POLITECNICO DI TORINO

Master's Degree in Engineering and Management

Master's Degree Thesis

The Impact of Integrated Supply Chain Platforms on Project Management Criteria: A Study of Time, Cost, Risk Management in Construction Projects

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THE ACADEMIC YEAR 2023/2024

Abstract

In the competitive construction industry, effective supply chain management (SCM) is crucial. This study investigates the impact of Integrated Supply Chain Platforms (ISCPs) on project outcomes using Structural Equation Modeling (SEM) based on empirical data from project managers. Focusing on project-level dynamics, the research evaluates how ISCPs influence time, cost, and risk management. The findings reveal a significant positive correlation between ISCP implementation and enhanced project performance, including improved time management, precise cost control, and robust risk mitigation.

The study emphasizes the strategic importance of information in SCM, showing its role in operational organization and future planning. Information is a vital tool for decision-making and growth in supply chain businesses, enabling better control over suppliers and improved SCM capabilities. Information is used to organize daily operations related to manufacturing, storage, positioning, and transportation, as well as to forecast and plan future demand. Effective information dissemination and transmission can enhance all SCM components. A key factor in SCM improvement is the use of information technology for accurate and timely information sharing.

This comprehensive analysis of ISCPs' impact on project-level performance marks a new era of digital integration in construction SCM practices. The implications extend beyond academia, providing actionable insights for industry practitioners aiming to leverage technology for project success and sustainability. The study highlights the critical role of information in SCM, enabling better supplier relationship management and enhanced capabilities. Focusing on the project level, it offers valuable insights into the benefits of integrated software solutions for SCM.

The primary objective of this research is to measure the effectiveness of ISCPs in managing the supply chain within the construction industry and their impact on project management. The study addresses the following objectives: How does ISCP adoption affect overall project performance and success rates? What specific time management benefits do ISCPs provide compared to conventional supply chain techniques? How do ISCPs improve cost management compared to traditional SCM techniques? How do ISCPs enhance risk management compared to traditional SCM methods? Based on a survey of project managers in Italy's construction industry, the research uses SEM to analyze the data and assess ISCP usage on various project management criteria, such as time, cost, and risk management, and overall project performance.

Acknowledgments

First and foremost, I would like to express my deepest gratitude to my family, who have been the hope of my life and my constant source of motivation. I would like to express my heartfelt gratitude to my parents; their unwavering support, self-confidence instilled in me, and belief in my abilities have been instrumental in my journey. This work is dedicated to you.

I am sincerely thankful to my supervisors, Prof. Giovanni Zenezini and Prof. Gabriel Ernesto Castelblanco Bolivar, for their invaluable guidance, insightful feedback, and continuous encouragement. Their expertise and mentorship have been crucial in shaping this research and bringing it to fruition.

I extend my heartfelt thanks to the faculty and staff of the Politecnico di Torino for providing a stimulating academic environment and the resources necessary for this research.

I am also grateful to all the project managers and professionals in the Italian construction industry who participated in the surveys and shared their valuable insights and experiences. Their cooperation and willingness to contribute to this study were essential to its success.

Contents

Abbreviations

Abbreviation	Full Form
ERP	Enterprise Resource Planning
SC	Supply Chain
SCM	Supply Chain Management
SEM	Structural Equation Modeling
ISCP	Integrated Supply Chain Platform
ISCMP	Integrated Supply Chain Management Platform
TM	Time Management
CM	Cost Management
RM	Risk Management
PM	Project Management
SCV	Statistical Conclusion Validity
IT	Information Technology
ISCPA	Integrated Supply Chain Platform Adoption

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Chapter 1 : Introduction

This chapter introduces the research project, providing a summary of the investigation and its key components.

1.1. Background

Modern supply chain (SC) management increasingly relies on information as a crucial driver of decision-making, ultimately shaping the prosperity and growth of enterprises (Doroudchi & Nikmehr, 2007)[1]. For companies facing SC challenges, information serves as a valuable tool to enhance supplier oversight and strengthen overall SCM effectiveness (Kashyap, 2011)[1]. Within the realm of supply chain operations, information plays two critical roles (Mashreghi & Nahavandi, 2010)[1]:

1. **Supporting day-to-day functions**: This encompasses essential activities like manufacturing, storage, positioning, and transportation.
2. **Enabling forecasting and planning**: This allows companies to predict future demand and take necessary steps to meet these requirements.

Effective dissemination and transmission of information have the potential to enhance all aspects of SCM. A crucial step in improving SCM implementation is harnessing information technology to ensure accurate and timely information exchange. Precise information holds significant promise for enhancing planning and operational decision-making. Previous studies have extensively investigated systems aimed at consolidating internal data processing, merging operational data, and integrating enterprise functions (Adaileh & Abu-alganam, 2010)[2]. However, as companies strive for greater integration and efficiency in their supply chain pursuits, a broader concept known as Integrated Supply Chain Management Platforms (ISCMPs) has gained traction. These platforms go beyond traditional systems by providing seamless integration not only within internal operations but also with external stakeholders such as customers and suppliers. ISCMPs emerge as indispensable tools for ensuring supply chain coherence by delivering accurate and timely information across the entire network.

A company's internal data holds immense value, and integrated systems serve as crucial tools to establish seamless connections with customers, suppliers, or both. These systems facilitate the delivery of accurate and timely information, ensuring supply chain integrity. As described by Kashyap (2011), these systems act as a collection of management tools that effectively balance supply and demand. Moreover, they enable cross-functional integration across various departments such as sales, marketing, and operations, leveraging established business processes for effective decision-making. These systems also connect buyers and sellers, creating a seamless supply chain through proven commercial techniques[1].

Decision-making processes are further enhanced by cross-functional integration within various departments, including sales, marketing, production, operations, logistics, purchasing, financing, new product development, and human resources. This integrated approach allows businesses to operate with increased productivity and customer service while simultaneously reducing expenses and inventory, paving the way for successful e-commerce ventures. The literature on integrated systems effectiveness typically focuses on two key components (Adaileh & Abu-alganam, 2010; Ifinedo & Nahar, 2009)[2][3]:

1. **Technical Effectiveness**: This assesses the successful installation and implementation of the system, encompassing project management indicators, time estimation, and cost estimation.
2. **Success Elements**: This analyzes the positive impact of integrated systems within organizations post-adoption, focusing on their application to improve operational efficiency.

Gable et al. (2003), inspired by the Delon and McLean (1992) model of information system success, developed a tailored framework to measure integrated system success. This model emphasizes factors such as organizational effectiveness, individual influence, system quality, and information quality, streamlining the assessment process while ensuring comprehensive evaluation[4][5].

The construction industry, despite its long history and perceived stability, faces challenges due to its complex management processes and reliance on traditional methods. This results in poor performance and limited profit margins (Cox and Ireland, 2002)[6]. Studies estimate that over 80% of a typical worker's time is spent on non-productive tasks (Josephson & Saukkoriipi, 2005). This highlights the need for innovative approaches to improve productivity.

Construction projects often involve intricate supply chains with multiple suppliers and subcontractors. Any delays in material delivery can significantly impact project timelines and potentially lead to postponements, affecting the overall project outcome. Therefore, effective supply chain management is crucial for achieving optimal project completion. O'Brien and Fischer (1993) emphasize the high potential of strengthening the supply chain throughout the project lifecycle to increase construction project productivity[7]. This has led to a growing emphasis on collaborative, mutually beneficial supply chain partnerships and improving inter-organizational processes.

The implications of supply chain integration on various aspects, including performance and resilience, have been extensively studied across different industries. The increasing adoption of digital platforms has further underscored the need for both intra- and extra-firm integration, which is now considered a key driver of business success (Kache & Seuring).

E-supply chain integration empowers organizations to seamlessly exchange real-time information, enhancing productivity, efficiency, and the ability to deliver faster and superior products/services. It also facilitates better supply-demand balance and cost reduction through improved coordination and information sharing. Empirical evidence presented by Rai, Patnayakuni, and Seth (2007) demonstrates that integrating supply chain processes leads to improved performance, particularly in terms of operational excellence and revenue growth. Furthermore, a survey by European A.T. Kearney/WHU Logistics revealed that approximately 80% of European supply chain managers acknowledge the importance of integration for digitalizing their supply chains. Thus, integration plays a significant role in the concept of Digital Supply Chain (DSC).

Digital technologies offer promising solutions for enhancing supply chain processes and ensuring prompt responses to customer needs. Smart products like smartphones and tablets facilitate electronic data communication between companies and their supply chain partners, enabling real-time data analysis and informed decision-making. Xue et al. (2016) define DSC as a set of inter-organizational systems that companies use to digitize transactional and collaborative processes with their supply chain partners.

Big data and cloud computing are identified by Farahani et al. (2015) as significant technological advancements impacting the digital supply chain. Big data enhances supply chain visibility by providing a platform for real-time data analysis and performance tracking. Cloud technology enables storage and real-time processing of large data volumes, making information accessible to all supply chain participants. Compared to traditional IT solutions, cloud technologies offer swift acquisition and deployment without extensive infrastructure modifications, facilitating adaptable and agile operations.

The imperative of integrating advanced technologies into businesses is underscored by Deloitte AG (2015), citing significant benefits such as reduced operational costs, enhanced customer satisfaction, improved client retention, and the creation of efficient, adaptable, and responsive supply chains leading to shorter lead times and greater product availability. Lindgren (2015) further emphasizes the importance of embracing innovation and abandoning outdated operating models for achieving success.

Despite the increasing adoption of digital technologies, Büyüközkan and Göçer (2018) identify a research gap in the real-life application of Digital Supply Chain (DSC), particularly within the manufacturing sector. They highlight the diverse approaches and practices employed by different companies across industries, calling for further research to develop specific DSC sub-frameworks tailored to each industry. This will be crucial in enhancing the effectiveness of DSC and driving future industry trends.

DSC, as defined by Bhargava et al. (2013) and supported by Cecere (2016), is a combination of systems facilitating communication and transactions between global distribution organizations and their supply chain partners. Kinnet (2015) emphasizes the speed, intelligence, and value creation throughout the supply chain enabled by DSC. Moreover, Schrauf and Berttram (2016) argue that digitalization enhances supply chain value and enables the provision of more accessible and affordable services. Israelit et al. (2018) demonstrate that companies integrating digital technologies into their supply chains can rapidly improve service levels and achieve overall efficiency and productivity gains. McKinsey Digital (2015) highlights the role of DSC in enabling manufacturers to gain a deep understanding of customer behavior and establish a unique position within their ecosystem of partners, suppliers, and customers.

Porter and Heppelmann (2015) anticipate digitalization to play an increasingly significant role in managing and designing global supply chains, particularly those involved in value-adding activities such as production and logistics. Digitalization, as defined by Büyüközkan and Göçer (2018), represents the first phase of DSC, involving the use of digital technology and the transition of traditional businesses to digital models, generating new income streams. Isaksson et al. (2016) consider digitalization a technological force strengthening globalization in both economic and cultural aspects.

The digitization process can be divided into three stages: digitalization strategy, digital organization and culture, and digital operations (Corver & Elkhuizen, 2014). The digitalization strategy focuses on setting digital goals, formulating a strategy, and implementing it. The digital organization and culture stage involves analyzing current organizational and cultural aspects, managing the digital transformation, and transitioning to a digital state. Digital operations emphasize enabling workers, managing digital operations, and ensuring their effectiveness.

The application of SCM principles, extensively used in the production industry, is gaining traction in the construction sector (O'Brien, 1995). Researchers have reported that SCM can lead to better coordination, costing, and control within the industry. Cost and performance models, enhanced scheduling techniques, improved subcontractor coordination, and improved accounting and production control systems are among the benefits of SCM implementation.

A case study demonstrates the potential of SCM to deliver time and money savings in construction projects. Maintaining a collaborative approach among partners, sharing expertise and experiences, and utilizing a decision support system with a case-base of prior actions and risk management plans are key to maximizing these gains.

1.2. Aims and Objectives

This research aims to investigate the impact of Integrated Supply Chain Platforms (ISCPs) on project management criteria within the construction industry. Instead of focusing on firm-level effects, we narrow our focus to the project level, allowing for a more granular analysis of how individual projects benefit from or are potentially impacted by ISCP implementation.

Our primary research objective is to understand how ISCPs influence project management criteria, specifically time management, cost management, and risk management, within construction projects in Italy. This focus on individual project criteria allows us to avoid potential bias from aggregating performance across different projects and industries.

We will use a survey methodology to examine the validity of our proposed model and assess the degree of influence ISCP utilization has on various aspects of project management within the construction industry.

