	SPS4	0.779
	SPS5	0.823

In table 3, the high outer loading values for each research construct demonstrate the strong relationships between the items and their respective constructs, indicating construct validity. Generally, loadings above 0.7 are deemed acceptable. For Sustainability in Project Management, all items exceed this threshold, with SPM2 showing the highest loading at 0.816, indicating its significant contribution. In the Digitalization construct, DIG3 has the strongest loading at 0.890, reflecting its crucial role, while DIG2, with a loading of 0.716, is at the lower end but remains acceptable.

The Sustainable Project Planning construct exhibits strong loadings across all items, particularly SPP4, which has a notably high loading of 0.907, underscoring its importance in this area. Similarly, the Virtual Work Environment shows robust loadings, with VWE4 contributing significantly at 0.829.

Within the Stakeholders' Engagement construct, items SEG1 and SEG3 stand out with loadings of 0.836 and 0.876, respectively, highlighting their substantial impact on the construct, while SEG2, at 0.702, is slightly lower but still acceptable. Lastly, in the Sustainable Project Success category, all items demonstrate strong loadings, with SPS3 achieving the highest loading of 0.887.

Internal Consistency:

Table 4: Cronbach's Alpha

	Cronbach's Alpha
Sustainability in project management	0.811
Digitalization	0.819
Sustainable Project Planning	0.798
Virtual Work Environment	0.890
Stakeholders' Engagement	0.682
Sustainable Project Success	0.907

The table 4 presents the Cronbach's Alpha values for various constructions, indicating their reliability and consistency. A Cronbach's Alpha value exceeding 0.7 is generally considered acceptable, with higher values reflecting improved internal consistency. Sustainability in Project Management ($\alpha = 0.811$) and Digitalization ($\alpha = 0.819$) demonstrate good reliability, indicating that the items measuring these constructs are consistent. Sustainable Project

Planning (α = 0.798) is slightly below 0.8 but still suggests a reliable measure. The elements linked to this construct are very reliable, as shown by the Virtual Work Environment's high degree of internal consistency (α = 0.890). However, Stakeholders' Engagement (α = 0.682) falls below the generally accepted threshold of 0.7, suggesting weaker internal consistency and indicating potential improvements are needed for its measurement. Lastly, Sustainable Project Success (α = 0.907) has the highest reliability, demonstrating excellent consistency in capturing sustainable project success. The constructs show good reliability, except for Stakeholders' Engagement, which may require refinement.

Convergent Validity:

Table 5: Convergent Validity

	rho_A	Composite Reliability	AVE
Sustainability in project management	0.787	0.815	0.798
Digitalization	0.835	0.923	0.651
Sustainable Project Planning	0.797	0.816	0.572
Virtual Work Environment	0.813	0.818	0.767
Stakeholders' Engagement	0.893	0.787	0.815
Sustainable Project Success	0.935	0.946	0.980

The table 5 provides results for convergent validity, which evaluates whether multiple indicators measuring a construct agree. Three key metrics are considered: rho_A, Composite Reliability (CR), and Average Variance Extracted (AVE).

- Sustainability in Project Management shows strong convergent validity with rho_A = 0.787, CR = 0.815, and an AVE = 0.798, indicating that most of the variance is captured by the indicators of this construct.
- Digitalization demonstrates excellent convergent validity with rho_A = 0.835, CR = 0.923, and an AVE = 0.651, confirming that the construct is reliably measured.
- Sustainable Project Planning has slightly lower values, with rho_A = 0.797, CR = 0.816, and AVE = 0.572, suggesting moderate convergent validity, but still acceptable.
- Virtual Work Environment also reflects solid convergent validity with rho_A = 0.813, CR = 0.818, and an AVE = 0.767, ensuring reliability in its measurement.
- Stakeholders' Engagement shows a higher rho_A = 0.893 but lower CR = 0.787. However, its AVE = 0.815 is quite strong, indicating the majority of variance in the construct is well captured by its indicators.
- Finally, Sustainable Project Success has excellent convergent validity, with the highest values across the table: rho_A = 0.935, CR = 0.946, and AVE = 0.980. These results demonstrate high internal consistency and measurement reliability.

