



UNIVERSITY OF NOVI SAD
FACULTY OF TECHNICAL SCIENCES



THE IMPACT OF SMART WORKING ON PROJECT SUCCESS: THE ROLE OF INFORMATION AND COMMUNICATION TECHNOLOGIES AND WORKFORCE AGILITY

DOCTORAL DISSERTATION

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Table of abbreviations

Abbreviation	Definition
A	Adaptability
AGFI	Adjusted Goodness-of-Fit Index
AI	Artificial Intelligence
AR	Augmented Reality
AVE	Average Variance Extracted
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CLF	Common Latent Factor
CMB	Common Method Bias
CR	Composite Reliability
CRM	Customer Relationship Management
CSAT	Customer Satisfaction
EFA	Explanatory Factor Analysis
EHR	Electronic Health Record
EPA	Employee Assistance Program
ERP	Enterprise Resource Planning
ESG	Environmental, Social, and Governance
GFI	Goodness-of-Fit Index
IMPC	Impact on the Customer
IMPT	Impact on the Team
IoT	Internet of Things
IS	Information Systems
IT	Information Technology
KPI	Key Performance Indicators
LEED	Leadership in Energy and Environmental Design
LMS	Learning Management Systems
MFA	Multi-factor Authentication
NB	Net Benefit
NPS	Net Promoter Score
P	Proactivity
PCLOSE	Probability of Close Fit
PMBOK	Project Management Body of Knowledge
PMI	Project Management Institute
PS	Project Success
PSIS	Project Investment Success

PSMS	Project Management Success
PSOS	Project Ownership Success
R	Resilience
R&D	Research and Development
RMSEA	Root Mean Square Error of Approximation
ROI	Return on Investment
RPA	Robotic Process Automation
RPA	Robotic Process Automation
SDG	Sustainable Development Goal
SEM	Structural Equation Modeling
SQ	System Quality
SW	Smart Working
TAM	Technology Acceptance Model
U	Use/Intent to use
US	User Satisfaction
VR	Virtual Reality
WA	Workforce Agility

1. Introduction

1.1 Problem and scope of the research

The global landscape of work environments has undergone profound transformation in recent years, catalyzed by a confluence of unprecedented events. The emergence of the COVID-19 pandemic, along with supply chain disruptions, geopolitical tensions, and regional conflicts, has precipitated a seismic shift in how individuals operate within the professional sphere and how organizations conduct their affairs [1]. This transformative period has ushered in the era of Smart Working (SW), a paradigm characterized by remote collaboration, digital connectivity, and agile adaptation to dynamic circumstances [2].

The COVID-19 pandemic, in particular, emerged as a driving force behind the widespread adoption of SW practices, necessitating swift adjustments to traditional modes of operation [2]. With lockdown measures and social distancing protocols in place, organizations were compelled to rapidly deploy remote work solutions to ensure business continuity. Consequently, employees found themselves navigating a virtual workspace, leveraging digital tools and communication platforms to fulfil their professional responsibilities [3, 4].

Against this backdrop of transformation and upheaval, the efficacy of Information Systems (IS) in enabling SW practices assumes paramount importance. As organizations grapple with the complexities of remote collaboration and project management, the adequacy and sophistication of technological infrastructure become key determinants of success. Seamless integration of digital tools, robust cybersecurity measures, and intuitive platforms for virtual collaboration are indispensable prerequisites for navigating the evolving landscape of work [2, 5, 6].

Moreover, the cascading effects of disrupted supply chains and geopolitical uncertainties further underlined the imperative for organizational resilience and flexibility. Companies confronted unprecedented challenges in managing dispersed teams, coordinating activities across remote locations, and mitigating risks arising from volatile external factors. In response, the concept of Workforce Agility (WA) emerged as a linchpin for organizational survival, emphasizing the ability to respond promptly and effectively to changing circumstances and capitalize on emerging opportunities [7–9].

A compelling area of inquiry regarding the impact of these factors is projects, as they are an integral part of the global economy and agents of change, that are crucial in such constantly evolving circumstances [10]. According to Gartner-Inc [11], Information Technology (IT) projects alone having been estimated to reach 5.7 trillion dollars in spending in 2025. According to the International Journal of Project Management [12], projects can be categorized into several types, including strategy, engineer-to-order manufacturing, infrastructure and systems delivery, organizational development, and product development. Furthermore, the journal identifies a number of industries in which such projects are commonly undertaken, such as information technology, engineering and manufacturing, construction, consulting and professional services, as well as the public sector, encompassing international development and cooperation. Due to the immense impact, there should be a constant strive by the scientific community and professionals to explore the diverse factors that affect Project Success (PS) [13–15]. Projects possess a particular nature that stems from the fact that they are initiated with an end date [16]. At their completion, they should provide a deliverable be it tangible (product), intangible (changes in organizational structure), or a combination of the two. What makes this a unique feature is that most other business ventures are initiated to consistently perform and provide growth and benefits (financial or otherwise) without an end date. In contrast, projects are unique and temporary due to their one-off nature [17, 18]. The limited duration of projects allows their impact to be immediate and significant. However, this type of impact requires unique approaches to measuring performance and success since numerous factors are at play. Nevertheless, this task becomes increasingly difficult if on-site work is not an available option.

Projects in and of themselves must balance interesting dynamics, such as expectations of different stakeholders [19] and time constraints [13, 14], including additional constraints and challenges added a layer of complexity which was bound to have an impact on PS based on the solutions put in place by companies to address these hurdles. Companies have deployed remote working solutions to ensure business continuity which hinge primarily on two aspects: the level of sophistication of technology and tools used by employees, and the adaptability of employees themselves to the changing work environment. More specifically, this research identified IS and WA as the main pillars in measuring efficacy and provide a nuanced understanding of the impacts SW on PS. By elucidating the interconnectedness of these variables, we aim to provide insights

that inform strategic decision-making and enhance organizational resilience in an era defined by unprecedented change and uncertainty.

Existing literature has extensively examined the relationship between WA and PS [20–23], recognizing the fundamental role of adaptable teams in navigating dynamic project environments. Scholars have emphasized the importance of responsive decision-making, flexible resource allocation, and effective communication channels in enhancing project outcomes. Moreover, the impact of IS on PS [16] has also been investigated, as technology has a substantial influence on project outcomes. However, with the advent of SW, characterized by remote collaboration and digital connectivity, a critical gap emerges in literature. Traditional frameworks for understanding PS do not fully capture the complexities introduced by the remote work paradigm. The shift to SW necessitates a reevaluation of these dynamics, with particular emphasis on the contribution of IS and WA to facilitating efficient remote collaboration and project delivery. While existing research has explored the individual components of WA and IS, they have not been used in the context of SW to measure the impact on PS. This gap in literature stresses the need for a thorough framework that elucidates the interconnectedness of IS, WA, and project outcomes within the context of SW. By examining the interplay between these factors, we aim to offer a comprehensive insight into how organizations can leverage SW practices to enhance PS in an increasingly digitized and dynamic environment.

1.2 Research objectives

Therefore, the objective of this research is to discover the successfulness of SW for companies operating in project settings by evaluating the impacts of this approach through the use of IS systems and WA. The use of advanced technologies and their integration to operating tasks to support employees in their work by making it easier, accessible, and safer while increasing efficiency and providing workers with flexibility positively affects productivity and is called SW [24–26]. Its objective is to accommodate better working conditions for the employees to improve productivity [27]. In addition, it seeks to allow employees to perform as much work as possible by remote access through advanced technologies [28]. This mode of working has seemingly proven to be successful or at the very least not impactful on the companies' bottom line and project performance [26], as companies are electing to trade office space (selling/ discontinuing leases for

buildings and offices) and plan to continue to operate in this manner even when unaffected by external factors (e.g. COVID-19) [29]. However, concerns about the sustainability of this approach to working exist and are related primarily to:

- the adequacy of technology available that needs to guarantee efficiency and consistency of results, and the competency of use of this technology by employees, to avoid slowing down business operations,
- WA, that is, the proactivity, adaptability, and resiliency of employees who are willing and able to continue to work in this manner for an extended period or indefinitely.

1.3 Research questions and hypothesis

The research questions and hypothesis raised aiming to address the overarching objective of evaluating the success of SW in project-based environments by investigating the interplay between WA, IS, and PS, explore the key factors and mechanisms that drive SW's effectiveness, focusing on the roles of WA and IS. By posing and testing targeted research questions and hypotheses, the study seeks to uncover the pathways through which SW contributes to or detracts from project performance.

The research investigates three primary aspects:

- **WA as a driver of IS Systems:** The agility of the workforce, encompassing dimensions such as proactivity, adaptability, and resiliency, is hypothesized to be a critical enabler for IS success. Specifically, the study examines whether WA significantly impacts the Use/Intent to Use and Net Benefit of IS, thereby facilitating their effective integration into SW environments.
- **The role of IS Systems in achieving PS:** IS Systems are posited to be central to the realization of PS, acting as tools that enhance efficiency, streamline processes, and enable employees to meet project objectives under SW conditions. The research seeks to validate the extent to which IS Systems influence the key dimensions of PS.
- **The influence of WA on PS:** Beyond its role in driving IS success, WA is hypothesized to have a direct and significant impact on PS. By fostering a workforce that is proactive, adaptable, and resilient, SW environments are expected to support better project outcomes.

This research aims to distinguish the specific contributions of WA to PS and explore the dynamics between these factors.

By addressing these research questions and hypotheses, the study offers an integrated framework for analyzing the mechanisms underlying SW and offers valuable insights for organizations considering or implementing SW practices in project settings.

1.4 Theoretical and practical applications

From a theoretical standpoint, this research offers a nuanced contribution by combining existing models into a comprehensive framework for measuring the impact of SW on PS. By integrating elements from established frameworks of IS Success [30] and WA [31], this study bridges gaps in existing literature and offers a holistic approach to understanding the dynamics of SW. This research also advances the field by highlighting the importance of a balanced approach to measuring PS. By combining elements from two established frameworks [13, 14], the study minimizes biases and offers a robust evaluation methodology that reflects the intricacies of real-world projects through expanding the measurement of PS to encompass both short-term and long-term outcomes while addressing the perspectives of various stakeholders. This theoretical contribution enables researchers to better understand how SW can shape the future of project management and lays the groundwork for future research to further develop and extend these findings.

From a practical perspective, this research seeks to address the need to provide insight for companies in understanding and identifying if SW should be the preferred approach to future projects or if the traditional method still provides better performance. The findings of this study are expected to offer companies with a clearer picture of which direction to commit and invest funds. If the traditional approach is best, companies should invest funds in an infrastructure that can facilitate a safe return to the work environment. However, in the case if the research demonstrates significant added value in favor of SW practices and their improvement of company performance, this will allow companies to lower their cost and invest in employee training and in technologies that improve performance, efficiency, and reliability to foster WA.

With the use of SW approaches in projects there seem to be certain levels of ambiguity regarding the factors impacting the final outcome as most approaches to measuring PS focus exclusively on measuring the result without evaluating whether the environment in which the project was initiated and the accompanying factors were adequate for the project to thrive [32–34]. Therefore, this research carefully evaluates the impacts of technology and WA and its adequacy, before dealing with the issue of the successfulness of the actual SW approaches used in projects. By isolating these factors and evaluating their separate influence prior to assessing the overall impact the results of the study allow the companies to understand to a deeper extent which type of people and which type of tools allow projects to have better odds of producing satisfactory results.

To investigate the impact of SW on PS, a survey was conducted within the largest consulting company by revenue in the world. Data was collected from 198 employees at their Italian office. The survey aimed to capture insights from employees across various departments and hierarchical levels, encompassing diverse perspectives on SW practices and their implications for project outcomes. After collecting the survey data, a rigorous analysis was undertaken using Structural Equation Modeling (SEM) in IBM SPSS Amos. The findings revealed noteworthy insights into the relationships, supporting 23 out of 24 hypotheses. The results indicated a significant positive impact of IS on PS, underscoring the pivotal role of technology in enabling remote collaboration and efficient project management. Conversely, the impact of WA yielded mixed results, with variability observed across different factors such as proactivity, adaptability, and resiliency of the workforce. The findings of this study inform strategic decisions, aiding organizations in navigating the complexities of SW and fostering resilience amidst uncertainty.

1.5 Structure

This work is structured as follows:

Section 2 provides a comprehensive *literature review* that introduces and contextualizes the macro factors relevant to this research. It discusses key theoretical frameworks and previous studies that underpin the research focus, establishing a foundation for understanding the concepts of SW, PS, WA, and IS Success. The literature review aims to synthesize existing knowledge while identifying gaps that this study seeks to address.

Section 3 lays out the *research framework and hypotheses*, detailing the conceptual model employed in this study. This section explains how the independent and dependent variables are connected and discusses the rationale behind the chosen relationships. Hypotheses are presented with reference to existing studies and theories, providing a logical pathway from literature to the research questions posed by this study.

Section 4 elaborates on the *research materials and methods* used, including the design, sampling techniques, and data collection procedures. This section outlines the methodological approach adopted to ensure the reliability and validity of the data gathered. It includes details on the instruments used for data gathering, as well as the statistical methods employed for analysis. Furthermore, it addresses potential biases and the measures implemented to address them.

Section 5 presents the *results* of the research, offering a detailed account of the statistical analyses carried out. This section includes data tables, figures, and charts to visually represent the findings. The results are structured around the hypotheses and research questions, with clear explanations of which were supported or rejected based on the analysis.

Section 6 provides a *discussion* of the results, analyzing their implications from both theoretical and practical perspectives. Theoretical implications are framed within the context of the literature reviewed in Section 2, highlighting how this research contributes to the existing body of knowledge. Practical implications explore how the findings can be applied within organizational settings, particularly concerning SW and its influence on PS. This section also addresses any unexpected results and offers potential explanations or interpretations. Moreover, in this section we dive deeper into the components of the *structural model*, explaining the interconnectedness between variables in greater detail. This section provides a technical breakdown of the SEM used, clarifying the connections between WA, Information System Success, and PS. It also discusses the fit indices and how well the model represents the data.

Section 7 *concludes the work*, summarizing the main findings and contributions of the study. It reflects on the significance of the results, both in terms of advancing academic understanding and offering actionable insights for practitioners. Key takeaways are highlighted, with a focus on how this research can inform future strategies for implementing SW and improving project performance. In addition, it outlines the *limitations* of the research, acknowledging areas where the study may be constrained by factors such as sample size, data collection methods, or

generalizability of the results. It also proposes *future research directions*, offering suggestions on how subsequent studies could build on these findings, explore related questions, or refine the methodology to address any limitations identified.

2. Background and related work

The conceptualization phase of this research was based on a literature review to introduce the topic and lay the required theoretical foundation. The focus of the review is literature regarding the impact of SW on PS (how it is measured, what is necessary to achieve it, what are the factors affecting it), IS (in the domain of projects), and WA (in the domain of projects).

A systemic literature review was carried out using SCOPUS and Web of Science databases due to their access to global scientific publications. Only literature relevant to the research question was taken into consideration. The period analyzed consider work published from 2014 to 2024 with a stronger emphasis on the latter, and only English language papers were taken into consideration. Collection of literature was done through a search for relevant keywords in the SCOPUS and Web of Science databases such as: project + smart working, project success + smart working, project performance + smart working, project impact + smart working, project + agile working, project success + agile working, project performance + agile working, project impact + agile working, project + technology, project + workforce agility, project + agility, technology + workforce agility technology + agility, project success, project performance, project impact. This literature review provides a clear research objective and is a basis for the formulation of research hypotheses and research questions.

2.1 Smart work

Although the use of SW is broad, the main aspect of SW tackled in this research regards the technologies that have allowed for worker flexibility in terms of physical location without compromising effectiveness and completing complex tasks [8]. More specifically, SW approaches and methodologies applied in projects that include remote working. Thanks to these advanced technologies, employees enjoy a higher degree of freedom and flexibility when selecting the location and working environment that best suits them for completing their tasks and activities [8]. This aspect of SW, often termed agile working, endows employees with increased adaptability and responsiveness, thereby facilitating a better alignment of work settings with personal preferences and life circumstances [2]. Critiques exist regarding the productivity of remote work [9]; however, empirical evidence increasingly supports the notion that working from more comfortable, self-selected environments can lead to better employee performance, improved team dynamics, and

enhanced overall well-being [8, 23]. Adopting SW approaches gives companies a distinct advantage of reacting faster to external factors than competitors to changing market conditions [35].

2.1.1 Industry 4.0 overview and context

The Fourth Industrial Revolution, commonly referred to as Industry 4.0 [36], represents a paradigm shift in industrial practices, driven by advancements in automation, connectivity, and data exchange technologies. Coined in 2011 by the German government, the term describes the digital transformation of manufacturing and industry, propelled by emerging technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), Cloud Computing, and Big Data [5, 26, 28, 37–39]. Thanks to technological advancements, work has never been more integrated and synchronized [40].

At the core of Industry 4.0 are several key technological advancements that enable the integration of cyber-physical systems into industrial processes. These technologies work synergistically to enhance the precision, efficiency, and flexibility of industrial operations:

- **IoT:** The IoT allows for the seamless connection of physical devices and machines to the internet, enabling real-time data collection and communication between systems. In an Industry 4.0 context, IoT facilitates enhanced machine-to-machine communication, leading to more efficient and flexible manufacturing processes [26, 37].
- **Cloud Computing:** This technology enables the storage, management, and processing of large datasets in a scalable and flexible manner. In Industry 4.0, cloud platforms are often utilized to aggregate and analyze sizable amounts of data produced by IoT-enabled tools, allowing for the optimization of production and supply chain processes [5].
- **Big Data and AI:** These two technologies are often used in tandem. AI's ability to analyze large datasets allows companies to extract actionable insights that can enhance decision-making, forecast trends, and even automate routine tasks. In an industrial setting, AI-driven analytics can lead to improvements in predictive maintenance, supply chain efficiency, and the development of personalized products [26, 27].

These technologies not only form the foundation of Industry 4.0 but also underpin the transition towards SW environments. With IoT providing real-time data, cloud computing ensuring

accessibility, and AI facilitating intelligent decision-making, these advancements have revolutionized the way work is organized and executed.

Industry 4.0 encompasses four key dimensions, often referred to as the "four smarts": SW, Smart Manufacturing, Smart Supply Chain, and Smart Product [5, 26, 41–43]. These dimensions highlight how Industry 4.0 extends beyond just automation in factories, offering an integrated vision for the future of work and production.

Smart Manufacturing involves the integration of advanced technologies like robotics, AI, and IoT to create more adaptable, efficient, and scalable manufacturing processes. These systems adjust autonomously to changes in production demands, enhancing productivity while minimizing waste [26]. While, on the other hand, Smart Supply Chains within Industry 4.0 are technologies that enable real-time tracking and data sharing across supply chains. This integration leads to reduced delays, improved resource management, and greater flexibility in responding to shifts in consumer demand [5, 27].

Products designed with embedded IoT capabilities allow for real-time monitoring and feedback during their lifecycle and are called Smart Products. This innovation enables companies to offer personalized products, monitor product performance post-sale, and enhance customer experiences [26]. Finally, SW refers to the transformation of work processes through technology, particularly remote work solutions, digital collaboration tools, and agile methodologies that increase flexibility and productivity in the workplace [5].

Each of these dimensions is interconnected, forming an integrated ecosystem where data flows seamlessly between manufacturing systems, supply chains, products, and the workforce. The adoption of these dimensions has led to enhanced resource efficiency, flexibility, and decentralization in industries across the globe [37].

Industry 4.0 is characterized by several defining features, each of which contributes to the overall transformation of industrial and work environments [37]. Consistently seeking to improve efficiency is at the core of Industry 4.0, which can be seen from shorter development and innovation times. Time to market for certain products has shown to be key in many industries as investors are becoming increasingly eager due to elevated competition and the constant market pressure. By leveraging AI and Big Data, companies can streamline the design, testing, and manufacturing processes, enabling faster innovation cycles [27, 37]. Moreover, consumers are

becoming more and more demanding and are prepared to pay premiums for customized and unique products. An adaptation of production processes is necessary to satisfy demand. Industry 4.0 enables manufacturers to meet the rising consumer demand for personalized products.. With the aid of AI and IoT, production lines can be adjusted in real-time to produce customized items while maintaining the efficiencies of mass production [37]. As work conditions continue to evolve, manufacturers are required to be innovative and agile across all stages of production, from design to manufacturing. Modern production environments must be agile to adapt to changing market demands and disruptions. Industry 4.0 technologies enable companies to switch between product designs and adjust supply chain processes with minimal downtime [26, 27].

The unstable environment in which companies operate requires efficiency in execution and decentralized decision-making enables precisely that. Technologies can be leveraged to reorganize companies and enhance their adaptability. Decentralized decision-making enabled by Industry 4.0 technologies is crucial in responding to unpredictable environments. In a decentralized system, local units have the autonomy to make decisions using real-time data, resulting in more efficient and timely responses to market shifts [27, 37]. Furthermore, resource efficiency is key in today's environment and advanced technologies of Industry 4.0 can be used to promote it. Improvements in resource efficiency impact a vast array of stakeholders, from the company itself to the consumers and society as a whole [19]. By streamlining all facets of the production process, from energy consumption to raw material sourcing, Industry 4.0 enhances sustainability efforts and reduces environmental impact. This increased resource efficiency benefits companies, consumers, and society as a whole [26, 27].

The combined effects of these characteristics result in a more efficient, responsive, and sustainable industrial environment, allowing companies to stay competitive in an increasingly globalized and complex marketplace. Adopting SW approaches gives companies a distinct advantage of reacting faster to external factors than competitors to changing market conditions [35].

Industry 4.0 is often compared with previous industrial revolutions, which were characterized by the introduction of mechanization (1st Industrial Revolution), electricity (2nd Industrial Revolution), and digital technologies (3rd Industrial Revolution). What differentiates

Industry 4.0 from its predecessors is its emphasis on connectivity and integration, enabling a fully digital and automated industrial landscape [27, 37].

The adoption of Industry 4.0 has been uneven across the globe, with developed economies like Germany, the United States, and Japan leading the way. However, emerging economies are increasingly investing in Industry 4.0 technologies to boost productivity and compete on the global stage [9, 27]. The global adoption of Industry 4.0 has accelerated due to the COVID-19 pandemic, as companies realized the need for greater flexibility and resilience in their operations [2, 6].

The global context of Industry 4.0 highlights its far-reaching implications for different sectors, from manufacturing to healthcare, and the opportunities it offers for enhanced productivity, innovation, and sustainability [2, 26].

2.1.2 In-depth exploration of smart working

SW refers to the incorporation of digital technologies into work processes to enhance employee flexibility, autonomy, and productivity [25]. SW is grounded in the use of tools such as collaborative platforms, cloud computing, mobile applications, and AI-based systems, all aimed at optimizing workflows and decision-making processes [26, 37]. The core objective of SW is to allow employees to work from any location, at any time, without compromising the quality of their work or the efficiency of business operations [5, 8, 44, 45]. Therefore, SW does not aim to replace employees but rather to enable them to perform tasks more efficiently and focus on more critical work where they can make a significant contribution [5].

Unlike traditional work models, which often require physical presence and adherence to rigid schedules, SW focuses on output-based performance rather than time spent at the workplace. This shift not only promotes employee autonomy while also promoting an increased sense of ownership and accountability, as employees are measured by their contributions rather than their physical presence [2].

Moreover, SW enables organizations to leverage technology to streamline communication, reduce operational costs, and ensure business continuity even in times of disruption, such as during the COVID-19 pandemic [2, 6, 46]. By optimizing work processes and offering employees more

control over their schedules, SW helps balance professional and personal responsibilities, which can lead to improved job satisfaction and overall well-being [4].

SW is not a new concept, but its widespread adoption has accelerated dramatically in recent years. Initially, remote work or telecommuting was seen as a luxury that only a small portion of the workforce could access, often limited to high-income, white-collar professionals [6]. Over the past two decades, advancements in IS have expanded the feasibility of SW across different sectors. By the early 2000s, industries such as IT, finance, and professional services had begun to adopt more flexible working models [9].

However, the COVID-19 pandemic acted as a catalyst for the broader implementation of SW practices, especially in sectors that previously relied on traditional office settings. The global lockdowns forced millions of employees to transition to remote work almost overnight, leading to a global experiment in SW [2, 3, 9, 29, 47]. This sudden shift not only highlighted the benefits of SW but also exposed the difficulties associated with communication, collaboration, and sustaining productivity in a virtual setting [6].

The adoption of SW has varied across regions and industries, with developed countries leading the way. For instance, in the United States, a study by Dingel and Neiman found that 37% of jobs could be performed entirely from home, with these jobs accounting for 46% of total wages [9]. Similarly, in Europe, certain countries, such as Germany and the UK, have adopted SW more widely, driven by high levels of digital infrastructure and supportive labor policies [4].

However, the situation is quite different in emerging economies, where the percentage of jobs that can be performed remotely is significantly lower. In many lower-income countries, industries are more reliant on physical labor and face significant challenges related to the digital divide, such as limited access to reliable internet and technology [9]. As a result, while SW is rapidly gaining traction in the Global North, its adoption in the Global South is slower, albeit growing.

For example, a survey conducted in Lithuania during the COVID-19 pandemic revealed that only 13% of the workforce had been engaged in teleworking before the pandemic. However, this figure rose to 40% during the pandemic as businesses were forced to shift to remote working to maintain operations [4]. This shows that although some countries lag in SW adoption, external factors such as the pandemic can drive sudden and significant shifts in work models. This provides

for a sample that allows for the evaluation of how project performance is impacted, since the use of these methods and tools has increased as shown by Schmidtner et al. [3].

The convergence of technologies and technological enablers has made it possible for companies to adopt hybrid work models, in which employees divide their time between home and the office [48]. This not only enhances operational flexibility but also promotes a more resilient business model that can withstand disruptions [2, 26]. Unlocking numerous benefits to both employees and organizations [8, 23, 49–51]. With an increase in flexibility and autonomy, employees have greater control over their schedules, which may contribute to improved work-life balance and higher job satisfaction [2, 4]. In addition, studies have shown that employees who work from home often experience fewer distractions and are more productive. For instance, the Lithuania survey highlighted that a significant portion of workers reported higher productivity during the quarantine period [4]. Whereas companies experience cost savings and business continuity as SW reduces overhead costs associated with maintaining office space, utilities, and other physical resources [4] and allows companies to continue operations even during disruptions such as natural disasters or pandemics, as seen during COVID-19 [2].

However, SW also presents several issues that organizations need to tackle [9]. A major challenge in SW is maintaining effective communication among dispersed teams. Virtual communication can lead to misunderstandings, delays in decision-making, and feelings of isolation among employees [6]. Moreover, as more employees work remotely, the risk of data breaches and cyberattacks increases. Companies must invest in robust cybersecurity measures to protect sensitive information [27]. Although SW enhances flexibility, it can also blur the line between work and personal life, potentially resulting in burnout..

2.1.3 Technological enablers of smart working

SW relies heavily on various technological enablers that provide the infrastructure and tools required to support remote work, collaboration, and productivity. These technologies have revolutionized the modern workplace, enabling a more flexible, efficient, and adaptable work environment. The rapid advancement of cloud computing, IoT, AI, and big data has created a foundation for SW to thrive in today's digital landscape [24, 26, 59–62, 28, 52–58].

One of the most significant enablers of SW is cloud computing, which allows employees to store, access, and manage data and applications remotely. By shifting from on-premise systems to cloud-based platforms, organizations can enable their workforce to access necessary tools and information from anywhere in the world, thus eliminating geographical limitations [56, 58–62]. Cloud infrastructure is highly scalable, allowing companies to expand or reduce resources based on demand. This flexibility is crucial for remote teams, especially during times of rapid growth or contraction [37].

Cloud-based collaboration tools such as Google Workspace, Microsoft Teams, and Slack provide employees with real-time access to shared documents, projects, and communication channels. These platforms allow for seamless interaction between team members, regardless of their physical location [6]. Moreover, cloud services typically operate on a subscription model, which helps companies reduce upfront costs for hardware and software. Organizations can avoid costly IT infrastructure investments and instead pay for only the resources they use [26]. With cloud computing serving as the backbone of SW, it enables teams to work collaboratively across multiple time zones, ensuring that business operations continue uninterrupted, even when employees are working remotely.

Another enabler, the IoT is a network of interconnected devices capable of communicating and exchanging data in real time. Within the context of SW, IoT plays a major role in facilitating automation, monitoring, and data collection. IoT technologies enable organizations to create smart offices and optimize remote work environments through connected devices [26].

Key applications of IoT in SW is to allow employers to monitor the performance of remote teams by tracking key metrics such as productivity, resource usage, and system uptime. For instance, IoT sensors can provide real-time data on energy usage in home offices, helping organizations promote sustainability while ensuring efficient operations [5]. Likewise, in automation IoT devices, combined with AI and machine learning, can automate routine tasks such as inventory management, equipment maintenance, and IT support. This reduces the burden on employees, allowing them to focus on more critical tasks [5, 26]. Additionally, IoT-enabled devices, such as smart speakers and video conferencing systems, improve communication by enabling seamless integration between different platforms and devices [27]. The interconnectedness brought about by IoT helps organizations gather data in real-time, which can

be used to optimize processes, enhance decision-making, and ultimately improve employee productivity in a SW environment.

AI is a transformative force in SW, driving the automation of repetitive tasks, enhancing decision-making, and improving overall productivity. AI tools are capable of rapidly and accurately processing large volumes of data, providing insights that enable organizations to make better business decisions. In the context of SW, AI plays several important roles. AI-driven tools, including chatbots, virtual assistants, and robotic process automation (RPA) can handle mundane tasks such as responding to customer queries, scheduling meetings, or managing workflows, freeing up employees time to focus on more strategic activities [26, 27].

AI can analyze historical data to predict future trends, enabling organizations to make data-driven decisions. For example, predictive analytics can be used to forecast project timelines, identify potential bottlenecks in workflows, and optimize resource allocation [27]. Moreover, AI can tailor work experiences based on individual preferences. For instance, AI-driven tools can recommend the best times for employees to take breaks or provide personalized learning recommendations based on their career goals [26]. By incorporating AI into SW practices, organizations can not only improve efficiency but also enhance the employee experience by making work more engaging and less time-consuming.

Big data is another critical enabler of SW. It involves the collection, analysis, and interpretation of vast amounts of data generated by organizations. In a SW context, big data allows employers to gain insights into employee behavior, project performance, and operational efficiency [5, 24, 26, 28, 52–57].

By analyzing data related to work patterns, project timelines, and team communication, companies can track employee performance and pinpoint areas for improvement. This data-driven approach ensures that employees remain productive while working remotely [27]. In addition, big data analytics can reveal inefficiencies in work processes, allowing organizations to streamline operations and reduce costs. For instance, data analytics tools can identify bottlenecks in workflows or highlight areas where resource allocation can be improved [26]. As well as, enhancing decision-making. With access to real-time data, managers are able to make better-informed decisions regarding project timelines and resource allocation, and employee engagement. Big data helps organizations stay agile and responsive to changing market conditions [27].

The combination of big data and AI creates a powerful feedback loop, where data is continuously analyzed and applied to improve performance, efficiency, and overall business outcomes in a SW environment [27].

One of the most visible changes in the modern workplace is the rise of collaborative technologies. These tools are essential for facilitating communication and teamwork among remote employees [6, 63]. Collaboration tools allow for real-time communication through instant messaging, video conferencing, and virtual meetings, allowing employees to stay connected and collaborate effectively, even when they are physically distant from one another [2, 63, 64]. Tools like Asana and Trello allow teams to track project progress, assign tasks, and manage deadlines in a transparent and organized way. These platforms make it easier for teams to collaborate asynchronously across different time zones [6]. While cloud-based tools like Google Workspace and Microsoft OneDrive enable employees to share documents and work collaboratively on the same file in real time, eliminating the need for back-and-forth emails and version control issues [6].

Collaborative technologies play a key role in sustaining productivity, communication, and team cohesion in SW environments. These platforms allow teams to function smoothly, despite being geographically dispersed, ensuring that business goals are met effectively.

As more organizations embrace SW, cybersecurity has become a top priority. The increased reliance on digital tools and remote work environments opens new vulnerabilities that cybercriminals can exploit. Companies must invest in implementing strong cybersecurity measures to safeguard sensitive data and ensure that their remote workforces operate in a secure environment [4, 27]. Some of the main strategies focus on elements such as encryption, multi-factor authentication (MFA), and training and awareness. Encryption and secure networks ensure that all communication and data transfers are encrypted to help prevent unauthorized access to sensitive information [27]. Implementing MFA for accessing work systems provides an additional layer of security by mandating that users confirm their identity through multiple verification methods [26]. Educating employees about cybersecurity best practices, such as recognizing phishing attacks and using secure passwords, is critical to reducing the risk of cyber threats in a SW environment [27].

By implementing these cybersecurity measures, organizations can safeguard their digital infrastructure and protect both company data and employee privacy in the context of SW.

2.1.4 Workforce well-being and smart working

As organizations increasingly adopt SW practices, there has been growing attention to the impact of these changes on the well-being of employees. Workforce well-being refers to the overall physical, mental, and emotional health of workers, which is critical for maintaining efficiency and employee satisfaction. In the context of SW, employees are granted more flexibility and autonomy, but they may also face challenges related to isolation, work-life balance, and mental health. This section explores the benefits and challenges that SW presents to workforce well-being and highlights strategies that organizations can implement to support their employees.

The flexibility offered by SW is one of its greatest advantages, and it has been shown to have a positive impact on employee well-being. Several studies have demonstrated that employees who have more control over their work schedules tend to report higher levels of job satisfaction, reduced stress, and improved work-life balance [4, 8]. One of the primary advantages of SW is that it allows employees to structure their workdays in a way that accommodates personal responsibilities. This flexibility is especially beneficial for workers with family obligations, such as parents or caregivers, who may need to balance work with childcare or eldercare duties. Studies have shown that remote work can help employees achieve a better balance between their professional and personal lives, resulting in lower stress levels and greater job satisfaction [4, 6].

The ability to work from home eliminates the need for commuting, which is often a major source of stress for employees. Long commutes have been linked to higher levels of stress, fatigue, and reduced job satisfaction. By eliminating this daily burden, SW helps employees reclaim valuable time that can be spent on rest, leisure, or family activities [8, 26]. SW empowers employees by giving them more control over when and how they complete their tasks. This increased autonomy can lead to a greater sense of ownership and responsibility, which in turn enhances motivation and job satisfaction [4, 6]. Employees who perceive trust and empowerment are more likely to be engaged in their work and actively contribute to organizational success. Research indicates that employees who enjoy a higher degree of flexibility and autonomy are more satisfied with their jobs and experience increased engagement with their work [63]. SW

environments that emphasize autonomy tend to foster an organizational culture that fosters a sense of value and support for employees.

While SW offers many benefits, it also presents unique challenges that can negatively affect employee well-being if not managed properly [9]. One of the most commonly reported downsides of SW is the sense of isolation that can arise when employees are separated from their colleagues for extended periods. Social interaction plays a crucial role in the workplace, and remote work may result in feelings of isolation, which can subsequently impact both mental health and productivity. This is particularly problematic for employees who thrive on collaboration and team interaction [4, 6, 8].

Although SW offers increased flexibility, it can also obscure the boundaries between work and home life. Employees may find it difficult to "switch off" from work when they are constantly connected to their devices and working from home. This can lead to burnout and increased stress levels, as employees find it challenging to maintain a clear distinction between their professional and personal lives [6, 8]. The flexibility of SW can sometimes result in employees feeling the pressure to be available at all hours. This "always-on" culture, where employees are expected to respond to emails and messages outside of regular working hours, can lead to overwork and negatively impact mental health. This issue was particularly highlighted during the COVID-19 pandemic when many employees reported working longer hours while working from home [4, 6].

Working remotely may limit employees' access to the same level of support and resources that they would typically have in an office setting. For example, employees may face difficulties in accessing IT support, training, or mentorship opportunities when working remotely. This lack of access can hinder professional development and exacerbate feelings of isolation [6, 63].

The impact of SW on workforce well-being is not uniform across all employees. Different demographics, such as age, gender, and job roles, may experience varying effects of SW. Research has shown that women may benefit more from the flexibility of SW, particularly those with caregiving responsibilities. However, they may also face additional challenges in balancing work and household duties, which could lead to increased stress [4]. On the other hand, men may report different experiences regarding isolation and engagement in the workplace.

Younger employees who are more familiar with digital technologies may adapt more easily to SW environments, while older employees may require more training and support. However,

younger employees may also be more prone to feelings of isolation due to their preference for face-to-face interactions [4, 6]. In contrast, older employees may appreciate the flexibility and reduced commuting stress offered by SW. Furthermore, employees in managerial or senior roles may experience more autonomy and flexibility in a SW environment, whereas junior employees may struggle without the structure and guidance of a traditional office setting [4]. Moreover, employees who are new to remote work may find it difficult to navigate virtual workspaces and maintain productivity.

To fully realize the benefits of SW while addressing its challenges, organizations must adopt strategies that prioritize employee well-being. Organizations should promote the establishment of clear boundaries between employees' work and personal time. This could involve setting clear expectations for communication outside of working hours or providing tools that allow employees to manage their time more effectively [6, 8]. Employers can also promote wellness initiatives, such as virtual fitness programs or mental health support services, to help employees maintain a healthy balance.

To combat feelings of isolation, organizations can create opportunities for social interaction via virtual team-building exercises, frequent check-ins, and collaborative initiatives [6]. Encouraging frequent communication between team members can help strengthen relationships and create a sense of belonging, even in a remote setting [4]. Equipping employees with the appropriate training and resources to thrive in a SW environment is essential. This includes offering training on digital tools, time management, and remote collaboration techniques [6, 63]. Additionally, managers should receive training on how to lead remote teams efficiently, ensuring they can offer the necessary support and guidance for employees to succeed.