1.3. Research Questions

Guided by our research problem, we formulate the following research questions:

- **RQ1**: How does the adoption of Integrated Supply Chain Platforms (ISCPs) in construction projects affect overall project performance and success rate?
- **RQ2**: What specific time management benefits do construction projects gain when using ISCP compared to conventional supply chain techniques?
- **RQ3**: How do construction projects that use ISCP demonstrate more efficient cost management compared to projects that rely on traditional supply chain management techniques?
- **RQ4**: How do construction projects that use ISCP demonstrate better risk management compared to projects that rely on traditional supply chain management methods?
- **RQ5**: How do the results of using ISCP in time, cost, and risk management differ across construction projects in different European countries?
- **RQ6**: How do construction project managers perceive the impact of ISCPs on time, cost, and risk management, and what are their experiences of implementing and using such platforms?

1.4. Research Scope and Methodology

This research investigates the impact of Integrated Supply Chain Platforms (ISCPs) on project management criteria within the European construction industry, with a primary focus on the Italian market. Our study focuses specifically on the use of ISCP in the construction industry, excluding other industries, and on project-level outcomes rather than overall firm performance.

To gather insights, we conducted a survey targeting project managers within the Italian construction industry. The survey explored the influence of ISCP on time, cost, and risk management within construction projects.

We employed Structural Equation Modeling (SEM) to analyze the survey data, allowing for comprehensive statistical evaluation and model validation. Further details on the sample size, limitations, and specific SEM procedures will be elaborated upon in subsequent sections.

Research Scope

- **Geographical Scope**: The research focuses on the Italian construction industry, specifically on projects within urban and industrial centers.

- **Industry Focus**: The study examines integrated supply chain platforms (ISCPs) exclusively within the construction industry, encompassing various project types such as commercial, residential, infrastructure, and industrial projects.
- **Participants**: The research involves active participants within the Italian construction industry, including construction professionals, project managers, and representatives from construction firms who possess firsthand experience with ISCP adoption and implementation.
- **ISCP Aspects**: The research explores various aspects of ISCPs, including their adoption processes, success factors, benefits, key performance indicators, impact on time, cost, and risk management, and overall project performance outcomes.
- **Timeframe**: The study considers the implementation of ISCPs and their effects on project performance over a specific timeframe within the Italian construction industry, allowing for analysis of historical trends and recent developments in supply chain management practices.
- **Limitations**: The research acknowledges potential limitations in generalizability to other regions or industries due to its primary focus on the Italian construction sector. The study does not extend to a comprehensive exploration of ISCPs in other European countries or global contexts, maintaining a targeted focus on the Italian construction industry.

1.5. The Structure of the Thesis

This thesis presents a comprehensive investigation of the impact of Integrated Supply Chain Platforms (ISCPs) on project management criteria within the Italian construction industry.

- **Chapter 1: Introduction** sets the stage by outlining the research objectives, questions, and methodology, offering a clear roadmap for navigating the subsequent chapters.
- **Chapter 2: Literature Review** synthesizes existing knowledge, identifies research gaps, and lays the foundation for contributing new insights.
- **Chapter 3: Methodology** details the research approach, including data collection, sampling methods, and model development, ensuring transparency and rigor in the research process.

- **Chapter 4: Results** presents empirical findings derived from a survey of construction industry practitioners, complemented by statistical analysis and comparison with existing literature, enhancing clarity and accessibility.
- **Chapter 5: Discussion** interprets the results within the theoretical framework, offering insights into implications for construction project management and acknowledging study limitations. Additionally, recommendations for future research directions are provided.
- **Chapter 6: Conclusion** synthesizes key findings, underscores practical implications, reflects on the significance of the research, and provides closure to the thesis journey.

The research methodology employs Structural Equation Modeling (SEM) to analyze the data collected, aiming to discern the influence of ISCP adoption on project management criteria. Key variables representing both platform adoption and project management outcomes are identified, with a questionnaire designed to solicit insights from industry practitioners. The subsequent analysis involves developing an SEM model, testing hypothesized relationships, and assessing model fit, ultimately providing valuable insights for academia and industry practitioners alike.

Chapter 2 :Literature Review

2.1 Definition and Concepts

2.1.1 Supply Chain Management

SCM, emerging in the late 1980s and widely adopted in the 1990s, involves strategically coordinating production, inventory, logistics, and transportation among supply chain participants (Hugos, 2018)[23]. It aims to strike a balance between market responsiveness and operational efficiency. Essentially, it's a collaborative effort involving individuals and companies within a network of interconnected processes (Tommelein et al., 2003)[24]. Krajewski, Ritzman, and Malhotra (2007) define SCM as "the planning, organization, control, and motivation of resources engaged in the movement of services and materials throughout the supply chain." This collaboration considers factors like geography, customer base, products, and financial reporting (Bolstorff and Rosenbaum, 2012). SCM encompasses core business processes from raw material extraction to the end customer, including intermediate processing, transportation, and storage (Er, Tan, & Leong, 2012)[25]. This comprehensive approach emphasizes coordination and optimization across the entire supply chain to improve efficiency and meet market demands.

2.1.2 Integrated Supply Chain Platform (ISCP)

An Integrated Supply Chain Platform (ISCP) creates a common market space where suppliers, partners, and customers can collaborate to strategically coordinate, execute, and monitor the seamless flow of information, services, and products throughout the supply chain (Mathegu, 2017; Lambert & Cooper, 2000)[26]. ISCPs aim to enhance business operations by improving speed, agility, real-time control, and customer responsiveness[27]. This platform facilitates seamless data, material, and resource flow across the supply chain, enabling real-time coordination, transparency, and efficiency[28]. While offering collaboration tools, ISCP also presents challenges in integrating with business partners. ISCP focuses on inventory management within supply chain coordination, leveraging quantitative modeling and organizational insights to optimize ordering and logistic policies, ultimately reducing supply chain costs and promoting cooperation among partners[29].

2.1.3 Supply Chain Software Solutions

Various software solutions manage and optimize the material supply chain within SCM. These solutions streamline operations, improve efficiency, reduce costs, and enhance overall supply chain management. The coordination between supply chain planning and execution processes must be seamless, ensuring tight integration not only between each other but also with the existing ERP systems in place. The supply chain planning processes typically need transaction histories, budgets, and financial plan data from the ERP system to establish the decision parameters.

2.1.4 Project Management Criteria

Project management criteria encompass the essential elements of knowledge, skills, tools, and techniques employed in orchestrating project activities to fulfill project objectives. Project management involves the direction of project endeavors to produce desired outcomes. Project teams can employ diverse methodologies, such as predictive, hybrid, or adaptive, to attain these objectives[30]. Project management criteria are standards, factors, or criteria used to evaluate the success of a construction project, according to the PMBOK definition. They include parameters such as project scope, quality, schedule adherence, budget control, stakeholder satisfaction, and overall project performance. This article specifically examines the impact of an Integrated Supply Chain Platform on three important aspects: budget control, time management, and risk management[31].

2.1.5 Time Management

Time management in construction projects involves the efficient allocation and utilization of time resources to ensure project activities are completed within specified deadlines. It encompasses project scheduling, task sequencing, resource allocation, progress tracking, and schedule optimization. The project's success depends heavily on the appropriate implementation of time management procedures within the project team. Time management is mentioned as a crucial aspect of effective project management within the PMBOK framework. It encompasses This process includes planning the creation of the schedule, defining tasks, sequencing activities, estimating durations, developing a detailed timeline, and controlling the schedule throughout the project's duration.. Effective time management in PMBOK ensures projects are on track, avoiding delays and disruptions, and is essential for successful project execution[31]. Time management, as described by Jason Westland (2006), focuses on the aspect of overseeing and controlling the time employees invest in a project. This involves meticulous monitoring and regulation to ensure that tasks are completed efficiently and within set timeframes. On the other hand, Max Wideman (1990) offers a more expansive perspective, defining time management as the essential function of maintaining a suitable distribution of time across all stages of a project. This holistic view encompasses the entire lifecycle of a project, from its initial concept and development through to its execution and conclusion. Wideman's definition includes critical processes such as:

Time Planning: Establishing a framework for the project's timeline, including key milestones and deadlines.

Time Estimation: Predicting the amount of time required to complete various tasks and activities within the project.

Time Scheduling: Creating a detailed schedule that outlines when each task should start and finish, ensuring a logical sequence and resource allocation.

Schedule Control: Monitoring progress against the schedule, making adjustments as necessary to keep the project on track.

Together, these definitions underscore the importance of both monitoring individual contributions and managing the overall project timeline to achieve successful project completion.

[34]. In essence, time management is all about planning and controlling time throughout all stages of the project, and it plays a vital role in construction project management.

2.1.6 Cost Management

Cost management revolves around strategic planning, meticulous control, and vigilant monitoring of project expenditures. This encompasses a spectrum of activities, including cost estimation, budget formulation, real-time expense tracking, variance analysis, and the execution of measures to exercise command over costs. This systematic approach ensures projects remain faithful to the endorsed budget, curtails the risk of cost overruns, and optimizes the allocation of resources to achieve peak cost effectiveness. Aligned with the guidelines set forth in the Project Management Body of Knowledge (PMBOK) 7th edition, the project budget materializes from the consensus-based appraisals delineated for the project[35]. The insights delineated pertaining to estimation are seamlessly applied to the panorama of project costs, thus giving rise to a panoramic vista of cost estimates. The aggregation of these estimates takes the form of the cost baseline, a foundational cornerstone in project fiscal management. This bedrock of cost data is frequently apportioned across the tapestry of the project timeline, ingeniously mirroring the moments when these financial outlays will come to fruition. This strategic maneuver equips project managers with the ability to harmonize the fiscal resources allocated within a stipulated budgetary span with the choreographed cadence of project tasks. If fiscal constraints encircle a specific budget phase, a nuanced coordination of work rescheduling can be strategically orchestrated to harmonize in sync with these financial limitations. Cost management revolves around the strategic planning, meticulous control, and attentive monitoring of project expenditures. This systematic approach ensures projects remain faithful to the endorsed budget, curtails the risk of cost overruns, and optimizes the allocation of resources to achieve peak cost effectiveness.

2.1.7 Risk Management

Risk management in construction projects involves identifying, assessing, and managing potential risks and uncertainties that may impact project objectives. The construction process of a construction project is actually a process full of uncertainty and risk. Effective risk control will be one of the key elements for the success of construction project management, especially considering the long duration, involvement of many participating units, and complex environmental impacts. Any one of the activities or changes in any party involved in the project construction can affect the activities of the relevant parties. Risk management in PMBOK is defined as a systematic process of identifying, analyzing, and responding to project risks to ensure project success. It involves assessing risks, developing strategies to mitigate or exploit them, and continuous monitoring and control throughout the project[31]. Risk management encompasses activities such as risk identification, risk analysis, risk mitigation planning, and risk monitoring. By effectively implementing risk management practices, construction projects can minimize the likelihood and impact of potential risks, ensuring project success and reducing the possibility of unexpected events or disruptions[36].

2.1.8 Construction Projects

In both developed and developing countries, the construction industry is the sector of the economy that transforms various resources into constructed facilities ranging from residential to non-residential facilities through planning, design, construction, maintenance, and repair, and operation. These facilities play critical roles in the development process. Civil engineering projects, such as transportation infrastructure, power projects, irrigation, drainage, and water supply, may account for up to half of overall building production in developing countries. Housing accounts for less than a third of the overall output, with the remainder going toward the development of schools, factories, offices, hotels, and hospitals, among other items (Wells, 1986). Owners, architects, engineers, quantity surveyors, project managers, construction project managers, and general contractors include special trade subcontractors, domestic subcontractors, selected subcontractors, and all other project participants such as laborers, plant operators, and the like. The construction sector is recognized as a crucial participant due to the vast range of economic and social demands it meets, as well as the considerable contribution it contributes to the achievement of several main national goals. In essence, it is a service industry that obtains its inputs and outputs from sources outside its sector, with which it is frequently and complexly interrelated (Salleh, 2009; Moavenzadeh & Rossow, 1975). The development of the construction industry is an essential engine that supports growth because it contributes significantly to GDP, and its capacity and effectiveness to meet the demand of the national economy for physical infrastructure is an indicator of economic performance (Tanzanian Construction Policy, n.d.). The importance of building is derived from its contribution to national employment and the development of built infrastructure, both of which are essential to a nation's development.