Discriminant Validity
Fornell-Lacker Criterion:

Table 6: Fornell-Lacker criterion

	SPM	DIG	SPP	VWE	SEG	SPS
Sustainability in project management	0.514					
Digitalization	0.523	0.552				
Sustainable Project Planning	0.458	0.592	0.672			
Virtual Work Environment	0.723	0.638	0.582	0.612		

Stakeholders' Engagement	0.498	0.712	0.701	0.619	0.731	
Sustainable Project Success	0.671	0.719	0.678	0.505	0.711	0.572

The Fornell-Larcker criterion in table 6 compares the square root of each construct's Average Variance Extracted (AVE) with the correlations between that construct and others. The square root of AVE (shown on the diagonal) should be greater than the correlations with other constructs (off-diagonal values).

- Sustainability in Project Management (SPM) has a square root of AVE of 0.514, which is lower than its correlation with other constructs like Digitalization (DIG = 0.523) and Virtual Work Environment (VWE = 0.723). This indicates potential issues with discriminant validity, as SPM shares stronger correlations with these constructs.
- Digitalization (DIG) has a square root of AVE of 0.552, which is only marginally higher than its correlation with Sustainable Project Planning (SPP = 0.592) and Stakeholders' Engagement (SEG = 0.712), indicating some overlap and potential issues with discriminant validity.
- Sustainable Project Planning (SPP), Virtual Work Environment (VWE), Stakeholders' Engagement (SEG), and Sustainable Project Success (SPS) similarly show correlations with other constructs that are close to or higher than their AVE square roots. For example, SPS has a square root of AVE of 0.572, but its correlation with DIG is 0.719, indicating possible discriminant validity concerns.

Heterotrait-Monotrait (HTMT):

Table 7: Heterotrait-Monotrait (HTMT)

	SPM	**DIG**	**SPP**	**VWE**	**SEG**	**SPS**
Sustainability in project management						
Digitalization	0.418					
Sustainable Project Planning	0.605	0.635				
Virtual Work Environment	0.503	0.690	0.457			
Stakeholders' Engagement	0.516	0.465	0.562	0.615		
Sustainable Project Success	0.711	0.513	0.718	0.506	0.617	

The Heterotrait-Monotrait (HTMT) ratios in table 7 measure the discriminant validity between constructs, ensuring that they are distinct from one another. The findings indicate that the constructs exhibit significant differences and demonstrate strong discriminant validity, as the majority of the HTMT values fall below the established threshold of 0.85.

- The HTMT between Sustainability in Project Management (SPM) and Digitalization (DIG) is 0.418, indicating a moderate relationship but sufficient distinction between these constructs. Similarly, the relationships between SPM and Sustainable Project Planning (SPP) (0.605), Virtual Work Environment (VWE) (0.503), and Stakeholders' Engagement (SEG) (0.516) also suggest moderate associations but remain within acceptable limits. The relationship between SPM and Sustainable Project Success (SPS) is slightly higher at 0.711 but still falls within the acceptable range, indicating that these constructs are related but distinct.

- The HTMT values between DIG and other constructs, such as SPP (0.635), VWE (0.690), SEG (0.465), and SPS (0.513), all remain below the threshold, suggesting that Digitalization is appropriately differentiated from these constructs.
- The HTMT value between SPP and Sustainable Project Success (SPS) is 0.718, which is relatively high compared to other pairs but still within the acceptable limit. This suggests a stronger relationship between sustainable project planning and project success but maintains sufficient discriminant validity. Similarly, the HTMT between SPM and SPS is 0.711, indicating a strong but acceptable association.
- Other relationships, such as between VWE and Stakeholders' Engagement (SEG) (0.615) and VWE and SPS (0.506), are moderate, supporting the distinctiveness of these constructs.

Structural Equation Model:

The measurement model of this study is given in Figure 4 below.