Organizations should prioritize mental health by offering resources such as counseling services, employee assistance programs (EAPs), or mental health days [8, 63]. Managers can play an active role by regularly checking in with employees to assess their well-being and offering support when needed. To prevent burnout, companies should implement policies that discourage overworking. This could include setting limits on after-hours communication, providing flexible work hours and promoting regular breaks throughout the day [2, 6]. By implementing these strategies, organizations can create a healthier and more supportive work environment that allows employees to thrive in a SW setting.

2.1.5 Agile working and remote work

The concept of agile working is central to SW, emphasizing adaptability, flexibility, and responsiveness to change [2, 64]. In a rapidly evolving work environment, particularly with the broad adoption of remote work, agility has emerged as a critical factor in maintaining organizational efficiency and employee satisfaction. Agile working is not only about where people work but how they work, employing digital tools and methodologies that empower employees to work collaboratively, make quick decisions, and respond effectively to changing market conditions [65]. This section explores how agile working aligns with SW, the rise of remote work, and the challenges and opportunities that have emerged as organizations continue to adopt these practices.

Agile working refers to a work methodology that focuses on delivering value quickly and efficiently through iterative processes and continuous feedback. Originating in software development, the Agile methodology has since been applied across various industries as a means of enhancing flexibility and efficiency [66]. Unlike traditional work models that often rely on rigid hierarchies and long-term project planning, agile working encourages decentralized decision-making, short feedback loops, and the ability to pivot in response to new information or changes in the business environment [5, 26].

Key principles that characterize agile work are teams that are encouraged to be flexible in how they approach tasks, allowing them to adjust their workflows based on new information or project needs [5]. Agile teams emphasize open communication and collaboration, often using tools like Slack, Zoom, or Microsoft Teams to keep everyone aligned and informed [6]. On the other hand, work is broken down into smaller, manageable chunks called sprints, allowing teams to test and iterate on ideas quickly [5]. Teams are empowered to make decisions without waiting for approval from higher levels of management, which helps to reduce bottlenecks and speeds up the decision-making process [26].

Agile working is particularly well-suited to remote work environments, where employees are dispersed geographically and need to remain connected and collaborative despite not being physically present in the same office. This flexibility allows organizations to be more responsive to external pressures, such as shifting market demands or unforeseen disruptions like the COVID-19 pandemic [5, 26, 47].

Remote work, also referred to as teleworking or telecommuting, has been gaining momentum over the past few decades but saw a dramatic increase during the COVID-19 pandemic. Before the pandemic, remote work was primarily a privilege for higher-income earners and employees in certain industries. However, the pandemic forced many organizations across the globe to transition to remote work almost overnight, leading to a global experiment in virtual working [2, 9, 47].

Remote work is defined as the ability for employees to work from locations other than a central office, often facilitated by digital tools and platforms. It offers several benefits, such as employees being able to choose when and where to work, which improves work-life balance and job satisfaction [4]. Moreover, remote work reduces the need for physical office space, commuting, and other overhead costs [4].

Studies have shown that employees working remotely often report higher levels of productivity due to fewer distractions and more control over their work environment [2, 4]. However, remote work also presents unique challenges. Employees may struggle with feelings of isolation, experience difficulties maintaining work-life boundaries, and face technical issues related to unreliable internet or a lack of necessary tools [4, 6].

The principles of agile working align closely with the needs of remote teams, making it an ideal framework for managing distributed workforces [65]. Agile methodologies support the fluid and flexible nature of remote work by emphasizing daily standups. These short, focused meetings help remote teams stay connected and aligned on their goals. Standups also ensure that everyone is aware of their tasks and responsibilities for the day [6]. Additionally, agile working encourages frequent check-ins and feedback loops through sprint planning and retrospective meetings. This helps remote teams to evaluate their progress regularly and adjust their strategies as needed [5]. The use of digital collaboration platforms, such as Trello, Jira, or Asana, allows teams to track project progress and collaborate in real time. These tools are essential for remote teams to maintain transparency and accountability [6, 63].

Agile working helps bridge the gap between traditional office-based work and remote work, ensuring that teams remain productive and collaborative despite not being in the same physical location [65]. The focus on iterative development and real-time communication ensures that remote teams can adapt quickly to changes, maintain alignment, and deliver consistent results.

Despite the alignment between agile working and remote work, several challenges must be addressed to ensure the success of both practices. One of the biggest challenges remote teams face is ensuring effective communication across different time zones and locations. While tools like Zoom and Slack can facilitate communication, they cannot fully replace the nuances of in-person interaction [4, 6]. Teams may encounter miscommunications or delays in decision-making when relying solely on virtual communication. When teams are distributed across multiple time zones, it can be difficult to coordinate meetings and collaborate in real time. Agile practices such as daily standups or sprint retrospectives may need to be adapted to accommodate team members in different parts of the world [4].

Agile working thrives on collaboration and team cohesion, but remote work can make it harder to build and maintain formidable team dynamics. Without regular face-to-face interactions, teams may feel disconnected from one another, which can lead to decreased engagement and productivity [6, 63]. Agile working and remote work both rely heavily on digital tools and platforms to facilitate collaboration, project management, and communication. Technical issues, such as poor internet connections or software malfunctions, can disrupt workflows and hinder productivity [2].

When implemented effectively, agile working can significantly enhance the remote work experience by promoting adaptability, collaboration, and accountability [65]. Agile working allows remote teams to respond quickly to changing project requirements or external factors, ensuring that they remain aligned with organizational goals [5]. This adaptability is especially important in dynamic environments where market conditions can shift rapidly. Agile methodologies, such as Kanban or Scrum, provide a structured approach to managing projects and deliverables, even in remote settings. By breaking projects into smaller tasks and regularly reviewing progress, remote teams can maintain focus and ensure that deadlines are met [6].

Agile working gives employees greater control over how they complete their work, empowering them to make decisions and solve problems independently. This autonomy is particularly beneficial in a remote work context, where employees may need to manage their time and resources more proactively [5, 26]. Moreover, by encouraging continuous feedback and iterative development, Agile Working promotes a culture of innovation where remote teams are

constantly looking for ways to improve their processes and deliverables. This mindset is critical for organizations looking to stay competitive in a fast-paced digital landscape [26].

As remote work becomes more normalized, the agile working model is likely to play an increasingly prominent role in shaping how teams operate. Many organizations that were forced to adopt remote work during the pandemic have since recognized its long-term benefits and are shifting toward hybrid work models that combine remote work with traditional office-based work [2, 4, 47].

The future of agile working will likely involve hybrid teams, advanced digital tools and a focus on employee well-being. As more organizations adopt hybrid work models, agile practices will need to be adapted to accommodate a mix of in-office and remote employees [6, 26, 48]. Similarly, as remote work becomes more widespread, new digital tools and platforms will emerge to support agile methodologies and enhance collaboration [6]. Finally, as organizations continue to adopt agile working and remote work, there will be an increased emphasis on employee well-being, ensuring that workers remain engaged, motivated, and healthy while working in flexible environments [2, 4]. By continuing to refine the intersection of agile working and remote work, organizations can create resilient, adaptable, and productive teams that are well-equipped to thrive in the ever-changing business landscape.

2.1.6 Smart working during and post-COVID-19

The COVID-19 pandemic radically altered how organizations and employees view work, particularly with the widespread adoption of SW. What was once a flexible, optional practice for a select group of employees became a global necessity as lockdowns and social distancing measures forced companies to adopt remote work on an unprecedented scale. This section explores how SW evolved during the pandemic, its lasting effects on the global workforce, and what the future holds for SW in a post-pandemic world [47].

Before the pandemic, SW was primarily a tool for enhancing flexibility and productivity in specific sectors, such as technology, finance, and professional services. However, with the outbreak of COVID-19, organizations across nearly every industry were compelled to adopt SW practices to maintain business continuity and protect the health of their employees. As companies

transitioned to remote work, they faced numerous challenges, including technical infrastructure limitations, maintaining team cohesion, and addressing employee well-being [2, 6, 8, 46].

The pandemic had had significant impact on SW as organizations had to accelerate their digital transformation initiatives almost overnight. Many companies invested in cloud computing, collaboration platforms, and cybersecurity measures to ensure that their employees could work remotely effectively [2, 26]. Furthermore, the pandemic forced both employers and employees to reconsider traditional work models. Remote work, once viewed as a temporary solution or a benefit, became a permanent fixture in many organizations. As companies saw the potential for sustained productivity and cost savings, the mindset around SW shifted from an emergency measure to a long-term strategy [2, 4, 8, 47].

The pandemic provided a unique opportunity for a global experiment in remote working. Companies that had previously been hesitant to adopt SW were suddenly thrust into it, gaining firsthand experience with its benefits and challenges. This widespread experiment has led to lasting changes in work culture, with many organizations adopting hybrid work models post-pandemic [2].

Numerous studies have emerged analyzing the effects of SW during the pandemic. These studies have provided valuable insights into how SW affected productivity, employee well-being, and organizational performance. Contrary to initial concerns, many organizations found that productivity did not suffer during the pandemic. In fact, some studies reported increases in productivity as employees adapted to working from home. Without the distractions of a traditional office environment and with more control over their schedules, employees were able to focus more on their tasks [2, 9]. However, this boost in productivity was not universal, with some employees struggling to adapt to the challenges of remote work, particularly in industries less suited to such practices [4].

While SW provided flexibility and the opportunity to work in a comfortable environment, it also introduced challenges related to employee well-being. Isolation, difficulty maintaining work-life balance, and the pressures of being constantly “on” led to increased levels of stress and burnout for some employees [2, 4]. Companies that implemented support systems, such as mental health resources, virtual team-building activities, and clear communication around working hours, were better able to mitigate these negative effects [4]. Additionally, the pandemic saw a surge in the

adoption of digital collaboration tools, such as Zoom, Microsoft Teams, and Slack. These platforms became essential for maintaining communication, collaboration, and productivity across dispersed teams [8, 63]. The adoption of AI-driven tools and cloud-based systems allowed companies to automate processes and ensure business continuity in remote settings [26, 27].

Agile working methodologies, which emphasize flexibility, adaptability, and short-term goals, became critical during the pandemic as organizations faced rapidly changing circumstances [26]. Teams were able to iterate quickly and adjust their strategies to meet new challenges, such as shifting consumer demands or disruptions to supply chains [5].

The pandemic has left a lasting mark on how organizations approach work. As the world transitions into a post-pandemic era, several trends are expected to shape the future of SW. One of the most significant long-term changes is the rise of hybrid work models, where employees split their time between working remotely and in the office. Many companies have found that hybrid models offer the best of both worlds – providing flexibility for employees while maintaining a sense of community and collaboration through in-person interactions [4]. This model allows organizations to optimize office space, reduce overhead costs, and maintain employee satisfaction [2, 4].

With the widespread acceptance of remote work, many organizations are embracing the idea of workforce decentralization. Employees are no longer required to live near company headquarters, allowing organizations to tap into a global talent pool. This has particularly impacted tech and knowledge-based industries, where location is less critical for daily operations [4, 9]. However, decentralization also poses challenges, such as managing employees across different time zones and ensuring consistent company culture [4]. Some companies have chosen to adopt permanent remote work policies for specific roles that do not require a physical presence in the office. This has been particularly prevalent in industries such as tech, finance, and consulting [8]. Permanent remote work offers advantages in terms of cost savings, employee retention, and increased flexibility, but it also requires companies to invest in robust digital infrastructure and cybersecurity measures to support long-term remote operations [26, 27].

The pandemic highlighted the importance of employee well-being, leading organizations to place a greater emphasis on mental health support and work-life balance initiatives [2]. Companies are now more attuned to the risks of burnout and isolation, especially in remote work settings, and

are implementing strategies such as virtual wellness programs, flexible working hours, and regular check-ins to support their employees [4]. The rapid digital transformation that took place during the pandemic will continue to accelerate in the post-pandemic world. Organizations that invested in digital tools and platforms are likely to build on these foundations, further integrating technologies such as AI, automation, and big data into their workflows [26, 27]. These technologies will not only enhance productivity but also enable greater agility and resilience in the face of future disruptions [5].

Looking ahead, the future of SW is bright, as organizations continue to adapt and innovate in reaction to the challenges and opportunities arising from the pandemic [47]. Employees are likely to demand more flexibility in their work arrangements moving forward. Organizations that offer flexible working hours, hybrid models, and remote work options are likely to gain a competitive edge in attracting and retaining talent [4, 8]. Moreover, as companies continue to invest in digital tools, the use of automation and AI will become even more widespread. These technologies will play a key role in streamlining operations, improving decision-making, and enhancing employee productivity in SW environments [26].

The pandemic has raised awareness of the environmental impact of traditional work practices, such as commuting and large office spaces. As a result, many organizations are exploring more sustainable work models, such as remote work and hybrid models, which can reduce their carbon footprint [5]. Additionally, with the shift to remote and hybrid work models, cybersecurity will remain a top priority for organizations. Companies will need to invest in robust security measures, such as MFA, encryption, and employee training, to protect sensitive data and ensure the security of their digital infrastructure [27].

The role of the office is expected to evolve, with many companies reimagining their physical spaces to accommodate hybrid work models [48]. Offices may become more collaborative and flexible, designed to facilitate in-person meetings and team-building activities rather than serving as the primary workspace for employees [2, 4]. As organizations and employees continue to embrace the principles of SW, the future of work will be defined by greater flexibility, innovation, and resilience [67]. The lessons learned during the pandemic will shape the way we work for years to come, as SW becomes an integral part of the global workforce [47].

2.1.7 Productivity and success of smart working

One of the most critical aspects of SW is its impact on employee productivity and organizational success. With the adoption of SW practices, organizations have sought to measure how these flexible and remote work models influence performance, efficiency, and overall business outcomes. This section explores the relationship between SW and productivity, the metrics used to evaluate success, and the key factors that contribute to making SW a successful model for organizations.

Productivity in SW environments is often assessed differently from traditional office settings. Instead of relying on metrics such as time spent at the office or attendance, SW measures productivity based on outputs and results, focusing on the quality of work, project completion, and overall contribution to organizational goals [4, 9]. In the context of remote work, productivity measurement requires the integration of digital tools and performance management systems that enable managers to monitor progress without micromanaging.

Some common ways to measure productivity in SW include tracking progress based on the completion of project milestones and deliverables offers a tangible way to evaluate employee productivity [6, 63]. Instead of measuring work by hours spent on a task, output-based performance focuses on the results delivered. Employees are judged by the quality and quantity of their work rather than their adherence to a fixed schedule [2, 9]. Additionally, regular feedback from employees and managers through surveys or check-ins can provide insights into productivity levels. By understanding how employees feel about their workloads, managers can identify areas that need improvement and adjust workloads accordingly [8, 63].

Several factors contribute to the success of SW in terms of productivity. These factors revolve around effective communication, proper resource allocation, and the ability to foster a sense of ownership and autonomy in employees. Providing employees with the right tools and technologies is crucial for productivity in SW. This includes cloud-based collaboration platforms, reliable internet access, and software for project management and communication [2, 6]. Organizations that invest in digital infrastructure see higher levels of employee efficiency and smoother workflows.

Setting clear goals, expectations, and deadlines is essential in a SW environment. Regular virtual meetings, daily standups, and asynchronous communication methods help keep teams

aligned and ensure that tasks are completed on time [6, 63]. Clarity in communication reduces confusion, minimizes delays, and fosters accountability among employees. One of the core principles of SW is giving employees the freedom to manage their own schedules and workloads. When employees have the autonomy to structure their days around their personal and professional responsibilities, they are more likely to be productive and engaged [2, 4]. Studies have shown that employees who feel trusted and empowered are more motivated to meet their goals [2, 4].

Employee well-being has a direct impact on productivity. Organizations that prioritize work-life balance and provide resources for managing stress, such as mental health support or flexible working hours, see higher levels of productivity [68]. Employees who feel supported and maintain a healthy balance between work and personal life are more focused and less prone to burnout [2, 4]. Continuous learning and development are essential for maintaining productivity in SW environments. Organizations should provide ongoing training in digital tools, remote collaboration techniques, and time management to help employees adapt to SW and remain productive [6, 63].

Several studies have examined the effects of SW on productivity. The findings suggest that SW can lead to significant productivity gains, but this is contingent on the proper implementation of tools, processes, and support systems. For example, a 2020 study showed that 37% of jobs in the U.S. could be done remotely, and employees in these roles demonstrated higher productivity due to reduced distractions and more control over their work environments [9]. Similarly, surveys conducted in Lithuania during the pandemic found that many remote workers reported increased productivity compared to working in an office setting [4].

However, these gains are not universal. Certain sectors, such as manufacturing and healthcare, face more significant challenges when it comes to implementing SW, as these roles often require physical presence. Additionally, some employees struggle with the isolation and lack of structure in a remote environment, which can negatively impact productivity if not properly managed [4, 9].

While there are clear benefits to SW, measuring productivity in a remote or hybrid work environment comes with challenges. These challenges arise primarily from the difficulty of tracking employee output when traditional metrics such as office hours or face-to-face supervision are no longer applicable. Managers may struggle to monitor productivity effectively in a remote work setting due to the lack of physical visibility [69]. While digital tools can provide some

insights into task completion, they do not always capture the full picture of employee contributions [2, 6].

The flexibility of SW can sometimes lead to overworking, as employees may feel pressure to be constantly available. Without clear boundaries between work and personal life, some employees may work longer hours, leading to burnout and decreased productivity over time [2, 4, 6]. In a remote work setting, coordinating between team members can be more challenging, especially when working across different time zones or without the benefit of spontaneous in-office communication [4, 6, 8]. Poor coordination can lead to delays, miscommunication, and missed deadlines, which negatively impacts productivity.

To maximize productivity in SW environments, organizations need to adopt strategies that support employees while maintaining clear expectations and workflows. Organizations should establish clear, measurable performance metrics for employees in SW environments. These metrics should focus on output and the quality of work rather than time spent working, allowing for a more results-oriented approach [27, 63]. Moreover, by fostering a culture of accountability, where employees are responsible for meeting their goals and deadlines, organizations can ensure that employees remain productive even without direct supervision [6, 26].

Frequent check-ins with managers help employees stay on track and provide opportunities for course correction if needed. Feedback is essential for both employees and managers to align on expectations and performance [6]. Furthermore, organizations should continue to invest in digital tools that streamline communication, collaboration, and task management. The use of AI-powered productivity tools, such as automated scheduling or project management software, can help optimize workflows and ensure that teams remain efficient [26]. As discussed earlier, maintaining employee well-being is critical for sustaining productivity. Offering resources such as flexible work hours, mental health support, and virtual wellness programs can help prevent burnout and ensure that employees remain engaged and productive [2, 4, 68].

For organizations to evaluate the success of SW practices, they must adopt a variety of metrics that go beyond traditional productivity measures. A successful SW environment is one where employees can quickly adapt to changing circumstances without sacrificing productivity. Measuring agility involves tracking how well teams respond to new challenges, such as shifting project priorities or unexpected disruptions [5, 26].

Employee engagement and satisfaction are critical indicators of SW success. Regular surveys, feedback sessions, and performance reviews can help organizations assess how employees feel about their work environments and identify areas for improvement [4, 63]. SW aims to optimize workflows and reduce inefficiencies. Measuring success in this area involves tracking how effectively teams complete tasks, how well resources are utilized, and how much time is saved by using digital tools and automation [26, 27].

By continuously evaluating these metrics, organizations can refine their SW practices, ensuring that they achieve sustainable productivity gains while maintaining employee well-being and engagement.

2.1.8 The future of smart working

As SW becomes increasingly embedded in organizational cultures worldwide, its future is set to be shaped by evolving technologies, changing workforce expectations, and the lessons learned during global disruptions such as the COVID-19 pandemic. The widespread adoption of SW has proven that flexible, remote, and hybrid work models are not only feasible but can lead to increased productivity, better employee satisfaction, and significant cost savings for organizations. This section explores the trends, challenges, and opportunities that will shape the future of SW in the coming years.

Several key trends are expected to define the future of SW, driven by advancements in technology, shifting employee preferences, and the increasing importance of flexibility and agility in the workplace. As more organizations recognize the benefits of remote work, many are adopting hybrid work models, where employees split their time between working remotely and in a physical office. This approach allows companies to balance the flexibility of remote work with the collaboration and social interaction that in-office work provides [2, 4]. Hybrid models are particularly appealing because they offer employees the freedom to choose the work environment that best suits their tasks, while also reducing overhead costs for employers [48].

The integration of AI and automation will continue to play a crucial role in SW environments. AI can automate repetitive tasks, provide real-time data analysis, and offer personalized recommendations for employees, allowing them to focus on more strategic and

creative activities [26, 27]. As AI tools become more sophisticated, they will likely be used to optimize workflows, improve decision-making, and enhance employee experiences through personalization. Moreover, the pandemic stressed the importance of employee well-being in maintaining productivity and engagement [68]. Moving forward, organizations will prioritize mental health resources, flexible work hours, and wellness programs to support their employees in remote or hybrid settings [2, 4, 48]. Companies that invest in well-being initiatives will not only attract and retain top talent but also foster a healthier, more productive workforce.

The shift to remote work has allowed organizations to expand their talent pool beyond geographic boundaries. The decentralization of the workforce will continue as companies recruit talent from diverse locations, creating global teams that operate across time zones [4, 9]. While this presents opportunities for accessing a wider range of skills, it also poses challenges in terms of communication, collaboration, and maintaining a unified company culture. As organizations become more conscious of their environmental impact, the future of SW will increasingly focus on sustainable work practices. Remote and hybrid work models reduce the need for commuting, office space, and energy consumption, contributing to a smaller carbon footprint [5]. Sustainability will become a key consideration for companies as they design their SW policies, with some organizations even offering incentives for employees who adopt eco-friendly work practices.

The role of the office is changing. Rather than being the primary location for daily work, offices in the future will serve as hubs for collaboration, social interaction, and team-building activities. Companies are likely to redesign their physical spaces to support hybrid work models, creating flexible, adaptable environments that can be used for meetings, brainstorming sessions, and collaborative projects [2, 4, 8]. This shift will also allow organizations to optimize space usage and reduce real estate costs.

While the future of SW holds great promise, it also presents several challenges that organizations must address to ensure their long-term success. As remote and hybrid work models become more prevalent, organizations will need to find new ways to maintain their company culture. Ensuring that employees feel connected to their colleagues and the broader organization, even when working remotely, will require intentional efforts such as virtual team-building activities, regular check-ins, and creating opportunities for informal social interactions [4, 6].

While SW provides flexibility, it can also create inequities if not managed carefully. Employees who have access to better home office setups, reliable internet, or fewer family obligations may have an advantage over others. Organizations must work to ensure that all employees have equal access to the tools, resources, and support they need to succeed in SW environments [2, 4]. Additionally, promoting diversity and inclusion in a decentralized workforce will require organizations to be more intentional about hiring, onboarding, and supporting employees from diverse backgrounds. Leading a distributed workforce comes with unique challenges, particularly when it comes to communication, collaboration, and performance management. Managers must adapt to new leadership styles that emphasize trust, accountability, and flexibility, while also leveraging digital tools to keep teams aligned and productive [6, 63]. Training managers to effectively lead remote teams will be essential for the success of SW models.

As remote work continues to grow, so do concerns about cybersecurity and data privacy. Organizations must invest in robust cybersecurity measures, such as MFA, encryption, and regular employee training to prevent data breaches and protect sensitive information [26, 27]. Ensuring secure communication channels and safeguarding company data in decentralized work environments will be an ongoing priority.

The future of SW presents numerous opportunities for innovation, particularly in how technology can enhance productivity, collaboration, and employee satisfaction. AI has the potential to personalize the SW experience for employees by offering customized workflows, learning opportunities, and productivity tips based on individual preferences and behavior [26]. AI-driven tools can analyze employee data to recommend the best ways to manage time, prioritize tasks, and improve efficiency, allowing for a more tailored and engaging work experience.

Virtual and augmented reality (VR/AR) technologies are poised to revolutionize remote collaboration and training in SW environments. VR and AR can be used to create immersive virtual workspaces where employees can collaborate in real-time, attend virtual meetings, and participate in training simulations [26]. These technologies will bridge the gap between remote and in-person work, providing employees with the benefits of face-to-face interaction without the need for physical presence. As organizations continue to embrace automation, there will be increased opportunities to streamline repetitive tasks, such as administrative work, scheduling, and data entry [26]. Automation tools will allow employees to focus on higher-value activities, enhancing

productivity and reducing the time spent on mundane tasks. The future of SW will see the development of more advanced collaboration tools that facilitate real-time communication and project management across dispersed teams. These tools will incorporate AI, machine learning, and predictive analytics to help teams work more efficiently and proactively address potential challenges [6, 63].

As SW continues to evolve, it is clear that organizations that fully embrace SW will have a competitive advantage in the marketplace. Companies that offer flexibility, prioritize employee well-being, and leverage technology to enhance productivity will be better positioned to attract and retain top talent, particularly as the workforce increasingly values work-life balance and autonomy [2, 4, 8]. Additionally, businesses that adopt hybrid work models will benefit from cost savings on office space, reduced overheads, and access to a global talent pool. These organizations will be more agile and resilient, able to adapt to changing market conditions and external disruptions with ease [4, 9].

The future of SW is one of continuous innovation, greater flexibility, and a focus on creating work environments that prioritize both employee satisfaction and operational efficiency. By staying ahead of trends, investing in digital infrastructure, and fostering a culture of adaptability, organizations can ensure they remain competitive and successful in the evolving world of work. As the world continues to evolve in response to technological advancements, global challenges, and changing workforce dynamics, SW has emerged as a crucial model for organizations seeking to enhance productivity, flexibility, and employee well-being [68]. What began as an innovative approach to workplace flexibility has, particularly in the wake of the COVID-19 pandemic, become a fundamental component of how companies operate and thrive in a highly connected, digital world.

The future of work is inherently flexible, digital, and global. SW will continue to evolve, shaped by advances in automation, AI, and data analytics, as well as by changing employee expectations and business needs [26, 27]. As organizations embrace SW, they will need to stay ahead of trends, invest in continuous innovation, and prioritize the well-being of their workforce to remain competitive. SW provides organizations with an effective framework to manage the complexities of contemporary work environments. By leveraging technology, fostering flexibility, and focusing on employee engagement, companies can create work models that not only drive

business success but also support a thriving and satisfied workforce. Future success depends on the ability to adapt, innovate, and support employees as the world of work continues to transform.

2.2 Project success – Theoretical model

2.2.1 Introduction to project success

PS has long attracted attention within both project management practice and academic research. The definition of success in projects has evolved over time, from a narrow focus on time, cost, and scope to more complex frameworks that consider stakeholder satisfaction, long-term benefits, and sustainability. In today's dynamic business environment, PS is no longer confined to the traditional measures established decades ago, but now encompasses a range of perspectives, each shaped by the evolving needs of industries, customers, and stakeholders [70].

In its early stages, PS was largely defined by the Iron Triangle, a concept introduced by Martin Barnes in the 1970s. This framework assessed the success of a project based on whether it met three key criteria: time, cost, and scope (or quality). A project that was completed on time, within budget, and according to the predefined scope was deemed a success. This model provided a simple and widely accepted way of evaluating project outcomes, particularly in industries like construction, engineering, and manufacturing, where these three variables were central to project execution [32, 33, 78–83, 34, 71–77].

However, while the Iron Triangle provided a clear set of objectives, it soon became apparent that this framework did not fully capture the nuances of PS [84]. Project management success as defined by the Iron Triangle could be achieved, but still result in a project that failed to meet the needs of its stakeholders or deliver long-term value. The case of the Sydney Opera House is a prime example of this. Although the project exceeded its original budget and timeline by a significant margin, the Opera House has since become a cultural and economic asset, generating substantial returns for the city of Sydney [85–87]. This case highlights the limitations of the Iron Triangle and the need for a more expansive view of PS.

As industries became more complex and globalized, the demands placed on projects also grew. Today, PS is understood as a multi-dimensional concept, influenced by factors such as stakeholder satisfaction, team performance, customer impact, and the long-term strategic value a

project creates for the organization. The emergence of more holistic models, such as those proposed by Shenhar and Dvir [13] and Zwikael and Smyrk [14], reflects this shift towards a broader understanding of what it means for a project to succeed [15].

Defining PS is challenging because of the diverse range of factors that influence project outcomes. Each project operates within its own unique context, shaped by industry norms, the complexity of the project, and the expectations of stakeholders [32–34, 88–94]. A successful project in one industry may not meet the same criteria in another. For instance, a project in the construction industry may be judged primarily on its adherence to budget and timeline, while a project in the IT sector may be evaluated on how well it delivers innovative solutions that satisfy customer requirements [34, 95].

Furthermore, as projects grow in scale and complexity, so too do the factors that contribute to their success or failure [72, 96, 97]. Technical uncertainty, which refers to the unknown variables involved in project execution, often complicates success measurements, particularly in industries that rely on cutting-edge technologies. For example, in IS projects, technical challenges can derail timelines, inflate costs, and hinder deliverable quality. These challenges are often difficult to predict at the outset, making it harder to define clear criteria for success [34, 98].

In addition to technical complexity, client engagement and the definition of project goals are critical factors that influence success. Projects that lack clear objectives or fail to involve key stakeholders in the decision-making process often struggle to meet their desired outcomes [16, 33, 70, 94]. Client engagement is particularly important in industries where customer satisfaction plays an essential role in determining the project's value, such as software development and customer service projects [15, 66, 98].

Another layer of complexity arises from the team dynamics within a project. Successful projects require effective collaboration, motivation, and retention of key talent. Team size and skill diversity also play significant roles in determining how well a project is executed. Large, multi-disciplinary teams may bring diverse perspectives but can also face challenges in coordination and communication, which can impact the overall success of the project [15, 95].

As the scope of projects has evolved, so too has the approach to defining and measuring PS. Researchers have long struggled to develop a comprehensive framework that encompasses the wide range of variables, stakeholders, and time horizons that influence project outcomes. Early

frameworks like the Iron Triangle provided a useful foundation but failed to account for the broader, more nuanced dimensions of success that have emerged in modern project management [71, 72].

To address these shortcomings, more expansive frameworks have been developed, which integrate both short-term and long-term aspects of PS. Modern frameworks, such as those proposed by Shenhar and Dvir [13], consider not only project management success (efficiency in terms of time, cost, and scope) but also the impact on the team, the customer, and the business's long-term objectives [16, 20]. Similarly, Zwikael and Smyrk [14] offer a three-dimensional view of success that includes Project Management Success (PSMS), Project Ownership Success (PSOS), and Project Investment Success (PSIS). These frameworks provide a more comprehensive and flexible approach to measuring success, allowing project managers to tailor their evaluations based on the specific needs and goals of the project.

For example, Shenhar and Dvir's model expands the traditional definition of success to include the project's impact on the customer, such as the degree to which the project solves customer pain points and satisfies technical and functional requirements. It also considers the impact on the team, measuring factors like team member growth and retention, which are critical for ensuring long-term organizational capability. This model was first introduced by Shenhar et al. [99] in 1997 but did not include the dimension impact on the team which was later added [13, 98].

Meanwhile, the Zwikael and Smyrk [14] model introduces the concept of investment success, which measures the project's financial worth relative to the risks taken by the investors. This framework provides a more comprehensive view of how a project's value is assessed over time, offering insights into how successful the investment was in achieving the desired business outcomes [15].

Both frameworks seek to provide an impartial assessment by taking into account internal and external project impacts, integrating quantitative and qualitative data to deliver a comprehensive evaluation of PS [33]. These models are especially effective in capturing the temporal dynamics of project performance, assessing success criteria at multiple points in time [32, 100] to mitigate short-term bias and account for long-term effects [80, 82, 101].

A multi-dimensional approach to PS is crucial in today's project landscape. Projects are increasingly complex, involve multiple stakeholders, and are expected to deliver value beyond the

immediate scope. Measuring success solely based on whether a project is completed on time and within budget is insufficient in capturing the true value of modern projects. Instead, success must be evaluated through a combination of hard criteria, like time and cost, and soft criteria, such as stakeholder satisfaction, team development, and long-term strategic benefits [32, 80, 82, 98, 100, 101].

PS is no longer a simple matter of meeting the Iron Triangle metrics [16, 33, 70, 94]. The evolving nature of projects requires a more comprehensive framework that incorporates a wide range of factors, from immediate project efficiency to long-term impacts on stakeholders and the organization [80, 82, 101]. The combination of the factors of the two models by Shenhar and Dvir [13] and Zwikael and Smyrk [14] is represented below in figure 1 and consists of the following measures: PSMS, Impact on the team (IMPT), Impact on the customer (IMPC), and PSIS, allowing project managers to evaluate success in a more holistic and dynamic way, ensuring that all aspects of the project are taken into account.

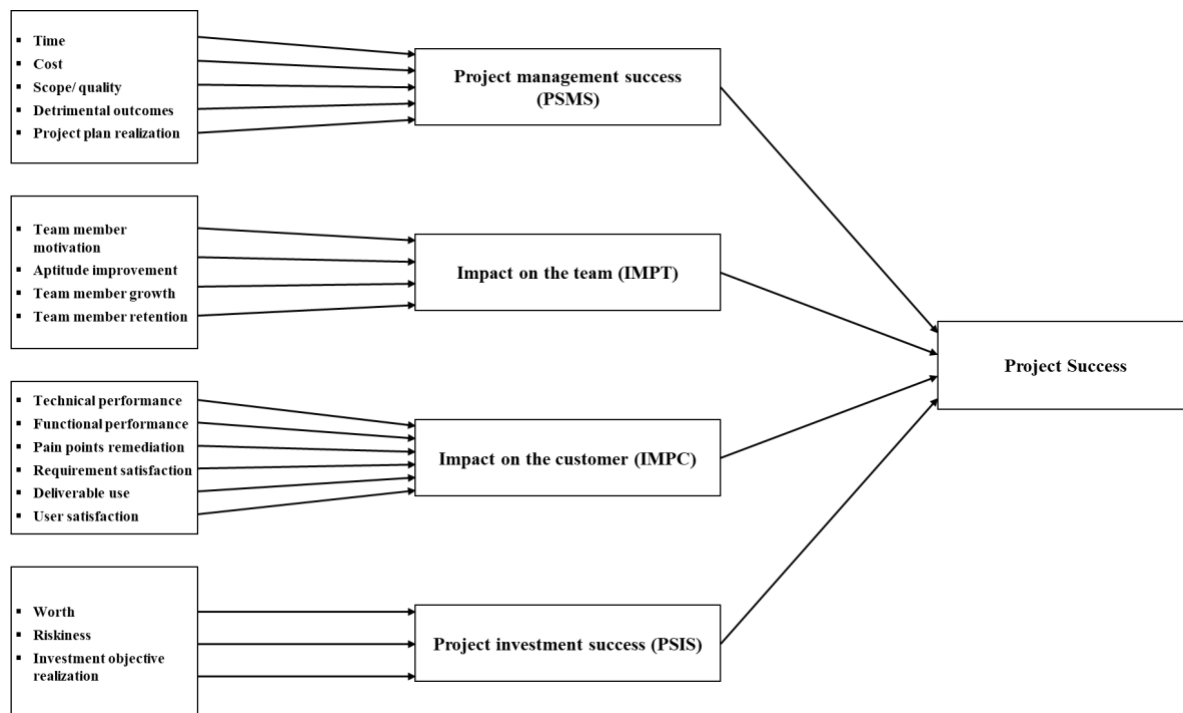


Figure 1. Project Success – theoretical model

The understanding of PS has evolved considerably over the years. From the early days of simple, efficiency-based criteria to more complex, multi-dimensional frameworks, the journey of defining PS reflects the increasing complexity and diversity of projects in the modern business environment. This section traces the evolution of PS frameworks, starting with the Iron Triangle and moving toward contemporary models that address both short-term and long-term outcomes, as well as different stakeholder perspectives.

The Iron Triangle, also known as the Triple Constraint or Project Management Triangle, was one of the earliest frameworks for measuring PS. Developed in the 1970s by Martin Barnes, this model became the cornerstone of project management success measurement for several decades [32, 33, 79–83, 34, 72–78]. The Iron Triangle evaluates a project's success based on three essential criteria:

- **Time:** Whether the project was completed according to the planned schedule.
- **Cost:** Whether the project stayed within the predefined budget.
- **Scope/Quality:** Whether the project met the intended specifications and deliverables.

The Iron Triangle was particularly relevant during the industrial era when PS was typically defined by outputs such as buildings, infrastructure, and manufacturing. These projects required strict adherence to budgets and timelines, as delays or cost overruns often translated directly into financial loss. The simplicity and clarity of the Iron Triangle made it a popular tool for decades, particularly in industries where projects had clear, measurable outputs [71, 72].

However, the Iron Triangle also had its limitations. As projects became more complex and the needs of various stakeholders grew more nuanced, it became clear that simply meeting deadlines, budgets, and specifications did not guarantee that a project was truly successful. It focuses exclusively on project management success, overlooking the quality of the deliverable, the post-completion impacts of the project (*both positive and negative*), and the factors that define success from the perspectives of different stakeholders [33, 92–94] and at different points in time [16]. Moreover, depending on the chosen success measure, a project can be considered successful even if it was poorly managed, and vice versa [102]. A clear illustration of this is the Sydney Opera House, which was neither completed on time (*14 years versus the planned four*) nor within budget (*AUD 102 million actual versus AUD 7 million planned*). Nevertheless, considering the project's

outcomes, such as direct revenue from operations, indirect revenue from tourism, and its status as one of the most iconic buildings in the modern world, it can be regarded as a success [86, 87]. By 2018, the Opera House had generated an estimated AUD 6.2 billion in social asset value, AUD 2.3 billion in physical site value (*from an initial construction cost of just over AUD 100 million*), and contributes approximately AUD 1.2 billion annually to economic activity [85]. This example underscores that project management success represents only one component of overall PS [103], which is typically assessed at the project's conclusion [104].