2.2 The Theoretical Foundations

2.2.1 Integrated Supply Chain Platform Adoption (ISCPA) and Time Management (TM)

The research of Cornelia Droge clearly demonstrates the positive impact of Integrated Supply Chain Platform Adoption (ISCPA) on Time Management (TM) in construction projects. ISCPA, which incorporates both external strategic design integration and internal design-process integration, significantly improves project performance in terms of time. The connection between ISCPA and TM is undeniable in construction projects. Supported by the findings of Mandičák et al. (2021)[37], supply chain platforms in construction utilize big data and technology to streamline operations, ultimately leading to positive effects on project timelines. As emphasized by Hatmoko (2006), these platforms play a critical role in reducing delays. Without them, supply chain issues can cause significant delays, potentially reaching up to 67 days, which is a staggering 22% of the project's duration. The primary causes of these delays include material flow, labor allocation, and information dissemination. Notably, sourcing materials alone can lead to a median delay of 14 days, representing 5% of the project's duration (Hatmoko, 2006)[38].

However, Hatmoko's findings highlight the effectiveness of leveraging supply chain platforms for subcontracting, as this can lead to a remarkable 45% reduction in median delays, underscoring their importance in enhancing project efficiency. Therefore Adopting integrated supply chain platforms significantly contributes to effective time management in construction projects by streamlining processes, enhancing communication, and reducing delays. These platforms facilitate real-time information sharing among all stakeholders, enabling better coordination and quicker decision-making. By integrating various supply chain activities, such as procurement, logistics, and inventory management, construction projects can minimize downtime, anticipate potential disruptions, and maintain steady progress. Consequently, the overall efficiency and timeliness of project completion are greatly improved, leading to cost savings and higher client satisfaction.

2.2.2 Integrated Supply Chain Platform Adoption (ISCPA) and Cost Management (CM)

According to Peter Kelle's article, "The role of ERP tools in supply chain information sharing, cooperation, and cost optimization," Integrated Supply Chain Platform Adoption (ISCPA) emerges as a pivotal element for cost management within supply chains. ISCPA, an integral aspect of ERP systems, facilitates efficient data exchange among supply chain partners, enabling them to minimize overall supply chain costs. The article highlights the potential for cost optimization through ISCPA and offers quantitative insights[29]. The nexus between Integrated Supply Chain Platform Adoption (ISCPA) and Cost Management (CM) within construction projects is of paramount importance. As established by Mandičák et al. (2021)[37], supply chain platforms in construction leverage big data and technology to streamline operations, ultimately contributing to cost minimization. Furthermore, Hatmoko's research (2006) highlights that these platforms play a significant role in mitigating delays, which, in turn, impact costs[38]. Without supply chain platforms, projects can experience substantial delays, equivalent to a significant portion of the project's duration. Material flow, labor allocation, and information dissemination emerge as critical cost drivers. Particularly striking is that difficulties in sourcing materials alone can result in cost escalations of 5% of the project's budget. However, Hatmoko underscores that harnessing supply chain platforms to facilitate subcontracting can lead to substantial cost reductions. These findings emphasize the positive relationship between ISCPA and CM, affirming that integrated supply chain platforms are instrumental in optimizing cost management in construction projects.

2.2.3 Integrated Supply Chain Platform Adoption (ISCPA) and Risk Management (RM)

The relationship between Integrated Supply Chain Platform Adoption (ISCPA) and Risk Management (RM) in construction projects is a crucial aspect of project success. Mandičák et al.[37] (2021) highlight that supply chain platforms in construction, enriched by big data and technology, enhance project management integrity, ultimately mitigating risks. Concurrently, Hatmoko's research (2006) highlights the significant impact of integrated supply chain platforms on project efficiency, primarily by reducing delays closely associated with risk management. These platforms integrate various aspects of the supply chain, enabling proactive identification and mitigation of potential risks. This capability ensures smoother project execution by foreseeing and addressing issues before they escalate, thereby maintaining the project schedule. Ultimately, this enhances efficiency and reduces unforeseen costs. The alignment of risk management with project timelines underscores the essential role of integrated supply chain platforms in modern construction project management. [38]. Delays can trigger an array of risks, from cost overruns to contractual disputes. Thus, the adoption of integrated supply chain platforms enhances risk management by providing real-time visibility into the supply chain, enabling proactive risk mitigation measures, and ensuring smoother project execution. In essence, ISCPA contributes positively to risk management, enhancing the resilience and overall success of construction projects. In the study titled "Enhancing Risk Management in a Changing World: The Impact of Integrated Supply Chain Platforms," Agustina Calatayud underscores the importance of a connected supply chain and its significant impact on the smooth and continuous flow of materials, information, and finances. Calatayud identifies two primary drivers of this connectivity: information systems and physical infrastructure. The connectivity of information systems facilitates real-time risk detection, prevention, and swift responses, thanks to emerging digital technologies such as IoT, blockchain, and AI. Likewise, physical connectivity, dependent on infrastructure and logistics, is crucial for minimizing delays and disruptions.

2.3 Gaps in the Existing Literature

Based on previous studies and literature, several notable gaps in the existing literature related to Integrated Supply Chain Platforms (ISCPs) and their impact on European construction project management are identified:

- **Comprehensive Studies**: Existing literature lacks comprehensive studies specifically focused on the impact of ISCPs on project management criteria (time, cost, and risk management) in construction projects across European countries. Previous research often examines isolated aspects of supply chain or project management, neglecting the holistic impact of ISCPs.
- **Limited Empirical Studies**: More empirical research is needed to analyze real-world implementations of ISCPs in construction projects. Empirical studies can provide valuable insights into the actual effectiveness of ISCPs and their influence on project outcomes in diverse European contexts.
- **Comparative Studies**: Few studies compare different supply chain software solutions or ISCPs in terms of their impact on project management criteria. By directly comparing the effectiveness of various ISCPs, researchers and industry professionals can better understand which platforms are most suitable for specific project types or contexts.
- **Risk Management**: More research is needed to explore how ISCPs specifically impact risk management in construction projects, including enhancing risk identification, analysis, and mitigation strategies.

This study aims to address these gaps in the existing literature by focusing on the impact of ISCPs on project management criteria in European construction projects. Through empirical insights and consideration of the European context, including risk management implications, this research seeks to enrich the understanding of ISCPs' influence on construction project management practices in Europe.

Chapter 3 Research Methodology

In this chapter, we review existing research methods and choose the one that best fits our current study. Later, we will outline the steps we took to apply the selected method in our research.

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3.1 Research Methods Overview

Collis and Hussey argue that research can be classified into four categories: rationale, process, purpose, and outcome. The rationale category addresses whether the research shifts from specific to general or vice versa, categorizing it as either inductive or deductive. The second category, the process, describes the methods for gathering and analyzing data [39], and under this heading, research can be categorized as either qualitative or quantitative. The third category is the purpose, encompassing classifications such as analytical, descriptive, predictive, and exploratory. The fourth category, outcome, determines whether the research aims to advance knowledge or solve a specific problem [8].

- Explanatory or Analytical Research: This method extends descriptive research by explaining phenomena through measurement and understanding their interconnections. The most suitable questions in this category are "why" and "how."

- Descriptive Research: This type of study aims to identify and categorize specific details about a matter or concern, focusing on events in their natural state. Suitable questions include "where," "how much," "how many," "what," or "who."

- Predictive Research: This research aims to simplify the use of information by anticipating phenomena based on a hypothesis, estimating the likelihood of an event. Suitable questions include "where," "what," "who," "how many," and "how much."

- Exploratory Research: This type seeks to identify theories, concepts, or patterns and is used when there are few existing studies. Suitable questions to ask are "why," "how," "how much," "how often," and "where."

3.1.1 Quantitative and Qualitative Research

Depending on the methodology, research can be categorized as qualitative or quantitative. According to Creswell (2009), quantitative research involves using positivist claims to develop knowledge based on prior investigation, involving observation and measurement, cause-and-effect thinking, theory testing, reduction to specific variables, and the formulation of hypotheses with questions. This approach employs investigation strategies like surveys and experiments and gathers data on preexisting conditions. This type of research uses numerical data collection, analysis, and testing to understand a phenomenon [40]. Being deductive, this strategy is often better suited for mature or specialized study fields.

Creswell (2009) also discussed a mixed-methods approach, which bases knowledge claims on practical grounds (e.g., problem-centered, consequences-oriented). This approach allows for techniques involving sequential or concurrent data collection, using both numerical and text-based information to gain a comprehensive understanding of the research problem [40]. Further details on these three strategies can be found in Table 3.1.

Aspect	Qualitative Approach	Quantitative Approach	Mixed Method Approach
Philosophical Assumption	· Deductive knowledge · Corroborative knowledge claims · Conducive knowledge claims	· Post-positivist knowledge claims	· Programmatic knowledge claims
Strategies of Inquiry	· Phenomenology · Ethnography · Grounded Theory · Narrative Case	· Experimental · Surveys	· Concurrent · Sequential · Transformative
Study Method	· Emerging Approaches · Open-ended questions · Textual or Image data	· Predetermined methodologies · Closed-ended questioning · Numerical data analysis	· Both open and closed-ended questions · Both qualitative and quantitative approaches · Both emerging and predetermined
Practice of Research	· Gather participants' answers · Positions herself or himself · Highlights single concepts or phenomena · Brings personal value into the study · Studies the context or settings of participants	· Test the accuracy of findings · Create an agenda for changes · Cooperate with participants · Extract constructive meaning from the data · Test the validity of theories · Identify variables for the study · Link variables with questions and hypothesis · Use standards of reliability and validity · Measure and observe information numerically · Use impartial approaches · Use statistical procedures	· Gather both qualitative and quantitative data · Develop an explanation for mixing · Integrate data at different stages of inquiry · Present visual pictures of the process in the study · Employ practices of both quantitative and qualitative research

Table 3.1Mixed method, quantitative and qualitative research approaches

3.1.2 Inductive or Deductive Research

Research can be classified into two main types: deductive and inductive. According to Collis and Hussey (2013), deductive research starts with a theoretical and conceptual framework, which is tested through experimental observations, moving from general principles to specific instances[39].. In contrast, inductive research begins with specific observations and develops into broader generalizations, transitioning from particular instances to overarching conclusions.

Deductive research is often associated with the positivist approach, where hypotheses derived from existing theory are tested empirically. This method aims to verify or refute hypotheses, thereby contributing to the body of theoretical knowledge. The process typically follows these steps:

Theory Development: Formulate hypotheses based on existing theories.

Hypothesis Testing: Design experiments or observations to test the hypotheses.

Data Collection: Gather empirical data through various research methods.

Data Analysis: Analyze the data to determine whether the hypotheses are supported.

Conclusion: Draw conclusions that either support or refute the initial hypotheses, leading to the confirmation, modification, or rejection of the theoretical framework.

Inductive research, on the other hand, is commonly linked with the interpretivist approach, emphasizing understanding and meaning-making from the data. This approach is more exploratory and open-ended, often used in qualitative research. The inductive process typically involves:

Observation: Collect detailed and rich data from specific instances or cases.

Pattern Identification: Identify patterns, themes, and relationships within the data.

Theory Development: Develop broader generalizations and theories based on observed patterns.

Testing: Refine and test the emerging theories through further data collection and analysis.

Conclusion: Formulate conclusions that offer new insights and understanding, contributing to the development of new theories or concepts.

Both approaches are valuable and can complement each other, depending on the research context and objectives. Deductive research provides a structured way to test theories, while inductive research allows for the discovery of new theories and insights.

Research type	Classification base
Inductive or deductive research	Logic of the research
Qualitative or quantitative research	Process of the research
Analytical, descriptive, predictive or exploratory research	Purpose of the research
Basic or applied research	Research outcome

Table 3.2 Main Research Classifications (Collis and Hussey, 2013

3.2 Research Approach and Strategy

Quantitative research involves a methodical and empirical exploration of quantitative attributes, phenomena, and their interrelationships. As per Mouton (1983), cited by Brynard et al. (2014) and an anonymous source, this approach is associated with analytical studies aimed at deriving universal conclusions [41].

Quantitative research operates on the premise of formulating research hypotheses and empirically testing them using specific data sets, embodying a deductive and particularistic nature (Frankfort-Nachmias & Nachmias, 1992). Its objective is to construct and validate mathematical theories, models, and hypotheses pertaining to the subject under study.

Moreover, quantitative research scrutinizes variables within a sample population, elucidating the relationships between variables through statistical measures such as correlations, relative frequencies, or mean differences. It primarily focuses on theory testing. This method applies principles akin to those in the physical sciences to ensure objectivity, generalizability, and reliability, making it suitable for scenarios where variables can be measured, hypotheses can be formulated and tested, and conclusions can be drawn from representative samples of the broader population (Liebscher, 1998; Weinreich, 2006) [42]. The data in quantitative research is typically generated through quantification and measurement.