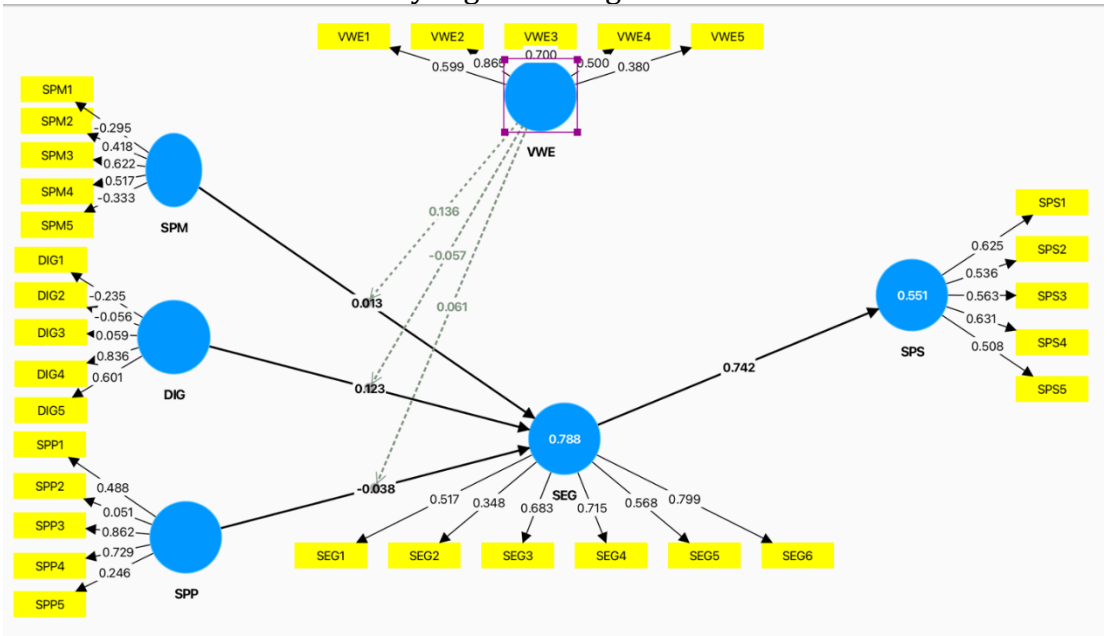

Figure 4: Measurement Model of the study

Direct Relationship:

The model for a direct relationship between variables is given in figure 5:

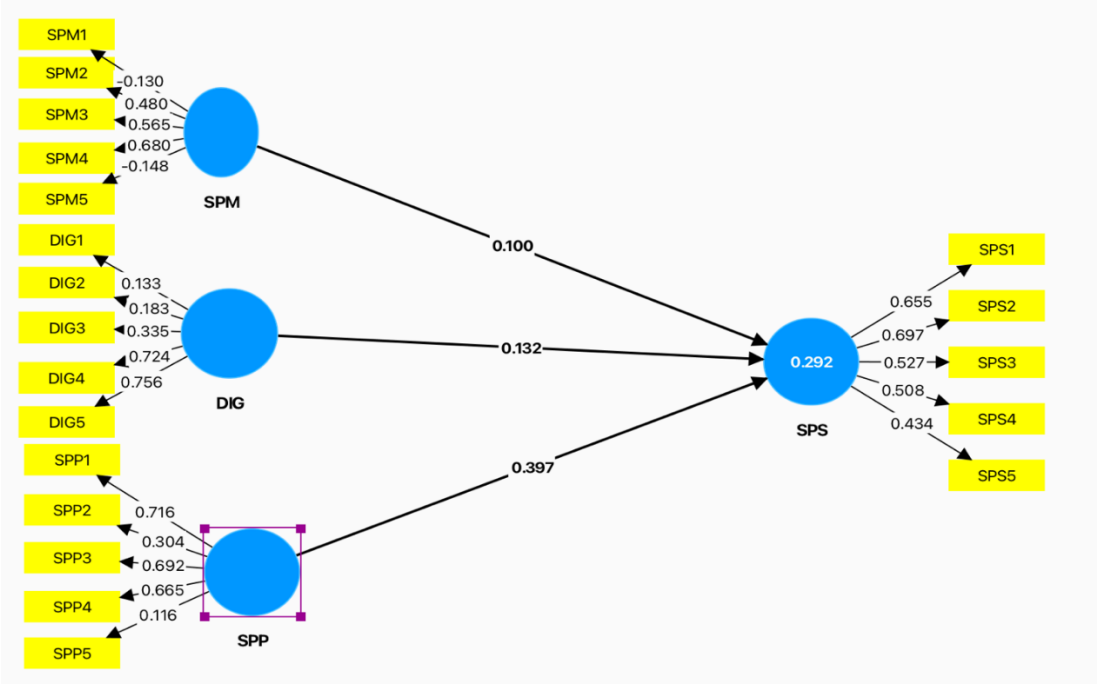

Figure 5: Direct Relationship between Variables

Table 8: Direct Relationship

	Hypothesis	Std Beta	SD	T values	P values
H1	**Sustainability in project management→Sustainable Project Success**	0.311	0.221	2.182	0.000
H2	**Digitalization→Sustainable Project Success**	0.243	0.325	13.001	0.000
H3	**Sustainable Project Planning→Sustainable Project Success**	0.232	0.312	15.232	0.000