While the Iron Triangle remains an important tool in project management [33, 83], it is increasingly viewed as incomplete. Several limitations have been identified over the years:

- **Narrow Scope:** The Iron Triangle focuses exclusively on the project's internal efficiency (time, cost, and scope) without considering the external factors that may influence its ultimate success, such as stakeholder satisfaction or market conditions [84].
- **Short-Term Focus:** The Iron Triangle does not take into account the long-term impact of a project. For example, a project may be delivered on time and within budget, but if the end product fails to provide value to the organization or its customers, it cannot be considered successful in the long run [16, 32, 100].
- **Stakeholder Perspective:** The Iron Triangle measures success from a purely managerial perspective, ignoring the requirements and expectations of other key stakeholders such as customers, investors, and team members. As projects increasingly require input from a variety of stakeholders, this singular focus has proven to be insufficient [33, 72, 92–94].

Due to these limitations, the need for more sophisticated frameworks that could address the complexities of modern projects became apparent. Researchers and practitioners began exploring new ways of defining and measuring PS, leading to the development of multi-dimensional models that could capture a broader range of success criteria.

As the limitations of the Iron Triangle became more apparent, new frameworks emerged to provide a more holistic approach to measuring PS. These frameworks were designed to account for both internal project management efficiency and external impacts such as customer satisfaction, team performance, and long-term value creation.

One of the most influential frameworks to emerge in this context was the Shenhar and Dvir Model [99]. This model, first introduced in the late 1990s, expanded the definition of PS beyond the traditional efficiency measures of time, cost, and scope. It was later enriched to include also the dimension “Impact on the Team” [13]. It introduced five dimensions of PS:

1. **Project Efficiency:** This dimension corresponds to the traditional measures of success from the Iron Triangle, such as completing the project within budget and on time.
2. **Impact on the Team:** A project’s success can be measured by the motivation, growth, and retention of its team members. Projects that develop team capabilities and increase employee satisfaction contribute to long-term organizational success.
3. **Impact on the Customer:** This dimension focuses on whether the project met customer needs, solved customer pain points, and provided a product or service that achieved user satisfaction and utility.
4. **Business Success:** Beyond delivering the project itself, projects should also generate commercial success by creating new business opportunities, increasing market share, or providing a competitive advantage.
5. **Preparing for the Future:** Projects that lay the groundwork for future innovation, new technologies, and market growth are also considered successful. This dimension looks at how well the project positions the organization for long-term success [15, 98].

Shenhar and Dvir’s model was revolutionary because it incorporated both short-term success (efficiency and customer satisfaction) and long-term success (business impact and future preparedness). This model recognized that projects often have effects that extend beyond their immediate completion, particularly in industries like technology and innovation, where the full value of a project may only become apparent years after delivery.

Around the same time, Zwikael and Smyrk [14] developed another influential framework for measuring PS. Their model introduced three distinct dimensions of PS:

1. **PSMS:** This dimension corresponds to the success of the project manager in delivering the project according to plan. It considers factors such as time, cost, and scope, as well as how well the project manager handled unforeseen risks and challenges.

2. **PSOS:** This dimension evaluates the success of the project from the perspective of the project owner or sponsor. It assesses whether the project achieved the business objectives for which it was initiated, including financial performance and operational outcomes.
3. **PSIS:** This dimension focuses on the return on investment (ROI) generated by the project. It considers the worth and riskiness of the investment, as well as whether the project met the long-term strategic goals of the organization [15].

The Zwikael and Smyrk model was significant because it introduced the concept of investment success, recognizing that projects are not just one-off activities but rather investments that should generate long-term value. This model also highlighted the importance of separating project management success from project investment success, acknowledging that a project can be well-managed but still fail to deliver on its investment goals, and vice versa [15].

Both Shenhar and Dvir and Zwikael and Smyrk models provide more comprehensive frameworks for evaluating PS than the Iron Triangle. However, these models are complementary rather than mutually exclusive. For instance, while Shenhar and Dvir emphasize the importance of team and customer satisfaction, Zwikael and Smyrk provide a structured approach to evaluating the financial and investment dimensions of success. By integrating these models, project managers can gain a more complete understanding of PS. For example, while Shenhar and Dvir's "Impact on the Team" measures how well the project developed and retained team members, Zwikael and Smyrk's "Project Investment Success" provides insights into how the project contributed to the organization's long-term financial health [15, 98].

This multi-dimensional approach allows organizations to assess success across multiple levels and time horizons, ensuring that projects are not only efficient but also valuable to all stakeholders involved. As the scope of projects continues to expand in terms of complexity and stakeholder involvement, such comprehensive frameworks are becoming increasingly important for ensuring the long-term success of both the projects themselves and the organizations that undertake them.

The historical evolution of PS frameworks reflects the growing complexity of projects and the increasing importance of considering multiple perspectives. While the Iron Triangle remains a useful tool for assessing project efficiency, modern frameworks like those proposed by Shenhar and Dvir and Zwikael and Smyrk provide a more nuanced and holistic view of success. These

frameworks account for the varied expectations of stakeholders, the long-term strategic value of projects, and the impact on team and customer satisfaction. As organizations continue to navigate a rapidly changing business environment, these comprehensive success frameworks will become essential for ensuring that projects deliver both immediate and lasting value.

2.2.2 Stakeholder perspectives on project success

PS is a multi-dimensional concept that varies depending on the perspectives of the various stakeholders involved. Each stakeholder, from the project manager to the customer, has unique interests, goals, and criteria for what constitutes success. Therefore, PS cannot be evaluated through a single lens. It must take into account the diverse priorities of internal and external stakeholders who may view the outcomes of a project very differently. This section explores the differing perspectives on PS among various stakeholders and how these views impact the criteria and methods used to evaluate success.

The term stakeholder refers to any individual or group with a vested interest in the project. According to Freeman [105], stakeholders are "*any group or individual who can affect or is affected by the achievement of an organization's objectives.*" In the context of projects, stakeholders typically include:

- **Project Manager:** Responsible for planning, execution, and delivering the project according to scope, time, and budget constraints.
- **Project Team:** Individuals working directly on the project who have their own success criteria, including job satisfaction, skill development, and career advancement.
- **Customers/End Users:** Those who will ultimately use or benefit from the project deliverables. Their focus is on the functionality, quality, and utility of the project's outcomes.
- **Investors/Sponsors:** These are the financial backers of the project, primarily concerned with whether the project achieves a ROI.
- **Regulators:** In some industries, external bodies contribute to the overall success of the project by ensuring compliance with legal and regulatory frameworks.

Given the diversity of stakeholders, a one-size-fits-all approach to defining PS is insufficient. Each group has its own success criteria based on its involvement and expectations of the project, which may sometimes be in conflict. As a result, PS frameworks must account for these varying perspectives to provide a more comprehensive and accurate assessment of outcomes [15, 81].

For the project manager, success is traditionally measured through the lens of the Iron Triangle – completing the project on time, within budget, and according to scope. The project manager is primarily concerned with the internal efficiency of the project and ensuring that all project deliverables meet the predefined specifications.

However, project management success is just one dimension of the overall PS. While the project manager's primary goal may be to guarantee the seamless execution of the project and meets its technical requirements, this perspective can sometimes neglect the broader business and stakeholder outcomes. For example, a project may be finished on time and within budget but still fail to deliver significant value to the end user, leading to poor customer satisfaction [71, 72]. The Zwikael and Smyrk [87] model captures this distinction by separating PSMS from PSOS and PSIS. This model recognizes that project managers are responsible for delivering the project efficiently, but their perspective is not the sole determinant of PS [15].

The project team, on the other hand, measures success through a different set of criteria. For team members, success often involves more subjective factors, such as job satisfaction, team cohesion, and opportunities for personal and professional growth. A successful project from the team's perspective is one that fosters collaboration, enhances their skills, and contributes to their long-term career development.

The Shenhar and Dvir [13] model highlights the importance of the IMPT in determining PS. This dimension measures the project's success by evaluating factors such as team member motivation, aptitude improvement, and retention. Projects that allow team members to grow, learn, and stay motivated are more likely to be successful in the long term because they help build organizational capacity [98].

Moreover, PS from the team's perspective is closely tied to leadership and governance. Studies have shown that effective leadership contributes significantly to team satisfaction, particularly when leaders create an environment that encourages open communication, support,

and autonomy [15, 87]. Therefore, PS frameworks should take into account the role of leadership in fostering team success as a key indicator of overall PS.

For the customer or end user, PS is primarily evaluated based on the utility and quality of the final deliverable. A project is successful in the eyes of the customer if it meets or exceeds expectations by providing a product or service that addresses their needs, solves their problems, and delivers value.

The IMPC dimension of the Shenhar and Dvir [13] model captures this perspective by measuring PS through technical performance – how well the project delivers the required technical specifications, functional performance – the usability and functionality of the project deliverables, along with user satisfaction – whether the client is pleased with the overall experience of using the product or service.

Projects that prioritize customer satisfaction often benefit from higher rates of product adoption and customer loyalty, which, in turn, contribute to long-term business success. Conversely, failure to meet customer expectations can lead to project failure, even if the project was completed on time and within budget. This customer-centric view of PS is especially important in sectors such as software development, retail, and healthcare, where customer satisfaction is crucial to the success of both the project and the business as a whole [15, 98].

From the perspective of investors or project sponsors, the primary criterion for success is the project's ROI. Investors are concerned with the financial performance of the project – whether the project generates sufficient profits to justify the resources and risks involved. This perspective is especially important in capital-intensive industries like construction, real estate development, and technology start-ups, where substantial financial investments are made in the hopes of achieving long-term returns.

The PSIS dimension from the Zwikael and Smyrk [87] model addresses this perspective by evaluating how well the project delivers on its investment objectives. This includes measuring the project's worth, riskiness, and the realization of investment objectives [15]. For investors, a project may be considered a failure if it does not deliver the expected financial returns, even if it was completed efficiently from a project management perspective.

Additionally, investors are often interested in the long-term sustainability of the project. Projects that deliver lasting value, whether through continued revenue generation, market share growth, or brand equity, are more likely to be deemed successful by investors. This long-term perspective aligns with modern success frameworks that emphasize sustainability and strategic alignment [81, 87].

Given the differing priorities of each stakeholder group, it is not uncommon for conflicting views on PS to arise. For example, a project that is deemed successful by the project manager may not meet the expectations of the customer or investor. Likewise, a project that generates significant ROI for investors may have failed to satisfy team members or customers due to poor leadership or lack of engagement.

To address these challenges, modern frameworks like those developed by Shenhar and Dvir and Zwikael and Smyrk provide a multi-dimensional approach to success evaluation. By considering the success criteria of all major stakeholder – project managers, teams, customers, and investors – these frameworks offer a more holistic view of PS [15, 98].

Additionally, effective stakeholder management is key to ensuring that all perspectives are considered throughout the project lifecycle. This requires early engagement with stakeholders to clearly define success criteria, ongoing communication to ensure alignment, and flexibility to adjust project objectives based on changing stakeholder needs. In this way, PS can be evaluated not just by its immediate outcomes but by its ability to deliver sustained benefits for all stakeholders involved.

PS is a subjective and multi-faceted concept that depends on the perspectives of various stakeholders. While traditional models of success have focused on internal efficiency and project management success, modern frameworks recognize the importance of considering the requirements and expectations of all key stakeholders. By incorporating the views of the project team, customers, and investors, modern success frameworks provide a more comprehensive and accurate measure of PS. As projects become increasingly complex and stakeholder involvement grows, ensuring that success criteria are aligned across all stakeholders will be critical for achieving long-term PS.

2.2.3 Project success and sustainability

As the concept of PS continues to evolve, one of the most significant developments in recent years is the incorporation of sustainability into success frameworks. In the contemporary global context, where organizations face growing expectations to act responsibly and contribute positively to society and the environment, sustainable development goals (SDGs) and environmental, social, and governance (ESG) criteria have become central to defining the long-term success of projects. This section explores how sustainability impacts PS, how it is integrated into modern frameworks, and why it is crucial for organizations to consider sustainability as a key factor in their project management practices.

The traditional Iron Triangle, focused on time, cost, and scope, offers a narrow view of success that does not account for the wider societal and environmental impacts of a project, and future business opportunities. In contrast, modern project management frameworks now recognize that PS must be evaluated in terms of its contribution to sustainable development.

Sustainability in project management refers to the long-term impacts of a project, which extend beyond the immediate deliverables. In the modern context, successful projects are those that go beyond achieving their immediate objectives and also generate lasting positive outcomes for the organization, society, and the environment. Incorporating sustainability into PS frameworks ensures that projects contribute to both the triple bottom line – people, planet, and profit – and align with broader organizational values [19, 106].

Several industries, such as construction, energy, and manufacturing, are increasingly required to consider the environmental and social implications of their projects. For instance, construction projects today are often judged on their ability to reduce carbon footprints, minimize waste, and incorporate energy-efficient designs. Similarly, projects in the energy sector are evaluated on their contributions to renewable energy and sustainable resource management [106].

The Project Management Institute (PMI) has recognized the growing importance of sustainability by integrating it into their Project Management Body of Knowledge (PMBOK) guidelines [33]. Sustainability is no longer an optional consideration but a fundamental aspect of how PS is evaluated.

The Shenhar and Dvir [13] model of PS, with its five dimensions, provides an ideal framework for incorporating sustainability into PS evaluations. Two dimensions, in particular, are closely aligned with sustainability principles:

1. **Business Success:** This dimension focuses on the project's ability to generate commercial success and increase market share. From a sustainability perspective, this includes ensuring that the project delivers long-term value to the organization without compromising future opportunities. Sustainable projects are often those that open new markets, create innovative products, and ensure the business is prepared for future challenges [98].
2. **Preparing for the Future:** Projects that promote innovation and lay the groundwork for future growth are considered successful. In the context of sustainability, this means creating systems, products, or services that support future development, enhance sustainability goals, and contribute to societal well-being. For example, a project focused on green technologies might not only address current environmental challenges but also prepare the company to compete in a future economy dominated by sustainability standards [15].

In this model, sustainability is embedded in the long-term outcomes of the project, rather than being a short-term objective. Projects that fail to consider their future impact may achieve short-term success but will be at a disadvantage in an environment where sustainability is increasingly prioritized by regulators, consumers, and investors [81].

The Zwikael and Smyrk [87] model also incorporates sustainability through its focus on PSOS and PSIS. These two dimensions evaluate success based on the long-term value and investment returns generated by the project. Sustainability, in this context, is critical to ensuring that projects deliver enduring value while managing risks associated with environmental and social factors [15].

PSOS evaluates whether the project achieved the desired business outcomes. Projects that contribute to sustainable growth – whether through resource efficiency, reduced environmental impact, or socially responsible practices – are more likely to meet these long-term objectives. Sustainable projects also minimize operational risks by ensuring compliance with environmental regulations and social governance standards [15].

From an investor's perspective, PSIS, sustainability is closely tied to risk management. Projects that ignore sustainability may face significant risks in the future, such as regulatory penalties, reputational damage, and financial losses due to shifting market demands. On the other hand, projects that integrate sustainability are seen as more resilient and better positioned to provide long-term returns [87].

By incorporating these sustainability elements, the Zwikael and Smyrk model ensures that PS is measured not just by immediate financial gains but by the project's ability to sustain value over time. While sustainability is important in all sectors, its influence on PS is particularly strong in industries with high environmental and social impacts, such as construction, energy, and technology.

Sustainable construction projects are judged by their use of eco-friendly materials, reduction of carbon emissions, and adherence to green building standards such as LEED (Leadership in Energy and Environmental Design). These projects aim to minimize waste, reduce energy consumption, and ensure long-term benefits to the community [106]. The success of such projects is not merely about completing the building on time and within budget but about ensuring the structure's environmental performance over its lifecycle.

In the energy sector, projects that focus on renewable energy, such as solar or wind farms, are considered successful if they contribute to decreasing dependence on fossil fuels and minimizing greenhouse gas emissions. Additionally, energy projects are evaluated on their ability to provide clean, affordable energy while promoting sustainable resource management [106]. For tech companies, sustainable PS often involves the development of energy-efficient products, the use of recycled materials, and adherence to responsible supply chain practices. Projects that reduce the environmental impact of production or create circular economy models are increasingly valued in the technology industry [87].

A major factor shaping the integration of sustainability into PS is leadership. Project managers and organizational leaders play a critical role in setting the tone for sustainability within the project. Leaders who prioritize sustainable practices not only help their projects meet regulatory and market demands but also contribute to brand value and stakeholder trust.

Research has demonstrated that transformational leadership – characterized by a focus on long-term vision, innovation, and motivation – can significantly enhance the sustainability

outcomes of a project. Leaders who promote a sustainability culture within their teams are more likely to achieve sustainable PS, as they foster a mindset of responsibility and innovation that permeates all levels of the project [81, 87].

While the integration of sustainability into PS frameworks is widely accepted as necessary, there are still significant challenges that organizations face. Unlike traditional success criteria such as time and cost, sustainability metrics can be difficult to quantify. While some industries have well-established standards (e.g., LEED for construction), others may struggle to define clear and measurable sustainability outcomes [106]. In some cases, the upfront costs of implementing sustainable practices may be high, leading to conflicts between short-term financial targets and long-term sustainability goals. Project managers must navigate these trade-offs to ensure both immediate and lasting success [87]. Different stakeholders may have varying expectations when it comes to sustainability. Investors may prioritize financial returns, while regulators may emphasize compliance with environmental standards. Aligning these expectations is crucial to achieving a balanced approach to PS [15].

Sustainability has become an integral part of how we define PS. No longer confined to the traditional metrics of time, cost, and scope, PS now incorporates long-term impacts on the environment, society, and business sustainability. The modern frameworks proposed by Shenhar and Dvir and Zwikael and Smyrk demonstrate that sustainability must be considered both from a business perspective in terms of market share, innovation, and investment returns, and from a societal perspective, in terms of environmental and social outcomes. Through the integration of sustainability into the core of PS frameworks, organizations can ensure that their projects deliver lasting value and contribute positively to their brand, community, and the global environment.

2.2.4 Challenges in measuring project success

Measuring PS is far more complex than simply determining whether a project has met its objectives on time, within budget, and according to scope. As project management frameworks have evolved, so too have the challenges involved in measuring success. Today's projects are not only judged on their immediate efficiency but also on their long-term impacts, including customer satisfaction, team development, stakeholder engagement, and sustainability. This section explores

the key challenges in measuring PS, highlighting the difficulties in capturing both tangible and intangible outcomes.

Modern projects often involve a high level of complexity, which can make it difficult to establish clear criteria for success. Factors such as technical uncertainty, stakeholder diversity, and multi-project environments add layers of complexity that can obscure traditional measures of success. Projects that rely on cutting-edge technologies or that operate in highly innovative environments face significant challenges related to technical uncertainty. For example, in IT projects, unpredictable variables like changing software requirements, evolving user needs, and technological shifts can derail timelines, increase costs, and impact deliverable quality. Measuring success in these environments requires a more flexible approach that accounts for these uncertainties [34].

As noted by Quazi et. al [95], complex projects often involve multiple teams, cross-functional collaboration, and interdependencies between various elements. These projects are more prone to scope changes, budget overruns, and unforeseen risks, making it difficult to evaluate success through traditional metrics [95]. Complex projects require a more nuanced evaluation, where success may be redefined throughout the project lifecycle as new challenges emerge. Moreover, many organizations today manage multiple projects simultaneously, a practice that presents unique challenges in terms of resource allocation, scheduling, and performance management. According to Zika et. al [107], project overload can lead to inefficiencies, burnout, and reduced performance. In these settings, it becomes challenging to assess the success of an individual project in isolation, since the performance of one project may be influenced by the demands of others [107].

In response to these complexities, modern PS frameworks like Shenhar and Dvir and Zwikael and Smyrk have evolved to include factors such as risk management, team performance, and stakeholder alignment. These frameworks recognize that success cannot be measured solely by efficiency but must account for the broader challenges that arise in complex project environments [15, 98].

Another challenge in measuring PS is balancing short-term and long-term objectives. While some projects may achieve short-term success by delivering on time and within budget, they may fail to create sustainable value or meet long-term strategic goals. Conversely, projects that exceed

their initial timelines or budgets may still be considered successful if they contribute to long-term business growth or provide lasting benefits. Traditional metrics like time, cost, and scope are often used to evaluate the immediate success of a project. These metrics are easy to quantify and provide a clear indication of whether the project has met its initial objectives. However, focusing too heavily on these metrics can obscure the bigger picture. Projects that meet their short-term goals may still fail to deliver value if they do not align with the organization's long-term strategy or fail to generate sufficient ROI [15].

Long-term success is more difficult to measure because it involves evaluating outcomes that may not materialize until months or even years after the project has been completed. For example, a project that delivers a new product to market may only be deemed successful if the product achieves customer adoption, market share growth, and long-term profitability. Measuring these long-term outcomes requires tracking a range of performance indicators over time, including customer satisfaction, business success, and investment success [81, 87].

The Shenhar and Dvir model addresses this challenge by incorporating both short-term and long-term success criteria, such as Project Efficiency (short-term) and Business Success and Preparing for the Future (long-term) [98]. Similarly, the Zwikael and Smyrk model evaluates success from multiple perspectives, ensuring that both the immediate performance of the project and its long-term impact are considered [15].

One of the most significant challenges in measuring PS is capturing intangible outcomes that are not easily quantified. These outcomes, such as team satisfaction, customer experience, and brand reputation, are instrumental in shaping the overall success of a project, yet they often go unmeasured in traditional frameworks. The IMPT dimension in the Shenhar and Dvir [13] model recognizes that PS is not only about delivering the final product but also about fostering a positive and productive team environment. Success in this context includes factors like team member growth, motivation, and retention, which are difficult to quantify but essential for long-term organizational capacity [98].

Customer satisfaction is another key indicator of PS, particularly in industries where customer engagement and retention are critical to business success. Measuring customer satisfaction involves assessing factors such as product usability, functionality, and overall experience. These intangible outcomes can be difficult to capture through traditional metrics but

are vital for ensuring the long-term success of the project [98]. Projects that enhance a company's reputation or brand value are often considered successful, even if they do not immediately generate significant financial returns. For example, a project that improves a company's sustainability practices may not deliver direct profits but can boost the company's image, attract new customers, and create long-term competitive advantages. The Zwikael and Smyrk [87] model addresses this by including PSIS, which evaluates the overall worth and riskiness of a project beyond its immediate financial performance [15, 87].

The process of collecting data to evaluate PS presents another major challenge. Accurately measuring both quantitative and qualitative success criteria requires access to reliable and comprehensive data, which is not always available. Some success metrics, such as financial performance and project timelines, are easy to track using project management software and other tools. However, data related to team satisfaction, customer feedback, and long-term project impacts may be more difficult to gather [71, 95].

In some cases, the process of gathering data on PS can be influenced by biases. For example, stakeholders may overestimate the success of a project to protect their personal or organizational reputation, leading to skewed data. Stakeholder engagement and clear definitions of success at the outset of the project can help mitigate this issue, but it remains a significant challenge in many projects [95]. Additionally, in modern projects, success is often measured through multiple metrics, including financial performance, customer satisfaction, and team productivity. Integrating these different data points to produce a comprehensive assessment of PS can be challenging, particularly when the metrics are qualitative and difficult to standardize [72].

Another challenge in measuring PS is aligning the expectations of multiple stakeholders, each of whom may have different criteria for what constitutes success [15, 71]. In some cases, these different expectations can conflict, making it difficult to establish a unified definition of success. For example, a project that delivers significant customer satisfaction may exceed its budget, leading to dissatisfaction among investors. To overcome this challenge, modern project management frameworks emphasize the importance of stakeholder alignment at the outset of the project. By engaging stakeholders early and establishing clear, shared success criteria, project managers can ensure that all parties are aligned on what constitutes success [72].

Measuring PS is a complex process that involves balancing short-term and long-term goals, quantifying both tangible and intangible outcomes, and managing the expectations of multiple stakeholders. Modern frameworks such as Shenhar and Dvir and Zwikael and Smyrk offer more comprehensive approaches to evaluating success, recognizing the importance of factors like team development, customer satisfaction, and investment returns alongside traditional efficiency metrics [15, 98]. In an increasingly complex project environment, the ability to accurately measure success will be essential to ensure that projects achieve their short-term goals while generating lasting value for all stakeholders involved. As the nature of projects continues to evolve, so too must the methods and tools used to measure their success.

2.2.5 Modern trends in project success

The definition and measurement of PS have continuously evolved, particularly in response to emerging technologies, changes in work practices, and shifting stakeholder expectations. Today's rapidly changing business environment demands that project management practices adapt to modern challenges, such as digital transformation, Agile methodologies, and sustainability goals. This section explores the latest trends influencing how PS is defined and measured, highlighting how these developments are reshaping the landscape of project management.

One of the most significant trends influencing PS in recent years is the rise of Agile methodologies. Originally developed for software development, Agile has become a popular project management approach across various industries due to its focus on flexibility, customer collaboration, and incremental delivery. Unlike traditional project management frameworks, which rely on linear processes and rigid milestones, Agile allows teams to adapt to changes and continuously refine their deliverables based on feedback.

The success of Agile projects is often measured differently from traditional projects. In Agile, success is not merely about delivering a product within a fixed scope, time, and budget but about delivering value to the customer and ensuring that the final product meets evolving customer needs. Agile methodologies prioritize customer feedback throughout the project lifecycle. This approach ensures that the product is continuously refined to meet customer expectations. As a result, PS is measured by the customer's satisfaction with the delivered product, rather than strict adherence to initial project plans [20].

In Agile, PS is measured iteratively at the end of each sprint or iteration. This allows for frequent reassessments of the project's direction and progress, enabling teams to make adjustments quickly. Success is no longer a binary outcome determined at the project's end but is evaluated incrementally, providing more flexibility to adapt to new requirements [15]. Agile's adaptability to change, customer focus, and iterative approach have made it particularly valuable in environments where market conditions and customer preferences are constantly shifting. In this context, success is not measured by static metrics but by the team's ability to respond to changes, deliver value, and ensure customer satisfaction over time.

The advent of digital transformation has fundamentally reshaped the way organizations approach project management and measure success. Digital transformation involves the adoption of digital technologies, including cloud computing, big data, AI, and automation into all areas of a business, transforming how organizations operate and deliver value to customers. As digital transformation becomes more prevalent, projects are increasingly evaluated on their ability to support and enhance an organization's digital capabilities. Success in this context is measured not only by the efficiency of project delivery but also by the project's ability to enable innovation, improve operational efficiency, and enhance customer experience.

Projects that facilitate the adoption of new technologies, such as AI or machine learning, are considered successful if they enable innovation and help organizations stay competitive in a digital-first world [108]. While many digital transformation projects are aimed at improving operational efficiency through automation and data-driven decision-making. Success is measured by the project's ability to streamline workflows, reduce costs, and increase productivity [34]. Moreover, one of the main goals of digital transformation is to enhance customer experience through personalized services, improved user interfaces, and faster delivery of products and services. Projects that contribute to a superior customer experience are viewed as successful in the context of digital transformation [81].

Digital transformation also brings new tools and methods for measuring PS. Big data analytics, for example, allows project managers to gather real-time data on project performance, providing deeper insights into how well the project is progressing and where adjustments are needed. AI-powered project management tools can predict risks, automate resource allocation, and

provide recommendations for improving efficiency, helping to ensure that projects stay on track and deliver value [108].

As discussed previously, sustainability has become an essential factor in how PS is measured. Modern businesses are increasingly held accountable not only for their financial performance but also for their environmental and social impacts. This shift has led to the development of sustainability-focused PS metrics, which evaluate projects based on their contributions to long-term environmental, social, and economic goals.

Projects are now evaluated on metrics such as carbon footprint reduction, energy efficiency, and social responsibility. Success is no longer solely about delivering the project on time and within budget but also about ensuring that the project aligns with SDGs [106]. Sustainable projects are those that create long-term value for both the organization and society. These projects are measured not just by their immediate outputs but by their lasting contributions to sustainability, such as reducing environmental degradation, improving community well-being, or fostering innovation in green technologies [81].

The integration of sustainability into PS frameworks reflects a broader shift in business practices, where organizations are increasingly expected to balance profit with purpose. Projects that fail to incorporate sustainability into their objectives may achieve short-term success but face long-term risks related to regulatory penalties, reputational damage, and shifting market demands. On the other hand, projects that embrace sustainability are more likely to generate enduring value and position the organization for future success [81, 106].

Another key trend shaping modern PS is the growing emphasis on governance and accountability. As projects become more complex and involve a wider range of stakeholders, the need for transparent decision-making, risk management, and compliance with regulations has increased. Effective project governance ensures that projects are aligned with the organization's strategic objectives and that resources are managed efficiently. Governance structures provide oversight and accountability, ensuring that projects stay on track and deliver the expected benefits [87].

In modern project management, risk management is seen as a critical component of success. Projects that fail to identify and mitigate risks early in the project lifecycle are more likely to experience delays, cost overruns, and quality issues. Modern PS frameworks, such as those

developed by Zwikael and Smyrk, place significant emphasis on risk-adjusted success, measuring projects based on their ability to deliver value while managing risks effectively [15, 87]. In addition to risk and governance, there is a growing focus on ethical considerations in PS. Projects that adhere to high ethical standards – ensuring fair labor practices, social responsibility, and environmental stewardship – are increasingly seen as successful in today’s business environment. Projects that fail to consider these factors may face reputational damage, legal challenges, and financial penalties, even if they meet traditional success criteria [81].

As AI and big data technologies become more sophisticated, they are transforming how PS is measured and managed. These technologies offer new ways to analyze project performance, predict risks, and make data-driven decisions. AI tools can analyze large datasets in real time to provide insights into project performance, track milestones, and identify potential risks before they materialize [108]. While, big data allows organizations to gather vast amounts of information about project performance, from employee productivity to customer satisfaction. Using predictive analytics, project managers can forecast potential challenges and make informed decisions that improve the chances of success [34].

The integration of AI and big data into project management not only improves the accuracy of success measurement but also enables real-time monitoring and continuous improvement. This trend is particularly valuable in industries where projects must be delivered quickly and efficiently, such as technology, healthcare, and manufacturing [108]. The modern trends influencing PS highlight the need for adaptive, flexible, and holistic approaches to project management. As organizations navigate the challenges of digital transformation, Agile practices, sustainability goals, and governance requirements, the way success is defined and measured continues to evolve.

The rise of Agile methodologies has shifted the focus of success measurement from rigid milestones to customer satisfaction and incremental value delivery. At the same time, digital transformation and the integration of AI and big data have provided new tools for tracking project performance in real time and optimizing project outcomes. Moreover, the growing emphasis on sustainability and ethical considerations reflects a broader shift toward long-term value creation rather than short-term gains. In this evolving landscape, organizations must remain agile and forward-thinking, adopting modern success frameworks that account for both the tangible and intangible outcomes of their projects. By embracing these trends, organizations can ensure that

their projects are not only successful in the present but also contribute to lasting, positive impacts in the future.

2.2.6 Key takeaways – Project success

The concept of PS has undergone a significant transformation over the past several decades, evolving from a narrow emphasis on time, cost, and scope to a more complex and multi-dimensional view. Today, PS is evaluated through a variety of lenses, including stakeholder satisfaction, long-term value creation, sustainability, and risk management. This broader definition reflects the changing demands of a globalized, technology-driven world where projects are increasingly complex, interconnected, and subject to rapidly shifting market conditions.

Throughout this exploration of PS, several key themes have emerged:

1. **Historical Evolution:** Early frameworks such as the Iron Triangle emphasize efficiency by measuring success based on whether a project was completed on time, within budget, and according to scope. While still relevant, this framework has proven inadequate for capturing the full scope of project outcomes, especially in today's dynamic and complex project environments [71, 72].
2. **Modern Frameworks for PS:** Modern frameworks like those proposed by Shenhar and Dvir and Zwikael and Smyrk offer a more comprehensive understanding of PS. These frameworks include multiple dimensions, such as team impact, customer satisfaction, business success, and investment success, allowing for a more holistic evaluation of both short-term and long-term outcomes [15, 98].
3. **Stakeholder Perspectives:** Different stakeholders, project managers, teams, customers, and investors, have unique criteria for evaluating success. While project managers may focus on efficiency and project execution, customers are more concerned with the quality and utility of the final deliverable, and investors are focused on financial returns and risk management [15, 81]. Effective PS frameworks must consider these diverse perspectives to ensure that all stakeholders' expectations are met.
4. **Sustainability as a Key Success Factor:** Sustainability has become an integral part of how PS is defined. Projects are increasingly expected to align with SDGs and contribute to long-

term environmental and social impacts. Sustainable projects are those that create lasting value for both the organization and society, balancing people, planet, and profit [81, 106].

5. **Challenges in Measuring Success:** Measuring PS remains challenging, particularly in the context of complex projects, intangible outcomes, and multi-stakeholder environments. Issues such as aligning stakeholder expectations, balancing short-term and long-term goals, and capturing qualitative success criteria like team satisfaction and customer experience require more sophisticated approaches to success measurement [15, 95].
6. **Modern Trends in PS:** The rise of Agile methodologies, digital transformation, and the increasing focus on governance and accountability are reshaping how PS is measured. Success is no longer a binary outcome determined at project completion but is evaluated iteratively and based on the value delivered to the customer and the organization over time. The use of AI and big data analytics is further enhancing the ability of project managers to track, monitor, and optimize project performance in real time [15, 108].

For organizations seeking to ensure PS in today's complex environment, strategic implications such as adopting multi-dimensional frameworks, prioritizing stakeholder alignment, fostering sustainability, and leveraging technology must be considered. In particular, relying solely on traditional success metrics like time, cost, and scope is no longer sufficient. Organizations should adopt multi-dimensional frameworks that incorporate both short-term efficiency and long-term strategic outcomes. These frameworks should address diverse success criteria, including stakeholder satisfaction, team impact, and investment returns [15, 98].

Successful projects are those that meet the expectations of all stakeholders involved. To achieve this, organizations must engage stakeholders early and establish clear, shared definitions of success. Ongoing communication and alignment throughout the project lifecycle are essential to ensuring that all perspectives are considered [15, 72]. Moreover, sustainability should be a core consideration in any project. Organizations that prioritize sustainable practices – such as reducing carbon footprints, improving resource efficiency, and promoting social responsibility – are better positioned to achieve long-term success. Sustainable projects not only contribute to environmental and social well-being but also generate enduring value for the organization by enhancing reputation, brand equity, and customer loyalty [81, 106]. Finally, AI, big data, and digital tools are transforming how PS is tracked and measured. Organizations should leverage these technologies

to gain real-time insights into project performance, predict risks, and optimize resource allocation. The use of predictive analytics and automated tools can improve decision-making and increase the likelihood of PS [34, 108].

Looking ahead, the future of PS will be shaped by continued advancements in technology, changing work practices, and increasing demands for corporate social responsibility. As digital transformation accelerates, organizations will need to adapt their project management strategies to integrate new tools, methodologies, and success metrics that reflect the evolving needs of the business landscape. As organizations continue to adopt Agile methodologies and hybrid project management approaches, success will increasingly be measured in incremental value delivery rather than final project outcomes. This shift will require organizations to build flexible frameworks that allow for frequent reassessments of progress and outcomes [20].

Similarly, sustainability and ethical considerations become central to business operations, projects will be evaluated not only for their financial returns but also for their contributions to environmental sustainability, social responsibility, and ethical governance. Organizations that fail to address these factors may struggle to achieve sustained success in an progressively careful marketplace [81, 106]. Moreover, the continued the incorporation of AI, automation, and predictive analytics is expected to improve organizations' capacity to measure PS in real time. These technologies will allow for data-driven decision-making, risk mitigation, and continuous improvement, ensuring that projects remain aligned with organizational goals and deliver value over time [108].

PS is no longer defined by a simple set of criteria, it is a complex, multi-dimensional concept that requires a comprehensive approach to measurement and evaluation. By embracing modern success frameworks, prioritizing stakeholder engagement, and leveraging technology, organizations can ensure that their projects deliver both immediate and long-term value, contributing to their overall strategic success.

2.3 Information system success – Theoretical model

2.3.1 Introduction to digital maturity and IS success

In the modern business landscape, the concept of digital maturity has become central to understanding how organizations operate, adapt to changes, and drive PS. Digital maturity refers to the extent to which an organization has integrated digital technologies into its processes, operations, and culture to enhance business performance [35]. Organizations with higher digital maturity are better equipped to harness advanced technologies such as cloud computing, AI, and big data analytics to gain a competitive advantage and sustain their operations, even during periods of market disruption.

One of the clearest examples of the importance of digital maturity was during the COVID-19 pandemic, which forced many businesses to quickly adapt to a remote or hybrid working environment [63]. Companies with strong IS and advanced digital infrastructures were able to continue operating seamlessly, whereas those with lower levels of digital maturity faced significant challenges in maintaining operations, employee productivity, and customer satisfaction [109]. In this context, information systems have been shown to play a pivotal role, as organizations that could effectively leverage their IS tools gained a competitive advantage in an increasingly digital economy [30, 110].

The effectiveness of SW depends on its two components, technology and the workforce, and their performance. Information technology is defined as the technological tools supporting individuals in obtaining and analyzing information [34]. At the same time, an information system is a working system composed of humans being supported by and using information technology in pursuit of acquiring, sharing, collecting, retrieving, processing, and presenting information to produce an output [34, 111]. A high quality digital infrastructure is necessary to establish effective communication and collaboration to respond to changes in the marketplace [112], therefore, the choice of an information system is crucial to the organization due to the immense impact on operational performance and profitability [113]. Researchers have uncovered that one of the key factors for SW quality refers to the accessibility of technology at home and its impact on communication [6, 114]. Communication impacts will not only negatively impact employees' efficiency, but also cause a strain on professional relationships leading to an increase in stress [6].

Digital maturity allows organizations to react quickly to external disruptions while sustaining operational efficiency in a rapidly changing environment. Companies with high digital maturity are equipped with the infrastructure to not only withstand market fluctuations but also take advantage of opportunities that arise during these periods. For example, cloud-based systems allow companies to scale their operations quickly, while big data analytics provide insights that guide decision-making in real-time.

An organization's level of digital maturity directly impacts its ability to adopt and implement SW practices, which involve the use of advanced technologies to enhance workforce flexibility, productivity, and collaboration. SW practices, which gained prominence during the COVID-19 pandemic, rely heavily on robust digital infrastructure to allow employees to work efficiently from remote locations without compromising on output quality [110].