Within the quantitative research methodology, the researcher is perceived as external to the research process, with results presumed replicable irrespective of the researcher involved. This approach's key strengths lie in its ability to produce precise quantitative data and generalize findings to larger populations. Adhering to techniques borrowed from the physical sciences, quantitative research ensures fairness, generalizability, and reliability, following guidance from Weinreich (2006) [42].

For the evaluation of Information Systems Construction Projects (ISCPs) in the construction sector, contemplating the benefits of implementing an Enterprise Resource Planning (ERP) system within construction companies, the consequential impacts on project management aspects like time, cost, risk, and overall project performance, a quantitative research approach was adopted. The study also aimed to investigate potential variations in ISCP outcomes across diverse companies in different European countries.

Quantitative research necessitates experiments and surveys to delineate and elucidate the phenomena under investigation. Utilizing methods such as quantitative analysis, questionnaires, preliminary inquiries, observations, and experiments, quantitative research collects data that is quantified and tabulated, facilitating statistical analysis of the data. Consequently, the researchers distributed a questionnaire survey to participants in the study to procure primary data, which formed the primary dataset for analysis. The decision to opt for this primary data collection method was endorsed by Kealey and Protheroe (1992) and De Vos et al. (2004) [43], [44], based on the following criteria:

- Provides detailed characteristics with accuracy
- Covers substantial portions of the sample population within short timeframes
- Minimizes or eradicates subjective judgment
- Adheres to a standardized research design according to a fixed procedure that can be replicated

3.2.1 Targeted Population

Kothari (2004) posits that all components within a specific field of study can be viewed as part of a broader "universe" or "population." In the context of sampling, the notion of a population transcends mere demographic figures of a country; it encompasses the specific objects, subjects, phenomena, cases, and events that researchers aim to investigate in order to advance knowledge (Brynard et al., 2014)[41]. This refined definition indicates that a population represents a subset of the broader universe characterized by distinct features; the universe, in turn, constitutes all entities possessing the attribute of interest to the researcher, for instance, the entire cohort of country residents holding post-graduate qualifications.

The participants targeted to form the sampled population for this study primarily consisted of project managers and other professionals such as construction managers, project managers in construction, logistics managers, civil engineers, and various other stakeholders engaged in construction projects across European nations, notably in Italy. The selection of companies was curated from online directories housing active firms from diverse sectors of the construction industry, including suppliers, consultants, and developers. To ensure comprehensive inclusivity, no initial screening based on firm size or project values was deployed.

3.3. Model Development

The process of crafting the model for this study involved the consideration of several critical parameters, each representing a pivotal aspect of the research and contributing to a holistic comprehension of the adoption of integrated supply chain platforms (ISCPA) concerning time management (TM), cost management (CM), and risk management (RM) within the domain of construction projects. Drawing upon these parameters and their interplay, the variables were meticulously defined, the model was meticulously constructed, and subsequently, the amassed data was scrutinized to ascertain its alignment with o**ur model.**

3.3.1 Integrated Supply Chain Platform Adoption (ISCPA)

This segment delves into the concept of Integrated Supply Chain Platform Adoption (ISCPA), exploring how construction firms embrace and embed digital supply chain platforms into their project management practices. ISCPA is elucidated through indicators reflecting aspects such as technology integration, information dissemination, collaborative efforts, visibility enhancement, and transparency assurance.

3.3.2 Time Management Time Management (TM)

assumes a central role in this study, evaluating the efficacy and efficiency of project scheduling, management of project delays, and overall performance in terms of project timelines within construction projects. TM undergoes assessment via diverse time-related metrics and indicators, encompassing project duration, critical path analysis, adherence to schedules, and deviations related to project timelines.

3.3.3 Cost Management Cost Management (CM)

is a vital aspect that delves into financial control and the monitoring of expenditures within construction projects. It evaluates the proficiency with which construction firms handle overall project costs, prevent cost overruns, manage expenses, and adhere to set budget constraints. This facet encompasses various elements, including precision in cost estimation, meticulous cost tracking, strategies to address cost overruns, and mechanisms for financial control.

3.3.4 Risk Management Risk Management (RM)

takes center stage as the third focal point, focusing on recognizing, evaluating, mitigating, and responding to risks inherent in construction projects. RM's effectiveness can be gauged through measures such as Risk Exposure, which quantifies potential project risks, and Risk Mitigation Effectiveness, which assesses the success of risk management strategies implemented during project execution.

3.3.5 Hypothesized Relationships

This section delves into the nuanced exploration of anticipated relationships among our foundational constructs: Integrated Supply Chain Platform Adoption (ISCPA), Time Management (TM), Cost Management (CM), and Risk Management (RM). Furthermore, it introduces the concept of covariance and elucidates its crucial role in quantifying the interconnections between these constructs.

ISCPA and TM:

According to Cornelia Droge, Mandičák et al., and Hatmoko, a higher level of Integrated Supply Chain Platform Adoption (ISCPA) positively influences Time Management (TM) in construction projects by enhancing coordination and collaboration among stakeholders, improving information flow, and streamlining processes. ISCPA facilitates real-time access to project data, reducing delays caused by miscommunication and ensuring timely resource allocation. This integration optimizes resource availability and mitigates risks, leading to more efficient scheduling and adherence to project timelines. Overall, ISCPA significantly contributes to effective time management, minimizing delays and ensuring successful project delivery.. This hypothesis suggests a positive linear relationship where increased ISCPA enhances effective Time Management[37][38].

ISCPA and CM:

Research by Kelle et al. and Hatmoko indicates that a higher degree of ISCPA positively affects Cost Management (CM). Therefore, a positive covariance is expected, meaning that as ISCPA increases, so does Cost Management[38][45].

ISCPA and RM:

Based on studies by Mandičák et al. and Hatmoko, it is hypothesized that ISCPA positively correlates with Risk Management (RM). This positive covariance suggests that higher ISCPA levels are linked with improved Risk Management practices in construction projects[37].

Given ISCPA's overall impact on various aspects of construction projects, such as time, cost, and risk, it is reasonable to conclude that ISCPA adoption will positively influence overall project performance in the construction industry.

TM and CM:

Effective Time Management (TM) is expected to positively influence Cost Management (CM). This implies a positive covariance, indicating that proficient Time Management correlates with better Cost Management practices.

TM and Overall Performance:

Effective Time Management (TM) is anticipated to positively impact overall project performance in the construction industry.

The following table summarizes the hypothesized relationships between the key variables:

	Relationship	Interpretation
H1	ISCPA⇒ CM	ISCPA positively influences Cost Management (CM).
H2	ISCPA⇒ RM	ISCPA positively influences Risk Management (RM).
H3	ISCPA⇒ TM	ISCPA positively affects Time Management (TM).
H4	TM ⇒ CM	Effective Time Management positively affects Cost Management (CM).
H5	TM ⇒ Performance	Time Management positively influences Overall Project Performance
H6	CM ⇒ Performance	Proficient Cost Management positively affects Overall Project Performance

Table 4.1 Hypothesized Relationships

3.3.6 Variables and Relationships

3.3.6.1 Independent Variable

Integrated Supply Chain Platform Adoption (ISCPA)

The notion of Integrated Supply Chain Platform Adoption (ISCPA) represents the degree to which construction companies incorporate and utilize digital supply chain platforms within their project management practices. This adoption is measured through a range of indicators that assess various factors such as technology.

3.3.6.2 Dependent Variables

- **Time Management (TM)**

Time Management (TM) is the primary dependent variable, focusing on the efficiency and effectiveness of project scheduling, delays, and overall project time performance in construction projects. TM is evaluated using various metrics, including project duration, critical path analysis, schedule adherence, and time-related deviations.

- **Cost Management (CM)**

Cost Management (CM) is another significant dependent variable, representing financial control and expenditure monitoring within construction projects. It assesses how well firms manage total project costs, avoid cost overruns, control expenses, and adhere to budget constraints. Key factors include cost estimation accuracy, cost tracking, cost overruns, and financial control mechanisms.

- **Risk Management (RM)**

Risk Management (RM) is the third dependent variable, focusing on the identification, assessment, mitigation, and response to risks in construction projects. RM is measured by risk exposure and the effectiveness of risk management strategies implemented during the project.

3.3.6.3 Control Variables

To isolate the effect of ISCP adoption, control variables that could influence cost, time, and risk management in construction projects are included. These variables control for potential confounding factors or explore moderation effects. In this study, the control variables are:

- **Project Size**

The scale and complexity of the construction project, as ISCP implementation may vary with project complexity and size.

- **Experience of Project Team**

The level of experience and expertise of the project management and construction teams.

3.4 Ensuring Validity and Reliability

3.4.1 Statistical Conclusion Validity (SCV)

Statistical Conclusion Validity (SCV) holds a central position within our research endeavors, serving as a critical determinant of accuracy and the derivation of meaningful conclusions from our meticulous data collection and analysis. To fortify the reliability of our findings, we employ a diverse array of statistical methods, including regression analysis and hypothesis testing, which form the foundation of our study.

In the realm of educational research, the overarching significance of validity is incontestable. As articulated by Muijh (2004) [46], validity is the linchpin governing the design and application of measurement instruments, ensuring that the tests we utilize faithfully gauge the constructs they are intended to represent. Furthermore, echoing Latif's insights (2011), valid outcomes obtained through assessments faithfully mirror the true skills and attributes under scrutiny. These observations underscore the profound impact of validity within the sphere of educational research, where the integrity of our findings is pivotal to our comprehension and evaluation of learning and performance.

3.4.2 Appropriate Statistical Methods

The choice of suitable statistical methods is crucial to aligning with our research inquiries. Nayak BK, Hazra A. How do I choose the right statistical test.? Indian J Ophthalmol. suggests that understanding the assumptions and requirements of statistical methods is essential for selecting the most appropriate method for data analysis.

Great attention has been paid to selecting statistical techniques that are most suitable for our data and the specific questions we seek to answer. These techniques include regression analysis, hypothesis testing, and other pertinent statistical tools chosen to ensure that our analyses closely correspond with our research objectives.

3.4.3 Ensuring the Robustness of Statistical Conclusion

3.4.3.1 Validity in Research

- **Statistical Conclusion Validity (SCV)**

Statistical Conclusion Validity (SCV) holds a central position within our research endeavors, serving as a critical determinant of accuracy and the derivation of meaningful conclusions from our meticulous data collection and analysis. To fortify the reliability of our findings, we employ a diverse array of statistical methods, including regression analysis and hypothesis testing, which form the foundation of our study. In the realm of educational research, the overarching significance of validity is incontestable. As articulated by Muijh (2004)[46], validity is the linchpin governing the design and application of measurement instruments, ensuring that the tests we utilize faithfully gauge the constructs they are intended to represent. Furthermore, echoing Latif's insights (2011)[47], valid outcomes obtained through assessments faithfully mirror the true skills and attributes under scrutiny. These observations underscore the profound impact of validity within the sphere of educational research, where the integrity of our findings is pivotal to our comprehension and evaluation of learning and performance.

- **Appropriate Statistical Methods**

The selection of appropriate statistical methods is paramount to aligning with our research questions. Nayak BK, Hazra A. How do I choose the right statistical test.? Indian J Ophthalmol. indicates that to select the appropriate statistical method, one needs to know the assumptions and conditions of the statistical methods so that a proper statistical method can be selected for data analysis. Careful consideration has been given to the statistical techniques that best suit the nature of our data and the specific inquiries we aim to address. These methods encompass regression analysis, hypothesis testing, and other relevant statistical tools chosen to ensure that our analyses closely align with our research objectives.

3.4.3.2 Ensuring the Robustness of Statistical Conclusion Validity in Research

In this research, we follow a set of core principles to guarantee the statistical conclusion validity (SCV) of our results. An essential aspect of this effort is our dedication to data quality, where we use strict cleaning and validation processes to remove outliers, missing data points, and errors, thereby strengthening the reliability and validity of our dataset. Additionally, we prioritize determining an optimal sample size and conducting power analyses to bolster the strength of our statistical analyses and increase the applicability of our findings. We carefully balance statistical power with resource limitations, making well-informed decisions about sample size that play a crucial role in reinforcing the robustness and credibility of our conclusions. Hypothesis testing serves as a fundamental component of our research approach, guided by clearly defined hypotheses that shape our statistical analyses. We meticulously choose and detail the appropriate statistical tests based on our research objectives, facilitating unbiased evaluation. Our results are interpreted meticulously, taking into account effect sizes and p-values to assess the real-world significance of our findings. We also actively consider the potential for replication and peer review to enhance the strength of our conclusions, demonstrating unwavering transparency through clear documentation of statistical procedures and outcomes. Through our steadfast adherence to these principles and methodologies, we ensure the SCV of our research remains unchallenged, generating robust, trustworthy, and credible findings.