H1: Sustainability in Project Management → Sustainable Project Success

In table 8, the standardized beta (β) value is **0.311**, indicating a moderate positive effect of sustainability in project management on sustainable project success. The T-value of **2.182** is above the critical value for significance, and the P-value is **0.000**, confirming that this relationship is statistically significant. Therefore, the hypothesis is supported.

H2: Digitalization → Sustainable Project Success

In table 8, the standardized beta (β) value is **0.243**, suggesting that Digitalization has a positive but slightly weaker effect on sustainable project success than sustainability in project management. The T-value is **13.001**, and the P-value is **0.000**, both indicating a highly significant relationship. Hence, this hypothesis is also supported.

H3: Sustainable Project Planning → Sustainable Project Success

In table 8, the standardized beta (β) value is **0.232**, showing a positive influence of sustainable project planning on sustainable project success. This relationship is supported by a high T-value of **15.232** and a significant P-value of **0.000**. Therefore, this hypothesis is confirmed as well.

All three hypotheses (H1, H2, H3) show positive and statistically significant direct relationships with sustainable project success. The findings emphasize the importance of sustainability, Digitalization, and sustainable project planning in achieving project success.

Mediation Relationship

The model for mediating relationship between variables is given in figure 6:

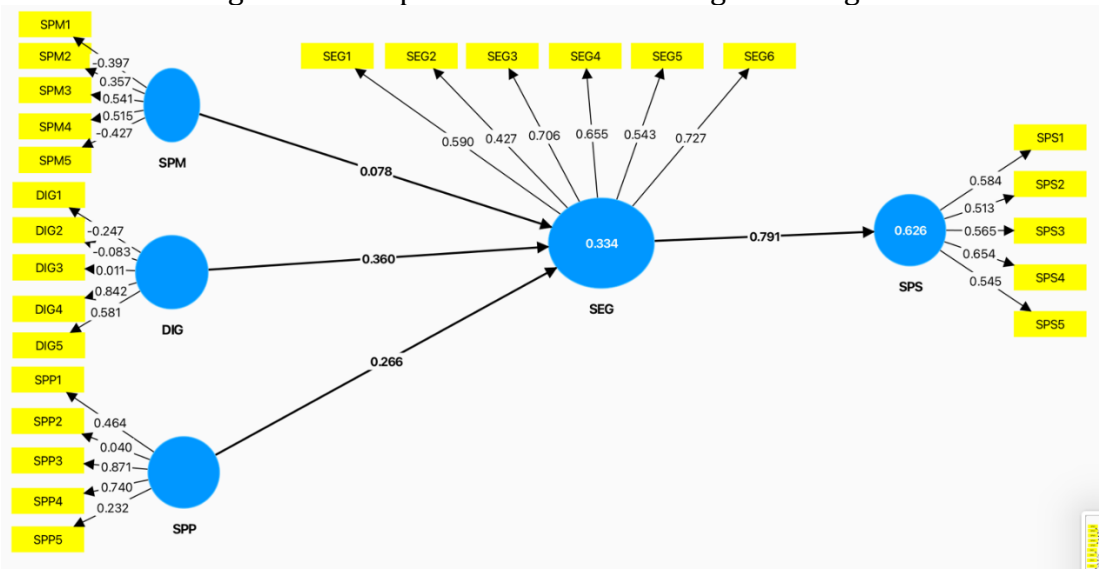

Figure 6: Mediating relationship between variables

Table 9: Mediation Relationship

	Hypothesis	Std Beta	SD	T values	P values
H4	Sustainability in project management→Stakeholders' Engagement→Sustainable Project Success	0.152	0.189	17.061	0.001
H5	Digitalization→Stakeholders' Engagement→Sustainable Project Success	0.174	0.128	5.812	0.000
H6	Sustainable Project Planning→Stakeholders' Engagement→Sustainable Project Success	0.243	0.172	4.101	0.000

H4: Sustainability in Project Management → Stakeholders' Engagement → Sustainable Project Success

In table 9, the standardized beta (β) value is **0.152**, indicating that stakeholders' Engagement partially mediates the relationship between sustainability in project management and sustainable project success. The T-value is **17.061**, and the P-value is **0.001**, suggesting a significant mediating effect. Therefore, stakeholders' Engagement enhances the positive impact of sustainability in project management on project success.