Companies with higher digital maturity can swiftly adapt to remote work, enable better collaboration among distributed teams, and maintain effective project management through the use of IS such as collaboration platforms, project management software, and virtual communication tools. In contrast, organizations with outdated systems or inadequate digital infrastructure struggled to cope with the sudden shift to remote work, leading to productivity losses, delays in project completion, and, in some cases, the loss of business [30].

The COVID-19 pandemic was a defining moment for digital transformation across industries [109]. Organizations that previously viewed digital transformation as a long-term goal were forced to accelerate their technology adoption plans to ensure continuity in a work-from-home environment. Information systems became central to this transformation, as companies adopted new digital tools to manage operations, maintain communication, and ensure productivity in a fully remote or hybrid work setup [110].

For instance, companies in sectors such as finance, healthcare, and retail rapidly adopted cloud computing solutions to enable remote access to critical systems and data. The use of cloud based IS platforms allowed these companies to remain operational without requiring employees to be physically present in the office. In contrast, organizations that had not invested in digital infrastructures found themselves scrambling to implement ad hoc solutions, which often led to inefficiencies, higher operational costs, and a loss of market competitiveness [110].

Digital maturity also played a critical role in how companies responded to new customer expectations during the pandemic. Businesses that had invested in customer relationship management (CRM) systems and other digital tools were able to continue offering high levels of customer service through digital channels, while those that lacked such systems faced difficulties in meeting evolving customer demands.

At the core of digital maturity is the effective use of IS. IS allow organizations to automate tasks, streamline workflows, and enhance communication across departments and teams. More importantly, IS tools provide businesses with the ability to make data-driven decisions, predict market trends, and improve overall project outcomes. As companies evolve their digital capabilities, IS becomes increasingly integrated into their strategic objectives, providing them with the flexibility needed to manage operations efficiently [113].

IS success is a critical component of digital maturity because the effectiveness of these systems directly influences project performance, customer satisfaction, and employee productivity. According to the DeLone and McLean IS Success Model [30], IS success can be evaluated through various dimensions, including system quality, information quality, service quality, use, user satisfaction, and net benefits [30]. These dimensions determine whether an organization's IS tools are capable of meeting the needs of both the organization and its employees in achieving strategic goals.

For example, an organization with a high-quality IS infrastructure may use data analytics tools to optimize its supply chain operations, reduce costs, and respond to market changes more efficiently. Similarly, a company with effective communication systems can enhance employee collaboration, leading to better project outcomes and higher satisfaction levels among remote workers. Therefore, the level of IS success is a direct reflection of an organization's digital maturity and its ability to thrive in a dynamic business environment [110, 115].

The relationship between digital maturity and competitive advantage has become increasingly evident in recent years, particularly during times of economic uncertainty. Companies that were digitally mature before the pandemic were able to not only survive but also capitalize on market opportunities as competitors struggled to adapt. In industries such as e-commerce, banking, and healthcare, businesses with advanced IS systems could deliver better customer experiences, optimize their operations, and outperform their peers [110].

E-commerce platforms that invested in digital payment systems, customer service automation, and inventory management tools were able to manage the surge in online shopping demand during the pandemic. These companies were able to ensure fast delivery times, personalized customer service, and accurate inventory management, which gave them a significant edge over traditional brick-and-mortar stores that struggled to transition to an online environment. Similarly, in the banking sector, financial institutions with sophisticated CRM systems and digital transaction platforms could continue serving clients without disruption. These banks were able to offer remote banking services, secure digital transactions, and personalized financial advice, which contributed to increased customer retention and loyalty [110].

Digital maturity is a key determinant of an organization's ability to adapt to market disruptions and maintain competitive advantage. The integration of information systems plays a fundamental role in enhancing digital maturity by providing the tools and infrastructure needed to support remote work, improve PS, and deliver value to customers. The COVID-19 pandemic highlighted the importance of having advanced digital systems in place, as businesses with higher digital maturity were better equipped to navigate the challenges of a rapidly changing business landscape. Moving forward, organizations must continue investing in their digital capabilities to remain competitive and resilient in the face of future disruptions [30, 46, 109, 110].

2.3.2 DeLone & McLean IS success model overview

The DeLone and McLean IS success model [30, 116] has emerged as one of the most widely accepted frameworks for evaluating the performance and success of information systems in organizations. Originally introduced in 1992, and subsequently revised in 2003, the model offers a multi-dimensional approach to measuring IS success, incorporating both technical and human factors. The model's relevance across industries and evolving technologies underlines its robustness as a tool for understanding how information systems impact organizational performance, project outcomes, and long-term strategic goals [30, 110].

This section delves into the historical development of the DeLone and McLean model, explains its core components, and discusses how the model has been validated in diverse industries, ranging from e-government to corporate enterprise systems. The model's application in

real-world settings helps organizations assess the effectiveness of their IS systems and optimize their operations based on the insights derived from the framework.

When DeLone and McLean introduced their original IS success model in 1992 [116], it represented a significant breakthrough in the evaluation of IS. Prior to the development of this model, measuring IS success was largely limited to technical performance metrics such as system uptime, response times, and data throughput. However, DeLone and McLean recognized that IS success also depended on user satisfaction, system utilization, and the broader organizational impacts of the system [30].

The original model consisted of six interrelated dimensions: System Quality, Information Quality, Use, User Satisfaction, Individual Impact, and Organizational Impact. These components provided a comprehensive framework for evaluating how well an information system served the needs of its users and contributed to organizational objectives. Over time, however, the role of information systems within organizations evolved, and the need to revise the model became apparent.

In 2003, DeLone and McLean introduced a revised version of the model, incorporating insights from empirical research and changes in the technological landscape [30]. This updated model included Service Quality as a new dimension, reflecting the growing importance of external support services in the successful operation of IS. Furthermore, Individual Impact and Organizational Impact were consolidated into a single dimension, Net Benefits, which captures the overall value derived from the use of IS [30, 110].

The DeLone and McLean IS Success Model is built around six core components that interact with one another to provide a holistic view of IS success. Each of these dimensions measures different aspects of IS performance, from the technical quality of the system to the satisfaction of its users and the benefits it delivers to the organization.

1. **System Quality:** This dimension measures the performance of the information system itself. It evaluates factors such as usability, reliability, response time, and flexibility. A high-quality system is one that is easy to use, consistently performs well, and can be adapted to meet changing user requirements. System quality is particularly important in industries that rely on real-time data processing and mission-critical operations, such as financial services, healthcare, and e-commerce [115].

2. **Information Quality:** The precision of information generated by an IS is a crucial factor in determining its success. Information quality is measured in terms of accuracy, completeness, relevance, and timeliness. High-quality information allows users to make better decisions, leading to improved business outcomes [113].
3. **Service Quality:** Service quality refers to the support provided to users by IT teams or external service providers. This dimension assesses the availability, responsiveness, and professionalism of support services, which are critical to ensuring that users can effectively use the system. Poor service quality can undermine even the best-designed IS, leading to user frustration and decreased productivity [110].
4. **Use/Intent to use:** The use dimension measures the actual utilization of the IS by end-users. It reflects how often and to what extent the system is employed to complete tasks and achieve organizational goals. However, DeLone and McLean recognized that simply measuring usage might not capture the full picture, especially in cases where system use is mandatory. As a result, the model also includes the dimension of intention to use, which measures users' attitudes towards adopting the system [110]. Therefore, even if Use and Intention to use are conceptually distinct constructs. Use refers to the actual utilization of an information system, while Intention to Use captures a user's expressed willingness or likelihood to engage with the system in the future. Despite their differences, particularly in terms of being behavioral (Use) versus attitudinal (Intention to use), the two constructs are closely related and often temporally dependent. In practice, especially in cross-sectional survey research or studies where system implementation is recent or ongoing, respondents may not yet have had the opportunity to fully use the system. In such cases, Intention to Use serves as a strong proxy for actual Use. Accordingly, the DeLone and McLean model allows for the combination of these variables, treating them as a unified construct representing system acceptance and engagement. In this study, given the variability in project phases and ICT tool maturity across respondents, both measures were integrated into a single Use/Intent to use factor to ensure consistency and comparability across cases.
5. **User Satisfaction:** User satisfaction measures the overall experience of users when interacting with the system. It is closely related to system quality, information quality, and service quality. High levels of user satisfaction are often associated with higher levels of

system use and better project outcomes. In organizations where user satisfaction is prioritized, information systems are more likely to be embraced and used effectively [115].

- 6. Net Benefits:** The final dimension, net benefits, captures the overall value that the IS delivers to the organization. These benefits can take many forms, including improved productivity, cost savings, better decision-making, and enhanced customer service. By focusing on the net benefits of IS, organizations can determine whether their investment in information systems has yielded a positive return and contributed to their strategic goals [30, 110].

One of the key strengths of the DeLone and McLean IS Success Model is its recognition of the interdependence between its components. For example, system quality directly influences both user satisfaction and use, while information quality affects the accuracy and usefulness of decisions made by system users. Similarly, service quality can improve the overall user experience, resulting in increased satisfaction and more extensive system utilization.

The model also acknowledges the feedback loops that exist between these components. For instance, positive net benefits from using the system can lead to increased user satisfaction, which in turn may encourage greater use of the system in the future. These interactions make the DeLone and McLean model a dynamic tool for evaluating IS success, as it captures the complex relationships between technical performance, user experience, and organizational outcomes [115]. The D&M IS Success Model is reported below in figure 2.

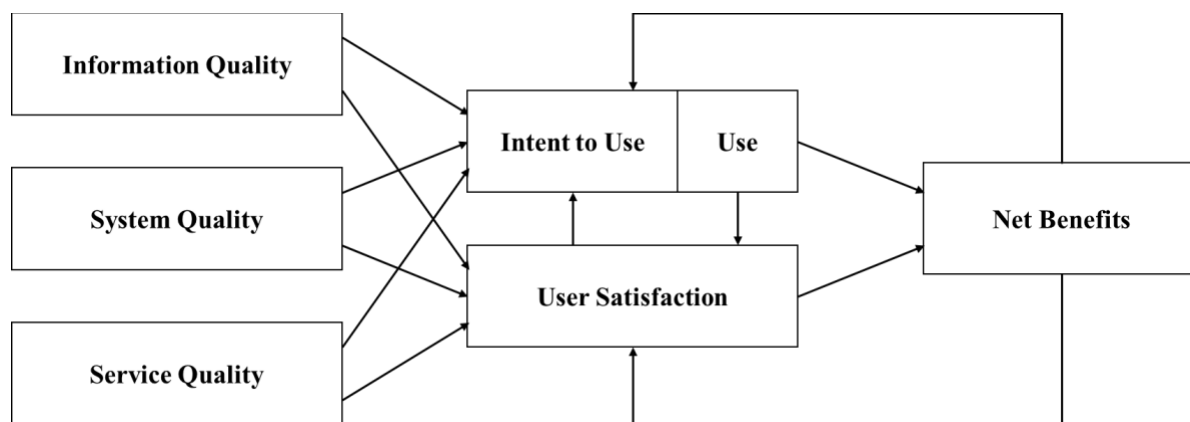


Figure 2. IS Success – theoretical model [30]

The DeLone and McLean model has been validated through extensive empirical research across a wide range of industries and organizational contexts [115, 117]. Its adaptability and comprehensive nature make it a valuable tool for assessing IS success in various sectors, including healthcare, education, banking, and e-government.

For example, in e-government systems, where public trust and service efficiency are paramount, the model has been used to assess how well digital platforms meet citizens' needs. Studies have shown that improvements in system quality, information quality, and service quality can lead to increased public trust in government services and higher levels of citizen engagement [117]. In the healthcare sector, the model has been applied to evaluate the success of Electronic Health Record (EHR) systems, focusing on how these systems improve patient outcomes and streamline administrative processes [113].

Similarly, in the banking industry, the model has been used to measure the success of CRM systems and mobile banking platforms. These systems are critical for enhancing customer service, reducing operational costs, and increasing customer retention. By using the DeLone and McLean model, banks can assess how well their systems support these objectives and identify areas for improvement [110]. The DeLone and McLean IS Success Model provides a comprehensive and adaptable framework for evaluating the effectiveness of information systems. By focusing on key dimensions such as system quality, information quality, service quality, use, user satisfaction, and net benefits, the model captures both the technical and human aspects of IS success. Its relevance across diverse industries and evolving technological landscapes underlines its robustness as a tool for understanding the influence of IS on PS and organizational performance.

As organizations continue to invest in digital transformation and adopt new technologies, the DeLone and McLean model remains an essential tool for ensuring that these investments lead to tangible improvements in productivity, customer satisfaction, and overall business outcomes. Moving forward, companies must consider not only the technical aspects of their information systems but also the human factors that drive user adoption, satisfaction, and long-term success [30, 110, 115].

2.3.3 Information quality, system quality, and service quality in IS success

In the DeLone and McLean IS Success Model, the dimensions of Information Quality, System Quality, and Service Quality form the foundation for evaluating the performance and effectiveness of an information system. These three factors directly influence user satisfaction, system use, and the net benefits derived from the system. By focusing on these aspects, organizations can assess how well their information systems support their strategic goals, improve operational efficiency, and enhance user experiences [30, 110].

This section delves into each of these quality dimensions, exploring their definitions, impact on IS success, and real-world applications. By understanding these core elements, organizations can develop better IS systems that not only meet technical requirements but also align with user needs and organizational objectives.

Information quality refers to the accuracy, relevance, completeness, and timeliness of the data provided by an information system. It is one of the most critical dimensions of IS success because the quality of information directly affects decision-making processes, operational efficiency, and the ability to meet organizational goals. High-quality information allows users to make informed decisions, which in turn improves the performance and outcomes of projects [110, 113]. In terms of accuracy, information must be correct, reliable, and free from errors. Inaccurate data can lead to poor decisions and negatively impact project outcomes. For example, inaccurate financial data in a banking system could lead to incorrect risk assessments and potentially costly investment decisions [115].

Information must be relevant to the tasks and decisions at hand. Irrelevant information can overwhelm users, leading to confusion and reduced productivity. In sectors such as healthcare, ensuring that doctors and medical staff have access to relevant patient data is essential for providing timely and accurate treatment [113]. Additionally, information should be comprehensive, providing all the necessary data for decision-making. Incomplete information may lead to missed opportunities or suboptimal decisions. For instance, in the supply chain industry, incomplete data on inventory levels could result in stockouts or overstocking, disrupting operations [110]. Finally, information must be available when needed to support decision-making. Outdated information can be as harmful as inaccurate data. For instance, in e-commerce, access to real-time

data on customer preferences, inventory status, and delivery logistics is essential for fulfilling customer expectations and maintaining seamless operations [113].

The quality of information generated by an information system has a direct impact on PS. When information is accurate, relevant, complete, and timely, it enables project teams to make better decisions, allocate resources effectively, and meet project goals. Conversely, poor information quality can lead to project delays, budget overruns, and stakeholder dissatisfaction [110]. For instance, in the finance industry, investment firms rely heavily on high-quality data to make informed investment decisions. If the information provided by their investment analysis systems is inaccurate or incomplete, it can lead to poor investment choices, resulting in financial losses. Similarly, in the healthcare sector, the accuracy and completeness of patient records are critical for ensuring that patients receive the right diagnosis and treatment in a timely manner [113].

System quality encompasses the overall performance of an information system, including its usability, reliability, flexibility, and scalability. A system with high quality should be easy to use, function consistently, and meet the changing needs of users. System quality is a crucial dimension of IS success because it directly influences user satisfaction, system use, and the system's ability to support business operations [30]. The system must be intuitive and user-friendly. A complex or confusing interface can deter users from fully utilizing the system's capabilities, leading to reduced productivity and satisfaction. For instance, an enterprise resource planning (ERP) system that requires extensive training or has a steep learning curve may experience low adoption rates among employees [115]. Furthermore, the system must perform consistently and be available when needed. Frequent downtime or system crashes can significantly disrupt business operations and reduce user confidence in the system. For instance, an online banking platform must be reliable to ensure that customers can access their accounts and complete transactions without interruptions [110].

The system should be adaptable to changing business needs and requirements. As organizations grow and evolve, their information systems must be able to scale and accommodate new functionalities. A lack of flexibility can limit the system's long-term usefulness. In e-commerce, for instance, a flexible system can quickly integrate new payment methods or accommodate higher transaction volumes during peak seasons [115]. In order to handle increasing workloads and user demands without compromising performance the system needs to be scalable.

In industries like cloud computing, scalability is essential for managing large amounts of data and accommodating fluctuations in user activity [110].

High system quality is essential for ensuring that an information system is used effectively and meets the organization's operational needs. A system that is easy to use, reliable, and flexible increases user satisfaction and encourages greater use. Conversely, systems that are difficult to navigate, prone to errors, or inflexible can lead to frustration, reduced productivity, and a reluctance to adopt the system fully [110, 115].

Service quality refers to the support provided to users of the information system, including technical support, maintenance, and user assistance. This dimension assesses the responsiveness, reliability, and professionalism of the service provided by internal IT teams or external service providers. High-quality service ensures that users can effectively use the system and resolve any issues that arise during its operation [110]. The provider needs to be able to respond quickly to user inquiries, requests, and issues. Prompt responses are critical for minimizing system downtime and ensuring that users can continue their work without significant delays. For example, in healthcare, timely technical support is essential for maintaining the availability of EHR systems that doctors and nurses rely on to treat patients [113]. Moreover, the dependability of the service provider in addressing system issues and maintaining system performance. Reliable service ensures that users can trust the system to function consistently. In e-commerce, for instance, service reliability is crucial for ensuring that payment systems and order management platforms operate smoothly, especially during peak sales periods [110]. Finally, the professionalism and expertise of the service provider in resolving technical issues. Skilled IT teams or external providers can diagnose and fix complex system problems quickly, ensuring that users experience minimal disruptions [110].

Service quality plays a pivotal role in ensuring that users can derive maximum value from an information system. High-quality service leads to higher user satisfaction, as users feel supported and confident that any issues they encounter will be resolved quickly and effectively. Conversely, poor service quality can result in frustration, system abandonment, and reduced productivity [110, 115].

For example, in the financial services sector, where uptime and system availability are critical, the quality of support provided by IT teams can make a significant difference. If users

experience difficulties with online trading platforms or encounter security issues, quick and reliable support can mitigate the impact on operations. In contrast, poor service can lead to prolonged outages, loss of revenue, and damaged customer trust [110].

The dimensions of Information Quality, System Quality, and Service Quality are central to the success of any information system. High-quality information enables better decision making and improves operational efficiency. Meanwhile, robust system quality allows users to depend on the system to perform consistently and meet their evolving needs. Lastly, high-quality service provides the necessary support for users to resolve issues and continue their work without significant disruptions. Together, these dimensions drive user satisfaction, system use, and ultimately, the net benefits that organizations derive from their information systems [30, 110, 115].

2.3.4 Intention to use, use, and user satisfaction

In the DeLone and McLean IS Success Model, Intention to Use, Use, and User Satisfaction are critical components that reflect the relationship between the technical quality of an information system and its impact on users and the organization. The interaction between these dimensions determines how well the system is adopted by users, how satisfied they are with it, and how effectively the system supports the organization's goals.

This section explores the significance of Intention to Use, Use, and User Satisfaction within the context of IS success, examining the factors that influence each dimension and the ways in which they contribute to the overall effectiveness of the information system.

One of the critical insights of the DeLone and McLean model is the recognition that intention to use an information system can be just as important as actual use. Intention to use reflects a user's willingness or motivation to engage with the system. It is influenced by several factors, including the user's experience with the system, the system's perceived usefulness, and the organizational context in which the system is being implemented [110]. Intention to use is influenced by both individual user attitudes and organizational factors:

In terms of perceived usefulness, users are more likely to engage with an information system if they believe that the system will allow them to complete their activities more efficiently or effectively. In the Technology Acceptance Model (TAM), perceived usefulness is a key predictor

of user acceptance of a new technology [115]. The more user-friendly a system is, the more likely users are to adopt it. If a system is complicated or requires significant training, users may be reluctant to engage with it. This is especially critical in sectors like healthcare, where complex systems like EHR systems must be intuitive and accessible for users to quickly adapt [113].

The organizational environment similarly has a major influence in shaping users' intentions to use an information system. If an organization promotes a culture of digital innovation and provides sufficient training and support, employees are more likely to adopt the system [115]. In contrast, a lack of support or training can lead to resistance, even if the system has clear benefits. In many organizations, the intention to use a system is influenced by whether its adoption is voluntary or mandatory. For example, in a corporate environment, an IS tool such as ERP software might be mandatory for all employees to use. In such cases, the actual use might not be indicative of the system's success, as employees might use it out of necessity rather than willingness. Intention to use helps measure whether users are genuinely inclined to adopt and embrace the system, providing a clearer picture of its effectiveness [110].

Use denotes the actual interaction of users with the information system. This dimension is commonly measured by usage frequency, duration, and the range of tasks completed using the system [30]. In some cases, high levels of system use may indicate the success of the system; however, this can be misleading if the use is not accompanied by user satisfaction or perceived effectiveness. The DeLone and McLean model recognizes that actual use alone may not be sufficient to assess IS success, particularly in cases where the system is required by the organization. Therefore, intention to use and user satisfaction are also critical in understanding how effectively the system is being utilized [110].

For example, in the finance sector, employees may be required to use a financial reporting system, but their engagement with the system may vary depending on its ease of use and perceived value. If employees are simply using the system because it is mandatory, without fully engaging with its capabilities, the organization may not be reaping the full benefits of the technology [115].

User satisfaction is one of the most important determinants of IS success, as it reflects the extent to which the system fulfills the needs and expectations of its users. High levels of user satisfaction typically correlate with higher levels of system use and improved organizational performance [30]. Several factors contribute to user satisfaction, including:

- **System Performance:** The system's speed, reliability, and ease of access are key drivers of satisfaction. Users expect information systems to operate efficiently without frequent errors, downtime, or technical difficulties. For instance, in e-commerce, an unreliable system can lead to frustration for both employees managing the platform and customers trying to make purchases [110].
- **Information Quality:** As discussed previously, high-quality, relevant, and timely information is essential for decision making. Users are more likely to be satisfied with an IS that provides accurate, comprehensive, and actionable data. For instance, in the healthcare sector, doctors and nurses are more satisfied with EHR systems when they can easily access accurate patient data in real time [113].
- **User Support and Training:** The availability of technical support and training also significantly impacts user satisfaction. Users who receive adequate training on how to use the system and know where to seek help when issues arise tend to report higher satisfaction levels. In contrast, a lack of support or inadequate training can lead to dissatisfaction, even if the system itself performs well [115].
- **System Usability:** Ease of use is a critical factor in determining whether users are satisfied with an IS. If the system is intuitive and user-friendly, users are more likely to feel comfortable navigating it and using its full range of features. Systems that are too complex or difficult to learn can lead to frustration and dissatisfaction, regardless of their technical performance [110].

Organizations use various tools to measure user satisfaction, including surveys, focus groups, and user feedback mechanisms. These tools provide insights into how users feel about the system and identify areas for improvement. Common metrics used in these assessments are Net Promoter Score (NPS), which measures how likely users are to recommend the system to others, Customer Satisfaction (CSAT) Scores that evaluate overall user satisfaction with different aspects of the system, such as performance, usability, and support, and Feedback Surveys collecting detailed responses from users regarding their experiences with the system.

For example, in the education sector, universities and schools often use feedback surveys to assess the success of their learning management systems (LMS). These surveys ask students and

faculty to rate the system's ease of use, the quality of support services, as well as the overall effectiveness of the platform in facilitating their teaching and learning objectives [115].

There is a well-established correlation between user satisfaction and the overall success of an information system. Higher levels of user satisfaction increase the likelihood of frequent system use, fuller exploration of its capabilities, and greater value derived from its features. This enhanced engagement, in turn, generates higher net benefits for the organization, including improved productivity, cost reductions, and more informed decision-making. [30, 110].

Conversely, when users are dissatisfied with an information system, they are less likely to use it consistently or effectively. Dissatisfaction can result in the underutilization of the system, wasted resources, and, ultimately, a lower ROI for the organization. Therefore, measuring and improving user satisfaction is essential for ensuring the success of any IS [110, 115].

The DeLone and McLean model highlights the dynamic relationship between use, user satisfaction, and net benefits. When users engage with the system and are satisfied with its performance, their continued use of the system leads to greater net benefits for the organization. These benefits can include increased efficiency, improved decision-making, and enhanced customer service [30, 110]. At the same time, the net benefits derived from the system reinforce user satisfaction, creating a positive feedback loop. The more value users derive from the system, the more satisfied they become, which in turn encourages them to use the system more frequently and effectively [110].

For example, in manufacturing, a robust ERP system may initially face resistance from users who are unfamiliar with its features. However, as users become more comfortable with the system and recognize its ability to streamline operations and improve inventory management, their satisfaction increases, leading to greater usage and more significant benefits for the organization [115].

The dimensions of Intention to Use, Use, and User Satisfaction are critical for evaluating the success of an information system. Intention to Use provides insights into user attitudes and the likelihood of system adoption, while Use reflects the actual engagement with the system. User Satisfaction serves as a primary measure of how effectively the system fulfills user needs and expectations, directly influencing the system's success and its impact on the organization. By focusing on these dimensions, organizations can ensure that their information systems are not only

technically sound but also effectively embraced by users, leading to greater net benefits and improved project outcomes [30, 110, 115].

2.3.5 Net benefits and their influence on project success

The final dimension in the DeLone and McLean IS Success Model is Net Benefits, which represent the ultimate measure of an IS's success. Net benefits encompass the overall value and impact that an IS has on the organization, its users, and its stakeholders. These benefits are typically assessed in terms of improved productivity, cost savings, enhanced decision-making, and customer satisfaction. The success of an IS can be determined by how effectively it delivers net benefits over time and how these benefits contribute to the broader organizational objectives, including PS [30, 110].

This section examines the role of net benefits in determining the success of an information system and how these benefits contribute to PS. By exploring various metrics and empirical evidence, we can understand how organizations derive value from their IS and use this value to improve project outcomes and overall business performance.

In the DeLone and McLean IS Success Model, net benefits are the cumulative advantages gained from the implementation and use of an information system. These benefits are measured in terms of both quantitative and qualitative outcomes, including enhanced efficiency, lower operational costs, better decision-making, and better communication within and outside the organization [30]. The net benefits derived from an IS can be categorized into operational efficiency, cost reductions, better decision-making, enhanced customer satisfaction, and increased innovation and agility.

Information systems can significantly improve operational efficiency by automating routine tasks, reducing errors, and streamlining processes. For example, in the manufacturing sector, an IS that integrates supply chain management with production planning can shorten lead times, lower inventory costs, and enhance overall production efficiency [115]. Additionally, a well-implemented IS can lead to substantial cost savings by reducing the need for manual labor, improving resource allocation, and optimizing workflows. In the finance sector, automated

reporting systems can replace manual data entry and reconciliation processes, leading to cost reductions and faster report generation [110].

One of the most important benefits of an IS is its ability to provide real-time data and analytics that enhance decision-making. In healthcare, for instance, EHR systems provide doctors and healthcare professionals with up-to-date patient information, allowing for better diagnosis and treatment plans [113]. Information systems also play a critical role in improving customer experiences by providing personalized services, faster response times, and better communication channels. In e-commerce, for example, IS tools like CRM systems help businesses track customer preferences, enabling more targeted marketing and improved customer service [115]. Information systems contribute to organizational agility by enabling innovation and facilitating quick adaptation to changes in the market. In industries like technology and software development, agile project management methodologies, supported by IS tools, allow organizations to pivot quickly in response to customer feedback and market trends [66, 110].

Measuring net benefits is essential for determining the success of an information system. Different organizations and industries may prioritize specific benefits depending on their strategic objectives, and as a result, they may use various metrics to assess the success of their IS implementation [110]. Common quantitative metrics used to measure net benefits include:

- **ROI:** ROI measures the financial return on an IS investment relative to the costs incurred. It is a key metric for determining whether an IS has delivered value in terms of cost savings and increased revenue [110].
- **Key Performance Indicators (KPIs):** Organizations often use KPIs to track specific performance metrics related to their IS implementation. For example, in supply chain management, KPIs might include inventory turnover rates, lead time, and order fulfillment accuracy [115].
- **Productivity Gains:** Assessing the productivity gains achieved through the use of an IS is another way to assess net benefits. In the finance sector, an IS might automate complex calculations and reporting, enabling employees to concentrate on more strategic activities, thereby increasing overall productivity [30].

In addition to quantitative metrics, qualitative benefits can be just as important when measuring the success of an information user satisfaction system. First, elevated levels of user satisfaction are indicative of a successful IS. Users who are satisfied are more likely to interact with the system and utilize its full capabilities, and derive greater value from its features. This leads to improved outcomes for projects and the organization as a whole [110]. Second, an organization's capacity to rapidly adapt to market shifts and evolving customer demands is a critical measure of net benefits. An IS that enables faster decision-making and supports agile project management practices can enhance the organization's adaptability, particularly in fast-paced industries like technology and e-commerce [110]. Finally, customer feedback is another qualitative measure that can be used to assess the success of an IS. In service-oriented industries such as retail and hospitality, customer feedback on response times, service quality, and overall satisfaction can provide insights into how well the IS supports customer-facing functions [115].

The net benefits derived from an information system play a crucial role in determining PS. A successful IS implementation can lead to better project outcomes, including on-time delivery, cost control, and stakeholder satisfaction [110]. In project management, net benefits are often realized in terms of the project's ability to meet its goals and deliver value to stakeholders. A project that incorporates a high-quality IS is more likely to achieve its objectives because the system supports efficient communication, collaboration, and data management [30].

For instance, in the construction industry, the use of project management software can facilitate better coordination between architects, contractors, and clients, reducing delays and ensuring that the project stays on budget. Similarly, in IT development projects, IS tools can help manage project timelines, track milestones, and allocate resources efficiently, leading to higher PS rates [115].

Beyond individual project outcomes, the net benefits of an information system can have a long-term impact on the organization's overall performance. For instance, a CRM system that improves customer retention and satisfaction can lead to sustained revenue growth over time, enhancing the organization's market position [115]. Similarly, an IS that supports innovation and agility can enable the organization to stay competitive in an evolving marketplace [110].

In the healthcare sector, the adoption of EHR systems not only improves patient outcomes but also leads to long-term cost savings by reducing medical errors, streamlining administrative

processes, and improving the overall quality of care [113]. These long-term benefits demonstrate how an effective IS can contribute to both immediate PS and sustained organizational growth.

Net benefits are the ultimate measure of an information system's success, providing organizations with a comprehensive view of the value generated by their IS investments. These benefits encompass both quantitative gains, such as cost savings and increased productivity, and qualitative improvements, such as user satisfaction and organizational agility. The ability of an IS to deliver these benefits is directly tied to its influence on PS, as an effective system can streamline operations, enhance decision-making, and improve communication among stakeholders.

By linking the net benefits of an IS to project outcomes, organizations can better understand how their information systems contribute to on-time delivery, budget control, and stakeholder satisfaction. Furthermore, the long-term impact of an IS on organizational performance, such as increased customer retention, sustained revenue growth, and improved innovation, demonstrates the enduring value of a successful IS implementation. Ultimately, organizations that effectively measure and maximize the net benefits of their information systems are better positioned to achieve both immediate project goals and long-term strategic success [30, 110, 115].

2.4 Workforce agility – Theoretical model

2.4.1 Introduction to workforce agility

In the current fast-paced and highly unpredictable business environment, organizations must rapidly adjust to ever-changing market demands, technological advancements, and competitive pressures. The ability of a company to thrive amidst these challenges is often determined by its organizational agility, which is defined by its capacity to respond swiftly and effectively to changes in both internal and external environments [118, 119]. Within this framework, WA has emerged as a critical component, focusing on the adaptability, responsiveness, and resilience of employees in navigating these complexities.

WA refers to the capability of employees to respond to and anticipate shifts in their work environment, whether technological, market-driven, or strategic. It encapsulates how well the workforce can adjust to new challenges, learn rapidly, and implement innovative solutions [31, 120]. As businesses face increasingly complex operating environments, the importance of a

flexible and agile workforce cannot be overstated. Employees who possess high levels of agility are not only able to adjust to disruptions but also leverage those disruptions to create value for their organizations [119].

With the rise of the knowledge economy, driven by digital transformation, the dynamics of work have shifted dramatically. Knowledge-based industries such as IT, finance, and healthcare rely on workers who can quickly adapt to new technologies, market shifts, and changing client needs [118]. In these sectors, success is no longer determined solely by operational efficiency but by an organization's ability to innovate, learn, and react swiftly to competitive forces.

WA thus becomes a key enabler of organizational agility. By fostering an environment where employees are proactive, adaptable, and resilient, companies can maintain their competitive edge [121, 122]. Studies show that organizations with agile workforces tend to outperform those with rigid, hierarchical structures, especially in industries where rapid innovation and technological change are the norm [31].

The WA framework proposed by Sherehiy et al. [31] is designed to assess the effectiveness and impact of Workforce Agility. It evaluates WA across three key components [70]:

- **Proactivity:** the capacity to actively pursue new opportunities to positively influence one's environment, including organizational outcomes, while managing potential threats rather than merely reacting to changes [123–129],
- **Adaptability:** the ability to modify one's approach to better align with rapidly changing environments, often without prior warning, and to acquire the knowledge needed to respond effectively [31, 127, 129, 130],
- **Resiliency:** the capability to sustain effective performance under increased stress and shifting conditions, maintaining a solution-oriented mindset and critical thinking [31, 127, 131].

The framework is represented in figure 3 and it divides WA into its primary and most influential components, ensuring a thorough approach to quantifying the impact of WA. A noteworthy element is the physical distance between team members and/or clients in projects [132]. This factor's influence has been measured through WA, as it is considered a change in the work environment that is something a highly agile workforce should have no issue dealing with.

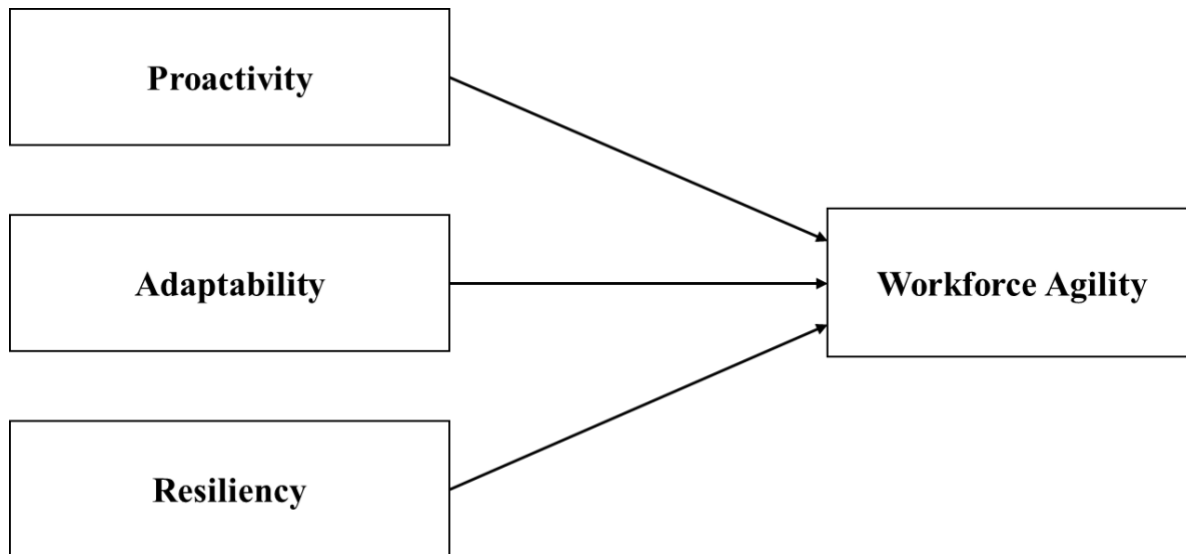


Figure 3. Workforce Agility – theoretical model [31]

By cultivating these characteristics, organizations create a workforce that is not only equipped to handle immediate challenges but can also anticipate and prepare for future disruptions [31, 133].

The increasing volatility of today’s global markets has heightened the need for agile workforces across all industries. Globalization, technological advancements, and the rise of remote and hybrid work environments have dramatically altered the way companies operate. In particular, the global shift to SW practices, where advanced technologies and flexible work arrangements are utilized to enhance productivity, has amplified the need for WA [22, 31].

During the COVID-19 pandemic, for example, companies that had fostered agile workforces were better equipped to transition to remote work models and continue operations despite the disruption [29]. Employees who were adaptable and proactive in adjusting to new technologies like virtual collaboration platforms, cloud computing, and data management systems ensured their companies maintained business continuity [112]. As a result, these organizations not only survived the pandemic but often thrived, outperforming competitors that were less prepared for such rapid shifts [134].

Moreover, the increasing use of automation and AI has transformed traditional roles in many industries, requiring employees to continuously acquire new skills and adapt to evolving job

requirements [119]. This continual learning and adaptation are at the heart of WA, as employees must not only respond to immediate changes but also be forward-thinking in their approach to personal and professional development [133].

For organizations, the ability to cultivate and maintain a highly agile workforce is no longer optional, it is a strategic imperative. Companies that successfully implement WA practices are more likely to achieve PS, innovate, and remain competitive in their markets [121]. Research has shown that businesses with higher levels of WA experience better financial performance, greater employee satisfaction, and improved customer outcomes [31].

Furthermore, WA is closely linked to organizational agility, as agile employees facilitate quicker decision-making, more efficient communication, and a culture of continuous improvement [119, 120]. By developing WA, organizations empower their employees to assume responsibility for challenges and proactively contribute to the organization's overall success [119]. The implementation of SW relies on the capabilities of advanced technologies and employee skills to efficiently and effectively use these tools, to achieve faster time to market, decentralization, adaptability, customization and resource efficiency [114], allowing for an improved user experience and a more sustainable and safe work environment [5, 114]. Therefore, it is important to note that the agile characteristics and skills of employees are a key component, not just directly impacting SW, but also when considering the use and the benefits of technology [70].