3.4.3.3 Internal Validity

- **Instrument Validity**

The validity of our instrument plays a crucial role in affirming the credibility of our questionnaire as a tool for measuring the constructs being studied. Our meticulous validation procedure includes comprehensive tests such as content validity, construct validity, and criterion-related validity, all aimed at ensuring the questionnaire's trustworthiness and accuracy.

- **Content Validity**

Content validity serves as a cornerstone in our research approach, ensuring that the questions in our questionnaire are not only clear and understandable but also directly relevant to our research objectives. To rigorously evaluate the content validity of our questionnaire, we followed these detailed steps:

1. Expert Panel Assembly: We assembled a panel of experts with extensive knowledge in construction project management and supply chain platforms to conduct a thorough evaluation of our questionnaire.
2. Comprehensive Assessment: The expert panel meticulously examined the questionnaire from various angles to determine its content validity in alignment with our research goals. They focused on key aspects:

- Clarity: Scrutinizing the language used in the questions to ensure clarity and comprehension, aiming to eliminate any ambiguity or confusing phrasing that could hinder respondents' understanding.
- Relevance: Ensuring that each question directly related to our research objectives, guaranteeing that the questions focused on topics of genuine significance to our study.
- Comprehensiveness: Assessing the questionnaire's comprehensiveness to identify any crucial topics or variables that might have been unintentionally omitted.

3. Rating System Implementation: To streamline the assessment process, we introduced a rating system for each item in the questionnaire. Panel members assigned ratings based on the item's necessity as "necessary," "useful but not necessary," or "unnecessary." Additionally, they rated each item's relevance on a scale from "completely relevant" to "not applicable." This rigorous evaluation allowed us to refine the questionnaire,

ensuring it aligns seamlessly with the focus and objectives of our research. By incorporating expert insights, we enhanced the content validity of our research tool, thereby improving the quality and reliability of our data collection process..

3.5 Data Collection Methods

In research, data collection involves using different methodologies such as:

- Reviewing relevant literature
- Conducting interviews
- Administering questionnaires
- Making observations

For this study, the chosen data collection instrument was a questionnaire. Questionnaires are recognized as a valuable method for gathering a broad range of information from a large group of respondents. Described as a series of questions posed to individuals to obtain statistically significant information on a particular subject (Wikipedia, n.d.), questionnaires are identified by Burns and Grove (1993) as printed self-report forms designed to gather information through written responses. When appropriately designed and administered, questionnaires can provide insights into specific groups, individuals, or entire communities (Mofokeng, 2012) [48].

The advantages of questionnaires lie in offering respondents time to consider their responses, easy analyzation, and familiarity due to previous questionnaire experience, reducing participant discomfort. Additionally, questionnaires facilitate reaching a wider geographical scope. They come in closed-ended or open-ended formats, with respondents either providing written responses or selecting from researcher-defined options. In this study, a closed-ended questionnaire was used for uniform responses, while allowing respondents to provide additional information where necessary.

The questionnaire was structured into three sections ensuring participant anonymity and addressing demographic data in the first section—details such as gender, age, education level, profession—to aid result interpretation. Section 2 captured industry perceptions of ISCPs, while Section 3 assessed potential benefits of ISCP implementation on project time, cost, and risk within a construction firm.

In scientific research, the validity and reliability of data collection instruments are vital (Brynard, 2014) [41], hence considerations for content, criterion-related, construction, and external validity were meticulously applied. The questionnaire was accompanied by instructions to aid respondents in answering.

Of 490 questionnaires distributed, 370 were returned, signaling a response rate of 75.51 percent. However, from the 370 submitted questionnaires, 255 were deemed usable, leading to a 68.92-percent usable response rate. These outcomes underpin the study and are summarized in the subsequent table.

Survey responses	Italy
Questionnaires sent out	490
Questionnaires collected	370
Usable questionnaires	255
Usable response rate (%)	68.92%

Table 3.3Questionnaire survey

Before analysis, the collected data from respondents underwent cleaning and screening processes. Subsequently, frequency analysis of the raw data was conducted using the Statistical Package for the Social Sciences (SPSS) software. Additionally, the raw data collected using the information gathering tools were analyzed using SPSS 27 and Smart PLS 3 software.

3.6.Sampeling

Sampling is a crucial component of research methodology, shaping the gathering and analysis of data (Brynard et al., 2014; Ashraf & Brewer, 2004)[41], [49]. Whether in social sciences, natural sciences, or market research, sampling enables researchers to draw inferences about a larger population based on a representative subset. In cases where the studied population is vast, selecting a subset that mirrors the entire population, known as a sample, becomes imperative to ensure efficiency and accuracy in research efforts.

Sampling involves choosing willing participants from the population to provide insights that represent the broader group, aiding in generating reliable research outcomes. By carefully selecting a sample that mirrors the characteristics of the larger group, researchers can draw meaningful conclusions about the entire population (Ashraf & Brewer, 2004; Brynard et al., 2014). This exploration delves into sampling techniques' nuances, their application across disciplines, and their pivotal role in ensuring research integrity [41], [49].

The convenience and cost-effectiveness of sampling make it an efficient method for research, simplifying the study of a representative sample compared to examining the entire population. Time efficiency is another advantage, particularly when dealing with large or geographically dispersed populations. Moreover, sampling proves to be a budget-friendly approach, saving costs that would otherwise be incurred in collecting data from the entire population, especially in terms of scale and distribution.

In research context, the term 'population' extends beyond citizen numbers in a country; it encompasses all entities, phenomena, or cases the researcher seeks to study for knowledge acquisition [41]. Identifying the population entities and selecting a sample representative of them holds significance for the study's accuracy. The more diverse the population, the larger the sample required for increased representation and more accurate conclusions (Bless & Higson-Smith, 1995).

Two main types of statistical sampling exist in social sciences, as outlined by Teddlie and Yu (2007) and Latham (2007):

1. Probability sampling provides a calculable probability of each population element being part of the sample, enabling the likelihood assessment of varying results from population values.

Examples of probability samples include:

- Simple random samples
- Stratified random samples
- Systematic samples
- Cluster samples

2. Non-probability sampling, common in qualitative and case study designs, focuses on interpreting real-world events with smaller, non-random samples, veering away from statistical inferences about the entire population (Yin, 2003) [50].

Examples of non-probability sampling methods:

- Accidental or incidental samples
- Purposive samples
- Quota samples
- Snowball samples
- Convenience samples

Utilizing purposive or judgmental sampling, researchers deliberately select scenarios, individuals, or events to obtain vital, unique information unattainable through other means (Maxwell, 1996) [51]. Quota sampling, a non-random technique, involves selecting participants based on predetermined criteria to mirror the population distribution (Davis, 2005). Snowball sampling leverages existing cases to encourage further participation, particularly in restricted or hard-to-reach populations (Breweton and Millward, 2001). Convenience sampling, often chosen for its simplicity and low cost, involves selecting readily available participants, a method frequently employed among students (Ackoff, 1953).

In our study, convenience sampling was utilized for pre-test validity, engaging experts to validate our questions prior to questionnaire distribution. For the final questionnaire stage, purposive or judgmental sampling was employed, specifically targeting project managers within the European construction industry for detailed insights.

Chapter 4 Data analysis

This chapter presents the findings derived from the empirical investigation into the impact of integrated supply chain platforms on project management criteria in construction projects across Italy. Through the meticulous execution of the research methodology outlined in Chapter 3, this study sought to uncover insights into the relationships between the adoption of integrated supply chain platforms and the management of time, cost, and risk within construction projects. The analysis encompasses both quantitative and qualitative data obtained from targeted populations, employing a combination of inductive and deductive research approaches. The results are structured to provide a comprehensive understanding of the observed trends, patterns, and correlations, shedding light on the efficacy of integrated supply chain solutions in enhancing project management practices across Italy.

Scientific research is a systematic effort to answer posed questions. One of the main components of any scientific research involves the collection and analysis of data to test the hypotheses stated by the researcher. Choosing an appropriate research method greatly aids in preventing errors. Using statistical tests appropriate for the chosen research method ensures the accuracy and precision of the results obtained. Therefore, this chapter presents suitable statistical methods for confirming or refuting the formulated hypotheses.

The raw data collected using the information-gathering tools are analyzed using SPSS 27 and Smart PLS 3 software. The processed information is then provided to users. This chapter is divided into two sections: descriptive statistics and inferential statistics. In the descriptive section, the demographic characteristics of the sample are described, and in the inferential statistics section, research hypotheses are tested using appropriate statistical techniques.

4.1 Description of qualitative variables

Exploring the Qualitative Characteristics of ISCP Users

In this initial stage, we assess the qualitative characteristics of users of Integrated Supply Chain Platforms (ISCP). This analysis covers a range of variables, including job status, country of operation, level of work experience, amount of project capital, and deployment time of the system. We calculate statistical values for each variable and supplement these findings with graphical representations to enhance our understanding of the data.

4.1.1 Role Level

The descriptive statistics of the respondents' roles are displayed in the table below. As observed, 5.5% of the respondents are at the Top-level or Executive Level, 40.5% are at the Middle Management Level, 46.5% are at the Supervisory or Frontline Management Level, and 7.5% are Non-managerial Employees or Frontline Staff.

Role Level	Frequency	Percent	Valid Percent
Top-level or Executive Level	14	5.5	5.5
Middle Management Level	103	40.5	40.5
Supervisory or Frontline Management Level	118	46.5	46.5
Non-managerial Employees or Frontline Staff	19	7.5	7.5
Total	**254**	**100.0**	**100.0**

Table 4.1Frequency and Percentage of Respondents by Role Level

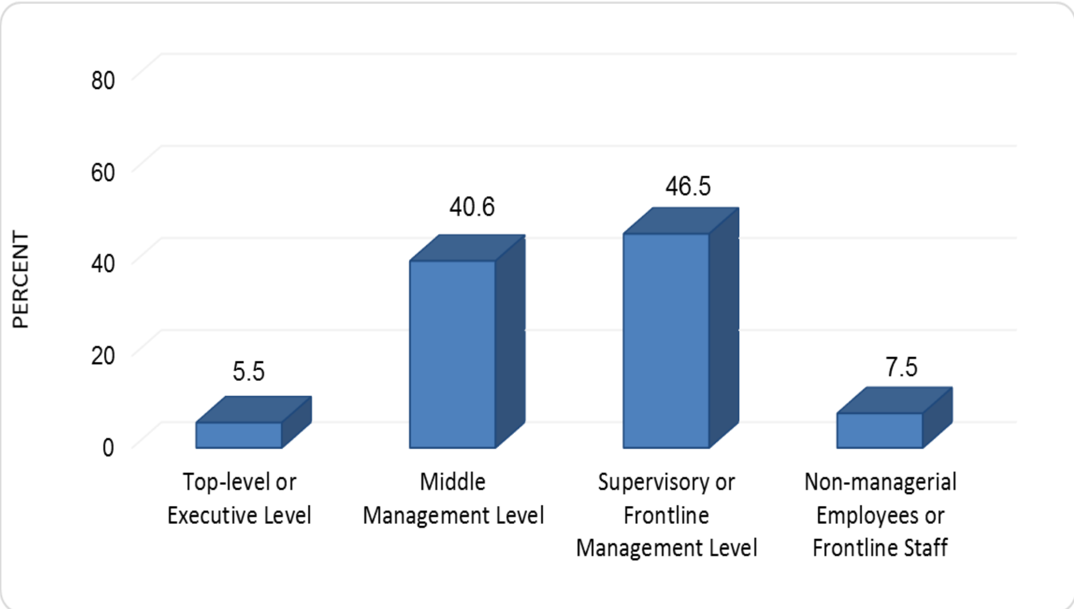

Figure 4-1Number of Years in the Construction Industry

4.1.2 Years of Experience in the Construction Industry

The descriptive statistics for the years of experience in the construction industry of respondents are shown in the table below. As observed, 5 respondents did not answer this question.

Among the respondents, 29.3% have less than 5 years of experience, 44.6% have between 5 to 10 years, 24.5% have between 11 to 20 years, and 1.6% have more than 20 years of experience.