H5: Digitalization → Stakeholders' Engagement → Sustainable Project Success

In table 9, the standardized beta (β) value is 0.174, demonstrating a moderate mediating effect of stakeholders' Engagement in the relationship between Digitalization and sustainable project success. The T-value of 5.812 and the P-value of 0.000 confirm this mediation is statistically significant. This implies that Digitalization leads to better project outcomes when combined with effective stakeholder engagement.

H6: Sustainable Project Planning → Stakeholders' Engagement → Sustainable Project Success

In table 9, the standardized beta (β) value is 0.243, showing a strong mediating effect of stakeholders' Engagement on the relationship between sustainable project planning and sustainable project success. The T-value is 4.101, and the P-value is 0.000, indicating a highly significant mediation. This highlights that stakeholder engagement plays a crucial role in linking sustainable project planning to successful project outcomes. All mediation hypotheses (H4, H5, H6) are supported, confirming that stakeholders' Engagement considerably mediates the relationships between sustainability in project management, Digitalization, and sustainable project planning with sustainable project success. This underscores the significance of involving stakeholders in project approaches to enhance overall project success.

Moderation Relationship

The model for moderating the relationship between variables is given in Figure 7:

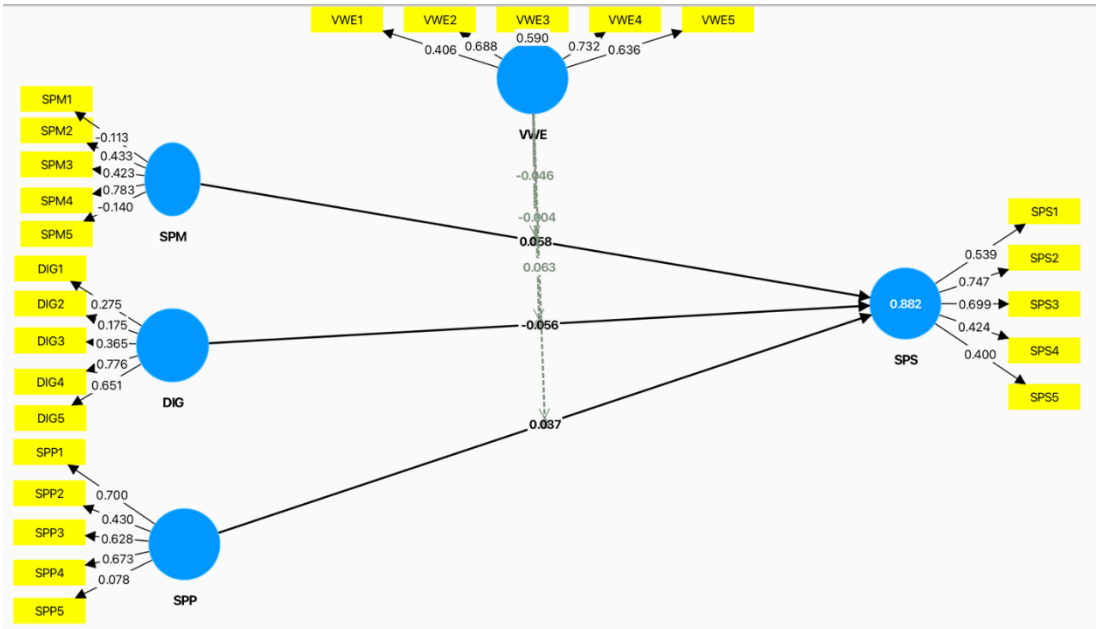

Figure 7: Model for moderating relationship between variables

Table 10: Moderation Relationship

	Hypothesis	Std Beta	SD	T values	P values

H7	Virtual Work Environment→Sustainability in Project Management →Sustainable Project Success	0.182	0.167	3.161	0.001
H8	Virtual Work Environment→Digitalization→Sustainable Project Success	0.186	0.176	12.139	0.000
H9	Virtual Work Environment→Sustainable Project Planning→Sustainable Project Success	0.189	0.187	6.719	0.000

H7: Virtual Work Environment → Sustainability in Project Management → Sustainable Project Success

In table 10, the standardized beta (β) value is **0.182**, indicating that the virtual work environment positively moderates the relationship between sustainability in project management and sustainable project success. The T-value is **3.161**, and the P-value is **0.001**, showing that the moderation effect is statistically significant. This suggests that when the virtual work environment is well-integrated, the influence of sustainability in project management on project success increases.