Originally, technology was considered the primary driver of organizational agility, however it was discovered that the workforce is the predominant element as ultimately it is the workforce that need to embrace and learn how to use a certain technology [120, 133]. A companies' level of WA has been demonstrated to be an indicator of PS and company performance [134, 135]. Therefore, scholarly attention rapidly shifted toward the role of individuals and the most impactful dimensions used to evaluate WA [31, 123, 131].

2.4.2 Defining workforce agility and its components

As organizations seek to navigate an increasingly complex and dynamic business landscape, the concept of WA has emerged as a crucial determinant of success. WA can be described as employees' ability to respond proactively and effectively to unforeseen changes in the

environment, whether technological, market-driven, or strategic [31, 133]. It focuses on how employees not only adjust to these changes but also leverage them to create new opportunities, improve operational efficiency, and maintain competitiveness.

WA is a multifaceted concept that includes various behaviors and skills, but most frameworks and studies agree on three core components: proactivity, adaptability, and resiliency. These dimensions are vital for ensuring that employees can cope with the fast-paced nature of today's work environment and contribute to long-term organizational success [31, 133].

Organizational agility consists of four components: organization, technology, people, and innovation [31]. Broadly, it refers to the speed and flexibility with which an organization responds to changing and uncertain conditions [31]. Some definitions emphasize product quality, customizability, and competitiveness [121, 136]. In this study, however, the focus is on the component of people, specifically WA. A literature review by Breu et al. [133] identified several indicators for defining WA, including responsiveness to external conditions, adaptability to diverse factors (e.g., new work environments, IT changes), collaboration, and empowerment. Technological tools are often provided to support employees in performing their tasks efficiently, enabling shorter development cycles, decentralization, flexibility, customization, and resource efficiency; these tools are referred to as SW technologies [114]. The SW approach generally leverages both advanced technologies and workforce capabilities to create a productive, flexible, and safe work environment [5, 25, 114]. Consequently, the capabilities of an agile workforce are a central component of SW [114]. WA can therefore be defined as employees' ability to respond effectively to daily challenges and strategic ambiguity by applying technical and business knowledge [119].

Among the important factors influencing the performance of workers using SW methodologies is self-discipline, as it allows for the overcoming of challenges such as procrastination and to deal with interferences [6]. The advantages of being self-disciplined are not only demonstrated in the improvement in work performance but also in the well-being of workers [6, 68]. Self-discipline should allow team members to transition into leadership roles as individuals who are self-disciplined demonstrate stability and serve as a reference point for management and other team members. Good, proactive leadership can help overcome the difficulties caused by a virtual work environment by guiding colleagues and explaining how tasks should be performed

[63]. Therefore the quality of leadership is an important contributor to the performance of employees, especially in crisis situations when traditional leadership techniques cannot be practiced and it is necessary to provide clarity in the manner tasks should be done and deal with coordination and communication challenges [63].

Agility is a key driver of organizational performance and competitiveness, enabling companies to adapt to fast-paced and constantly changing business environments. The quality of this performance is often closely linked to the skills and capabilities of the workforce [31, 112, 121, 127, 137–139]. An organization is characterized as agile if it can respond to changing and uncertain conditions with speed and flexibility [31] and although organizational agility is comprised of four components (people, organization, technology, and innovation) [31], this research focuses on the people aspect as a driver of WA [70]. Specifically, it is possible to define WA “*as the reactivity of employees to daily challenges dealing with strategic ambiguity through the use of technical and business knowledge*” [70]. Based on the workforce companies are able to adapt to changes and thrive in the novel environment as employees are capable of processing information swiftly, are proactive and take initiatives for self-improvement [120, 140].

Proactivity: Anticipating change and taking initiative

Proactivity refers to an employee’s ability to anticipate challenges and opportunities and take initiative before external conditions force a response. Rather than waiting for directives or reacting to situations as they arise, proactive employees are forward-thinking and take ownership of their tasks. They actively seek out improvements, identify potential risks, and mitigate issues before they escalate [31, 122].

In many ways, proactivity is the foundation of WA, as it ensures that employees are not merely passive responders to change but active agents of transformation. For example, in a rapidly evolving technology landscape, a proactive employee might identify a new software tool that can improve workflow efficiency and champion its adoption within the team [22]. This behavior demonstrates foresight and the ability to align personal and organizational goals with emerging trends.

Studies show that organizations with proactive workforces experience higher levels of innovation, as employees are constantly identifying ways to improve processes and bring new ideas to fruition [23, 133]. Moreover, proactive employees often serve as informal leaders, guiding their colleagues through changes and encouraging a culture of continuous improvement [127].

A case study of an international IT firm found that teams with higher levels of proactive behavior consistently delivered projects ahead of schedule. These teams were able to identify potential bottlenecks early in the project lifecycle and implement solutions, preventing delays. The firm attributed this success to its emphasis on encouraging employee initiative and autonomy [119].

Adaptability is the ability of employees to adjust their behaviors, strategies, and approaches in reaction to shifts in the work environment. Whether it's a shift in market conditions, a new technology implementation, or evolving customer demands, adaptable employees demonstrate flexibility and the capacity to modify their responses to achieve desired outcomes [31, 119].

Adaptability is particularly important in industries where technological advancements occur at a rapid pace. For instance, employees in the software development sector must regularly adapt to new programming languages, development frameworks, and project management methodologies like Agile or Scrum [20, 29, 66, 141]. In these environments, those who can quickly learn and apply new skills are essential for sustaining the organization's competitive advantage. Adaptability is also about navigating ambiguity. Employees who thrive in uncertain situations are able to remain focused on the organization's goals, even when the path to success is unclear [31]. They embrace change as an opportunity rather than a threat and continuously seek out learning opportunities to enhance their skills and knowledge [127].

During the COVID-19 pandemic, many organizations had to pivot to remote working arrangements with little notice. Companies with adaptable workforces were able to transition more smoothly, as employees quickly adopted new collaboration tools and modified their workflows to suit the new reality. These organizations reported higher productivity levels compared to those with less adaptable teams, where employees struggled to adjust to the new working conditions [22].

The third critical component of WA is resiliency, which refers to the capacity of employees to maintain effective performance in the face of challenges, stress, and adversity [120]. Resilient

employees are not only able to recover from setbacks, but they also use these experiences as learning opportunities to improve their future performance.

In today's volatile and unpredictable markets, resiliency has become a vital trait for employees. They must cope with increasing workloads, tighter deadlines, and the pressure to continuously innovate, all while managing personal stress and maintaining high productivity levels. Resilient employees demonstrate a growth mindset, viewing challenges as opportunities to develop their skills and expand their knowledge [133]. Resiliency is closely tied to emotional intelligence, as employees who can manage their emotions and maintain a positive outlook are more capable of managing the stress and uncertainty that frequently accompany rapid changes [31, 119]. Organizations can support the development of resilience by creating an environment in which failure is treated as a valuable learning opportunity rather than a cause for punishment. This encourages employees to take calculated risks and bounce back quickly when things don't go as planned [122].

A manufacturing company undergoing a significant digital transformation found that teams with high resilience were better able to integrate innovative technologies and maintain productivity, even during the initial learning curve associated with adopting complex systems. These teams consistently outperformed those with lower resilience, who experienced declines in performance during the transition [119, 120].

While each of the three components of WA – proactivity, adaptability, and resiliency – are distinct, they are also deeply interconnected. Employees who are proactive are more likely to adapt quickly to changes, as they are already anticipating potential challenges. Similarly, resilient employees, who can cope with stress and bounce back from setbacks, tend to be more adaptable and proactive in their approach to problem-solving [22, 127].

This dynamic interplay between the three dimensions forms the backbone of an agile workforce, ensuring that employees can not only respond to changes but actively drive improvements within their organizations [119]. By fostering these traits, organizations create a culture of agility that permeates every level of the business, from individual contributors to leadership teams.

WA is a multidimensional concept that plays a crucial role in enabling organizations to maintain competitiveness and resilience in today's rapidly changing business environment. The

three key components of WA, proactivity, adaptability, and resiliency, collectively empower employees to anticipate changes, adjust to new challenges, and maintain prominent levels of performance even in the face of adversity. By fostering these traits within their workforce, organizations can ensure that their employees are not only reactive but also proactive in driving innovation and navigating complexity. The synergy between these dimensions creates a highly agile workforce capable of turning uncertainty into opportunity, ultimately contributing to sustained organizational success.

2.4.3 Workforce agility and organizational performance

As organizations face increasingly turbulent markets and rapid technological advancements, the ability of their workforce to be agile has emerged as a significant determinant of overall performance. WA enables companies to not only survive but thrive in uncertain environments by fostering a workforce that is responsive, adaptive, and resilient to change [133]. Numerous studies have shown that companies with higher levels of WA achieve better outcomes in terms of innovation, customer satisfaction, operational efficiency, and financial performance [7, 120]. This section explores how WA directly impacts these areas and contributes to long-term organizational success.

One of the key ways in which WA impacts organizational performance is by driving innovation. In dynamic industries such as IT, finance, and manufacturing, companies need to constantly innovate to remain competitive. Agile workforces, characterized by proactive, adaptable, and resilient employees, are better positioned to embrace change, experiment with new ideas, and implement creative solutions [133, 142].

Organizations with high WA encourage their employees to take calculated risks, experiment with new processes, and seek out opportunities for improvement. This culture of proactivity allows organizations to foster a continuous cycle of innovation, where new products, services, and business models are developed at a faster pace than in companies with less agile workforces [23]. By anticipating market trends and customer needs, agile employees can drive the organization forward, ensuring that it stays ahead of competitors.

A study of several global technology firms revealed that those with a more agile workforce were able to launch new products up to 30% faster than their competitors. These companies had cultivated a culture of agility by empowering employees to experiment with new ideas and offering them the tools and autonomy needed to bring these innovations to market [22].

In addition to driving innovation, WA has a direct impact on customer satisfaction. As customer preferences shift and evolve, organizations must be capable of responding rapidly and efficiently to meet these new demands. Agile employees, who are equipped to adapt to changing circumstances and offer personalized solutions, can significantly enhance the customer experience [7, 134].

For instance, in the service industry, companies with an agile workforce are better able to tailor their services to individual customer needs, ensuring a higher level of satisfaction. Agile employees actively listen to customer feedback, adjust their approaches based on real-time input, and deliver solutions that exceed expectations [133]. This responsiveness not only leads to greater customer retention but also builds brand loyalty and reputation.

A major retail company implemented an agile workforce model where customer service teams were empowered to make real-time decisions regarding product returns and support. This flexibility led to a 25% increase in customer satisfaction scores and a significant reduction in complaint resolution times [7].

WA also plays a critical role in improving operational efficiency. Agile employees who can quickly adjust to innovative technologies and processes contribute to streamlined operations and reduced waste. In industries where efficiency and time-to-market are crucial, WA ensures that organizations can deliver products and services faster without compromising quality [7, 120].

Agile workforces can seamlessly transition between distinct roles or functions within the organization, enabling more flexible resource allocation and cross-functional collaboration. This fluidity reduces bottlenecks, minimizes downtime, and enhances overall productivity [23]. Moreover, organizations that foster agility tend to experience fewer delays and disruptions, as their employees are better equipped to handle unforeseen challenges.

A global manufacturing company found that by implementing agile training programs and fostering cross-functional agility among its workforce, it reduced production lead times by 20%.

Employees were able to switch roles quickly, adapt to new technologies, and solve problems on the production line without waiting for managerial intervention [121].

The financial impact of WA is profound. Companies that invest in fostering agility within their workforce often see significant improvements in profitability and ROI [120]. Agile employees, who are proactive in identifying cost-saving opportunities and adaptable to new cost-reduction technologies, contribute to more efficient budgeting and resource management [7]. In particular, organizations that undergo digital transformations often rely on WA to ensure that these changes are implemented successfully, reducing costs associated with inefficiencies or errors during the transition [121].

WA also helps organizations to remain financially competitive in rapidly changing markets. Companies that can quickly adjust their business strategies and realign their workforce to new market conditions are better positioned to capitalize on new opportunities, increase market share, and generate additional revenue [133]. An international banking firm reported a 15% increase in profitability after embedding agile practices across its workforce. By training employees to adapt to changing regulations, technologies, and customer expectations, the bank was able to streamline its operations and reduce overhead costs [7, 121].

Lastly, WA contributes to organizational sustainability by building a workforce that is not only responsive to present challenges but also resilient enough to thrive in future market conditions. By encouraging continuous learning, upskilling, and a growth mindset, organizations create a culture of agility that ensures long-term success [31, 119]. Employees who are equipped with the tools and mindset to handle future challenges are less likely to experience burnout, and organizations that invest in their agility are more likely to retain top talent [31].

A multinational healthcare company focused on developing a highly agile workforce by providing continuous training and leadership opportunities. This investment resulted in a workforce that could quickly pivot to address new market needs, contributing to the company's steady growth and sustainability over the past decade [31, 120].

WA is a key driver of organizational performance across multiple dimensions, including innovation, customer satisfaction, operational efficiency, and financial outcomes. Agile workforces not only adapt to changes but also actively contribute to the long-term competitiveness and sustainability of their organizations. By fostering proactivity, adaptability, and resilience,

companies can ensure that their workforce is prepared to address the challenges of a fast-changing business environment and capitalize on emerging opportunities [7, 133].

2.4.4 Technological enablement of workforce agility

As digital transformation reshapes industries, technology has become one of the most critical enablers of WA. From advanced information systems to cutting-edge collaboration tools, the integration of technology has allowed employees to enhance their proactivity, adaptability, and resilience, driving organizational success. In this section, we will explore how various technologies, ranging from AI and Big Data to cloud computing and collaborative platforms, have empowered workforces to become more agile. We will also examine how these tools have supported the development of SW environments, which rely heavily on technology to facilitate flexibility and innovation [121, 133].

IS are fundamental to the development of WA. These technologies provide the infrastructure that enables remote work, real-time collaboration, and the seamless exchange of information across geographic and organizational boundaries. By leveraging IS, employees can access the data and tools they need to make informed decisions quickly and efficiently [7, 143]. The advent of cloud computing has significantly transformed the workplace, enabling employees to collaborate and access resources from anywhere in the world. This has not only enhanced the adaptability of the workforce by allowing them to work in different environments but has also fostered resilience by ensuring that operations can continue uninterrupted in times of crisis, such as the COVID-19 pandemic [46, 67, 121, 143].

Additionally, IS tools like video conferencing platforms, instant messaging systems, and enterprise collaboration suites have facilitated smoother communication among teams in real-time, even when physically dispersed. This has enhanced proactivity, as employees can engage in faster decision-making processes and respond more quickly to emerging challenges [7]. A multinational consulting firm implemented a cloud-based collaboration platform that allowed employees from various countries to work together in real-time on projects. This tool enhanced cross-functional collaboration and ensured that employees could adapt to client needs faster, resulting in a 20% increase in project delivery speed and a notable improvement in client satisfaction [142].

Automation has become a powerful enabler of WA by enabling employees to concentrate on more strategic, high-value tasks while routine and repetitive processes are handled by technology. Automation tools, such as robotic process automation (RPA), have been widely adopted across industries to streamline operations, reduce errors, and increase efficiency [143]. For instance, in the manufacturing sector, automation has led to more agile production lines, where employees can adapt quickly to changes in product demand or specifications. By automating time-consuming manual tasks, employees can devote more time to strategic decision-making and innovation, enhancing their proactivity and adaptability [31].

Moreover, the ability to quickly reconfigure automated systems in response to new challenges has contributed to workforce resilience [67]. Employees no longer need to worry about performing mundane tasks under pressure, as automation ensures that critical functions continue operating smoothly, even in the face of disruptions [7].

A global financial services firm adopted RPA to handle recurring tasks such as data entry and financial reporting. This freed up employees to focus on more strategic work, improving decision-making and reducing operational costs by 25%. Employees reported higher job satisfaction and felt more empowered to contribute to long-term business goals [121, 142]. Moreover, a global e-commerce company implemented an AI-driven recommendation engine that allowed employees to anticipate customer needs and tailor product offerings. This technology not only increased customer satisfaction but also enabled employees to proactively address supply chain issues, leading to a 15% reduction in operational delays and a significant boost in customer loyalty [121, 133].

The concept of SW relies heavily on technological tools that empower employees to work more flexibly, efficiently, and collaboratively. SW environments utilize digital platforms, cloud-based systems, and collaborative technologies to remove traditional constraints of time and space, allowing employees to perform their roles from anywhere, at any time [31, 133].

Technology is instrumental in facilitating the core tenets of SW, including faster decision-making, decentralized work, and enhanced user experiences. By giving employees access to advanced tools and resources, organizations create an environment where they can quickly adapt to changing conditions and respond to new challenges [121, 142]. These SW tools not only

improve proactivity but also allow for greater customization and resource efficiency by providing the workforce with the flexibility to choose when and where they work [143].

A European telecom company fully embraced SW by implementing an integrated suite of cloud-based tools that allowed employees to work remotely and collaborate across teams. This transition not only increased productivity by 30% but also improved employee satisfaction, as workers had more control over their schedules and could easily adapt to different working environments [22].

While technology plays a vital role in enabling WA, it also presents issues that organizations need to tackle. One of the primary challenges is ensuring that employees have the necessary digital literacy and training to effectively use these tools. Without proper training and support, employees may struggle to adapt to new systems, leading to resistance and reduced productivity [31, 143].

Moreover, over-reliance on automation and AI tools can potentially reduce employee engagement and innovation if not managed properly. Employees may become overly dependent on technology, neglecting critical thinking and creativity in their roles. Organizations must find a balance between utilizing technology to boost agility and maintaining a culture of human-driven innovation [7].

Technology is an indispensable enabler of WA, enhancing employees' ability to be proactive, adaptable, and resilient in dynamic work environments. From AI and Big Data to cloud computing and automation, these tools empower employees to make data-driven decisions, collaborate seamlessly, and respond quickly to challenges. However, organizations must also recognize the potential challenges associated with technology adoption while ensuring that their workforce possesses the necessary skills and training to maximize the benefits of these tools. By leveraging technology strategically, organizations can cultivate an agile workforce that is well-prepared to meet the demands of the modern business landscape [31, 143].

2.4.5 Agility in different work environments: From traditional to agile

The transition from traditional work environments to more agile, flexible settings has transformed how organizations manage projects, collaborate, and respond to market demands. This shift has been driven by the need for faster innovation cycles, customer-centric approaches, and

the increasing complexity of global business operations. WA is central to this evolution, as employees must adjust to different work environments that range from rigid, structured frameworks to highly adaptable and decentralized models. In this section, we explore how WA manifests in traditional, agile, and hybrid work environments, highlighting the differences in workforce behavior and the organizational structures that support them.

In traditional work environments, the organizational structure is typically hierarchical, with clearly defined roles, processes, and workflows. Decision-making tends to be centralized, and employees are expected to follow established protocols to complete their tasks. While this approach can be effective in industries that prioritize consistency, efficiency, and risk management, it often stifles innovation and limits employees' ability to respond quickly to changes in the market [7, 143].

In traditional environments, proactivity and adaptability are often constrained by the rigid structure. Employees may lack the autonomy to explore new solutions or make decisions independently, relying instead on instructions from management [121]. This can lead to slower response times and an inability to pivot when unexpected challenges arise. Similarly, resiliency in traditional settings is more difficult to foster, as employees may become accustomed to following strict procedures and struggle to adapt to change when it occurs [142].

However, despite these limitations, there are still ways to enhance WA in traditional environments. For example, organizations can introduce cross-functional teams and continuous learning initiatives to encourage employees to develop a more agile mindset [7]. These initiatives help to gradually introduce elements of agility into otherwise rigid environments, allowing employees to become more proactive, adaptable, and resilient over time.

A traditional banking institution implemented a series of workshops and training sessions focused on building adaptability and problem-solving skills among its employees. Over time, the bank observed improvements in how teams responded to regulatory changes and client needs, demonstrating that even in highly structured environments, fostering elements of agility can improve overall performance [142].

At the other end of the spectrum are agile work environments, which prioritize flexibility, speed, and customer-centricity. These environments are characterized by decentralized decision-making, cross-functional collaboration, and a high degree of employee autonomy. Agile

methodologies, such as Scrum and Kanban, are often employed in these settings to ensure that teams can quickly respond to changes and iterate on products or services based on customer feedback [20, 133].

In agile environments, proactivity is encouraged, with employees taking the initiative to propose new ideas, solve problems, and make decisions without waiting for approval from upper management. Teams are often empowered to manage their own workflows, allocate resources, and pivot as needed based on real-time feedback [20, 22]. This autonomy fosters a culture of innovation, where employees are more likely to take calculated risks and experiment with novel approaches.

Adaptability is also a core feature of agile work environments, where teams are expected to quickly adjust to new priorities, customer demands, and technological changes. Agile frameworks emphasize iterative cycles, allowing teams to continuously refine their processes and deliverables based on evolving needs [22]. This flexibility ensures that organizations can remain competitive in fast-moving industries such as IT, software development, and marketing [20, 143].

Moreover, resiliency is naturally embedded into agile environments through continuous improvement and feedback loops. Employees are encouraged to learn from failures and use setbacks as opportunities for growth. The focus on team collaboration and open communication further enhances resilience, as employees are better equipped to support each other in navigating challenges [7, 67, 142].

A global software development company transitioned to an agile work environment using the Scrum framework. Teams were given the autonomy to prioritize tasks, allocate resources, and pivot quickly in response to customer feedback. As a result, the company saw a 40% increase in productivity and a 25% reduction in product delivery times, demonstrating the power of agility in driving operational efficiency and innovation [20, 29].

In many organizations, a hybrid work environment that blends elements of both traditional and agile structures has emerged as a common model [48]. Hybrid environments offer the benefits of flexibility and innovation found in agile models while maintaining some of the consistency and control associated with traditional approaches [142]. Hybrid work environments are particularly well-suited for organizations operating in industries that require both stability and innovation. For instance, a pharmaceutical company may rely on traditional structures to oversee compliance and

regulatory processes, while employing agile methodologies to accelerate product development and respond to market demands [121, 143].

In these environments, proactivity is cultivated by giving employees the freedom to explore new ideas within predefined frameworks. Teams may operate with a degree of autonomy but are still expected to align their initiatives with the broader organizational strategy. Adaptability is encouraged by using agile practices such as regular retrospectives and iterative project cycles, allowing teams to learn and adjust as they move through different stages of a project [143]. Resiliency is fostered through the combination of agile and traditional processes, as employees are given the support they need to recover from setbacks while also being encouraged to take ownership of challenges. The hybrid model provides a safety net for employees to experiment and learn, knowing that they have the structure and resources to fall back on when needed [133].

A global pharmaceutical company adopted a hybrid work environment, combining traditional regulatory frameworks with agile project management practices. This approach allowed the company to bring new drugs to market faster while maintaining compliance with industry regulations. Employees reported higher job satisfaction due to the increased flexibility, and the company saw a 15% increase in overall efficiency [29, 143].

As organizations continue to evolve, the distinction between traditional, agile, and hybrid work environments is becoming less rigid. Many companies are adopting blended models that integrate the advantages of both approaches, recognizing that different projects and functions may require varying degrees of structure and flexibility [7, 143]. What remains consistent, however, is the need for WA in any environment.

Whether in traditional, agile, or hybrid settings, WA remains critical to ensuring that employees can navigate change, drive innovation, and contribute to the organization's success. Organizations that invest in building a highly agile workforce will be better equipped to adapt to future challenges, regardless of the work environment they operate in [22, 133].

WA manifests differently in traditional, agile, and hybrid work environments, but its importance is universal across all settings. In traditional environments, agility can be cultivated through incremental changes, while in agile environments, it thrives through flexibility and autonomy. Hybrid models offer a balanced approach, blending structure with adaptability to create resilient and innovative teams [48]. Regardless of the model, organizations that foster WA will be

better positioned to navigate the complexities of the modern business landscape and remain competitive [7, 143].

2.4.6 The role of leadership in fostering workforce agility

In today's dynamic and fast-changing business environment, leadership plays a pivotal role in shaping WA. Agile organizations thrive not only due to the flexibility and responsiveness of their employees but also because of the leadership that fosters a culture of adaptability, continuous learning, and empowerment. Leaders who actively promote and model agile behaviors create an environment where employees are encouraged to be proactive, adaptable, and resilient [121, 142]. This section explores the different ways leadership contributes to fostering WA, focusing on the key leadership qualities, strategies, and frameworks that empower agile workforces.

Leaders serve as the primary catalysts for instilling agility within an organization. Their actions and decisions directly influence the degree to which employees are able to embrace change, respond to uncertainty, and innovate. Agile leadership is distinct from traditional leadership in that it prioritizes flexibility, decentralized decision-making, and a people-centric approach [7, 143].

In agile organizations, leaders are not seen as authoritarian figures who dictate all actions. Instead, they act as enablers, providing the tools, resources, and support needed for employees to take ownership of their tasks and initiatives [23]. By empowering their teams to make decisions, agile leaders cultivate a culture of autonomy and accountability, enabling employees to act more quickly and confidently. This sense of empowerment encourages employees to be more proactive in identifying and solving problems [22].

Leaders also model resiliency by demonstrating a growth mindset and showing how to learn from setbacks. When leaders are transparent about their own challenges and how they have overcome them, it encourages employees to adopt a similar attitude toward failure, seeing it as an opportunity for growth rather than a roadblock [7]. A study conducted on leadership practices in a high-tech manufacturing company revealed that leaders who embraced agile principles – such as encouraging transparent communication and enabling employees to take ownership of decision-making – saw higher levels of innovation and productivity. Employees reported feeling more

confident in their ability to adapt to changes, leading to a 25% increase in project completion rates [121, 143].

Agile leaders exhibit several key qualities that support the development of WA. These traits differentiate them from traditional leaders and position them as drivers of continuous improvement, innovation, and organizational adaptability. Below are some of the critical leadership qualities that contribute to fostering WA:

- **Visionary Leadership:** Agile leaders provide a clear vision and strategic direction but are also open to evolving plans as circumstances change. This flexible vision empowers employees to act independently while staying aligned with the organization's goals [118].
- **Emotional Intelligence:** Leaders with high emotional intelligence are adept at understanding and managing their own emotions and the emotions of their teams. They provide support in times of stress and uncertainty, helping employees remain resilient when faced with challenges [23, 142].
- **Adaptability and Flexibility:** Agile leaders model the adaptability they wish to see in their teams. By remaining open to new ideas and changing course when necessary, they demonstrate that agility is not just a mandate but a practice that starts at the top [142, 143].
- **Empowerment:** One of the hallmarks of agile leadership is the willingness to empower employees by granting them the authority to make decisions. This creates a sense of responsibility and accountability among employees, motivating them to take initiative and act proactively [22].
- **Servant Leadership:** Agile leaders often adopt a servant leadership style, where their primary role is to serve the needs of their teams. This involves providing resources, removing obstacles, and fostering a safe environment in which employees feel supported when taking risks [7, 23].

A global financial services firm that adopted servant leadership principles saw significant improvements in WA among its teams. Leaders focused on empowering their employees by removing bureaucratic obstacles and promoting a culture of trust. As a result, employees were more proactive and adaptable, leading to a 20% increase in customer satisfaction and a 15% improvement in project delivery times [143].

In addition to embodying specific qualities, agile leaders employ several strategies to build and maintain WA within their organizations. These strategies focus on creating a culture that supports agility, providing the necessary tools and frameworks for agile behaviors to flourish, and fostering continuous learning and development [143]. One of the most effective strategies for building WA is promoting a culture of continuous learning. In agile organizations, learning is not seen as a one-time event but as an ongoing process that allows employees to acquire new skills, adapt to changing technologies, and stay ahead of industry trends [22, 121]. Leaders who prioritize learning ensure that employees have access to resources, such as training programs, mentorship, and opportunities for hands-on experience.

Agile leaders also encourage employees to take ownership of their personal and professional growth. By promoting self-directed learning, leaders empower employees to identify areas where they can improve and take proactive steps to enhance their skills [142]. This continuous focus on learning ensures that the workforce remains agile and prepared for future challenges. Collaboration is another critical strategy used by agile leaders to foster WA. By breaking down silos and encouraging cross-functional teamwork, leaders enable employees to learn from each other, share knowledge, and tackle problems from different perspectives [20]. This collaborative approach not only enhances innovation but also ensures that employees can quickly adapt to new challenges by drawing on the expertise of their peers.

In agile environments, leaders often use frameworks like Scrum or Kanban, which promote iterative cycles of collaboration and feedback [141]. These methods help teams remain focused on continuous improvement and adaptation, ensuring that they can pivot quickly when market demands or project requirements change [29]. Agile leaders recognize that agility is best fostered when decision-making is decentralized. Rather than requiring all decisions to be approved by upper management, they empower teams to make decisions at the level where the work is being done [20]. This strategy not only speeds up the decision-making process but also enables employees to act proactively and take ownership of outcomes [22]. Decentralized decision-making allows teams to respond to changes in real time, reducing the lag that often occurs in hierarchical organizations. Leaders who implement this strategy ensure that their employees have the information, authority, and support needed to make informed decisions quickly [20].

In fostering WA, one of the most powerful strategies is for leaders to lead by example. When leaders embody the agile behaviors they wish to see in their teams, such as adaptability, proactivity, and resilience, they create a culture that encourages employees to follow suit. Leading by example involves demonstrating flexibility in decision-making, showing openness to feedback, and maintaining a growth-oriented mindset even in the face of challenges [22, 142]. Leaders who actively participate in agile practices, such as daily stand-ups or sprint reviews, show their teams that agility is not just a management directive but a shared commitment across the organization. This hands-on approach reinforces the importance of agility as a core organizational value and offers employees a clear framework for guiding their actions with agility in their own roles [29].

At a multinational IT firm, senior leaders regularly participated in team retrospectives and design thinking workshops to model agile behaviors. By actively engaging in these agile practices, leaders built trust and demonstrated their commitment to the company's agility goals. As a result, employees felt more empowered to innovate and take risks, leading to a 30% increase in new product ideas [20, 22].

The role of leadership in fostering WA extends beyond the immediate development of agile employees. Agile leadership also is essential for maintaining the long-term agility and sustainability of the organization. Leaders who cultivate a workforce that is skilled in adaptation, innovation, and resilience lay the foundation for organizational agility that can weather market shifts, technological disruptions, and evolving customer needs [23, 121].

Organizations that consistently practice agile leadership are more effectively positioned to manage uncertainties and seize emerging opportunities. By embedding agility into the core values of the organization through leadership, companies ensure that their workforce is capable of responding quickly and effectively to both internal and external challenges [20, 142]. A leading automotive company undergoing significant technological disruptions in its industry used agile leadership principles to guide its workforce through the transformation. Senior leadership prioritized adaptability and continuous learning, resulting in a more agile workforce that was able to innovate in response to electric vehicle demand and sustainability regulations. This agile approach positioned the company as a leader in the automotive innovation space [22, 121].

While leadership plays a crucial role in fostering WA, leaders also face significant challenges in cultivating agility within their teams. These challenges often stem from organizational inertia,

resistance to change, and the need to balance short-term operational goals with long-term agility initiatives [142, 143]. One of the primary challenges leaders face is overcoming cultural resistance to agility. In organizations with deeply entrenched hierarchical structures or risk-averse cultures, leaders may encounter pushback when attempting to implement agile practices or promote greater autonomy among employees [23]. To mitigate this resistance, leaders must communicate the benefits of agility clearly and demonstrate how it aligns with the company's broader strategic goals [143].

Another challenge is ensuring that agility initiatives do not conflict with operational efficiency. While agility encourages flexibility and experimentation, some industries such as manufacturing or finance rely on highly efficient processes that may not easily accommodate the iterative cycles of agile methodologies [121]. Leaders must strike a balance between maintaining operational excellence and fostering a workforce that can adapt and innovate [7]. Despite these challenges, agile leaders who commit to long-term cultural shifts and continuously model agility can build a workforce that is not only more agile but also more engaged, innovative, and prepared for the future [23, 142].

Leadership is an indispensable factor in fostering WA. Agile leaders act as enablers, creating environments that support proactivity, adaptability, and resilience. By employing strategies such as promoting continuous learning, decentralizing decision-making, and leading by example, agile leaders empower their teams to navigate uncertainty and embrace innovation. Although there are challenges to building a highly agile workforce, leaders who commit to fostering a culture of agility will drive long-term organizational success, ensuring that their teams are well-prepared to meet the demands of a rapidly changing business landscape [20, 142].

2.4.7 Challenges and barriers to workforce agility

While WA offers numerous advantages, such as adaptability, innovation, and improved organizational performance, fostering an agile workforce is not without its challenges. Organizations often encounter barriers when attempting to implement or sustain WA, stemming from factors such as cultural resistance, organizational structure, technological constraints, and leadership gaps. These challenges must be addressed to ensure that WA initiatives can be

effectively integrated into the organization. This section will explore the key challenges and barriers to WA and offer potential solutions for overcoming them.

One of the most significant barriers to achieving WA is cultural resistance to change. In many organizations, employees are accustomed to rigid structures and established processes, making it difficult for them to embrace the flexibility and proactivity required by agile practices [142, 143]. Cultural resistance often manifests as fear of change, reluctance to adopt new technologies, and a preference for established routines. Employees may resist agility initiatives if they feel uncertain about their capacity to thrive in an environment that demands continuous learning, adaptability, and the willingness to take risks [23]. Similarly, organizational cultures that prioritize stability and risk avoidance over experimentation and innovation can stifle agility efforts, leading to employee disengagement or skepticism.

To overcome this barrier, organizations must prioritize cultural transformation alongside agility initiatives. Leaders need to clearly communicate the benefits of WA, align agile practices with the organization's overall mission, and provide support through training and continuous learning opportunities. By creating a culture of psychological safety, where employees feel secure in experimenting and learning from failures, organizations can reduce resistance to change and foster a more agile mindset [22].

A traditional retail company encountered resistance when transitioning to an agile workforce model, with employees expressing concerns about job security and their ability to adapt to new processes. By implementing a comprehensive communication strategy that highlighted the benefits of agility and provided resources for skill development, the company gradually overcame these barriers, leading to increased employee engagement and performance [121, 142].

Organizational inertia, or the tendency of companies to resist changes in established processes and structures, is another common challenge to fostering WA. In large or highly bureaucratic organizations, decision-making processes are often slow, and employees may lack the autonomy required to respond quickly to market shifts or internal changes [121, 142]. Rigid hierarchies and bureaucratic procedures can prevent employees from taking initiative, making it difficult for them to exercise the proactivity and adaptability that are hallmarks of an agile workforce. Employees in these environments may feel constrained by red tape, leading to missed opportunities for innovation and slower response times to external challenges [22].

To combat organizational inertia, companies can adopt decentralized decision-making processes and reduce layers of hierarchy to give employees more autonomy. By empowering teams to make decisions at the ground level, organizations can accelerate their responsiveness and allow employees to take ownership of their work. In addition, simplifying approval processes and encouraging cross-functional collaboration can help break down silos and enhance agility [23]. A large manufacturing company struggled to implement WA due to its highly bureaucratic structure, which slowed down decision-making and prevented employees from taking initiative. By restructuring its organizational hierarchy and decentralizing authority, the company enabled employees to make faster decisions, resulting in a 20% reduction in production lead times [22, 142].

Technology is a critical enabler of WA, but it can also present significant barriers if organizations lack the necessary infrastructure or if employees are not equipped with the right digital skills. In companies where technological adoption is slow or where employees are not adequately trained in using digital tools, agility initiatives can falter [142]. For instance, employees may struggle to adapt to new collaboration platforms, data management systems, or automation technologies, reducing their ability to work flexibly or efficiently. Digital literacy becomes a key challenge in such cases, as employees who lack the technical skills required to navigate new tools may feel overwhelmed, leading to frustration and resistance [20].

To address technological barriers, organizations must invest in ongoing digital training programs and ensure that their technology infrastructure supports agility. Providing employees with access to user-friendly tools, as well as continuous support for learning and development, can help bridge the digital skills gap and enable greater adaptability [23, 142]. A global financial services firm implemented new data analytics tools to enhance its agility, but many employees lacked the necessary training to use these systems effectively. To address this gap, the firm launched a comprehensive training program, which included hands-on workshops and digital literacy assessments. As employees became more comfortable with the technology, the company experienced a marked improvement in agility and decision-making speed [20, 142].

While agility enables organizations to respond quickly to market changes, it can sometimes conflict with the need for operational efficiency, especially in industries that rely on highly structured processes. For example, in industries such as manufacturing or healthcare, where

compliance, consistency, and efficiency are critical, adopting agile practices may seem counterintuitive [143]. Organizations must find a balance between agility and efficiency, ensuring that their operations remain lean while maintaining the flexibility to adapt to new challenges. This often requires a hybrid approach to agility, where certain functions remain structured and process-driven, while others embrace more flexible, iterative practices [22].

A pharmaceutical company implemented agile methods in its research and development (R&D) department to accelerate drug development timelines. However, the company maintained traditional processes in its regulatory and compliance functions to ensure adherence to industry standards. This hybrid approach allowed the company to balance agility with operational efficiency, resulting in faster innovation without sacrificing quality [121, 142].

Finally, one of the most critical barriers to fostering WA is the lack of leadership support. Leaders who do not fully understand or embrace the principles of agility may inadvertently create obstacles for employees. For example, leaders who prioritize short-term results over long-term agility initiatives may discourage employees from taking risks or experimenting with new ideas [121, 143]. In organizations where leadership does not actively promote agility, employees may struggle to see the value of agile practices or feel unsupported in their efforts to innovate. To overcome this barrier, leaders must model agile behaviors themselves, provide the necessary resources for agility, and align agility initiatives with the organization's broader strategic goals [22].

A telecommunications company embarked on a major shift towards WA to remain competitive in a rapidly evolving industry, where modern technologies and customer preferences demanded greater flexibility. Initially, the transition faced challenges, particularly due to inconsistent leadership support across various departments. While some leaders embraced the agile transformation, others were reluctant to move away from the traditional hierarchical model that emphasized top-down decision-making and risk aversion. This leadership inconsistency caused confusion among employees, who received mixed signals about the importance of agility and whether it was truly a company priority. Teams in departments with agile-aligned leaders experienced improved collaboration and faster decision-making, while other teams struggled with ambiguity, slower processes, and a lack of direction.