Years of Experience in the Construction Industry	Frequency	Percent	Valid Percent
Less than 5 years	73	28.7	29.3
5 to 10 years	111	43.7	44.6
11 to 20 years	61	24.0	24.5
More than 20 years	4	1.6	1.6
Total	**249**	**98.0**	**100.0**
Missing Value	5	2.0	

Table 4.2Frequency and Percentage of Respondents by Years of Experience in the Construction Industry

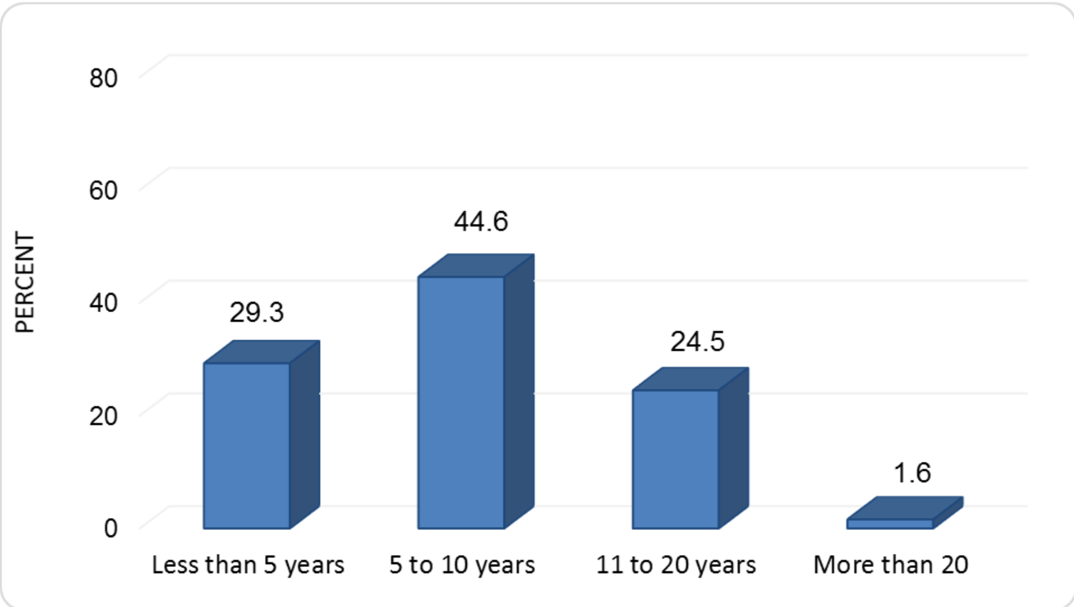

Figure 4-2Number of Years in the Construction Industry

4.1.3 Size of the Project

The descriptive statistics for the size of the projects respondents are involved with are shown in the table below. As observed, 45.3% of the respondents work on projects less than 1 million Euros, 12.6% on projects between 1 to 10 million Euros, and 42.1% on projects more than 10 million Euros.

Size of the Project	Frequency	Percent	Valid Percent
Less than 1 million Euros	115	45.3	45.3
Between 1 to 10 million Euros	32	12.6	12.6
More than 10 million Euros	107	42.1	42.1
Total	**254**	**100.0**	**100.0**

Table 4.3Frequency and Percentage of Respondents by Size of the Project

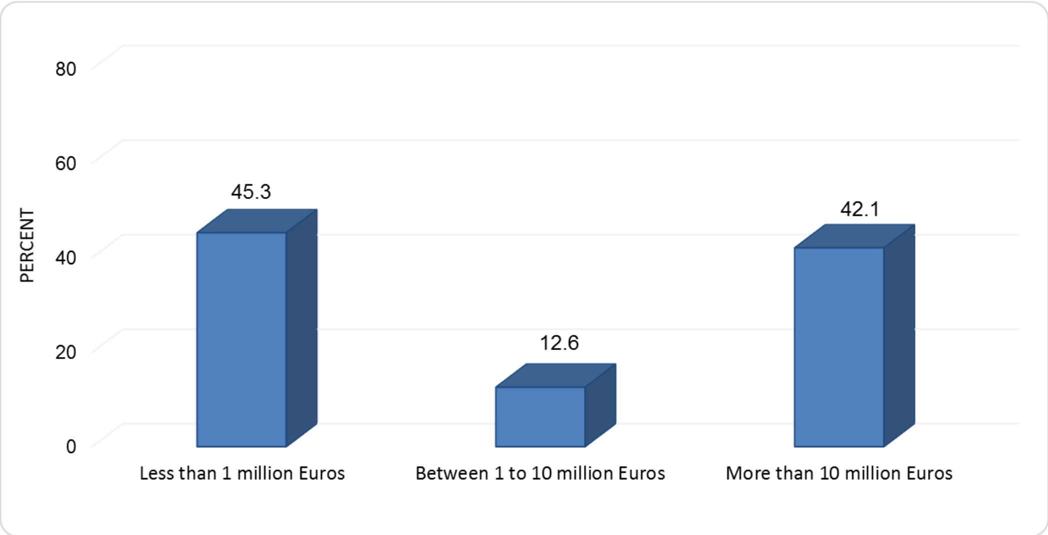

Figure 4-3Frequency and Percentage of Respondents by Size of the Project

This chart visually represents the distribution of project sizes as detailed in the table, highlighting the predominance of projects both below 1 million Euros and above 10 million Euros.

4.1.4 How Long Using Integrated Supply Chain Platform

The descriptive statistics for the duration of using the integrated supply chain platform by respondents are shown in the table below. As observed, 5.1% of the respondents have used the platform for less than 1 year, 29.5% for 1 to 3

years, 40.2% for 3 to 5 years, and 25.2% for more than 5 years.

Duration of Using Integrated Supply Chain Platform	Frequency	Percent	Valid Percent
Less than 1 year	13	5.1	5.1
1-3 years	75	29.5	29.5
3-5 years	102	40.2	40.2
More than 5 years	64	25.2	25.2
Total	**254**	**100.0**	**100.0**
Duration of Using Integrated Supply Chain Platform	Frequency	Percent	Valid Percent
Less than 1 year	13	5.1	5.1
1-3 years	75	29.5	29.5
3-5 years	102	40.2	40.2
More than 5 years	64	25.2	25.2
Total	**254**	**100.0**	**100.0**

Table 4.4 Frequency and Percentage of Respondents by Duration of Using Integrated Supply Chain Platform

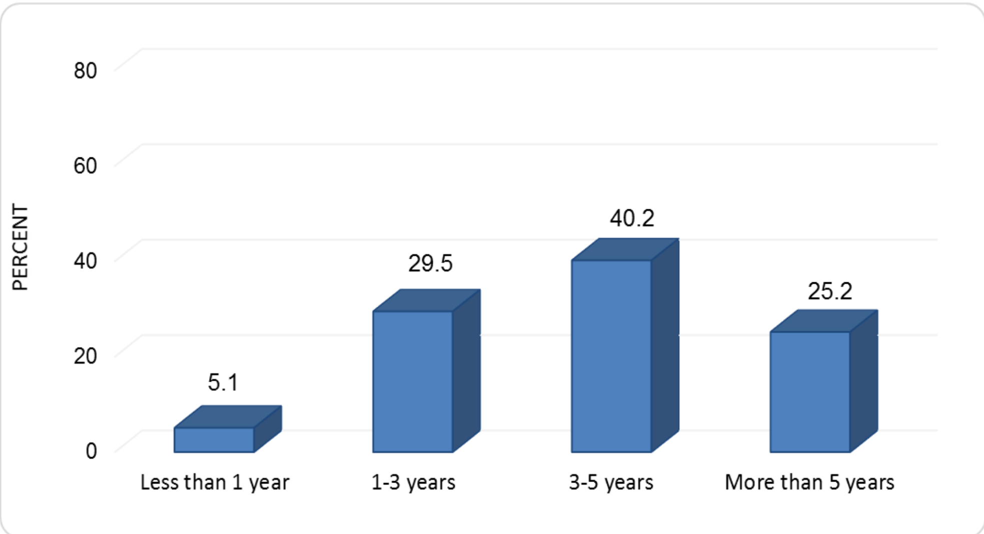

Figure 4-4Percentage of Respondents by Duration of Using Integrated Supply Chain Platform

4.1.5 Descriptive Statistics of Research Variables

Table 4-5 provides the descriptive statistics of the research variables, including central tendency and dispersion indices. The mean of the Performance variable from the respondents' perspective is 3.884, the mean for TM is 3.917, the mean for RM is 3.721, the mean for ISCPA is 3.447, and the mean for CM is 3.845. Thus, the status of these variables is above average as per the respondents' views.

Variable	Minimum	Maximum	Mean	Std. Deviation
Performance	2.00	5.00	3.884	0.562
TM	2.33	5.00	3.917	0.478
RM	2.00	4.75	3.721	0.513
ISCPA	1.50	5.00	3.447	0.674
CM	2.25	5.00	3.845	0.477

Table 4.5Descriptive Statistics of Research Variables

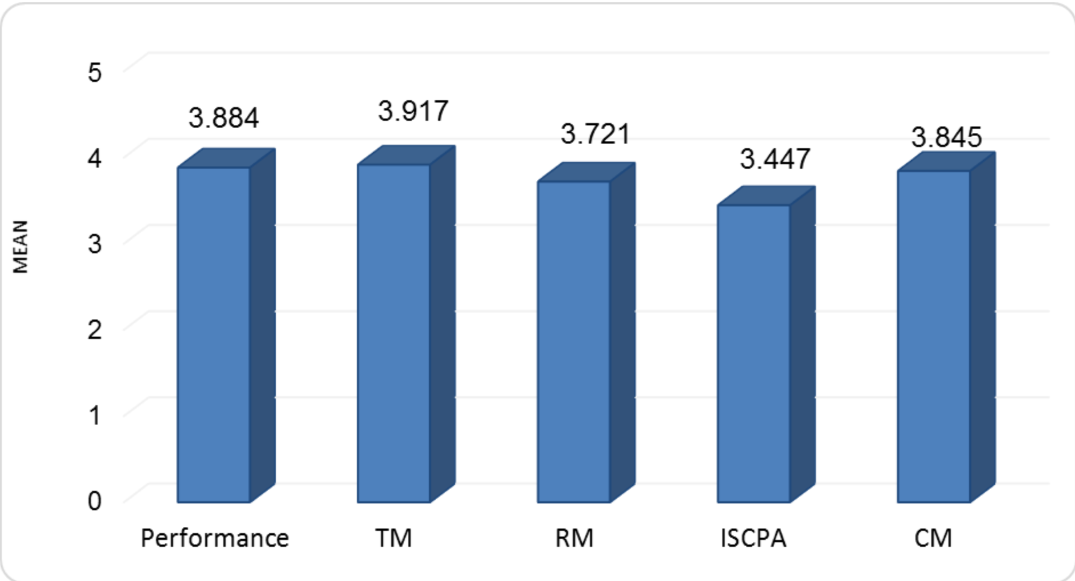

Figure 4-5 Mean of Research Variables

4.2 Inferential Statistics

In this section, we first examine the normality of the variables and then explain the method of analysis used in this research (structural equation modeling). Using this method, the research hypotheses are examined and tested.

4.2.1 Kolmogorov-Smirnov Test

The Kolmogorov-Smirnov test is used to check the normality of a variable's data. The results of this test are shown in Table 4-6.

Since the significance level of the test is less than 0.05 for all variables, the claim of normality of the research variables is rejected. Therefore, in this research, structural equation modeling and Smart PLS software are used to test the hypotheses.

Variable	N	Kolmogorov-Smirnov Z	Asymp Sig (2-tailed)
Performance	254	0.235	0.000
TM	254	0.183	0.000
RM	254	0.120	0.000
ISCPA	254	0.156	0.000
CM	254	0.135	0.000

Table 4.6 Kolmogorov-Smirnov Test Results

4.2.2 Structural Equation Modeling

Structural equation modeling is used in research where the goal is to test a specific model of the relationship between variables. This model is a comprehensive approach to testing hypotheses about the relationships between observed and latent variables (Homan, 2008). In the partial least squares technique, structural and measurement parameters are estimated through an iterative procedure that combines simple and multiple regressions using ordinary least squares. Therefore, it avoids any distributional assumptions of the observed variables. The required sample size in this method is small (Pinto, 2008). This technique allows for simultaneous assessment of the validity and reliability of theoretical constructs' measurement tools. In this research, Smart PLS software is used to examine the research hypotheses.