H8: Virtual Work Environment → Digitalization → Sustainable Project Success

In table 10, the standardized beta (β) value is 0.186, showing a positive moderating effect of the virtual work environment on the relationship between Digitalization and sustainable project success. The T-value of 12.139 and the P-value of 0.000 indicate a highly significant moderation effect. This suggests that the virtual work environment enhances the positive impact of Digitalization on project outcomes.

H9: Virtual Work Environment → Sustainable Project Planning → Sustainable Project Success

In table 10, the standardized beta (β) value is 0.189, demonstrating that the virtual work environment moderates the relationship between sustainable project planning and sustainable project success. The T-value is 6.719, and the P-value is 0.000, confirming a strong and statistically significant moderation effect. This highlights that when projects are conducted in a virtual work environment, the effect of sustainable project planning on project success is further strengthened.

All moderation hypotheses (H7, H8, H9) are supported, indicating that the virtual work environment substantially improves the relationships between sustainability in task control, Digitalization, and sustainable challenge-making plans with sustainable task fulfillment. This highlights the significance of digital painting dynamics in fostering better project consequences in modern project management settings.

The model of the study is illustrated in Figure 8:

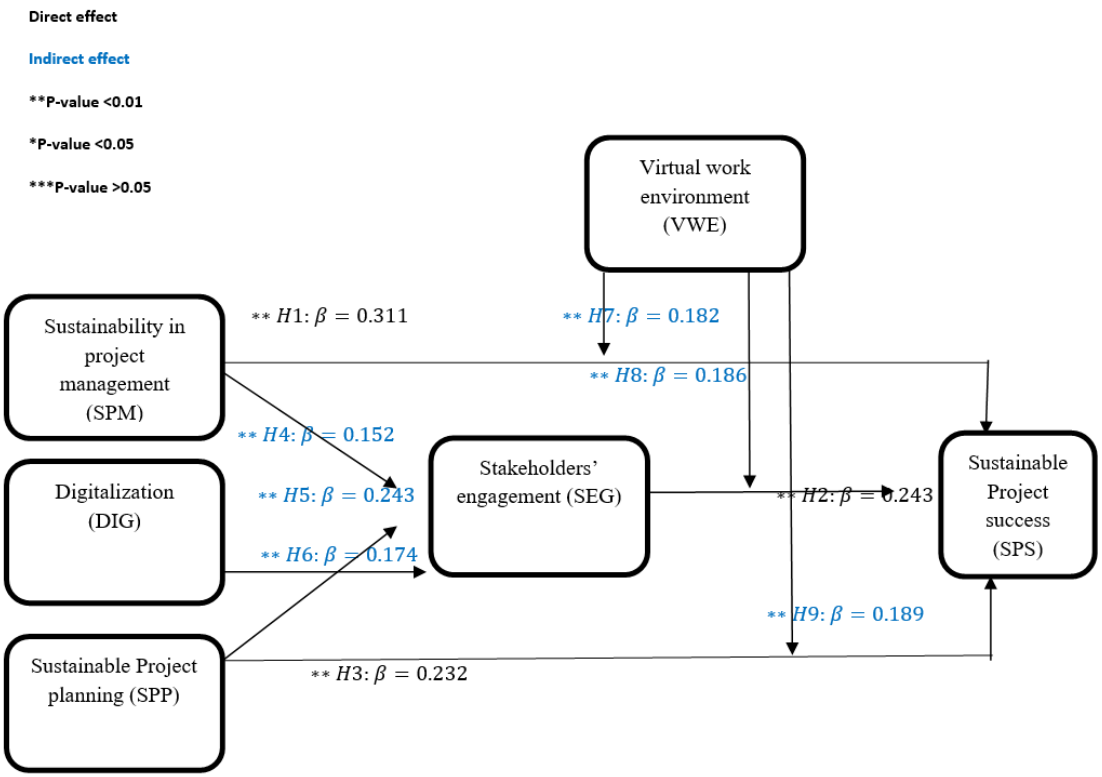

Figure 8: Conceptual Framework
Source: Developed by the researcher

DISCUSSION, CONCLUSION, AND IMPLICATIONS

Discussion

In recent years, there has been a notable increase in the popularity of project management practices that emphasize long-term sustainability [19], [27]–[30]. Furthermore, the virtual work environment (VWE) and stakeholder engagement (SE) have been acknowledged as key components of long-term project management methods [27], [31], [33], [34]. Project life cycles exhibiting these characteristics tend to be extended and encompass activities such as sustainability review, procedure optimization, and resource management. Organizations that prioritize a positive influence while reducing their footprint on society and the environment view sustainable project management as a continuous learning journey. The findings of this study indicate that digitalization, sustainable project planning, and sustainability in project management significantly influence the construction sector in Jordan. The virtual work environment and stakeholder participation serve to mediate and regulate the relationship between these characteristics.

Projects run with environmental responsibility are much more likely to be successful. This result is relevant to the study of Chow *et al.* [1], which revealed a strong positive correlation between the lifetime of project management and process performance in an alternate setting. Research conducted by previous studies [5], [6], [10], [111], [112]demonstrates that the project management methodology employed a life cycle model. The concept encompassed strategies for efficient planning, execution, supervision, and administration. Additionally, the effectiveness of a sustainable project is significantly influenced by its sustainable design.

Sustainable project management transforms the landscape of the industrial sector. This finding is consistent with past studies [113]–[117], which have shown that project planning significantly influences project success. A crucial element of the project management life cycle that influences the success of initiatives is sustainable project planning.

Further, the study revealed that the role of Digitalization is strategic in accomplishing sustainable projects. This finding supports the argument that [118] made that using digital tools facilitates a more efficient and transparent project and allows for better management of the resources and collaboration with the stakeholders. In any construction project where several people act in unison, Digitalization can help simplify communication, enabling better and quicker decisions and enhancing the project's success [119].