To overcome this barrier, the company introduced a leadership development program designed to align the entire leadership team with the company's new agile vision. The program included workshops on agile methodologies, change management, and the role of leadership in fostering WA. Leaders were trained in empowering their teams, encouraging collaboration, and decentralizing decision-making to speed up responses to market changes. The result was a significant cultural shift within the company. As leadership across all departments became more unified in their approach to agility, employees felt more confident in adopting agile practices. Teams across the organization began to operate with greater autonomy, leading to faster project delivery times, enhanced innovation, and improved employee engagement. Within a year of implementing the leadership development program, the company reported a 35% increase in project completion rates and a 20% improvement in customer satisfaction, demonstrating the impact of consistent leadership support on WA [23, 142].

While WA is crucial for navigating today's rapidly changing business landscape, achieving and sustaining it comes with several challenges. Cultural resistance, where employees are hesitant to leave behind familiar processes, remains one of the primary barriers to agility. Additionally, organizational inertia and bureaucracy can slow down decision-making, preventing employees from responding quickly to market demands. Technological gaps, including a lack of digital literacy, also hinder efforts to enhance WA, particularly in organizations that are slow to adopt new tools and platforms. Furthermore, balancing operational efficiency with agility can be a difficult challenge, especially in industries that prioritize stability and regulatory compliance.

Perhaps the most significant barrier is a lack of leadership support, as inconsistent or unclear guidance from leaders can create confusion and inhibit the development of an agile workforce. However, organizations can overcome these barriers by fostering a culture of continuous learning, decentralizing decision-making, investing in technological infrastructure, and ensuring strong, aligned leadership at all levels. By addressing these challenges, organizations can create a truly agile workforce that is capable of adapting to change, driving innovation, and contributing to long-term success [23, 142].

2.4.8 The strategic importance of workforce agility

WA has emerged as a key enabler of organizational success in today's dynamic, fast-paced, and increasingly uncertain business environment. As organizations face rapid technological advancements, shifting market demands, and heightened competition, the ability of their workforce to remain flexible, responsive, and resilient is crucial to maintaining a competitive edge. WA encompasses several core competencies which empower employees to navigate change effectively, drive innovation, and contribute to long-term organizational sustainability [23, 142].

Throughout this expanded analysis, we have explored the various dimensions of WA, including its practical applications across various industries, the obstacles and challenges that organizations encounter in cultivating agility, and the critical role of leadership in fostering an agile workforce. The case studies presented offer tangible examples of how organizations have successfully implemented WA to achieve operational efficiency, innovation, and improved customer satisfaction. From technology and financial services to manufacturing and healthcare, WA has proven to be a versatile and transformative force [20, 121].

The strategic importance of WA cannot be overstated. Organizations that prioritize agility within their workforce are better positioned to respond to the rapidly evolving demands of the modern marketplace. Agility enables companies to pivot quickly in response to emerging trends, seize new opportunities, and mitigate risks associated with disruption [142]. Moreover, WA fosters a culture of continuous improvement, fostering an environment where employees are encouraged to innovate, learn, and adapt to changes, making the organization more resilient in the face of challenges [29].

Additionally, WA has a direct impact on several key performance metrics, including innovation capacity, time-to-market, customer satisfaction, and employee engagement. Companies that have effectively incorporated WA into their operations have consistently outperformed their competitors in these areas, demonstrating the long-term value of fostering agility within the workforce [22].

2.4.9 Overcoming challenges and barriers to workforce agility

While the benefits of WA are clear, achieving and sustaining it requires overcoming several challenges, including cultural resistance, organizational inertia, technological gaps, and leadership deficiencies [142, 143]. Organizations must address these barriers by cultivating a culture that supports agility, investing in the necessary technological infrastructure, and providing employees with the tools and training required to navigate a more flexible and dynamic work environment.

Leadership plays an important role in overcoming these challenges, as leaders must model agile behaviors and provide the support and resources employees need to thrive in an agile work setting. By promoting a culture of psychological safety, leaders can help employees embrace change and take calculated risks without fear of failure [22]. Additionally, continuous learning initiatives and digital literacy programs are critical for ensuring that employees remain agile in the face of evolving technologies and processes [20, 142].

Looking ahead, the importance of WA will only continue to grow as organizations grapple with the increasing complexity and unpredictability of the global economy. The rise of remote work, hybrid work models, and digital transformation initiatives has accelerated the need for organizations to cultivate a more agile workforce. As companies increasingly adopt SW practices, where advanced technologies and flexible work arrangements play a central role, the demand for employees who can quickly adapt to new tools, work environments, and market conditions will become even more critical [22, 143].

AI and automation will also continue to shape the future of WA. As organizations implement more AI-driven tools and automation technologies, employees will need to develop new skill sets that enable them to work alongside these technologies and leverage them for greater productivity and innovation [142]. The ability to integrate AI and Big Data into daily workflows will be essential for maintaining a competitive edge in industries where data-driven decision-making is becoming the norm [22]. Furthermore, the concept of agile leadership will evolve as organizations seek to align their leadership structures with the demands of an agile workforce. Leaders will need to balance the competing priorities of operational efficiency and workforce flexibility, creating an environment where employees are given the authority to make decisions, work collaboratively across functions, and take ownership of their tasks [23].

Finally, the future of WA will likely involve an increased emphasis on sustainability and social responsibility. As organizations strive to address environmental challenges and implement more sustainable business practices, WA will be pivotal in ensuring that employees can adapt to new sustainability initiatives and contribute to the organization's long-term success [22, 142]. WA is a critical determinant of organizational success in the modern business landscape. By fostering agility within their workforce, organizations can drive innovation, improve operational efficiency, enhance customer satisfaction, and position themselves for long-term sustainability. While there are challenges to achieving WA, organizations that invest in building a culture of agility, supported by strong leadership, continuous learning, and digital transformation, will be better equipped to navigate the complexities of the future business environment. As companies continue to embrace SW and leverage emerging technologies, WA will remain a key enabler of competitiveness and resilience in the years to come [20, 142].

3. Research framework and hypotheses

3.1 Workforce agility impact on information system success

As stated by Storme et al. [120], the acceptance of technology and its eventual use is conditioned by the agility of the workforce to accept it and use it. This is in line with similar research measuring the impact of WA on IS [142], showcasing the importance of human involvement in successfully employing IS. Using the WA framework [31], the impact of each factor is assessed using the DeLone and McLean [30] Model of IS Success. The hypotheses are developed for the factors of Adaptability and Resiliency in such a way that their influence is measured on the overall Net Benefit of IS [127]. On the other hand, due to the engagement quality of Proactivity, its impact is measured on the Use/Intent to use factor [31]. Based on the preceding discussion and the research context, the following hypotheses have been developed:

H1a: Adaptability has an influence on Net Benefit

H1b: Resilience has an influence on Net Benefit

H1c: Proactivity has an influence on Use/Intent to use

3.2 Information system success impact on project success

By delving deeper into the model used to measure PS in this research which has been constructed based on two existing frameworks [13, 14], we can observe that User Satisfaction plays a crucial role in driving the impact of IS on PS [34]. In terms of PSMS, since the project owner evaluates this component [14], User Satisfaction is essential in assessing how IS influences PSMS [34]. The impact of the IMPT element [13] of the PS framework is assessed by team members based on their personal experience and satisfaction with using the systems [33]. Similarly, IMPC measures customer satisfaction [13] therefore, it is logical that this factor is also evaluated using User Satisfaction of the IS framework [33]. Finally, PSIS is evaluated through User Satisfaction, establishing a unique connection between the IS model and the PS framework [34]. This is in line also with similar research [16]. Based on these insights and the research context, the following hypotheses have been formulated:

H2a: User Satisfaction has an influence on PSMS

H2b: User Satisfaction has an influence on IMPT

H2c: User Satisfaction has an influence on IMPC

H2d: User Satisfaction has an influence on PSIS

3.3 Workforce agility impact on project success

As shown in the literature review, the WA framework [31] comprises three distinct and influential variables: Adaptability, Resiliency, and Proactivity. These variables provide a comprehensive overview of WA and cover a wide range of workforce characteristics that can influence PS in different ways. Previous research demonstrates that WA can be leveraged as an enabler of PS [7]. Adaptability is crucial in project management due to the dynamic and unpredictable nature of projects. Projects often face unexpected challenges like scope changes, resource constraints, and technical issues, and adaptable teams can quickly respond by adjusting plans and reallocating resources, ensuring project objectives related to time, cost, scope/quality, and plan realization are met [20]. Adaptability also impacts team dynamics and individual outcomes [112]. In adaptive environments, team members feel more motivated and empowered, develop new skills, and continuously learn, fostering a supportive culture and boosting overall team success [20, 23, 112]. Customer satisfaction is significantly influenced by the adaptability of the project team as adaptable teams address customer pain points promptly and effectively, enhancing deliverable usability and relevance [20]. This responsiveness increases user satisfaction and impacts project effectiveness. Project investment success is influenced by the ability to adapt and align with strategic goals. Although, the need to adapt might be an indication of issues that have come forth regarding the project, adaptable teams aim to manage resources efficiently, address challenges, and meet investment objectives [7, 20]. Therefore, adaptability is a key driver of project investment success, delivering anticipated benefits despite disruptions. This focus has given rise to the following hypotheses:

H3.1a: Adaptability has an influence on PSMS

H3.1b: Adaptability has an influence on IMPT

H3.1c: Adaptability has an influence on IMPC

H3.1d: Adaptability has an influence on PSIS

Resilience enables teams to recover from setbacks and maintain progress, ensuring key metrics like time, cost, scope/quality, and project plan realization are achieved [31, 67]. Thus, resilience directly enhances project management success [112]. Resilient teams handle stress better, fostering a supportive environment. This boosts motivation, skill development, and overall team growth, leading to improved team dynamics and individual well-being [7]. Resilient teams effectively manage customer pain points and adapt to setbacks, maintaining high-quality deliverables. This leads to increased customer satisfaction and trust, enhancing overall customer outcomes [70]. Resilience helps teams navigate financial and operational challenges, ensuring projects stay on track and achieve their value [7]. This ability to adapt and recover secures the intended return on investment, driving project investment success [70]. This focus has given rise to the following hypotheses:

H3.2a: Resilience has an influence on PSMS

H3.2b: Resilience has an influence on IMPT

H3.2c: Resilience has an influence on IMPC

H3.2d: Resilience has an influence on PSIS

Proactive teams foresee challenges and apply preventive measures, keeping projects aligned with timelines, budgets, quality standards, and overall plans [31]. This proactive approach directly enhances project management success [20, 70]. Proactive team members take initiative, foster innovation, and enhance collaboration [23], boosting team motivation, skills development, and overall effectiveness [112, 127]. Proactive management ensures customer needs are anticipated and met promptly, minimizing issues and maintaining high-quality deliverables, leading to better customer outcomes and increased satisfaction [20, 127]. Proactivity in addressing financial and operational challenges ensures projects remain on track to achieve investment objectives [31, 70]. This proactive management secures the intended return on investment and enhances PS. This focus has given rise to the following hypotheses:

H3.3a: Proactivity has an influence on PSMS

H3.3b: Proactivity has an influence on IMPT

H3.3c: Proactivity has an influence on IMPC

H3.3d: Proactivity has an influence on PSIS

3.4 Relationships within the information system success framework

To better understand the drivers of IS success and the intricate interrelationships among the variables in the DeLone & McLean model [30], we aim to explore the influences of its different elements. The model is fundamentally supported by System Quality, whose impact is evaluated across various elements [115]. For any IS, system quality was found to be strongly related to the use and user satisfaction [37]. We expect that higher High technical quality in an IS is expected to result in improved usability, higher user satisfaction, and enhanced overall benefits [115, 140]. Accordingly, the following hypotheses are put forward:

H4a: System Quality has an influence on User Satisfaction

H4b: System Quality has an influence on Use/Intent to use

H4c: System Quality has an influence on Net Benefit

Considering the context of this research and the influence of WA on IS within the overall framework, we assess the Net Benefits provided by the systems and in particular their impact on User Satisfaction and Use/Intent to Use. We expect that higher net benefits (i.e., productivity and efficiency) will lead to increased user satisfaction and higher usage of the IS [16, 114]. Drawing on the literature review and the statements above, the following hypotheses have been developed:

H4d: Net Benefit has an influence on User Satisfaction

H4e: Net Benefit has an influence on Use/Intent to use

3.5 Research framework

The chosen theoretical frameworks have been deliberately selected to evaluate multiple dimensions essential to the overarching aim of this study. By dissecting the elements of PS, IS success, and WA into discrete components and factors, we aim to identify the key drivers of SW and quantify their influence. Recognizing that SW is a multifaceted concept, we delineated it into two core components identified through a literature review: IS success and WA. Consequently, it is through these two components that PS is estimated. Drawing from existing literature and

theoretical constructs, the ensuing research framework (figure 4) has been meticulously crafted to bolster 24 hypotheses.

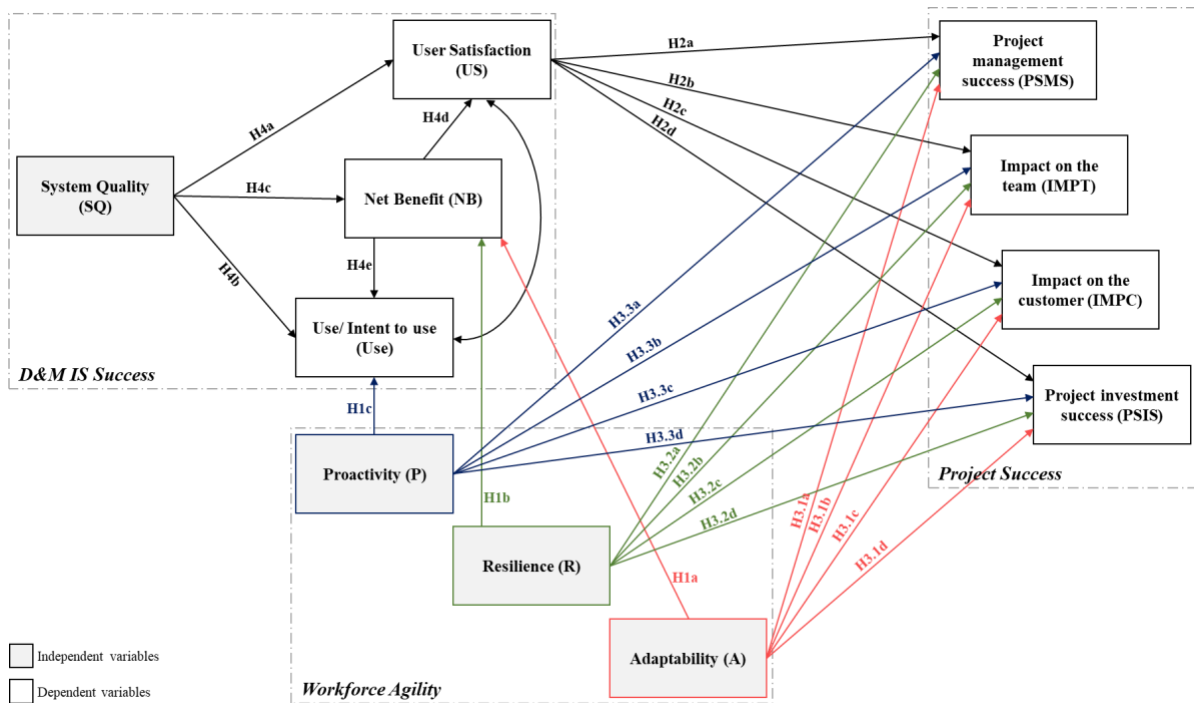


Figure 4. Smart Working – research framework

4. Materials and methods

4.1 Measures

To establish the constructs for the conceptual model, indicators were derived from foundational research in the field. This study contextualizes SW and assesses it through the influence of WA and IS on PS. Table 1 organizes these measures according to their corresponding frameworks and constructs, highlighting the attributes crucial for evaluating impacts on PS, DeLone and McLean's IS Success, and WA.

Table 1a. Construct measures for SW - PS

Framework	Construct	Indicator	References
Project Success (PS)	Project Management Success (PSMS)	(1) Time	[14]
		(2) Cost	[14]
		(3) Scope/quality	[14]
		(4) Project plan realization	[14]
	Impact on the team (IMPT)	(5) Team member motivation	[13]
		(6) Aptitude improvement	[13]
		(7) Team member growth	[13]
	Impact on the customer (IMPC)	(8) Pain points remediation	[13]
		(9) Deliverable use	[13]
		(10) User satisfaction	[13]
	Project investment success (PSIS)	(11) Worth	[14]
		(12) Investment objective realization	[14]

Table 1b. Construct measures for SW – D&M ISS

Framework	Construct	Indicator	References
D&M IS Success	System quality (SQ)	(1) User-friendly	[30]
		(2) Usability	[30]
	Use/Intent to use (U)	(3) Dependency	[30]
		(4) Frequency of use	[30]
		(5) Tendency to use	[30]
	User Satisfaction (US)	(6) Satisfaction with system	[30]
		(7) Recommendation	[30]
	Net Benefit (NB)	(8) Productivity	[30]
		(9) Efficiency	[30]

Table 1c. Construct measures for SW - WA

Framework	Construct	Indicator	References
Workforce Agility (WA)	Proactivity (P)	(1) Learning on the job	[31]
		(2) Issue anticipation	[31]
		(3) Threat management	[31]
	Adaptability (A)	(4) Responding to changing work conditions	[31]
		(5) Responding to feedback	[31]
		(6) Versatility	[31]
		(7) Collaboration	[31]
	Resiliency (R)	(8) Performance under stress	[31]
		(9) Performance under time constraints	[31]
		(10) Attitude	[31]

4.2 Sample and data collection procedure

The study's data were collected from the world's largest professional services network in terms of revenue and number of professionals, recognized as one of the Big Four consulting firms.

The focus was on the Italian geography and employees with a deeper understanding of projects and have worked hybrid or remotely. Out of 11,000 employees at the time of the survey, a random sample of 1,000 employees was selected from various business units to diversify the variety of sectors and industries covered and to avoid industry bias. Following Dillman's [144] recommendations for implementing the total design method of surveys, all 1,000 employees were contacted via email. Over a four-week period, 201 responses were received, yielding a response rate of 20.1%. All data were collected in accordance with ethical research standards. Participation in the survey was entirely voluntary, and respondents were notified in advance regarding the purpose of the study. They were clearly notified that their responses would be used solely for academic research purposes, ensuring transparency and informed consent throughout the data collection process.

Following an analysis for non-engagement bias, two responses were removed, and one response was excluded due to a lack of information regarding the work mode question. The remaining 198 valid responses were retained for data analysis, resulting in a usable response rate of 19.8%. Based on the results it can be seen that, in the post COVID era, work on most projects is performed hybrid (65%), meaning that work had been done partly remotely and partly on-site, or completely remotely (28%). A small percentage of the sample indicated on-site work (6%) and thus had to be omitted from the analysis, resulting in a final sample of 186 responses relevant to the research. The data is summarized in the following table (Table 2):

Table 2. Work mode composition

Characteristic	Number	Percentage
Work mode		
On-site	12	6.0%
Hybrid	130	65.3%
Remotely	56	28.1%

Therefore, the following descriptive statistics pertain solely to the hybrid and remote observations. The Age variable exhibits a right-skewed distribution, with approximately 59% (109) of respondents falling within the ages of 25-30, while 6% were under the age of 25, 16% between the ages of 31-35, 11% between the ages of 36-40 and 9% above the age of 40. The predominantly younger age of the sample was taken into consideration when devising the age brackets since the

consulting industry historically has a distinctive pyramidal organizational structure with graduates making the bulk of the workforce, as can also be seen from the results of this survey. The 6% of employees under the age of 25 is most likely composed of interns.

Table 3a. Demographic composition - Age

Characteristic	Number	Percentage
Age		
< 25	12	6.5%
25-30	109	58.6%
31-35	29	15.6%
36-40	20	10.8%
> 40	16	8.6%

The survey was able to cover a total of 16 different service offerings, which shows and commends the surveyed company's size and market coverage. However, the majority of results from the survey pertaining to the Service variable originate from two specific offerings: Enterprise Technology and Performance (29.6%) and Strategy, Analytics and M&A (27.4%).

Table 3b. Demographic composition - Service

Characteristic	Number	Percentage
Service		
Audit and Assurance	10	5.4%
Strategy, Analytics and M&A	51	27.4%
Customer and Marketing	6	3.2%
Core Business Operations	15	8.1%
Human Capital	7	3.8%
Enterprise Technology and Performance	55	29.6%
Financial Advisory	8	4.3%
Legal	3	1.6%
Risk Advisory	15	8.1%
Climate & Sustainability	9	4.8%

Education	2	1.1%
Other services ³	5	2.7%

For the Industry variable the majority of results are from the Banking and financial services industry (53.2%), most likely since this is the industry with the highest gross margins. The second most represented industry is Consulting and Professional Services with 13.4% showing the collaboration in the industry and the need to cover vacant openings at certain moments in time due to lack of staff. Overall, a total of 16 industries were covered by the survey. It is important to note that Construction, although one of the industries suggested by the classification offered by the International Journal of Project Management, received 0 responses from the questioned sample, this is most likely because this specific industry is often covered by smaller, niche consulting companies in this geography.

Table 3c. Demographic composition - Industry

Characteristic	Number	Percentage
Industry		
Information technology	15	8.1%
Engineering and manufacturing	10	5.4%
Consulting and professional services	25	13.4%
The public sector including international development and cooperation	21	11.3%
Banking and financial services	99	53.2%
Consumer goods	3	1.6%
Education	2	1.1%
Energy and Decarbonization	2	1.1%
Logistics	2	1.1%
Other industries ⁴	7	3.8%

Most projects saw the use of both Collaboration IS and Communication IS (74.2%), which was measured by the IS Use variable. Although designated Project management IS exist, their use is

³ Other services include those services that had a response rate below 1%: Civil society organisations; Consulting; Culture management; Healthcare industry; and Research in the field of political science

⁴ Other industries include those industries that had a response rate below 1%: Automotive; Civil society organisations - services for human trafficking victims; ESG Data Governance; Fashion; Pharmaceutical; Retail; Travel & Leisure; and Construction with 0%

far less likely in project settings than expected. This is probably because the project management skills of individuals working on projects render the functionalities of those tools unnecessary and often the required time to correctly use them is not suitable for a fast-paced project setting. This is in line with similar studies, showing that the main focus is on collaboration and communication tools [3]. Among the responses there was an indication of additional tools used in certain projects. The constructs were measured using a 5 scale Likert scale.

Table 3d. Demographic composition - IS Use

Characteristic	Number	Percentage
IS Use		
Collaboration IS	15	8.1%
Communication IS	18	9.7%
Collaboration IS, Communication IS	138	74.2%
Collaboration IS, Communication IS, Project management IS	10	5.4%
Other IS Use ⁵	5	2.7%

4.3 Survey details

This section presents the analysis of the survey carried out to assess PS, WA, and the effectiveness of IS systems used during the projects in table 4 (a,b,c). As indicated in the previous paragraph, responses from two participants were excluded due to engagement bias, one response was omitted because it did not indicate the work mode, and 16 responses focusing on on-site work were not considered in this analysis, totaling 186 cases used in the analysis. The remaining responses form the basis of the averages calculated for each question, providing insight into the overall trends observed in the projects.

The table below presents the survey questions, with the distribution of responses across a 5-point Likert scale ranging from 1 (Strongly Disagree), 2 (Disagree), 3 (Neither Agree nor Disagree), 4 (Agree) to 5 (Strongly Agree), along with the average response for each question.

⁵ Other IS Use include those ISs or combinations of ISs that had a response rate below 1%: Project management IS; Collaboration IS, Communication IS, Proprietary software; Collaboration IS, Project management IS; Collaboration IS, Communication IS, Irion; and Collaboration IS, Communication IS, Oracle EPM Cloud

Table 4a. Survey questions and responses – PS

Survey Question	1	2	3	4	5	Average
The project has been completed on time.	2	3	17	80	84	4.30
The project was completed within budget.	0	5	18	87	76	4.26
The project delivered what it was supposed to with quality.	0	3	17	66	100	4.41
During the project there were setbacks that can be attributed to project management.	30	28	70	39	19	2.94
The project plan set initially was realized.	3	6	24	90	63	4.10
The individuals working on the project were motivated.	1	1	34	93	57	4.10
The individuals working on the project improved existing skills or/and gained new skills.	1	6	12	92	75	4.26
The work on the project has led to career growth for individuals that worked on the project.	2	3	40	89	52	4.00
The team operating the project had a high retention rate of individuals (or low turnaround).	2	11	52	75	46	3.82
The deliverable has led to technical improvements for the customer.	0	6	21	94	65	4.17
The deliverable has led to functional improvements for the customer.	0	1	16	101	68	4.27
The pain point that led to the initiation of the project has been addressed and resolved upon completion of the project.	0	3	24	106	53	4.12
The deliverable produced by the project is being used by the customer.	1	2	10	86	87	4.38
The customer is satisfied by the deliverable produced by the project.	0	1	13	86	86	4.38
The project has attained the expected value.	1	0	11	98	76	4.33
The risk measured in terms of the probability that the project would not achieve its goals was high.	15	48	64	36	23	3.02
The economic loss potentially incurred if the project had not been completed was high.	11	17	82	54	22	3.32
The investment objective set at the initiation of the project has been achieved.	1	0	24	110	51	4.13

Table 4b. Survey questions and responses – IS Success

Survey Question	1	2	3	4	5	Average
The IS systems used during the project are user friendly.	0	7	20	91	68	4.18
The IS systems used during the project offer appropriate functionality.	1	4	18	91	72	4.23
I used IS systems to execute my project activities.	1	1	10	68	106	4.49
The frequency of use with the IS systems is high.	3	3	10	54	116	4.49
I am going to use the IS systems on other projects in the future.	1	2	13	46	124	4.56
You are satisfied with the IS systems used during the project.	0	6	19	90	71	4.22
I would recommend the IS systems used on the project to other employees.	0	7	25	76	78	4.21
The IS systems help me to improve productivity.	0	3	24	69	90	4.32
The IS systems help me to save time.	1	5	19	68	93	4.33

Table 4c. Survey questions and responses – WA

Survey Question	1	2	3	4	5	Average
The individuals working on the project have actively sought new opportunities (outside of the standard scope of activities) to positively affect the project's outcome.	5	11	54	84	32	3.68
The individuals working on the project have actively sought to learn and apply new methods to complete tasks and activities.	1	7	37	91	50	3.98
The individuals working on the project have sought to anticipate task and potential issues.	0	6	41	87	52	3.99
The individuals working on the project have actively sought to manage threats.	0	4	27	96	59	4.13
The individuals working on the project have adjusted the work approach used in response to changing working conditions.	0	2	24	104	56	4.15
The individuals working on the project are welcoming of receiving feedback for their work and adjusting accordingly.	0	1	26	99	60	4.17
The individuals working on the project are capable of switching tasks and activities.	0	1	23	102	60	4.19
The individuals working on the project are collaborative and work well with all other stakeholders.	0	3	15	86	82	4.33
The individuals working on the project have maintained effective performance even under situations of increased stress and shifting working conditions.	2	4	20	99	61	4.15
The individuals working on the project have maintained effective performance even under tight time constraints and short deadlines.	1	4	18	88	75	4.25
The individuals working on the project have sought to work towards resolving problems when they emerge.	0	7	15	80	84	4.30
The individuals working on the project have had a positive can-do mindset throughout the project even in situations of increased stress and shifting working conditions.	2	5	26	93	60	4.10

4.4 Data analysis

The collected data were analyzed using IBM SPSS AMOS, applying a combination of regression analysis, Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA), and Structural Equation Modeling (SEM). This multi-method approach was adopted to rigorously test the standardized model previously validated in the literature [117], this approach ensured a comprehensive assessment of the constructs under study. Initially, EFA was conducted to examine the dataset, focusing on the adequacy of sample extraction and the relevance of the factors [145]. This step was essential for identifying influential factors and evaluating the underlying structure of the multi-item scale [146]. Next, CFA was employed to estimate and validate the sample covariance matrix against the hypothesized population covariance matrix [145], refining the model by minimizing discrepancies between observed data and theoretical expectations. Finally, SEM was applied, encompassing both the measurement model (validated through CFA) and the structural model. This dual-component approach enabled a thorough investigation of the relationships between constructs and the testing of hypothesized links within the structural model. [147, 148].

The SEM and CFA methodology distinguishes between the following types of variables:

- exogenous – the variables that affect other components and are not affected by others themselves,
- endogenous – the variables that are influenced by exogenous and other endogenous variables,
- observed/ manifested – the variables directly observed and measured,
- latent – the variables that are not directly measured but obtain their value through the influence of observed variables.

5. Results

Overall, SEM was performed in SPSS AMOS to evaluate the model fit for each construct (assessing the measurement model) and to test the relationships among constructs (examining the hypotheses within the structural model).

5.1 Measurement model

The validity of the measurement model was confirmed using CFA in SPSS AMOS [149], employing widely accepted goodness-of-fit indices, including the Chi-square to degrees of freedom ratio (χ^2/df), Goodness-of-Fit Index (GFI), Adjusted Goodness-of-Fit Index (AGFI), Comparative Fit Index (CFI), Probability of Close Fit (PCLOSE), and Root Mean Square Error of Approximation (RMSEA). As presented in Table 5, all fit indices exceeded commonly recommended thresholds from previous studies [150–152], indicating that the measurement model provides an accurate representation of the collected data ($\chi^2 = 483.91$ with $df=378$, $GFI=0.862$, $AGFI=0.819$, $CFI=0.967$, $PCLOSE=0.969$, and $RMSEA = 0.039$).

Table 5. Summary of goodness of fit statistics for CFA and SEM

Model	χ^2/df	GFI	AGFI	CFI	PCLOSE	RMSEA
Measurement model	1.280	0.862	0.819	0.967	0.969	0.039
Structural model	1.381	0.842	0.804	0.952	0.796	0.045
Recommended value	<3.00 ^{a,b}	>0.80 ^b	>0.80 ^b	>0.90 ^{a,c}	>0.05 ^d	<0.05 ^{a,b,c}

Note: GFI, goodness of fit index; AGFI, adjusted goodness of fit index; CFI, comparative fit index; PCLOSE p of close fit; RMSEA, root mean square error of approximation.

^a Kline [153]

^b Hair et al [154]

^c Hu and Bentler [151]

^d Hair et al [154]

Reliability was assessed using Cronbach’s alpha coefficients [155]. The reliability values for each factor measured by the survey instrument were as follows: PSMS = 0.842; IMPT = 0.773; IMPC = 0.806; PSIS = 0.781; SQ = 0.878; Use = 0.839; US = 0.880; NB = 0.857; P = 0.771; A = 0.833; R = 0.886. The overall reliability of the survey instrument was 0.932. In addition, factor reliability and convergent validity were assessed using composite reliability (CR) and average variance extracted (AVE), with results summarized in Table 6. All Cronbach’s alpha coefficients and CR values exceeded the recommended threshold of ≥ 0.70 [156]. For each factor, CR values were greater than AVE, indicating adequate convergent validity. All AVE values surpassed the recommended 0.50 level [156], meaning that more than half of the variance in the items was accounted for by the respective factors. Discriminant validity was evaluated using AVE, maximum shared variance (MSV), and average shared variance (ASV), following Hair et al. [156]. None of the factors violated the criteria, confirming discriminant validity. In summary, the measurement model demonstrated satisfactory reliability, convergent validity, and discriminant validity.

Table 6. Reliability, convergent validity, and construct correlations

Factor	Mean	SD	Alpha	CR	AVE	MSV	ASV	A	PSMS	IMPT	IMPC	PSIS	SQ	Use	US	NB	P	R
A	4.210	0.551	0.833	0.833	0.556	0.542	0.252	0.745 ^a										
PSMS	4.265	0.642	0.842	0.833	0.557	0.539	0.232	0.374	0.747 ^a									
IMPT	4.117	0.641	0.773	0.774	0.533	0.392	0.198	0.482	0.378	0.730 ^a								
IMPC	4.293	0.569	0.806	0.807	0.586	0.549	0.223	0.380	0.694	0.626	0.766 ^a							
PSIS	4.230	0.589	0.781	0.791	0.658	0.549	0.266	0.378	0.734	0.550	0.741	0.811 ^a						
SQ	4.205	0.720	0.878	0.879	0.785	0.637	0.269	0.422	0.512	0.372	0.403	0.486	0.886 ^a					
Use	4.513	0.640	0.839	0.841	0.639	0.326	0.214	0.490	0.407	0.310	0.293	0.464	0.536	0.799 ^a				
US	4.210	0.742	0.880	0.881	0.788	0.637	0.247	0.412	0.401	0.311	0.347	0.345	0.798	0.571	0.888 ^a			
NB	4.325	0.734	0.857	0.860	0.754	0.596	0.211	0.452	0.323	0.339	0.223	0.221	0.670	0.544	0.772	0.869 ^a		
P	4.033	0.648	0.771	0.776	0.539	0.531	0.192	0.729	0.246	0.428	0.289	0.462	0.368	0.418	0.291	0.333	0.734 ^a	
R	4.163	0.706	0.886	0.888	0.727	0.542	0.263	0.736	0.516	0.526	0.400	0.541	0.457	0.504	0.396	0.371	0.581	0.852 ^a

Note: α , Cronbach’s alpha; CR, composite reliability; AVE, average variance extracted; MSV, maximum shared variance; ASV, average shared variance.

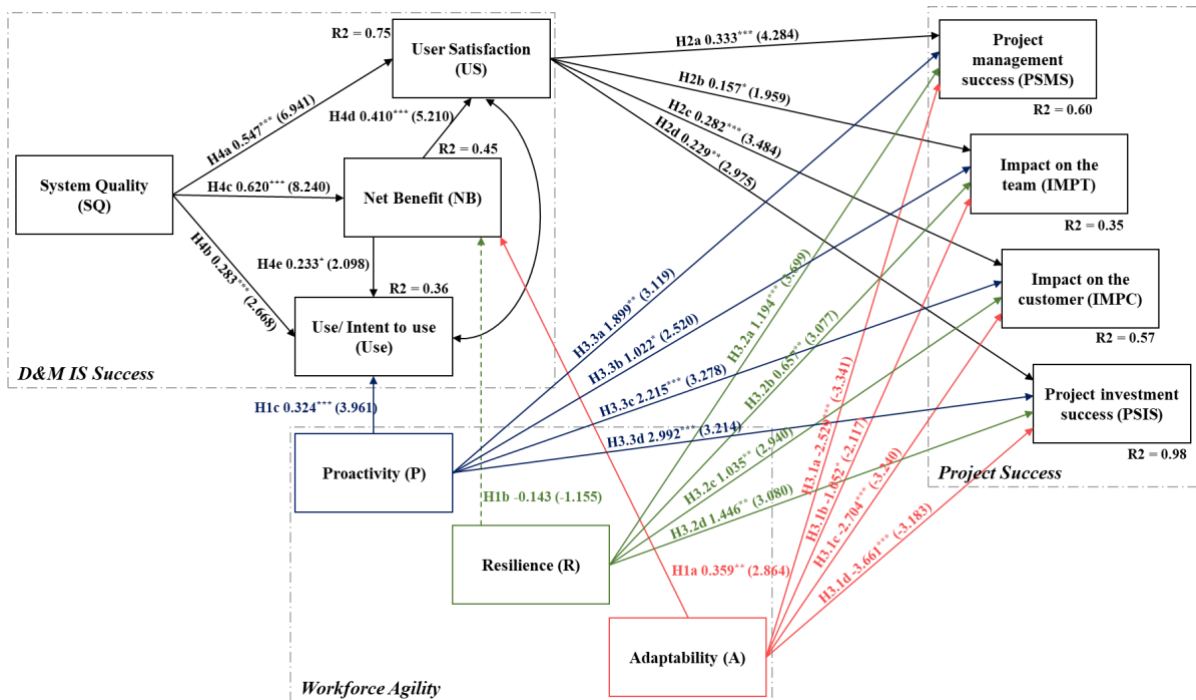
^aIt indicates the square root of AVE of the construct

Each factor was analyzed in SPSS Amos to confirm construct reliability and that Cronbach's alpha met the specified threshold. Where initial reliability estimates fell below this threshold, individual survey items were reviewed, and those that did not contribute to improving reliability were excluded from the final model. This iterative process led to the refinement of each construct and ensured robust measurement properties. For example, within the PSMS factor, the item *“During the project, there were setbacks that can be attributed to project management”* was removed, and for IMPT the item *“The team operating the project had a high retention rate of individuals (or low turnaround).”* was removed, as their inclusion reduced the overall reliability of the scale. This approach was systematically applied across all 11 factors to achieve satisfactory internal consistency.

Next, the Common Method Bias (CMB) was assessed. CMB arises from measurement error due to the method employed [157]. To examine CMB, the Common Latent Factor (CLF) test was applied, capturing the common variance among all observed variables [157]. A difference greater than 0.2 between standardized regression weights with and without the CLF indicates a potential CMB issue [157]. In this study, the CLF test revealed that differences in standardized regression weights for all 31 observed variables were below 0.2, providing strong evidence that CMB was not present in the sample.

5.2 Main structural model

The same set of fit indices was used to examine the structural model. Table 5 shows that all fit index values are in the acceptable range, indicating a good fit of the model ($\chi^2 = 552.33$ with $df = 400$, GFI=0.842, AGFI=0.804, CFI=0.952, PCLOSE=0.796, and RMSEA = 0.045). Path coefficients, p-values, z-scores, and variance explained are shown in figure 5.