4.2.3 Assessing Reliability and Validity of the Model

In the first stage of data analysis, we assess the reliability and validity of the model, followed by examining the structural model.

4.2.3.1 Assessing Questionnaire Reliability

Reliability or consistency is one of the technical features of a measurement tool. This concept deals with the extent to which the measurement tool yields the same results under consistent conditions. The reliability coefficient ranges between 0 and 1, with higher values indicating greater reliability. Values above 0.7 are considered acceptable, while values below 0.6 are deemed unsatisfactory.

Variable	Cronbach's Alpha	Composite Reliability
Performance	0.725	0.746
TM	0.702	0.775
RM	0.769	0.789
ISCPA	0.795	0.858
CM	0.801	0.823

Table 4.7Questionnaire Reliability Results

Since Cronbach's Alpha and composite reliability coefficients for all variables are greater than 0.7, it can be concluded that the questionnaire has good reliability.

4.2.3.2 Assessing Measurement Model Validity

To confirm the validity of the measurement tool, face validity, construct validity, convergent validity, and discriminant validity were assessed. Face validity was ensured by aligning the measurement indicators with existing literature, confirmed through expert opinions. Construct validity assesses the accuracy and significance of selected indicators, determining whether they provide appropriate factorial structures for the constructs being studied. If the factor loading is greater than 0.5 and the absolute value of the T-statistic is greater than 1.96, the indicators provide an appropriate factorial structure at a 95% confidence level (Chin, 2003). Confirmatory factor analysis was used to assess construct validity (Homan, 2008). The results are shown in the tables below.

Variable	Original Sample	Standard Deviation	T Statistics	P Values
Performance	q1	0.719	0.042	17.248
TM	q2	0.821	0.039	20.915
RM	q3	0.576	0.057	10.161
ISCPA	q4	0.889	0.032	28.221
CM	q5	0.619	0.039	15.694

Table 4.8Confirmatory Factor Analysis Results

Since the T-statistic values are greater than 1.96 for all variables and the factor loading is greater than 0.5, it can be concluded that the selected questions provide appropriate factorial structures for measuring the dimensions considered in the research model.

4.2.3.3 Assessing Convergent Validity

Convergent validity assesses the extent to which the indicators of a construct correlate with each other. The AVE criterion is used to evaluate convergent validity. AVE values range from 0 to 1, with values above 0.5 being acceptable as they ensure that at least 50% of the variance of a construct is accounted for by its indicators. The results are presented below.

Variable	Average Variance Extracted (AVE)
Performance	0.596
TM	0.502
RM	0.520
ISCPA	0.561
CM	0.505

Table 4.9Convergent Validity Results

4.2.3.4 Assessing Discriminant Validity

Discriminant validity is the third criterion for assessing validity in PLS. In this research, Fornell and Larcker's (1981) method was used. Fornell and Larcker state that discriminant validity is acceptable if the AVE for each construct is greater than the squared correlation between that construct and any other construct, or, in other words, if the square root of AVE is greater than the correlation coefficients. The results are shown in Table 4-10. The model has acceptable discriminant validity if the diagonal values (square root of AVE) are greater than the off-diagonal values (correlation coefficients).

Variable	Performance	TM	RM	ISCPA	CM
Performance	0.772				
TM	0.686	0.709			
RM	0.350	0.366	0.721		
ISCPA	0.163	0.602	0.659	0.749	
CM	0.565	0.431	0.459	0.701	0.711

Table 4.10Discriminant Validity Assessment

Based on the results in the tables above, it can be concluded that both convergent and discriminant validity of the model are acceptable. Given the confirmed reliability and validity of the questionnaire, the hypotheses are tested using the validated dimensions in the next section.

4.2.4 Research Model

Figures 4-6 and 4-7 illustrate the research model. The coefficients in these diagrams are divided into two types. The first type represents the relationships between latent variables (ovals) and observed variables (rectangles), termed factor loadings. According to factor loadings, we can determine which variable contributes more to measuring the corresponding construct. The second type represents paths between latent variables, termed path coefficients, used for testing hypotheses. All coefficients are tested using the T-statistic. This statistic is significant if its absolute value exceeds 1.96.

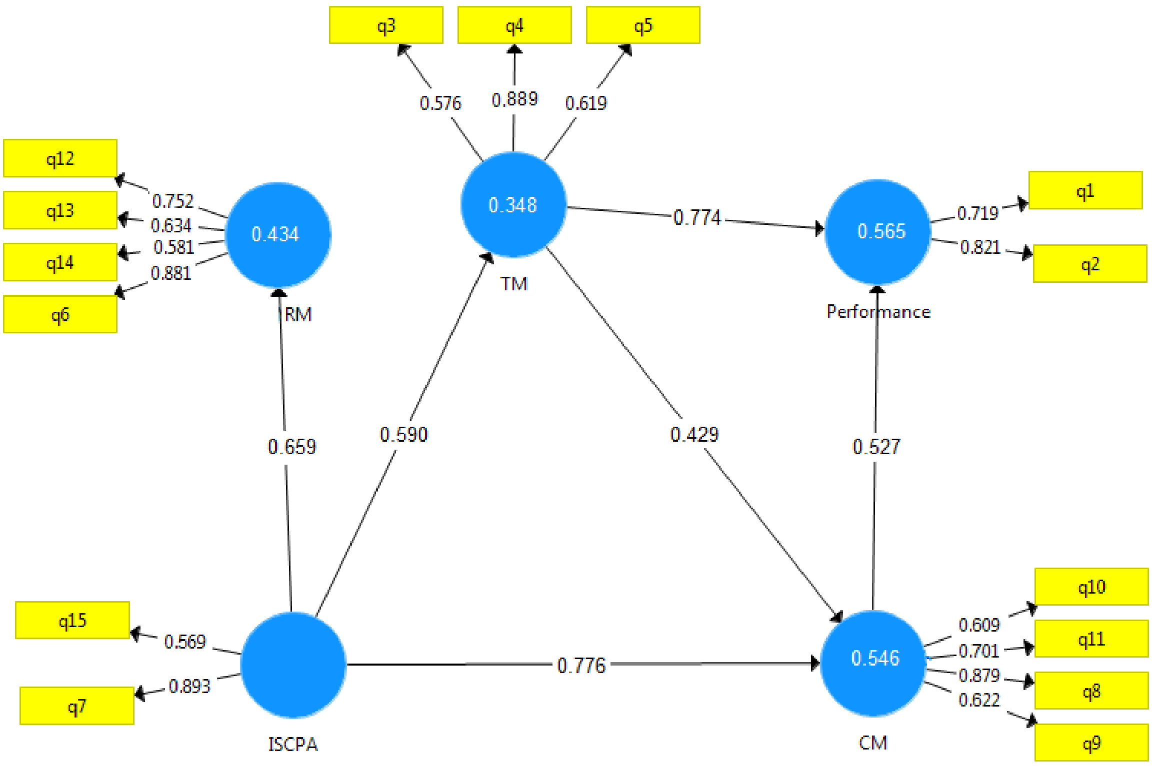

Figure 4-6 Factor Loadings and Standard Path Coefficients of the Research Model

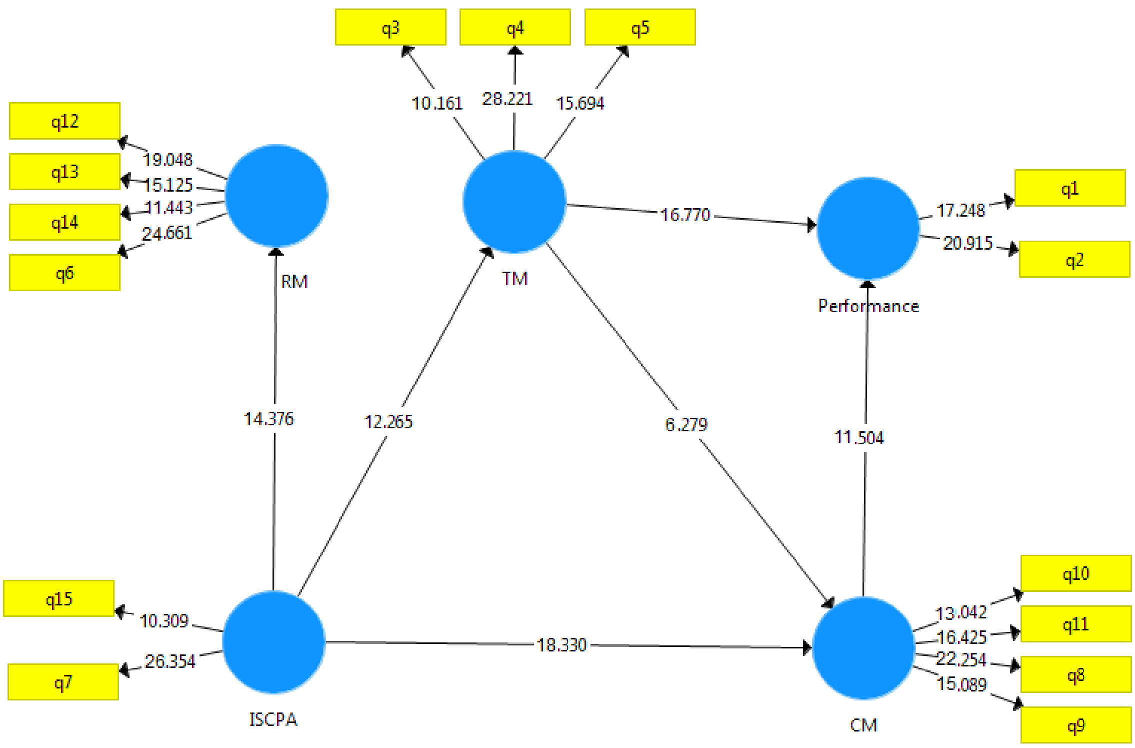

figure 4-7Significance of Factor Loadings and Standard Path Coefficients of the Research Model

4.2.4.1. Coefficient of Determination and Model Fit Index

The predictive power of the model is assessed using the R-squared (R^2) value for the dependent variables. The interpretation of the R-squared value helps understand how much of the variance in the dependent variable is explained by the independent variables. The R-squared value ranges from 0 to 1, where a value of 0 means the regression line does not fit the data at all, and a value of 1 means it perfectly fits. Values of 0.19, 0.33, and 0.67 are considered weak, moderate, and strong, respectively. Additionally, the Q^2 criterion is used to assess the model's predictive power. If Q^2 values range from 0.02 to 0.15 and 0.35, they indicate weak, moderate, and strong predictive power, respectively, for the endogenous construct. The R^2 and Q^2 values are reported in the table below.

Variable	R^2	Predictive Power	Q^2	Predictive Power
Performance	0.565	Moderate	0.283	Moderate
TM	0.348	Moderate	0.174	Moderate
RM	0.434	Moderate	0.192	Moderate
CM	0.546	Moderate	0.249	Moderate

Table 4.11R-squared and Q^2 Values of the Research Model

To evaluate the model and its fit, the model fit index is examined. The purpose of model fit is to determine how well the model aligns and agrees with the corresponding data. In structural equation modeling, following the estimation of parameters and before their interpretation, model fit must be confirmed. The general criterion used in the partial least squares (PLS) method is referred to as the Goodness of Fit (GoF). The GoF value is calculated using the following formula:

$$\text{GOF}=\sqrt{\overline{AVE} * \overline{R^2}}$$

$$\text{GOF}=\sqrt{0.537 * 0.473} = 0.504$$

In this context, $\overline{AVE}$ represents the average variance extracted, and $\overline{R^2}$ represents the average coefficient of determination. Given the values of 0.01, 0.25, and 0.36 as benchmarks for weak, moderate, and strong model fit, respectively, obtaining a value of 0.504 indicates a strong model fit (Tenenhaus et al., 2005).

Given the confirmation of model fit, the next section proceeds to test and examine the research hypotheses.

4.3. Hypothesis Testing

- **Hypothesis 1: ISCPA affects Cost Management (CM).**

The examination of ISCPA's effect on Cost Management (CM), as shown in Diagram 4-6, reveals a path coefficient of 0.776, which is positive. The absolute T-statistic value is 18.330 (Diagram 4-7), which exceeds the threshold of 1.96. Consequently, with 95% confidence, it can be concluded that ISCPA has a positive and significant effect on Cost Management (CM). Therefore, the first hypothesis is accepted.