The findings indicate that the virtual work environment only partially reduces the relationship between the previously mentioned elements and the long-term sustainability of a project. This finding gains additional importance considering that the COVID-19 epidemic has established remote work and the utilization of technological tools for collaboration as standard practice. Awuni *et al.* [120] highlight the importance of additional reviews of the current virtual environment in the improvement of collaboration and communication among project teams and improves sustainable practice efficiency.

The relevance of stakeholders' participation as a link between digitalization, sustainable project management, sustainability in project planning, and the accomplishment of effective sustainable projects is also investigated in this paper. The numerous stakeholders involved in the decision-making process support the assertion stated by Andolina *et al.* [121]that employee impact might greatly improve project outcomes. This shows that engaging stakeholders can improve the effectiveness of sustainability measures and digital media with sustainable project success to make the project more robust.

Conclusion

Emphasizing the Jordanian building sector, this study adds to the body of knowledge already in use by clarifying the relationships among digitalization, sustainable project planning, and the realization of sustainable project objectives. According to the studies, one sure approach to raise the success rate of construction projects is adding sustainable practices into project management processes. Therefore, it is in line with what is already recognized in the field: it is essential to give social and environmental issues connected to construction great thought if one is to control project operations sustainably. When implementing the sustainable principle, the project managers can improve the project's results and help achieve sustainable development objectives in the sector.

Another contribution of this study is to establish that Digitalization is a critical enabler of sustainable project success. Digital tools and technologies facilitate project performance to increase the speed and effectiveness of project delivery, information sharing, and organization. This conclusion aligns with other studies asserting that Digitalization enhances project performance for resource-intensive industries such as construction. Moreover, the present paper highlights sustainable project planning as another element where sustainability and Digitalization depend on the former and are a necessary conduit for project success. This is

appropriate because effective planning enables project teams to consider potential risks that the projects may encounter while also foreseeing how resources will be subdivided and how project plans will be adapted to conform to sustainable objectives.

The study also confirms high degrees of verticalness and stakeholder engagement as important moderator and mediator variables in the investigated relationships. Therefore, the concept of a virtual work environment has gained an integral place in the work environment, especially in the current fully operationalized digital environment. This research reveals that when the virtual platform environment is well managed, sustainability implementation increases and stakeholder communication improves, improving project outcomes. Moreover, it was found that stakeholder engagement mediates the activities of sustainability practice, digitalization, and the extent of project success. The involvement of relevant stakeholders throughout the project life cycle is more beneficial because it helps address various concerns in project works, hence coming up with a better-enhanced decision on the project works and problems, which helps the project work be done more safely and sustainably.