Note: statistically nonsignificant -; *p < 0.05, **p < 0.01, ***p < 0.001

Figure 5. Smart Working structural model

The results indicate that 23 out of 24 hypotheses were supported, with several nuanced interpretations. For instance, while Adaptability exhibited a significant influence on Net Benefit ($\beta = 0.359$, $t = 2.864$, $p < 0.01$), supporting H1a, Resilience does not significantly affect Net Benefit, thus H1b was not supported ($b = -0.141$, $t = -1.155$). Additionally, the hypothesis concerning Proactivity (H1c), which tested its impact on Use rather than Net Benefit, was supported; Proactivity significantly positively affected Use with a beta coefficient of 0.324 and a t-value of 3.961.

The impact of Use on PSMS, IMPT, IMPC, and PSIS was measured by the H2a through H2d hypotheses, and they were all supported with significant positive impact ($b = 0.333$, 0.157 , 0.282 , 0.229 respectively and $t = 4.284$, 1.959 , 3.484 , 2.975 respectively).

Noteworthy negative influences are determined in the relationships posited by H3.1a, H3.1b, H3.1c, and H3.1d, where Adaptability negatively affects PSMS, IMPT, IMPC, and PSIS, respectively. The negative coefficients ($b = -2.529$, -1.052 , -2.704 , -3.661) and significant t-values (-3.341 , -2.117 , -3.240 , -3.183) highlight the impactful nature of these negative associations.

Whereas both Resiliency and Proactivity positively affect PSMS, IMPT, IMPC, and PSIS, thus supporting hypotheses H3.2a to H3.3d with coefficients ranging from 0.657 (for the impact of Resiliency on IMPT) to 2.992 (for the impact of Proactivity on PSIS) and significant t-values ranging from 2.520 (for the impact of Proactivity on IMPT) to 3.699 (for the impact of Resiliency on PSMS).

Finally, the interactions within the DeLone and McLean [30] Model of IS Success was assessed, with hypotheses H4a, H4b, and H4c evaluating the impact of System quality on User Satisfaction, Use/Intent to use, and Net Benefit, respectively, with the hypotheses being supported with beta values of 0.547, 0.283, and 0.620 and significant t-values of 6.941, 2.668, and 8.240. In addition, the impact of Net Benefit on User Satisfaction and Use/Intent to use was verified in the H4d and H4e hypotheses, leading to significant positive impact in both cases ($b = 0.410, 0.233$; $t = 5.210, 2.098$, respectively). The findings regarding the 24 hypotheses are summarized in Table 7.

Table 7. Summary of hypotheses testing

Hypothesis	Relationship	t-Value	β -Value	Result
H1a	A → NB	2.864**	0.359	Supported
H1b	R → NB	-1.155 ⁻	-0.143	Not supported
H1c	P → Use	3.961***	0.324	Supported
H2a	US → PSMS	4.284***	0.333	Supported
H2b	US → IMPT	1.959*	0.157	Supported
H2c	US → IMPC	3.484***	0.282	Supported
H2d	US → PSIS	2.975**	0.229	Supported
H3.1a	A → PSMS	-3.341***	-2.529	Supported
H3.1b	A → IMPT	-2.117*	-1.052	Supported
H3.1c	A → IMPC	-3.240***	-2.704	Supported
H3.1d	A → PSIS	-3.183***	-3.661	Supported
H3.2a	R → PSMS	3.699***	1.194	Supported
H3.2b	R → IMPT	3.077**	0.657	Supported
H3.2c	R → IMPC	2.940**	1.035	Supported
H3.2d	R → PSIS	3.080**	1.446	Supported
H3.3a	P → PSMS	3.119**	1.899	Supported
H3.3b	P → IMPT	2.520*	1.022	Supported
H3.3c	P → IMPC	3.278***	2.215	Supported
H3.3d	P → PSIS	3.214***	2.992	Supported
H4a	SQ → US	6.941***	0.547	Supported
H4b	SQ → Use	2.668***	0.283	Supported
H4c	SQ → NB	8.240***	0.620	Supported
H4d	NB → US	5.210***	0.410	Supported
H4e	NB → Use	2.098*	0.233	Supported

Note: statistically nonsignificant ⁻; *p < 0.05, **p < 0.01, ***p < 0.001

As part of the structural model evaluation, Henseler et al. [158] recommend assessing the coefficient of determination (R^2) for endogenous latent variables to gauge the model's explanatory power. According to Cohen [159], R^2 values above 0.26 are considered substantial, indicating significant explanatory capability. In the present model, the observed R^2 values demonstrate strong predictive quality across several key variables. Specifically, Adaptability, Resiliency, and System Quality collectively predict 45% of the variance in Net Benefit, underscoring their critical roles in influencing PS dimensions. Likewise, the combination of System Quality and Net Benefit explains 75% of the variance in User Satisfaction, highlighting the direct impact of system effectiveness and benefits perceived by users. Moreover, when Proactivity, combined with System Quality and Net Benefit, predicts Use/Intent to Use, the R^2 value reaches 36%, illustrating the importance of

proactive behavior in leveraging system capabilities for effective usage. The model's predictive strength extends to PS variables, with User Satisfaction and the WA triad achieving an R² of 60% for PSMS, 35% for IMPT, 57% for IMPC, and 98% for PSIS. These values validate the structural integrity and relevance of our theoretical model and highlight the nuanced impacts of User Satisfaction and WA on diverse PS dimensions. Table 8 presents all direct, indirect, and total effects (beta values) among the variables in the final structural model, offering a detailed quantitative summary that complements the qualitative insights derived from the R² analysis.

Table 8. Effects of variables on the final structural model

		Direct effects (standardized)						
		NB	US	Use	PSIS	IMPC	IMPT	PSMS
SQ		0.620	0.547	0.283				
R		-0.143			1.446	1.035	0.657	1.194
A		0.359			-3.661	-2.704	-1.052	-2.529
P				0.324	2.992	2.215	1.022	1.899
NB			0.410	0.233				
US					0.229	0.282	0.157	0.333

		Indirect effects (standardized)						
		NB	US	Use	PSIS	IMPC	IMPT	PSMS
SQ			0.254	0.144	0.183	0.226	0.126	0.266
R			-0.059	-0.033	-0.013	-0.016	-0.009	-0.019
A			0.147	0.083	0.034	0.041	0.023	0.049
P								
NB					0.094	0.115	0.064	0.136
US								

		Total effects (standardized)						
		NB	US	Use	PSIS	IMPC	IMPT	PSMS
SQ		0.620	0.801	0.427	0.183	0.226	0.126	0.266
R		-0.143	-0.059	-0.033	1.432	1.019	0.647	1.175
A		0.359	0.147	0.083	-3.627	-2.662	-1.029	-2.480
P				0.324	2.992	2.215	1.022	1.899
NB			0.410	0.233	0.094	0.115	0.064	0.136
US					0.229	0.282	0.157	0.333

6. Discussion

6.1 Different perspectives of the SW model

Following the analysis of the primary research model, which demonstrated the overall impacts of SW on PS through WA and IS Success, this section will delve deeper into the underlying variables that compose these factors. By examining each of these variables individually, we aim to further elucidate their specific contributions and impacts on PS, WA and IS, thus providing a more granular understanding. The results from these individual models provide important insights into the complex dynamics operating within the broader framework of the study.

The findings provide meaningful contributions to the field, both from a theoretical and practical perspective. Theoretically, the research enriches the discourse on SW by employing robust methodologies, such as CFA and SEM, to explore the nuanced dynamics between WA, IS, and PS. The model explains substantial variations in key PS dimensions, highlighting the key role of adaptability, proactivity, and resiliency. Additionally, the study underlines the importance of aligning workforce capabilities with IS infrastructure to optimize both direct and indirect impacts on PS. Practically, the findings serve as a strategic guide for organizations adopting SW practices, emphasizing the need to cultivate resilient and proactive workforces while investing in robust IS infrastructure. These insights empower companies to make informed decisions, driving performance and efficiency in evolving project environments.

The analysis of WA reveals that Adaptability, Proactivity, and Resiliency serve as critical determinants of success within SW environments. The results highlight that while Adaptability drives responsiveness to dynamic project conditions, it also introduces a degree of variability in performance outcomes. To further unpack these complexities, future studies could explore how specific types of Adaptability, such as behavioral versus cognitive flexibility, affect different dimensions of project performance.

6.2 Workforce agility – Perspective

By delving deeper into the multifaceted landscape of WA, exploring the intricate interplay between its constituent elements and their corresponding indicators. At the core of this model lie three fundamental dimensions: Proactivity, Resiliency, and Adaptability, each representing distinct

facets of an agile workforce's capabilities. The details of the composition of the model are shown in figure 6. WA has been conceptualized as a multi-dimensional capability that allows employees to react swiftly and effectively to environmental turbulence and technological change, and process reconfiguration [138]. Prior reviews consolidate these facets into clusters that strongly align with our three core dimensions each reflecting distinct yet complementary behavioral repertoires that enhance organizational responsiveness [138]. Moreover, contemporary evidence from hybrid and agile software development contexts indicates that the acceleration of distributed and technology-mediated work further amplifies the strategic importance of WA, particularly regarding adaptability and collaboration across time, space, and functional boundaries [66]. Proactivity, which is crucial for anticipating and addressing emerging challenges, is supported by the continuous processes of Learning on the job, Issue anticipation, and effective Threat management. The inclusion of these indicators is consistent with the broader agility and adaptive performance literatures, which emphasize anticipatory action, continuous learning, and risk/threat management as central mechanisms through which individuals enact agility in complex socio-technical environments [66, 138]. In hybrid and agile development settings, proactive behaviors become even more relevant, as reduced co-location heightens the need for anticipating coordination failures and emergent risks [66]. Learning on the job serves as a cornerstone, fostering continuous skill development and knowledge acquisition, while Issue anticipation enables proactive problem-solving by anticipating potential obstacles. Furthermore, Threat management empowers individuals to mitigate risks effectively, thereby enhancing organizational resilience. The robust coefficients of determination (R^2) associated with these indicators – 31% for Learning on the job, 62% for Issue anticipation, and 44% for Threat management – stressing their substantial impact on fostering proactive behaviors within the workforce.

In parallel, the dimension of Resiliency emerges as a critical factor in navigating the complexities of today's work environments. Defined by the ability to thrive under pressure and adversity, Resiliency draws strength from Performance under stress, Performance under time constraints, and Positive attitude. These indicators, with their remarkable R^2 values of 79%, 77%, and 61% respectively, exemplify the resilience-driven mindset essential for overcoming challenges and achieving optimal performance. Performance under stress and time constraints showcase individuals' capacity to maintain composure and deliver results even in high-pressure situations, while a Positive attitude fosters an optimistic outlook conducive to resilience-building. This strong

statistical imprint of Resiliency is in line with findings that team-level resilience is directly associated with project management success, particularly in information systems settings characterized by uncertainty, time pressure, and interdependence [67]. Our results therefore extend prior evidence by demonstrating that resilience is not only consequential for collective outcomes, but is also structurally embedded in the micro-foundations of workforce agility at the individual level.

Moreover, Adaptability emerges as a cornerstone of workforce agility, reflecting the capacity to adjust and thrive amidst change. Anchored by indicators such as Responding to changing working conditions, Responding to feedback, Versatility, and Collaboration, Adaptability embodies the flexibility and versatility required to navigate evolving work dynamics successfully. Responding to changing working conditions and feedback underline the importance of adaptive responses to evolving circumstances, while Versatility and Collaboration highlight the ability to pivot and collaborate effectively across diverse contexts. With R2 values surpassing the threshold of 26% to consider them large – 47% for Responding to changing work conditions, 54% for Responding to feedback, 48% for Versatility and 54% for Collaboration – these indicators highlight the essential role of adaptability in fostering organizational agility. Adaptability has been repeatedly singled out as a critical determinant of performance in dynamic contexts, enabling rapid reconfiguration of roles, behaviors, and routines [138]. This becomes particularly visible in hybrid work + agile configurations, where employees must fluidly switch between synchronous/asynchronous collaboration modes, integrate continuous feedback loops, and maintain cross-functional collaboration under shifting constraints [66]. Our evidence empirically underlines this theoretical position, indicating that adaptability indicators explain substantial variance and exert sizeable positive effects on WA.

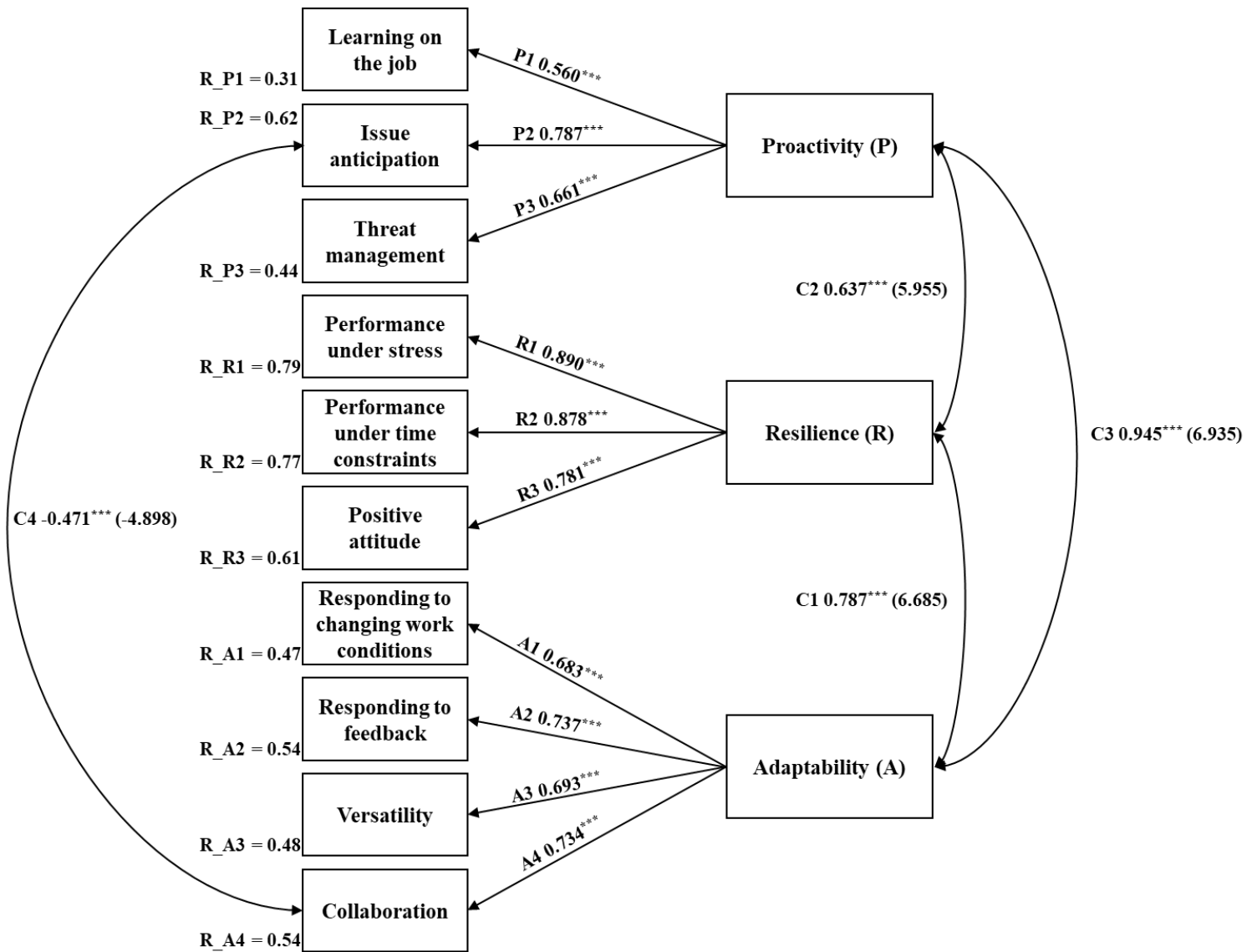


Figure 6. Workforce Agility focus

Analyzing the profound impact of these factors unveils a compelling narrative of significance and positivity, with all indicators demonstrating remarkable statistical significance (p-values below 0.001) coupled with a pronounced positive influence. Delving into the specifics, the dimension of Proactivity stands fortified by impactful betas: Learning on the job boasts a beta of 0.560, underscoring its fundamental role in fostering proactive behaviors within the workforce. Similarly, Issue anticipation and Threat management command attention with betas of 0.787 and 0.661, respectively, reaffirming their significance in equipping individuals to foresee and address challenges adeptly, thereby bolstering workforce proactivity.

Shifting focus to the dimension of Resilience, the indicators wield impressive betas indicative of their profound impact on individual and overall workforce resilience. Performance under stress emerges as a standout contributor, boasting a beta of 0.890, closely followed by Performance under time constraints and Positive attitude, with betas of 0.878 and 0.781, respectively. These indicators not only shed light on individuals' capacity to thrive amidst adversity but also highlight the invaluable role of a positive mindset in navigating challenges with resilience and determination.

Furthermore, the dimension of Adaptability emerges as a linchpin in navigating the complexities of dynamic work environments, with each indicator wielding considerable influence. Responding to changing working conditions, Responding to feedback, Versatility, and Collaboration each command attention with betas of 0.683, 0.737, 0.693, and 0.734, respectively. These findings underline the critical importance of adaptability in fostering organizational agility, enabling individuals to pivot effectively in response to evolving circumstances, embrace feedback constructively, exhibit versatility in their approach, and foster collaborative relationships conducive to innovation and growth.

Table 9. Summary of workforce agility factors and indicators

Factor	Indicator	Beta
Proactivity	Learning on the job	0.560***
	Issue anticipation	0.787***
	Threat management	0.661***
Resilience	Performance under stress	0.890***
	Performance under time constraints	0.878***
	Positive attitude	0.781***
Adaptability	Responding to changing working conditions	0.683***
	Responding to feedback	0.737***
	Versatility	0.693***
	Collaboration	0.734***

In essence, the empirical evidence presented not only validates the significance of these factors in shaping workforce agility but also illuminates the intricate nuances of their influence, offering valuable insights for organizations striving to cultivate a resilient, proactive, and adaptable

workforce poised for success in an ever-changing landscape. Table 9 provides a concise overview of the factors, their corresponding indicators, and the associated beta coefficients, encapsulating the essential information regarding the impact of these factors on workforce agility.

It is important to note that Issue anticipation and Collaboration were correlated to improve model fit and reduce the modification index. The correlation has a significant ($p < 0.001$) negative impact of -0.471, which could be due to several reasons. In some cases, individuals who are heavily involved in collaborative efforts may have less time or focus to dedicate to anticipating potential issues. This could result in a negative correlation, as those who prioritize collaboration may spend less time on proactive problem-solving. Similarly, extensive collaboration can sometimes lead to information overload or communication saturation. In such situations, individuals might become too immersed in collaborative activities, neglecting or overlooking opportunities for issue anticipation.

The significant negative correlation between Issue anticipation and Collaboration may be partially explained by interaction patterns in hybrid/agile environments, where intensive collaboration, continuous communication rituals (e.g., stand-ups, retrospectives), and frequent cross-functional coordination can shift attention and time away from individual anticipatory analysis [66]. In high-velocity settings, employees may rely on the collective sensemaking of the team to surface issues, reducing individual investment in proactive scanning. Moreover, organizations that heavily emphasize collaborative routines and shared ownership may unintentionally deprioritize role clarity for individual issue anticipation, echoing broader observations on how agile practices redistribute responsibility for risk sensing and mitigation across the team [66, 67].

In highly collaborative environments, individuals may rely heavily on their peers or teammates to identify and address potential issues. As a result, they might not feel the need to proactively anticipate problems themselves, leading to a negative correlation between collaboration and issue anticipation. Organizational culture can also influence outcomes. In cultures that strongly emphasize collaboration and incentivized, individuals may prioritize collaborative tasks over individual problem-solving or issue anticipation, potentially leading to a negative correlation between the two.

Collaboration and issue anticipation require different skill sets and mindsets. While collaboration relies on teamwork, communication, and interpersonal skills, issue anticipation requires analytical thinking, foresight, and problem-solving abilities. Individuals who excel in one area may not necessarily excel in the other, contributing to a negative correlation. Organizations may allocate resources differently based on their priorities. If resources are heavily directed towards fostering collaboration, there may be fewer resources available for activities related to issue anticipation, leading to a negative correlation between the two.

Understanding the underlying mechanisms driving the negative correlation between Collaboration and Issue anticipation can offer valuable guidance for organizations aiming to enhance workforce agility and effectiveness. It underscores the importance of balancing collaborative efforts with proactive problem-solving to ensure comprehensive and robust organizational capabilities.

Beyond its internal structure, WA has demonstrable downstream effects on organizational outcomes. Prior research shows that WA promotes innovation, which in turn mediates its effect on firm growth, particularly in high-growth firms that operate in turbulent markets [122]. In parallel, team resilience has been directly linked to project management success in information systems teams [67]. Taken together, these findings position WA not only as a human-capital capability but as a strategic lever that fosters innovation, project success, and sustainable competitive performance.

The results of this study provide several practical implications for organizations seeking to enhance their WA. First, the differentiated influence of each indicator across the three WA dimensions suggests the need for targeted capability-building strategies. Rather than adopting a one-size-fits-all approach, organizations should design micro-targeted interventions to address specific behavioral drivers. For instance, scenario planning and risk identification workshops can strengthen issue anticipation, while resilience training programs focusing on stress inoculation and recovery techniques may enhance performance under pressure. Similarly, structured feedback mechanisms and rotational roles can cultivate adaptability through continuous learning and exposure to diverse tasks. These targeted actions align with existing literature emphasizing the behavioral basis of agility and its responsiveness to focused development efforts [67, 138].

Moreover, the context of hybrid and agile work environments amplifies the relevance of WA, particularly with regard to collaboration and adaptability. The observed negative correlation between issue anticipation and collaboration highlights the potential trade-offs that emerge when collaborative intensity overshadows individual analytical effort. In such settings, organizations may benefit from rebalancing team dynamics: providing dedicated time for individual reflection, limiting meeting overload, or introducing asynchronous coordination tools to reduce communication saturation [66]. This balance is essential to maintain both proactive foresight and collective alignment, especially in distributed teams operating under rapid iteration cycles.

In addition, workforce agility emerges not only as a facilitator of internal flexibility but also as a driver of innovation, a critical capability for firms seeking to sustain high growth in volatile environments. Prior research has demonstrated that WA can function as a precursor to innovation capacity, which in turn mediates its influence on firm performance [122]. Therefore, organizations should consider aligning workforce agility initiatives with broader innovation strategies, integrating agility assessments into talent pipelines, and fostering a culture that rewards experimentation, responsiveness, and constructive feedback.

Finally, the strong empirical linkage between WA indicators, particularly those under Resilience, and project success reinforces the value of embedding these competencies into formal project management methodologies. Monitoring agility metrics at the team and project level, incorporating them into performance reviews, and supporting them with appropriate governance structures could help operationalize agility as a measurable, actionable, and strategically significant capability [67].

6.3 IS success – Perspective

The IS Success model, rooted in the D&M IS Success theoretical framework, presents an adapted perspective with User Satisfaction at its core, influencing PS. The foundational role of User Satisfaction within IS success has been reaffirmed by recent studies emphasizing its impact on system adoption and project outcomes [160]. These studies suggest that satisfaction not only reflects system usability but also acts as a predictor of long-term success. Within this model, System Quality emerges as a key factor, comprising two critical indicators: User friendliness and Usability. System Quality remains essential, with user interface design and usability increasingly

recognized as determinants of user engagement and satisfaction [161, 162]. Enhanced usability features directly contribute to users' perceived ease of use and overall system acceptance. System Quality serves as key determinant of Use/Intent to use, Net Benefit, and ultimately, User Satisfaction.

Delving into the dimensions of Use/Intent to use, it unfolds with a triad of indicators: Dependency, Frequency of use, and Tendency to use. Behavioral intention theories such as TAM and UTAUT correlate closely with the constructs of dependency, frequency, and tendency to use, revealing that higher perceived usefulness and ease of use drive sustained system engagement [163]. These dimensions collectively encapsulate users' reliance on the system, their engagement frequency, and their inclination towards sustained usage. Net Benefit is explained through Productivity and Efficiency, as these indicators encapsulate the benefits produced by IS. Empirical research confirms that IS adoption yields measurable improvements in productivity and operational efficiency, further reinforcing positive user perceptions and system value [16, 67, 164]. Additionally, the User Satisfaction dimension is delineated by Satisfaction with the system and the likelihood of Recommending the system to others. Notably, a correlation between Use/Intent to use and User Satisfaction is observed, highlighting the intricate relationship between perceived utility and satisfaction levels.

The correlation between Tendency to use and Recommendation serves to refine the model's fit and optimize predictive capabilities, contributing to a deeper and more comprehensive insight into user behavior and preferences. Notably, the correlation exhibits a significant positive impact ($p < 0.001$) with a beta coefficient of 0.438, underscoring the influence of user preferences on system adoption and endorsement. Furthermore, the correlation might be due to several aspects. Users who find a system useful and effective are more inclined to recommend it to others. This positive perception of utility not only increases their own tendency to use the system but also motivates them to endorse it to colleagues, friends, or other potential users. On the other hand, a positive user experience, characterized by ease of use, efficiency, and satisfaction with the system, often leads to a higher likelihood of both recommending the system and continuing to use it. Users who have a positive experience are more inclined to recommend the system to others while also being more likely to continue using it themselves. The link between user satisfaction and recommendation behavior is supported by social influence theories, highlighting how peer

endorsement significantly boosts adoption rates [67, 165]. Positive user experiences often propagate through organizational networks, creating a reinforcing cycle of system use.

When users trust a system and have confidence in its reliability and effectiveness, they are more likely to recommend it to others. This trust and confidence contribute to a higher tendency to use the system, as users feel assured that it will meet their needs and expectations. Trust in system reliability and security plays a crucial role in user acceptance, with studies demonstrating that trust mitigates perceived risks and enhances both usage intention and advocacy [166]. Recommendations from peers, colleagues, or trusted sources can significantly influence an individual's decision-making process. Positive recommendations from others can reinforce a person's perception of the system's value and heighten their likelihood of using it themselves. Recommending a system to others can be seen as a social benefit, reflecting positively on the recommender's knowledge and judgment. Individuals who perceive recommending the system as socially advantageous are more likely to both recommend it and use it themselves.

Users who are actively engaged with a system and derive ongoing value from it are more likely to recommend it to others as a way to share their positive experiences and insights. This continuous engagement fosters a positive feedback loop, wherein recommendation and tendency to use reinforce each other. Overall, the positive correlation between Recommendation and Tendency to use reflects the interconnected nature of user behavior, satisfaction, and social influence within the IS Success model. As users perceive value in a system, their propensity to both use it themselves and recommend it to others increases, contributing to its overall success and adoption.

Furthermore, the model's robustness is supported by the substantial coefficients of determination (R^2) associated with its various indicators. Notably, System Quality indicators boast R^2 values of 77% for User friendliness and an impressive 80% for Usability, emphasizing their profound impact on user experience and satisfaction. Similarly, the dimensions of Use/Intent to use and User Satisfaction demonstrate considerable explanatory power, with R^2 values ranging from 58% to 78%, well exceeding the threshold of 26% for considering them large. Whereas, Net Benefit indicators have R^2 equal to 68% concerning Productivity on the one hand, and 80% for Efficiency on the other.

The IS Success model, shown in figure 7 below, presents a comprehensive framework for understanding the dynamics of user satisfaction and system success within the realm of Information and Communication Technology. By elucidating the intricate interplay between system quality, user intent, and satisfaction, the model offers important guidance for organizations aiming to improve the adoption, utilization, and endorsement of IS solutions.

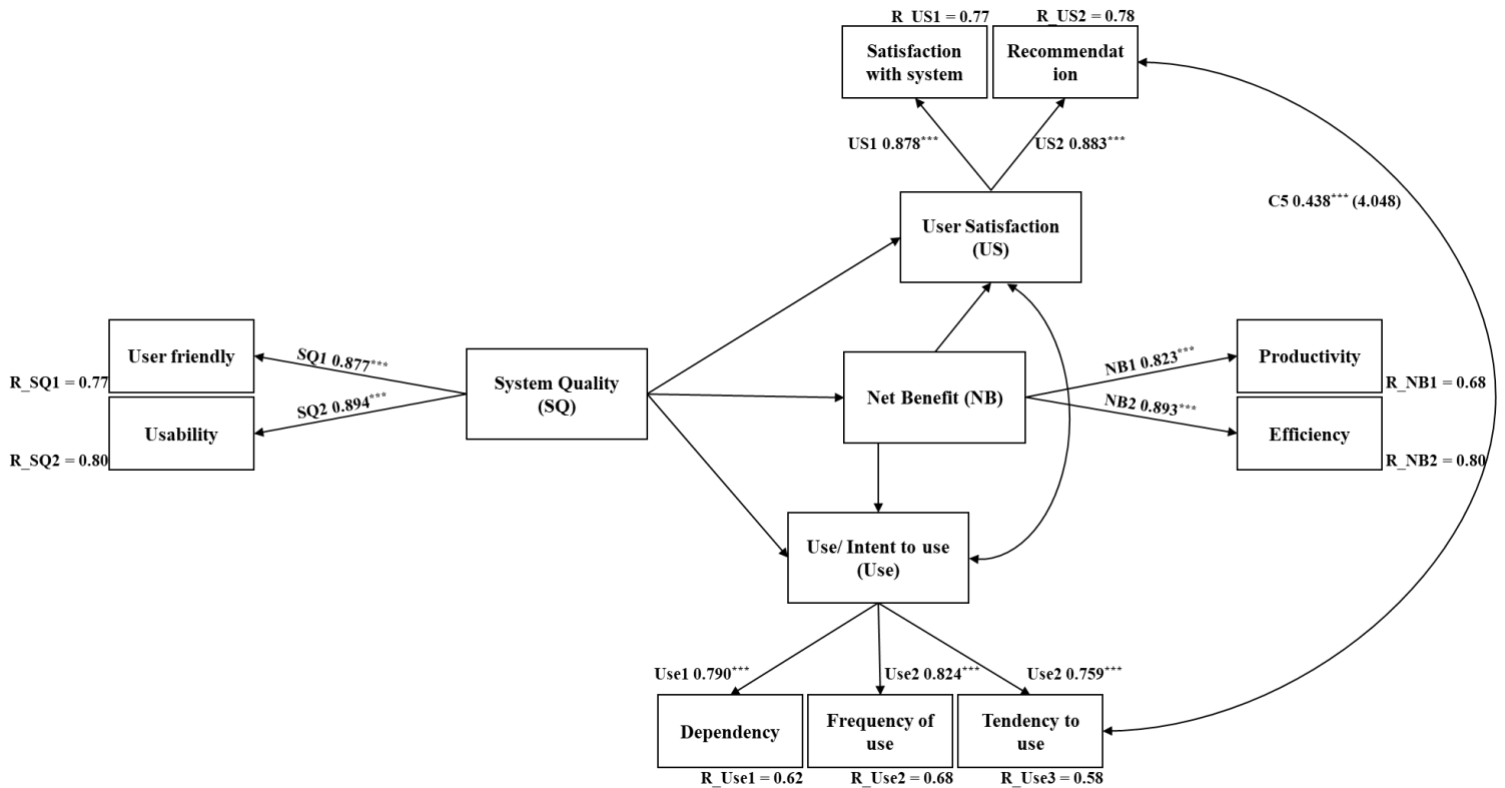


Figure 7. IS focus

Deeply delving into the intricate fabric of the model, we unveil the profound influence wielded by each variable, shedding light on their important roles in shaping user experiences and system success. At the forefront stands System Quality, a cornerstone of user satisfaction and acceptance. Within this dimension, User friendliness and Usability emerge as paramount factors, with their impacts resonating significantly across the model's landscape. The resounding statistical significance, supported by p-values below 0.001, highlights the robustness of these findings. Particularly noteworthy is the beta coefficient of 0.877 attributed to User friendliness, underscoring

its substantive positive impact on user perceptions and interactions with the system. Similarly, Usability commands attention with a beta coefficient of 0.894, epitomizing its essential role in orchestrating seamless and efficient user experiences, thereby enriching the overarching system quality.

Moving further, the dimension of Use/Intent to use unveils invaluable insights into users' behavioral intentions and engagement levels with the system. Through the lenses of Dependency, Frequency of use, and Tendency to use, users' reliance, interaction frequency, and propensity for sustained usage come into focus. With betas of 0.790, 0.824, and 0.759 respectively, these indicators testify to their substantial positive impacts on user engagement and system utilization. Indeed, they mirror users' profound dependence on the system, their recurrent interactions, and their innate inclination towards sustained usage, all of which coalesce to foster the system's holistic adoption and efficacy.

Meanwhile, the dimension of Net Benefit casts a spotlight on the tangible advantages conferred by system usage. Through the prism of Productivity and Efficiency, users' reaped benefits in terms of enhanced task performance and streamlined workflows are encapsulated. With betas of 0.823 and 0.893 respectively, these indicators resoundingly affirm the system's tangible value proposition, facilitating heightened productivity levels and streamlined operational efficiencies. Their palpable impact emphasizes the system's indispensable role in driving organizational success and amplifying user outcomes.

At the heart of the model lies User Satisfaction, a quintessential arbiter of system acceptance and success. Evaluated by indicators of Satisfaction with system and Recommendation, this dimension epitomizes users' contentment with the system's performance and functionality, alongside their propensity to endorse it to others. With betas of 0.878 and 0.883 respectively, these indicators bear testimony to the profound influence wielded by user satisfaction on system adoption and endorsement. They serve as tangible metrics of the system's efficacy and utility, reverberating its resonance within the organizational milieu.

The intricate analysis of each variable within the model unveils a tapestry of interconnected influences, underscoring their collective role in orchestrating user experiences and system success. Recent meta-analyses confirm the significance of model fit indices in IS success models, reinforcing the critical roles of usability and user satisfaction as dominant predictors [115]. By

unraveling the nuanced interplay between these variables, organizations can deftly navigate the terrain of user-centric design, steering towards optimized user experiences, heightened system adoption, and augmented organizational outcomes. The following Table 10 succinctly summarizes the factors, their corresponding indicators, and the beta coefficients associated with each indicator within the model.

Table 10. Summary of ITC factors and indicators

Factor	Indicator	Beta
System Quality	User friendliness	0.877***
	Usability	0.894***
Use/Intent to use	Dependency	0.790***
	Frequency of use	0.824***
	Tendency to use	0.759***
Net Benefit	Productivity	0.823***
	Efficiency	0.893***
User Satisfaction	Satisfaction with system	0.878***
	Recommendation	0.883***

The empirical validation of this ISS model offers meaningful implications for both system designers and organizational decision-makers. At the forefront stands System Quality, which exerts a dominant influence on user satisfaction and subsequent usage behavior. This aligns with recent evidence suggesting that, in increasingly complex IT environments, simplicity, clarity, and intuitive system design are not just desirable features, but fundamental prerequisites for adoption [110]. As systems become more sophisticated, reducing the cognitive burden through user-friendly interfaces and enhancing usability ensures smoother implementation and higher usage intent, ultimately leading to stronger organizational outcomes.

The prominence of Use/Intent to Use in driving satisfaction and recommendation behavior further underlines the importance of actively shaping user engagement strategies. Indicators such as dependency, frequency of use, and the tendency to continue use should not be treated as passive outcomes, but rather as behavioral targets shaped through onboarding programs, user feedback loops, and real-time support systems. As outlined in practitioner-driven research, organizations

increasingly value post-implementation adoption and user satisfaction as primary success criteria, often ranking them above technical completion or budget adherence [16].

Moreover, the strong linkage between Recommendation and Tendency to Use suggests that IS success operates not only as an individual user experience but also as a socially mediated process. As users derive value from a system and begin to endorse it to others, a network effect emerges, reinforcing collective adoption. This social dimension is rarely emphasized in early IS models, however, now it is essential for the perceived legitimacy and long-term sustainability of digital tools in the enterprise landscape [115]. The updated D&M framework highlights such interdependencies, suggesting that usage, satisfaction, and perceived benefit are not isolated variables, but evolving, reciprocal constructs shaped by context, communication, and culture.

Finally, the demonstrated strength of Net Benefits serves as a compelling reminder that technical features alone do not ensure system success. The ultimate metric remains the system's capacity to enhance operational performance and user effectiveness. As organizations navigate increasingly digital business models, tying IS performance metrics directly to productivity gains and workflow efficiencies can elevate IT from a support role to a strategic driver of value. Taken together, these findings and the supporting literature provide a robust framework for organizations to assess, refine, and optimize their information systems with the end-user at the center, bridging technical quality, behavioral engagement, and organizational value creation.

6.4 Project success – Perspective

As discussed, in the realm of project management, success is not merely an outcome but a culmination of various factors and indicators working in concert to achieve desired outcomes. Contemporary thought on project success emphasizes recalibration beyond traditional measures like time, cost, and scope, incorporating dimensions such as sustainability, stakeholder consensus, and long-term value alignment [167]. This reflects a shift toward more holistic, context-sensitive models of success. Within the expansive landscape of PS, the comprehensive framework used encompasses key dimensions such as PSMS, IMPT, IMPC, and PSIS. Through meticulous analysis and scrutiny, the framework unravels the intricate tapestry of indicators that underpin each factor, shedding light on their profound impact on project outcomes and organizational objectives. Through this process, a difference can be noted between the theoretical framework and the actual

realized framework as some indicators did not contribute significantly to the formation and evaluation of the factors.

Beginning with PSMS, the following multifaceted dimensions have significant impact in assessing this factor, Time, Cost, Scope/Quality, and Project Plan Realization. These indicators serve as quintessential barometers of project efficacy, encapsulating crucial facets such as adherence to timelines, budgetary constraints, scope definition, and the realization of project objectives. The robust coefficients of determination (R²), 45% for Cost, 47% for Time, 53% for Scope/Quality and 68% for Project Plan Realization, emphasize the substantial explanatory power of these indicators, affirming their key role in shaping project management success. Scholars have shown that combining traditional iron-triangle metrics with planning realization enhances evaluation robustness by linking delivery with outcome achievement [167].