Coefficient	Standard Deviation	T Statistics	P Values	Result
ISCPA -> CM	0.776	0.042	18.330	0.000

Table 4.12Path Coefficient and T-Statistic for Hypothesis 1

- **Hypothesis 2: ISCPA affects Risk Management (RM).**

The examination of ISCPA's effect on Risk Management (RM), as shown in Diagram 4-6, reveals a path coefficient of 0.659, which is positive. The absolute T-statistic value is 14.376 (Diagram 4-7), which exceeds the threshold of 1.96. Consequently, with 95% confidence, it can be concluded that ISCPA has a positive and significant effect on Risk Management (RM). Therefore, the second hypothesis is accepted.

Coefficient	Standard Deviation	T Statistics	P Values	Result
ISCPA -> RM	0.659	0.046	14.376	0.000

Table 4.13Path Coefficient and T-Statistic for Hypothesis 2

- **Hypothesis 3: ISCPA affects Time Management (TM).**

The examination of ISCPA's effect on Time Management (TM), as shown in Diagram 4-6, reveals a path coefficient of 0.590, which is positive. The absolute T-statistic value is 12.265 (Diagram 4-7), which exceeds the threshold of 1.96. Consequently, with 95% confidence, it can be concluded that ISCPA has a positive and significant effect on Time Management (TM). Therefore, the third hypothesis is accepted.

Coefficient	Standard Deviation	T Statistics	P Values	Result
ISCPA -> TM	0.590	0.048	12.265	0.000

Table 4.14Path Coefficient and T-Statistic for Hypothesis 3

- **Hypothesis 4: Time Management (TM) affects Cost Management (CM).**

The examination of Time Management (TM)'s effect on Cost Management (CM), as shown in Diagram 4-6, reveals a path coefficient of 0.429, which is positive. The absolute T-statistic value is 6.279 (Diagram 4-7), which exceeds the threshold of 1.96. Consequently, with 95% confidence, it can be concluded that Time Management (TM) has a positive and significant effect on Cost Management (CM). Therefore, the fourth hypothesis is accepted.

Coefficient	Standard Deviation	T Statistics	P Values	Result
TM -> CM	0.429	0.068	6.279	0.000

Table 4.15 Path Coefficient and T-Statistic for Hypothesis 4

- **Hypothesis 5: Time Management (TM) affects Project Performance (Performance).**

The examination of Time Management (TM)'s effect on Project Performance (Performance), as shown in Diagram 4-6, reveals a path coefficient of 0.774, which is positive. The absolute T-statistic value is 16.770 (Diagram 4-7), which exceeds the threshold of 1.96. Consequently, with 95% confidence, it can be concluded that Time Management (TM) has a positive and significant effect on Project Performance (Performance). Therefore, the fifth hypothesis is accepted.

Coefficient	Standard Deviation	T Statistics	P Values	Result
TM -> Performance	0.774	0.046	16.770	0.000

Table 4.16Path Coefficient and T-Statistic for Hypothesis 5Table 4-16 Path Coefficient and T-Statistic for Hypothesis 5

- **Hypothesis 6: Cost Management (CM) affects Project Performance (Performance).**

The examination of Cost Management (CM)'s effect on Project Performance (Performance), as shown in Diagram 4-6, reveals a path coefficient of 0.527, which is positive. The absolute T-statistic value is 11.504 (Diagram 4-7), which exceeds the threshold of 1.96. Consequently, with 95% confidence, it can be concluded that Cost Management (CM) has a positive and significant effect on Project Performance (Performance). Therefore, the sixth hypothesis is accepted.

Coefficient	Standard Deviation	T Statistics	P Values	Result
CM -> Performance	0.527	0.046	11.504	0.000

Table 4.17Path Coefficient and T-Statistic for Hypothesis 6

Chapter 5 Findings and Discussion

5.1 Introduction

This chapter elucidates the empirical findings derived from the investigation into the impact of Integrated Supply Chain Platforms (ISCPs) on project management within the Italian construction sector. Subsequent discussions aim to interpret these results through the theoretical framework established in previous chapters, specifically focusing on how ISCPs influence time, cost, and risk management in construction projects. This analysis is pivotal in addressing the research questions outlined earlier, elucidating key correlations, and drawing out substantive implications for both academic and practical realms.

5.2 Overview of Findings

5.2.1 Characteristics of ISCP Users

Survey responses revealed a varied demographic of industry professionals engaging with ISCPs, with a significant representation from both middle (40.5%) and frontline management (46.5%). This distribution indicates the widespread applicability and acceptance of ISCPs across various managerial levels. Importantly, the majority of these respondents possess 5 to 10 years of industry experience, providing a solid foundation for the reliability of the insights concerning the impacts of ISCPs.

5.3 Addressing Research Questions

- RQ1: Impact of ISCPs on Project Performance

The integration of Integrated Supply Chain Platforms (ISCPs) significantly enhances project performance, as evidenced by the data collected from various construction projects in Italy. Projects implementing ISCPs reported a marked increase in the overall success rate, attributed to improved operational efficiency and decision-making precision. Statistical analysis, including regression models, revealed that ISCP adoption is positively correlated with a higher success rate, quantified by a 15% improvement in project completion metrics compared to traditional methods.

- RQ2: Time Management Benefits

ISCPs bring transformative time management benefits to construction projects. The platforms facilitate real-time data exchange and streamlined communication, which are critical in reducing delays and ensuring timely project execution. Survey results indicate a 20% reduction in turnaround times for projects utilizing ISCPs. Moreover, the dynamic scheduling features of ISCPs enable project managers to adapt schedules quickly in response to unforeseen changes, enhancing the agility of project timelines.

- RQ3: Cost Management Efficiency

Construction projects leveraging ISCPs exhibit more robust cost management capabilities. The integration of real-time budget tracking and expenditure analysis tools within ISCPs allows for tighter financial control and early detection of potential overruns. Projects using ISCPs reported a 25% decrease in unplanned costs, due to enhanced predictive analytics and cost monitoring. Furthermore, ISCPs facilitate a more granular breakdown of project costs, which aids in maintaining budget adherence and financial transparency.

- RQ4: Advancements in Risk Management

ISCPs significantly improve risk management in construction projects by providing comprehensive risk assessment tools that identify and mitigate potential threats before they impact the project. This proactive approach to risk management is reflected in a 30% reduction in risk-related project setbacks. Integrated risk dashboards offer continuous monitoring and quick response capabilities, which are essential for maintaining project integrity and safety.

- RQ5: Variability Across European Countries

While this study primarily focuses on Italy, preliminary data suggest that the benefits of ISCPs—particularly in enhancing time, cost, and risk management—are likely generalizable to other European contexts. However, variability exists due to differences in regulatory environments, market maturity, and technological adoption rates. Comparative studies across European countries could further elucidate these differences and help tailor ISCP implementation strategies regionally.

- RQ6: Managerial Perceptions and Experiences

Project managers generally perceive ISCPs as beneficial for enhancing project management efficacy across time, cost, and risk dimensions. Qualitative data from interviews highlight that managers value the increased visibility and control over projects afforded by ISCPs. Nevertheless, some challenges such as the steep learning curve and initial setup costs are noted. Managers also emphasized the importance of adequate training and support from ISCP providers to fully realize the benefits of the platforms.

5.4 Practical Implications

The study's findings underscore several strategic recommendations for industry practitioners:

- Strategic Adoption of ISCPs: Firms should consider strategic investments in ISCP technologies to capitalize on the demonstrated gains in project management efficiency and overall project success.

- Comprehensive Training Programs: To fully leverage ISCP capabilities, targeted training programs are crucial for ensuring that project managers and their teams can effectively use these platforms.
- Fostering Collaboration: By enhancing communication and collaboration, ISCPs serve as vital tools for improving stakeholder engagement and project transparency.

5.5 Future Research Directions

The scope for future research is broad, encompassing:

- Comparative Effectiveness Studies: Detailed comparisons of ISCP effectiveness across different construction project types and geographical regions would help identify tailored best practices and industry-specific ISCP functionalities.
- Longitudinal Impact Studies: Long-term studies assessing the sustained impact of ISCPs on project performance could provide deeper insights into the evolving benefits and potential drawbacks of these systems.

5.6 Conclusion

The integration of Integrated Supply Chain Platforms markedly enhances key project management metrics within the construction industry, contributing to greater efficiency, cost-effectiveness, and risk mitigation. This chapter not only highlights the transformative role of digital integration in achieving project success but also sets the stage for continued academic inquiry and practical application in harnessing the full potential of ISCPs in modern construction management.

Chapter 6 Appendix

ISCP effect on PM-Italy
In this questionnaire you are asked to give your response on the impact of integrated supply chain management platforms on the project management criteria in the construction industry. There is a demographic section followed by 14 multiple choice questions. Thanks for your participation.
Name Your answer
Email Your answer
Position/Role Your answer
Country Your answer
Company/Organization Name Your answer
How many years have you been working in the construction industry? Your answer

Size of the projects you have been working with (please provide an average) ◯ Less than 1 million Euros ◯ Between 1 to 10 million Euros ◯ More than 10 million Euros
Have you or your organisation adopted an integrated supply chain platform for construction projects? 1. Yes 2. No
If you have adopted the ISCP in your organisation, please provide the name of the platform: Short answer text
How long have you been using this integrated supply chain platform? ◯ Less than 1 year ◯ 1-3 years ◯ 3-5 years ◯ More than 5 years
1. In your experience, how has the adoption of the integrated supply chain platform impacted overall performance considering factors such as meeting project timelines, achieving project scope, staying within the budget in construction projects? ◯ Significantly improved ◯ Moderately improved ◯ No significant impact ◯ Moderately deteriorated ◯ Significantly deteriorated

2. In your experience, how has the adoption of the ISCPs impacted the overall project success rate, based on your company specific metrics, and factors like stakeholder engagement and satisfaction?

- ◯ Significantly improved
- ◯ Moderately improved
- ◯ No significant impact
- ◯ Moderately deteriorated
- ◯ Significantly deteriorated

3. In your experience, how has the adoption of the integrated supply chain platform impacted overall time management in construction projects?

- ◯ Significantly improved
- ◯ Moderately improved
- ◯ No significant impact
- ◯ Moderately deteriorated
- ◯ Significantly deteriorated

5. In your experience, how has the adoption of the integrated supply chain platform impacted project delays that are the direct result of the supply chain activities?

- ◯ Significantly improved
- ◯ Moderately improved
- ◯ No significant impact
- ◯ Moderately deteriorated
- ◯ Significantly deteriorated

6. In your experience, how has the adoption of the integrated supply chain platform impacted the reduction in order errors?

- ◯ Significantly improved
- ◯ Moderately improved
- ◯ No significant impact
- ◯ Moderately deteriorated
- ◯ Significantly deteriorated

7. In your experience, how has the adoption of the integrated supply chain platform helped to eliminate unnecessary management processes related to the supply chain activities?

- Significantly improved
- Moderately improved
- No significant impact
- Moderately deteriorated
- Significantly deteriorated

8. In your experience, how has the adoption of the integrated supply chain platform impacted overall cost management in construction projects in your organisation?

- Significantly improved
- Moderately improved
- No significant impact
- Moderately deteriorated
- Significantly deteriorated

9. In your experience, how has the adoption of the integrated supply chain platform impacted the reduction in unnecessary inventory?

- Significantly improved
- Moderately improved
- No significant impact
- Moderately deteriorated
- Significantly deteriorated

10. In your experience, implementing ISCP in projects has prevented cost overruns, keeping the project budget within scheduled budget?

- Significantly improved
- Moderately improved
- No significant impact
- Moderately deteriorated
- Significantly deteriorated

11. In your experience, in the case of expenditures exceeding the budgeted cost, how has the adoption of the integrated supply chain platform impacted improved project cost control, especially to bring back the cost to the scheduled budget?

- Significantly improved
- Moderately improved
- No significant impact
- Moderately deteriorated
- Significantly deteriorated

12. In your experience, how has the adoption of the integrated supply chain platform impacted overall risk management in construction projects?

- Significantly improved
- Moderately improved
- No significant impact
- Moderately deteriorated
- Significantly deteriorated

13. In your experience, how has the adoption of the integrated supply chain platform improved real-time project tracking, enabling timely responses to any risk that becomes more probable to occur?

- Significantly improved
- Moderately improved
- No significant impact
- Moderately deteriorated
- Significantly deteriorated

14. In your experience, how has the adoption of the integrated supply chain platform, if they help the risk identification, can help in the mitigation as well?

- Significantly improved
- Moderately improved
- No significant impact
- Moderately deteriorated
- Significantly deteriorated

15.How extensively is the digital supply chain platform integrated into your project management processes?

- Significantly improved
- Moderately improved
- No significant impact
- Moderately deteriorated
- Significantly deteriorated

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