It is, therefore, a pertinent contribution to the current literature since it highlights how sustainability in project management, digitalization of projects, sustainable planning of the projects, and stakeholder participation link with sustainable project success in Jordan's construction industry. The implications of these research results highlight the importance and incorporation of these elements by the project managers as they manage construction projects, thus reflecting structure complexities. Future research may offer supplementary insights into the dynamics of relationships across various sectors and regions over extended periods, as well as establish effective strategies to increase the probability of long-term project success.

Implications of the Study

This document outlines key considerations regarding the implications of this study for the construction sector in Jordan and afterward. Above all, they bring into focus the general and specific calls for improvements in project management to incorporate sustainability concerns into all the stages of project implementation [122]. Many project managers are now encouraged to integrate an assessment of organizational environmental, social, and economic impacts into the plans right from the planning stage, and this has been proven to enhance effective results and effective use of available resources. Also, the large scale of Digitalization exemplifies the need to allocate more resources to develop superior instruments and technology. Industry players involved in construction should ensure that training and development take place to improve the ability of the technological workforce to use data analytics, project management software, and many related technologies [123], [124].

However, arguing for the framework of sustainability criteria during the planning process, the study draws attention to the importance of strategic sustainable planning. To promote sustainability within construction organizations, firms should incorporate the assessment of sustainability into their business by engaging stakeholders in sustainability workshops, constructing an assessment tool for sustainability, and integrating sustainability indicators when making business decisions [125]. The conclusions also substantiate that active communication with stakeholders should be pursued, therefore making construction companies work out valid strategies to enhance common interaction between all participants.

The application of communications that involve feedback and reporting systems, as well as incorporating the views of various stakeholders within a local community and governmental and regulatory authorities, should also be incorporated within project work structures.

Also, since the nature of the virtual work environment moderates the success of any project, organizations need to embrace teleworking as the order of the day. Therefore, this paper posits that such tenets of dependable communication, data security and a flexible working environment can offer the competitive advantage needed to enhance productivity if the stakeholder is engaged. The research results of this study will offer valuable insights to policymakers and regulatory agents in Jordan, underscoring the importance of implementing supportive policies to encourage the adoption of sustainable construction practices. Such policies may comprise incentives for implementing sustainable technologies, requirements for interested stakeholders to participate in project approval processes, and standard-setting on the sustainability of project results. These consequences taken together emphasize the need of a thorough plan in controlling sustainable building projects. They show that legislators and construction businesses might help to establish a more successful and environmentally friendly project environment in Jordan, maybe in other parts of the world.

Limitations and Future Research

This research should take under account the following limitations: It is restricted to the Jordanian building sector and cannot theoretically grow to other sectors or nations as it is industry and country specific. Another significant source of bias is the fact that the makeup and size of a sample could not fairly represent the full construction workforce. However, the study design cannot establish causal relationships because the data gathered are cross-sectional, and the self-administered survey leads to response bias since the participants may over-report the levels of Engagement and the effectiveness of sustainability practices. In addition, the emphasis on only quantitative data means that valuable qualitative data are not considered or ignored in the pursuit of bringing more benefits to stakeholders and sustainability.

The identified limitations clearly indicate that the following factors should be taken into account in future research endeavors; The study could be broadened to cover other sectors to get even more insight into the nature of sustainability and Digitalization and how they affect project success. More longitudinal studies are suggested, especially in establishing time series and causal relationships among the variables under study. Using mixed-method research designs that involve both the quantitative and qualitative methodology seems more appropriate for enriching findings on the multiple facades of stakeholder involvement and sustainable management practices.

Furthermore, future research testing cultural explanations for adopting sustainability and stakeholder engagement initiatives might help develop more appropriate solutions. Researchers need to identify the various digital tools that can improve stakeholders' participation in projects and analyze the effects of governmental and institutional policies concerning implementing sustainable development practices and digitalization in construction projects. The following are suggestions for future works that would enhance an improved knowledge of the various complexities in sustainable project management. By following these suggestions, future studies will help better understand the processes involved.

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