Moving forward, the framework pivots towards the IMPT, elucidating the transformative influence wielded by factors such as Team Member Motivation, Aptitude Improvement, and Team Member Growth. These indicators have similar R² values with Team member motivation having 51%, Team member growth 52% and Aptitude improvement 53%; they underline the critical importance of fostering a conducive team environment conducive to growth, motivation, and skill enhancement. Recent studies highlight how stakeholder engagement and team building moderate the effect of motivational and developmental indicators on project outcomes [168].

Simultaneously, the dimension of IMPC unveils a spectrum of indicators geared towards enhancing customer satisfaction and delivering tangible value. Through dimensions such as Pain Point Remediation, Deliverable Use, and User Satisfaction, the framework endeavors to address customer needs, expectations, and pain points, thereby fostering enduring relationships and loyalty. With R² values ranging from 41% for Pain Point Remediation) to 73% for User Satisfaction, these indicators reflect the holistic approach towards customer-centricity. The contemporary framing of success increasingly situates customer satisfaction and deliverable utilization as critical outcome measures—focusing on post-implementation value rather than procedural completion [167].

Finally, the framework converges on PSIS, a dimension centered on the realization of the project value and goals set at initiation by investors. Through indicators such as Worth and Investment Objective Realization, the framework seeks to gauge the efficacy of project investments and the attainment of desired outcomes by evaluating end of project outcomes. With

R2 values of 78% for Worth and 49% for Investment Objective Realization, these indicators accentuate the imperative of aligning project investments with organizational objectives. This aligns with principles outlined in modern project management manifestos emphasizing strategic alignment, sustainability of benefits, and stakeholder value creation [10].

The PS framework illustrated below in figure 8 offers a holistic lens through which to evaluate project performance and outcomes, underpinned by a nuanced understanding of key factors and indicators as they all fall above the 26% threshold. By unraveling the intricate interplay between dimensions organizations are able to manage the complexities of project management with heightened efficacy, agility, and strategic foresight, thereby driving sustainable success and organizational excellence.

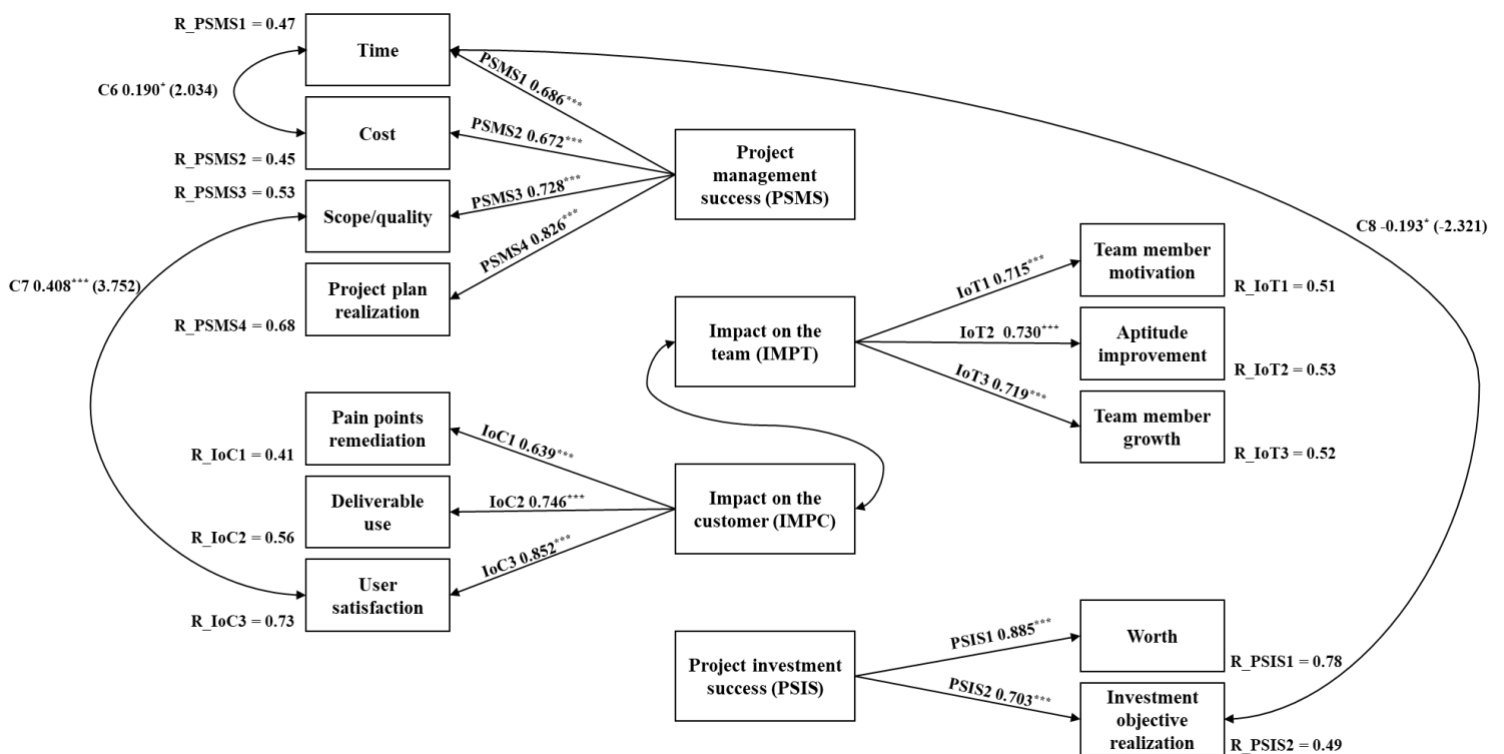


Figure 8. Project Success focus

In addition to their substantial coefficients of determination, each indicator within the PS framework exerts a statistically significant impact, underscoring their robust influence on project

outcomes. With p-values consistently below 0.001 across all dimensions, these indicators stand as compelling drivers of PS, reaffirming their significance within the organizational context.

Within the realm of PSMS, the beta coefficients further elucidate the magnitude of impact wielded by each indicator. Time, an essential metric for project efficiency, commands a beta coefficient of 0.686, emphasizing its fundamental role in project scheduling and execution. Similarly, Cost, reflecting budgetary considerations and financial constraints, boasts a beta coefficient of 0.672, underscoring its influence on project feasibility and resource allocation. Scope/Quality, encapsulating the breadth and depth of project deliverables, exhibits a robust beta coefficient of 0.728, highlighting its criticality in ensuring project alignment with stakeholder expectations. Project Plan Realization, reflecting the successful execution of project objectives and milestones, emerges as a potent driver of PS, with a notable beta coefficient of 0.826, affirming its role in translating project plans into tangible outcomes.

In the realm of IMPT, beta coefficients shed light on the transformative influence of indicators such as Team Member Motivation, Aptitude Improvement, and Team Member Growth. With beta coefficients of 0.715, 0.730, and 0.719 respectively, these indicators point out their significant positive impact on team dynamics and performance. Team Member Motivation, fueling enthusiasm and commitment among team members, serves as a catalyst for productivity and collaboration. Aptitude Improvement, facilitating the enhancement of skills and capabilities among team members, cultivates a culture of constant education and development. Team Member Growth, indicative of opportunities for career advancement and personal development, highlights the organization's commitment to nurturing talent and fostering a culture of excellence.

Moving to the dimension of IMPC, beta coefficients illuminate the profound influence of indicators such as Pain Point Remediation, Deliverable Use, and User Satisfaction. With beta coefficients of 0.639, 0.746, and 0.852 respectively, these indicators point out their significant positive impact on customer satisfaction and loyalty. Pain Point Remediation, addressing customer challenges and concerns, reflects the organization's responsiveness and commitment to customer-centricity. Deliverable Use, reflecting the extent to which customers derive value from project outcomes, highlights the tangible impact of project deliverables on customer operations and objectives. User Satisfaction, reflecting customers' perceptions and experiences with project outcomes, serves as a key metric of success and a driver of repeat business and referrals.

Finally, within the dimension of PSIS, beta coefficients provide insights into the strategic value and return on investment of project endeavors. With beta coefficients of 0.885 for Worth and 0.703 for Investment Objective Realization, these indicators emphasise the imperative of aligning project investments with organizational objectives and strategic priorities. Worth, reflecting the tangible benefits and outcomes derived from project investments, serves as a barometer of project efficacy and value creation. Investment Objective Realization, highlighting the degree to which project investments align with organizational objectives, offers insights into the effectiveness of resource allocation and investment decisions.

The beta coefficients within each dimension of the PS framework offer nuanced insights into the magnitude and direction of impact exerted by key indicators. By unraveling the intricate interplay between factors and indicators, organizations can effectively harness the power of data-driven decision-making, steering towards favorable project outcomes and enduring success. The following table 11 succinctly presents the factors, their corresponding indicators, and the beta coefficients associated with each indicator within the PS framework.

Table 11. Summary of Project Success factors and indicators

Factor	Indicator	Beta
Project Management Success (PSMS)	Time	0.686***
	Cost	0.672***
	Scope/Quality	0.728***
	Project Plan Realization	0.826***
Impact on the Team (IMPT)	Team Member Motivation	0.715***
	Aptitude Improvement	0.730***
	Team Member Growth	0.719***
Impact on the Customer (IMPC)	Pain Point Remediation	0.639***
	Deliverable Use	0.746***
	User Satisfaction	0.852***
Project Investment Success (PSIS)	Worth	0.885***
	Investment Objective Realization	0.703***

It is important to note the correlations added to improve model fit and resolve modification indices. First of all, between Time and Cost within the PSMS factor, which has a positive impact

of 0.190 with 0.1 significance. Then between Time of PSMS and Investment objective realization of PSIS, which has a negative impact of -0.193 at 0.1 significance. And lastly the correlation between Scope/Quality of PSMS and User Satisfaction of IMPC, which is positive (0.408) and significant at the 0.001 level.

In enhancing the robustness of the model and addressing potential discrepancies, correlations were strategically introduced to refine model fit and mitigate modification indices. These correlations, meticulously analyzed and integrated, serve as key adjustments, enriching the framework's predictive capabilities and coherence.

Firstly, within the realm of PSMS, a noteworthy correlation emerges between Time and Cost indicators. This positive correlation, denoted by a coefficient of 0.190, features the intrinsic relationship between time and cost considerations within project management. With a significance level of 0.1, this correlation illuminates the interconnectedness of time and cost dynamics, highlighting the imperative of balancing these factors to optimize project performance and resource utilization. In particular, the correlation could be due to various dynamics. In many projects, time and resources (which translate to costs) are closely intertwined. As project duration increases, more resources are typically consumed, leading to higher costs. Conversely, compressing timelines might necessitate additional resources to meet deadlines, thereby increasing costs. This interdependence highlights the positive correlation between Time and Cost.

Complex projects often require more time for planning, execution, and monitoring, leading to increased costs associated with resource allocation, overheads, and potential delays. The positive correlation between Time and Cost reflects this reality, where longer project durations are often accompanied by higher resource expenditures. Moreover, Time and Cost are both influenced by risk factors inherent in project management. Delays in project timelines can escalate costs due to penalties, overtime, or expedited resource procurement. Similarly, cost overruns can lead to delays in project completion, triggering a cascading effect on timelines. This risk interdependency contributes to the positive correlation between Time and Cost.

Meeting stakeholder expectations regarding project timelines and deliverables requires careful planning and resource allocation. Aligning project schedules with stakeholder demands may entail allocating additional resources, thereby increasing costs. This alignment highlights the positive correlation between Time and Cost as organizations strive to balance competing demands

and priorities. In essence, the positive correlation between Time and Cost reflects the complex interplay of factors inherent in project management. By recognizing and understanding this correlation, project managers are able to make informed decisions about resource allocation, risk management, and project planning to optimize project outcomes while managing costs effectively.

Subsequently, a salient correlation is observed between Time of PSMS and Investment Objective Realization of PSIS. In this instance, a negative correlation of -0.193 manifests, underscoring the nuanced interplay between project duration and investment objectives. With a significance level of 0.1 , this correlation sheds light on the potential trade-offs between project timelines and investment outcomes, emphasizing the need for strategic alignment and resource allocation to maximize project value and return on investment, which can be due to several factors. Prolonged project durations can result in opportunity costs, wherein resources tied up in a project could have been allocated to alternative investments yielding higher returns. As time extends, the potential for missed investment opportunities increases, leading to a negative impact on investment objective realization.

The business landscape is dynamic, with market conditions evolving rapidly. Projects characterized by extended timelines might face challenges adapting to changing market demands, thereby diminishing the feasibility and alignment of investment objectives with market realities. This inability to respond promptly to market dynamics contributes to the negative correlation between Time and Investment Objective Realization. Furthermore, long project durations often entail prolonged capital tie-up, where funds allocated to the project remain invested in specific initiatives for an extended period. This capital immobilization restricts the organization's flexibility to pursue alternative investment avenues or capitalize on emerging opportunities, thereby impeding investment objective realization.

Extended project timelines expose organizations to heightened risk factors, including market volatility, regulatory changes, and technological obsolescence. Such risks can undermine the achievement of investment objectives, as the longer duration increases the susceptibility of the project to external uncertainties and disruptions. Prolonged project durations are often accompanied by cost escalation, driven by factors such as inflation, resource shortages, and changing market dynamics. These cost escalations can erode project profitability and diminish the

likelihood of achieving investment objectives, contributing to the negative correlation between Time and Investment Objective Realization.

In rapidly evolving industries, time-to-market is critical for maintaining competitiveness. Projects characterized by extended timelines might lag behind competitors, resulting in lost market share and diminished returns on investment. This competitive pressure point out the negative correlation between Time and Investment Objective Realization as organizations strive to expedite project delivery to capture market opportunities effectively. The negative correlation between Time and Investment Objective Realization highlights the intricate balance between project duration and the realization of investment objectives. By recognizing and understanding this correlation, organizations can strategically manage project timelines, mitigate risks, and allocate resources optimally to increase the probability of meeting investment objectives within the desired timeframe.

Lastly, a notable correlation is identified between Scope/Quality of PSMS and User Satisfaction of IMPC. This positive correlation, characterized by a coefficient of 0.408, signifies the symbiotic relationship between project scope/quality and customer satisfaction. At a significance level of 0.001, this correlation underlines the fundamental role of delivering high-quality project outcomes in driving customer satisfaction and loyalty, reaffirming the intrinsic link between project performance and customer-centricity. Several points can elucidate why Scope/Quality and User Satisfaction are positively correlated. A well-defined project scope and high-quality deliverables are more likely to align with customer expectations. When project outcomes meet or exceed predefined scope and quality standards, customers are more satisfied with the results, leading to a positive correlation between Scope/Quality and User Satisfaction.

Projects characterized by comprehensive scope and high-quality deliverables often result in products or services that are functionally robust and user-friendly. Enhanced functionality and usability contribute to improved user experiences, fostering higher levels of satisfaction among customers. A thorough project scope and adherence to stringent quality standards minimize the occurrence of defects and the need for rework. By delivering products or services that meet quality expectations from the outset, organizations can mitigate customer dissatisfaction stemming from issues such as defects, errors, or functionality gaps.

Customers perceive greater value in products or services that fulfill their needs comprehensively and adhere to stringent quality standards. A well-defined project scope ensures that customer requirements are adequately captured and addressed, while high-quality deliverables enhance perceived value and utility, thereby fostering higher levels of satisfaction. Moreover, projects that prioritize scope definition and quality assurance contribute to positive brand perception and reputation. Organizations that consistently deliver high-quality products or services aligned with customer expectations are more likely to earn customer trust and loyalty, resulting in increased satisfaction levels.

Satisfied customers are more likely to become repeat customers and advocates for the organization, fostering long-term relationships and driving business growth. By focusing on scope clarity and delivering quality outcomes, organizations can nurture positive customer relationships, leading to sustained satisfaction and loyalty. In essence, the positive correlation between Scope/Quality and User Satisfaction highlights the critical role of project scope definition and quality assurance in driving customer satisfaction and loyalty. By prioritizing these aspects throughout the project lifecycle, organizations can enhance customer experiences, strengthen brand reputation, and achieve sustainable business success.

These correlations represent nuanced adjustments aimed at refining the PS framework, enhancing its predictive power, and aligning it more closely with real-world dynamics. By incorporating these correlations, organizations can steer the intricacies of project management with heightened efficacy, strategic foresight, and a deeper understanding of the multifaceted interdependencies shaping project outcomes.

The refined multidimensional PS framework delivered through this study has several actionable insights for both project teams and strategic leadership. Firstly, organizations should recalibrate their success metrics away from rigid delivery targets, integrating sustainability outcomes, stakeholder alignment, and project value realization into performance frameworks. This approach is supported by recent thinking on the “re-meaning” of project success, which advocates for sustainability and long-term value as core success dimensions [167].

Secondly, the role of team engagement and capability development cannot be overstated. The effectiveness of motivational and developmental indicators, such as team member motivation, skill improvement, and growth, occurs in tandem with supportive stakeholder engagement and

cohesive team-building efforts. While sustainable project management correlates positively with outcomes, the impact is moderated by engagement factors [168], suggesting that success emerges from both process and people dynamics.

Thirdly, emphasizing customer-centric outcomes – such as satisfaction, deliverable uptake, and problem remediation – can elevate project success from task completion to value delivery. End-user adoption and satisfaction not only reinforce immediate outcomes but also support repeat business and longer-term impact. Modern frameworks increasingly recognize this shift in stakeholder expectations [167].

Fourthly, treating projects as strategic investments, rather than isolated task sets, can improve decision-making and governance. Evaluating success through metrics like perceived worth and investment realization fosters alignment with organizational strategy and ensures resource allocation promotes long-term value rather than short-term output. Furthermore, acknowledging and proactively managing trade-offs between interrelated indicators such as time vs. cost, scope vs. satisfaction, and timeline vs. investment realization, is essential. These inter-factor correlations highlight the importance of systems thinking in project governance, ensuring decisions account for complexity and interconnected outcomes [167]. This robust framework provides a path for organizations to move from traditional delivery-focused success assessment to integrated, value-driven governance, driving sustainable success and strategic excellence.

6.5 Theoretical implications

From a theoretical perspective, this research aims to provide a comprehensive framework for assessing the impact of SW on PS (PSMS, IMPT, IMPC, PSIS) through the integration of IS and WA. The combination of these factors enables a thorough analysis of the elements driving SW effectiveness. The methodological rigor, incorporating CFA and SEM, strengthens the credibility of the findings. Conducting PLS-SEM analysis allows for a detailed examination of the hypotheses underlying the model, specifically, 23 out of 24 hypotheses were supported.

The impact of WA on IS highlighted the key role of adaptability stated in similar work [143], showcasing a significant positive influence on Net Benefit and explaining 45% of the variation in combination with System Quality. In contrast, Resiliency failed to exhibit a substantial effect on

Net Benefit, challenging the assumptions posited in H1b. This is different with respect to similar work [142], showcasing the variability of these factors across geographies and sectors. Proactivity, on the other hand was examined in terms of its impact on Use as the research tapped in the specific characteristics of this factor and it demonstrated a noteworthy positive effect accounting for 36% of the variation together with System Quality and Net Benefit, suggesting that proactive approaches play a crucial role in enhancing utilization and that proactive employees exhibit a propensity to use IS, leveraging the “Intent to use” aspect of the factor. This is in line with similar research that highlight the importance of Proactivity on IS [142].

Further scrutinizing the impact of IS [16] as the factor ultimately impacting identified key drivers of PS – PSMS, IMPT, IMPC, and PSIS – revealed uniformly positive outcomes, supporting hypotheses H2a through H2d. This suggests that the use of IS in project settings generates benefits for users and has a significant positive effect on project outcomes. However, the study also brought to light notable negative influences. Adaptability, while positively contributing to certain outcomes, exhibited adverse effects on PSMS, IMPT, IMPC, and PSIS. These negative associations highlight the complexities when measuring the impact of the workforce on PS and certainly need to be studied further, perhaps by delving deeper into the specific enablers of WA [127]. Therefore, while the connection had a significant impact, it was the opposite than expected. Conversely, both resiliency and proactivity emerged as positive contributors to the key PS dimensions as expected, supporting hypotheses H3.2a to H3.3d [70, 169]. The coefficients and significant t-values emphasize the substantial impact of these attributes on achieving PS.

In order to understand in more detail why Adaptability exhibited results contrary to expectations, it is important to contextualize different scenarios that might lead to this outcome. Although adaptability is typically associated with enhanced responsiveness to change, recent research indicates that in high-complexity environments, adaptive behavior may degrade performance if not supported by coherent team structures or effective coordination mechanisms [170]. For instance, agent-based simulations show that in complex settings, high individual learning or adaptability can reduce team performance when coordination is lacking, especially under time pressure or high interdependence [171]. Similarly, qualitative research on remote and hybrid software teams highlights how uncoordinated adaptive behaviors can fragment workflows and weaken project coherence when shared routines and norms are absent [172].

Moreover, under extreme external stress, such as during the COVID-19 pandemic, adaptive capacity may lose effectiveness [173]. A global longitudinal study found that pandemic-related stressors, such as uncertainty and emotional strain, significantly undermined the positive effects of adaptive behavior, unless buffered by strong self-regulation and psychological resilience [174]. In such conditions, adaptability can become reactive and misaligned with team goals, particularly when individuals face role ambiguity or insufficient support from leadership and HR systems [175].

Additionally, without robust coordination frameworks, well-intended adaptive behavior may disrupt team dynamics. When individuals respond to perceived change independently without aligning with the broader team, workflow imbalances and inefficiencies can emerge. This “adaptive divergence” may lead to communication breakdowns and overload, particularly in distributed or loosely structured teams [171, 172]. Therefore, adaptability, while valuable, must be embedded within organizational processes, supported by clear norms, inclusive leadership, and coordinated structures to contribute meaningfully to project success.

The model explains a staggering 98% of the variation in PSIS, leading to the conclusion that IS and WA are crucial in the long-term and when evaluating the financial outcome of the project. Moreover, the model accounts for elevated levels of variation also for PSMS and IMPC factors, 60% and 57% respectively, providing ample evidence that most of the aspects impacting these elaborate factors are accounted for. With 35% of variation for IMPT explained by the model it is evident that there are other factors influencing this element, although as mentioned this value does surpass the 26% threshold to be considered large [159]. Examination of the updated DeLone and McLean [30] Model of IS Success yielded further insights. System quality exhibited a significant positive effect on User Satisfaction, Use/Intent to Use, and Net Benefit. Additionally, Net Benefit was found to positively impact both User Satisfaction and Use/Intent to Use, highlighting the cascading effects of successful IS.

The study also distinguishes the direct and indirect effects on PS, because employees are the main users of IS [120], their agile qualities were measured impacting IS leading to indirect effects on PS. One of the most interesting results that should be further examined regards Adaptability, as it had a positive indirect effect while having a negative direct effect on PS, which insinuates that IS corrects the impacts of Adaptability, underlining the multi-dimensional complexities of PS [15].

The theoretical implications of this study emphasize the importance of aligning workforce adaptability with the systems in place to achieve long-term PS. A growing body of literature validates these findings, suggesting that adaptability, although beneficial for short-term adjustments, may yield negative effects on long-term project outcomes if not effectively managed. Therefore, organizations must not only invest in IS but also in continuous training and development programs that enhance adaptability without compromising other key aspects such as stability and consistency in project delivery.

6.6 Practical implications

This research provided a model to evaluate the factors necessary to achieve PS through the use of SW, assessed through the capacities of IS and the agility of the workforce, with the aim to guide companies in strategic decision-making regarding the adoption of SW. The results present a nuanced perspective, emphasizing the importance of adaptability and proactivity in adopting IS, in line with similar research [142], and highlight the importance of adequate IS [30] that lead to elevated levels of User Satisfaction and eventually PS [14, 99]. Furthermore, it enlightens the importance of having a resilient and proactive workforce to achieve PS [7]. This model seeks to offer clarity on the direction of investment – whether in traditional infrastructure or SW practices – companies can make informed choices that align with their goals, optimizing performance, efficiency, and WA in an ever-evolving project landscape.

To identify the optimal direction for investment and draw comprehensive conclusions, we meticulously analyzed various facets of the model scrutinized in this study. Firstly, from the perspective of human resources, companies should prioritize the recruitment and retention of individuals who exhibit proactive and resilient attributes for SW projects. These qualities have demonstrated a notable positive influence on PS and emerged as principal drivers thereof. This is in line with similar studies that stress the crucial role of workers [7]. Conversely, companies must ensure the availability of a robust IS infrastructure [30] to facilitate use and user satisfaction in order to effectively support the initiation and fruition of SW projects [14, 99]. While the impact of IS may not rival certain aspects of WA, it remains significant and beneficial.

This study supports findings from previous research [120], asserting that employees play an important role in driving PS, with IS serving as a supporting mechanism, albeit with substantial

importance. The effectiveness of IS should be seen not merely as functionality but as an enabler of digital fluency and workforce adaptability. Studies show that technology adoption yields performance benefits only when paired with innovation and resilient capabilities within organizations – that is, IS functions as an activated capability, not a standalone solution [141, 176]. Organizations should invest in integrated training programs and tools that align workforce agility with IS deployments, enabling teams to turn digital potential into tangible outcomes. Consequently, companies can achieve enhanced levels of PS by investing in IS infrastructure, and most importantly by emphasizing the cultivation of proactive and resilient skill sets among their workforce to navigate and excel in SW project environments compared to traditional approaches. Hybrid and remote work arrangements are no longer temporary, they shape modern project contexts. Team and organizational resilience depend on creating conditions where workforce agility can emerge organically in hybrid modes. Global surveys identify team agility and leadership quality as the top predictors of resilience in software projects operating remotely [177]. Complementing this, qualitative research on hybrid software teams reveals that team maturity, and hence resilience, depends heavily on interaction patterns, cohesion, and coordination support [178]. Accordingly, companies must adopt governance structures and routines that strengthen virtual collaboration, peer support, and collective decision-making.

Achieving workforce agility in SW settings requires robust HR support, particularly for work-from-home success. Agile work characteristics (e.g., autonomy, rapid feedback, and adaptability) have a measurable positive impact on remote work outcomes, conditioned by targeted HR interventions such as coaching, tailored support, and mental well-being resources [179]. Additionally, flexible work arrangements (like remote schedules and adaptive hours) cultivate work-life balance and trust, thereby enhancing engagement and resilience across the organization [177].

To sustain performance in remote and hybrid team environments, companies should intentionally build social cohesion and psychological safety. Organizational guidance highlights practices such as scheduled “creative breaks”, informal check-ins, and open feedback sessions to mimic the serendipity of in-office interaction even remotely [120]. These practices promote team bonding, continuous learning, and shared team purpose, helping to align workforce agility with long-term project success. As smart-working projects intertwine technology, team dynamics, and stakeholder value, organizations must adopt systems thinking. Evidence suggests that digital

transformation yields performance only when complemented by innovation and resilience, not implemented in isolation [63, 176]. Strategic decision-making frameworks should therefore balance infrastructure investments with workforce enablement and project governance.

High-performing organizations operate as smart systems where digital competency and WA reinforce each other to drive innovation and sustained advantage. Digital competency combined with WA equips organizations to thrive amid turbulent environments [180]. Viewing your model through this lens, investments in SW and IS infrastructure should be part of building broader organizational digital maturity, not simply as project enablers. By aligning IS investments with WA development, embedding supportive policies for hybrid working, fostering social cohesion, and applying systems governance thinking, organizations stand to realize more than operational success, they build sustainable and strategic capability. This enables projects not only to be completed efficiently, but also to generate lasting value, learning, and performance excellence.

7. Conclusion

7.1 Key findings

In conclusion, the study presents a comprehensive model demonstrating the interconnected roles of WA and IS in promoting PS under SW conditions. As organizations navigate increasingly complex and volatile business landscapes, the capacity to integrate advanced ISs with a highly adaptable workforce will remain essential. However, the mixed results related to adaptability suggest that more work is needed to optimize workforce behaviors that enhance PS across various contexts. Therefore, based on the comprehensive analysis and discussion, several key conclusions can be drawn about the impact of SW on PS through the perspectives of IS and WA. The strong influence of WA across all aspects of the research framework confirms the hypothesis that employees are the driving force behind PS, with IS serving as a supportive and influential tool.

Key findings include the positive impact of Proactivity on Use/Intent to use, indicating that engaged users are the ones who benefit most. Adaptability positively influences Net Benefit, demonstrating the advantage of being able to use different IS for various tasks. Interestingly, while Adaptability negatively influences PS directly, it positively influences PS when mediated by IS, highlighting the crucial role IS play in converting this employee characteristic into positive performance. Resilience, although not statistically significant in its impact on IS, profoundly affects PS, underscoring the importance of having a workforce capable of perseverance, especially in the long term, where resilience shows the strongest impact on long-term success measures (PSIS).

The findings emphasize the importance of IS success, as User Satisfaction translates into positive PS at all levels. This implies that a robust IS framework, combined with a balanced workforce in terms of agility skills, is essential for achieving PS in a SW setting. Employers should prioritize recruiting and retaining proactive and resilient individuals to operate effectively in the SW environment while maintaining PS. Additionally, investing in IS is crucial for facilitating successful project completion.

From a theoretical perspective, this research contextualizes SW through IS and WA, providing a nuanced and comprehensive framework for measuring the impact of SW on PS. It empirically explores and connects different proven theoretical models – WA framework, DeLone

and McLean Model of IS Success, and PS. In addition, it offers a nuanced approach to measuring PS by combining two existing models into a practical, comprehensive, and unbiased unique model.

Overall, this study advances a comprehensive understanding of the factors affecting PS in the context of SW, highlighting the pivotal role of IS infrastructure and the nuanced dynamics of WA. By addressing the identified limitations and exploring future research avenues, organizations can refine their strategies for project management in an increasingly digitalized and agile environment, ultimately optimizing performance, efficiency, and PS.

7.2 Limitations and future work

While this study offers valuable insights into the SW factors affecting PS through the lens of IS and WA, addressing some avenues suggested by Uraon et al. [23], several limitations must be acknowledged that may influence the scope and generalizability of the findings. First, the reliance on data from a single company may restrict the applicability of the conclusions to broader contexts. Future research should aim to broaden the sample size, focusing on industry specific factors delving deeper and providing tailored insights, and exploring potential variations across different organizational settings.

Another limitation lies in the cross-sectional design of the study, which limits the ability to establish causal relationships between the variables under investigation. Longitudinal studies or experimental designs could provide more robust evidence regarding the causal pathways between IS capabilities, workforce attributes, and PS. Moreover, while our study examined the overarching effects of IS and WA on PS, future research could explore the role of specific technological interventions or strategies in driving project outcomes. Technology-specific studies could offer a deeper and more detailed understanding of the challenges and benefits linked to different IS or methodologies in the context of SW projects.

Additionally, our research focused on the context of a specific economy or country, which may restrict the generalizability of our findings to different economic contexts with distinct socio-cultural, political, and economic dynamics. Future studies could adopt a comparative approach, examining how variations in the economic landscape influence the relationship between IS investments, workforce dynamics, and PS across different countries or economic systems.

In light of these limitations, future research avenues are abundant [66]. Broadening the sample to encompass diverse industries, conducting technology-specific studies, and exploring the causal mechanisms underlying the relationships between IS, WA, and PS are critical steps towards advancing our understanding of effective strategies for project management in an increasingly digitalized world. Based on the intriguing results surrounding Adaptability, future studies could further investigate the impact of this component on PS and the various driving aspects.

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План третмана података

Назив пројекта/истраживања
The Impact of Smart Working on Project Success: The role of Information System Success and Workforce Agility
Назив институције/институција у оквиру којих се спроводи истраживање
a) University of Novi Sad, Faculty of Technical Sciences
Назив програма у оквиру ког се реализује истраживање
Industrial Engineering and Engineering Management
1. Опис података
<p><i>1.1 Врста студије</i></p> <p><i>Укратко описати тип студије у оквиру које се подаци прикупљају</i> Doctoral dissertation</p> <p>1.2 Врсте података а) квантитативни б) квалитативни</p> <p>1.3. Начин прикупљања података а) анкете, упитници, тестови б) клиничке процене, медицински записи, електронски здравствени записи в) генотипови: навести врсту _____ г) административни подаци: навести врсту _____ д) узорци ткива: навести врсту _____ ђ) снимци, фотографије: навести врсту _____ е) текст, навести врсту _____ ж) мапа, навести врсту _____ з) остало: описати _____</p> <p>1.3 Формат података, употребљене скале, количина података</p> <p>1.3.1 Употребљени софтвер и формат датотеке: а) Excel фајл, датотека: xlsx б) SPSS фајл, датотека: spv, amw в) PDF фајл, датотека _____ д) Текст фајл, датотека: docx е) JPG фајл, датотека _____ ф) Остало, датотека _____</p> <p>1.3.2. Број записа (код квантитативних података)</p> <p>а) број варијабли 11 б) број мерења (испитаника, процена, снимака и сл.) 201</p>

1.3.3. Поновљена мерења

- а) да
- б) не**

Уколико је одговор да, одговорити на следећа питања:

- а) временски размак између поновљених мера је _____
- б) варијабле које се више пута мере односе се на _____
- в) нове верзије фајлова који садрже поновљена мерења су именоване као _____

Напомене: _____

Да ли формати и софтвер омогућавају дељење и дугорочну валидност података?

а) Да

б) Не

Ако је одговор не, образложити _____

2. Прикупљање података

2.1 Методологија за прикупљање/генерисање података

2.1.1. У оквиру ког истраживачког нацрта су подаци прикупљени?

- а) експеримент, навести тип _____
- б) корелационо истраживање, навести тип _____
- ц) анализа текста, навести тип _____
- д) остало, навести шта Google forms**

2.1.2 Навести врсте мерних инструмената или стандарде података специфичних за одређену научну дисциплину (ако постоје).

2.2 Квалитет података и стандарди

2.2.1. Третман недостајућих података

- а) Да ли матрица садржи недостајуће податке? Да **Не**

Ако је одговор да, одговорити на следећа питања:

- а) Колики је број недостајућих података? _____
- б) Да ли се кориснику матрице препоручује замена недостајућих података? Да Не
- в) Ако је одговор да, навести сугестије за третман замене недостајућих података

2.2.2. На који начин је контролисан квалитет података? Описати

I have used an electronic system for data entry. To validate the input data, I applied predefined rules and criteria to ensure accuracy at the moment of entry (e.g., mandatory fields, allowed value ranges). After collecting the data, I used the following methods:

1. **Error detection and correction** – Checking value ranges, identifying missing data, and detecting illogical values.
2. **Duplicate and anomaly detection** – Identifying and eliminating duplicate entries or anomalies.
3. **Consistency and completeness checks** – Ensuring all data is consistent (e.g., a birthdate cannot be in the future) and verifying that no critical information is missing.

2.2.3. На који начин је извршена контрола уноса података у матрицу?

3. Третман података и пратећа документација

3.1. Третман и чување података

3.1.1. Подаци ће бити депоновани у _____ репозиторијум.

3.1.2. URL адреса _____

3.1.3. DOI _____

3.1.4. Да ли ће подаци бити у отвореном приступу?

- a) Да
б) Да, али после ембарга који ће трајати до _____
в) **Не**

Ако је одговор не, навести разлог

The data will be used exclusively for scientific purposes, which will be presented and described in the dissertation, and in scientific papers, which will be published at domestic and international conferences and domestic and international journals.

3.1.5. Подаци неће бити депоновани у репозиторијум, али ће бити чувани.

Образложење

3.2 Метаподаци и документација података

3.2.1. Који стандард за метаподатке ће бити примењен? _____

3.2.1. Навести метаподатке на основу којих су подаци депоновани у репозиторијум.

Ако је потребно, навести методе које се користе за преузимање података, аналитичке и процедуралне информације, њихово кодирање, детаљне описе варијабли, записа итд.

3.3 Стратегија и стандарди за чување података

3.3.1. До ког периода ће подаци бити чувани у репозиторијуму? _____

3.3.2. Да ли ће подаци бити депоновани под шифром? Да Не

3.3.3. Да ли ће шифра бити доступна одређеном кругу истраживача? Да Не

3.3.4. Да ли се подаци морају уклонити из отвореног приступа после извесног времена?

Да Не

Образложити

4. Безбедност података и заштита поверљивих информација

Овај одељак МОРА бити попуњен ако ваши подаци укључују личне податке који се односе на учеснике у истраживању. За друга истраживања треба такође размотрити заштиту и сигурност података.

4.1 Формални стандарди за сигурност информација/података

Истраживачи који спроводе испитивања с људима морају да се придржавају Закона о заштити података о личности (https://www.paragraf.rs/propisi/zakon_o_zastiti_podataka_o_licnosti.html) и одговарајућег институционалног кодекса о академском интегритету.

4.1.2. Да ли је истраживање одобрено од стране етичке комисије? Да **Не**

Ако је одговор Да, навести датум и назив етичке комисије која је одобрила истраживање

4.1.2. Да ли подаци укључују личне податке учесника у истраживању? Да Не

Ако је одговор да, наведите на који начин сте осигурали поверљивост и сигурност информација везаних за испитанике:

а) Подаци нису у отвореном приступу

б) Подаци су анонимизирани

ц) Остало, навести шта

5. Доступност података

5.1. Подаци ће бити

а) јавно доступни

б) доступни само уском кругу истраживача у одређеној научној области

ц) затворени

Ако су подаци доступни само уском кругу истраживача, навести под којим условима могу да их користе:

The conditions under which the data can be used are referencing a scientific paper or dissertation.

Ако су подаци доступни само уском кругу истраживача, навести на који начин могу приступити подацима:

Data can be accessed by searching electronic or printed collections, journals, and by providing data by authors.

5.4. Навести лиценцу под којом ће прикупљени подаци бити архивирани.

6. Улоге и одговорност

6.1. Навести име и презиме и мејл адресу власника (аутора) података

Marko Samardzic, samardzic.m12@gmail.com

6.2. Навести име и презиме и мејл адресу особе која одржава матрицу с подацима

Marko Samardzic, samardzic.m12@gmail.com

6.3. Навести име и презиме и мејл адресу особе која омогућује приступ подацима другим истраживачима

Marko Samardzic, samardzic.m12@gmail.com