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The Influence of Knowledge on Managing Risk for the Success in Complex Construction Projects: The IPMA Approach

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Abstract: Organizations undertaking construction projects often deal with uncertainty and complexity. Risks include a wide range of occurrences that can lead to project failure. However, these difficulties may be minimized if risks are properly managed. In addition, knowledge management may emerge as a key element in facing unforeseen events and detecting the actions that are working well in other projects. In this context, this study intends to demonstrate the influence of managing organizational knowledge on risk management and the impact of both on the success of projects and associated businesses. To this end, a questionnaire was distributed among construction technicians, practitioners and managers in order to assess the importance of factors managing knowledge and risk and of success criteria. Thanks to the participation of almost four hundred respondents, cause-and-effect relationships are characterized by means of structural equation modeling, statistically confirming them. The specific links between the knowledge-management projects and the skills and abilities to face risks provided by the International Project Management Association (IPMA) standards, with a relation of 0.892 out of 1, justify the 75.1% of the success of the venture. These findings prove that the application of IPMA proposals enhances the required knowledge that leads to improved completion and delivery of complex construction projects in risky environments.

Keywords: risk management; knowledge management; project management; complex projects; constructions projects; International Project Management Association (IPMA)

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1. Introduction

According to the Standish Group [1], almost 20% of projects implemented are not finished, 45% are completed but with deviations from their original baselines and only 35% can be described as efficiently deployed. These ratios are similar in contexts from software development to construction industry [2]. Although the performance of construction projects has been traditionally low [3–7], their impact on the growth of the international economy over the past 40 years has been crucial in Africa [8], America [9], Asia [10], Europe [11] and Oceania [12]. This performance is affected by many factors [13,14], both relational (such as change requests or stakeholder needs and expectations) and technical (such as constraints and assumptions or threats and opportunities). In addition, the rising complexity of construction projects, with passive and active technologies integrated [15], high quality standards [16], strict scope, time and cost constraints [17] and stringent regulations [18], increasingly requires that these issues be solved by many and varied specialized technicians, practitioners and managers [19]. To do this, these construction agents must be coordinated [20], teams must be guided, resources must be scheduled according to constraints and risks must be kept under control. In short, these projects must be managed [21].

Complex projects usually deal with long durations [22], high costs [23], a large number of stakeholders [24], and a vague, ambiguous and/or inaccurate scope [25–27]. Their management is a prior objective for organizations that want to adapt to changing contexts, trying to achieve competitive advantage [28,29]. In organizations dealing with this kind of project, it is essential to perform proper risk management (RM) [30] in order to avoid deviations in schedule, budget or quality, as a mandatory step to achieve sustained success by successfully managing their projects [31]. For these reasons, RM emerges as a determining factor in their strategies [32]. Indeed, RM is one of the critical success factors most identified by researchers [33–40].

On the other hand, the identification of risks, the estimation of their impact and the definition of strategies to be followed, as well as decisions and responses finally adopted, can be compiled in lessons learned [41]. These can be used in other projects, present or future, to avoid repeating past errors in similar circumstances [42]. If shared and capitalized on, this generation and acquisition of knowledge enable risks to be properly managed [43]. Therefore, knowledge management (KM) empowers organizations to anticipate potentially adverse situations [44], allowing them to deal with unexpected and unpredictable events [45], which contributes to the achievement of their objectives. In this context of growing complexity, organizations need to analyze the challenges they face, as well as to assess the potential of applying RM and KM theories, principles, methods and models in their projects [46]. As recommended by international standards such as ISO 9004 [47] and ISO 21502 [48], this is their initial step on the road to ensuring sustained success (SS) in the projects they undertake [49].

For all the above reasons, KM and RM must not be considered as isolated sections in organizations, but as convergent domains, providing the application of better project management (PM) practices. This mutual feedback cannot be underestimated, especially when they are linked to complex projects [50]. Based on these principles, this study aims to highlight the advantages of using an already proven professional PM model, rather than proposing a new theoretical one. Apart from solutions proposed by researchers [51–55] or companies [56–60], two PM associations are of particular interest in this field: the IPMA (www.ipma.world, accessed on 1 May 2022) and the Project Management Institute (PMI) (www.pmi.org, accessed on 1 May 2022). They are the oldest, most widespread PM organizations, with the largest number of members, the highest amount of certified credentials and the greatest influence on administrations around the world. Although both share significant similarities [61], the IPMA approach promotes top–down and bottom–up strategies for considering knowledge in the whole process.

RM has been specifically analyzed in other economic sectors as a stimulating reinforcement for KM [62,63], enhancing the generation, capture, sharing and assessment of knowledge in organizations, which provides feedback [64] to enable better identification, analysis, and response to weaknesses, threats, strengths and opportunities. This improvement process increases the chances of success in the projects they undertake [65]. This study intends to prove this hypothesis for organizations developing complex projects in the construction industry. In addition, the IPMA approach has been challenged against other isolated contributions or models proposed by researchers, professional associations or standardization bodies that have studied different knowledge and/or risk topics in project environments. Through the participation of construction agents, it is expected that a large population sample will be able to contribute to providing evidence by using a well-designed methodology. The data obtained will be analyzed to confirm these assumptions.

In summary, as shown in Figure 1, the main purpose of this research focuses on whether the proper use of standardized project management methods, based on international standards such as those of IPMA (in green color), improves management processes and outcomes in complex construction projects (in blue color). Thanks to how knowledge is managed, risk management to ensure their success is influenced; promised results in cost, time and quality are delivered; and stakeholders are satisfied, which generates business for the organization, ensuring its continuity.

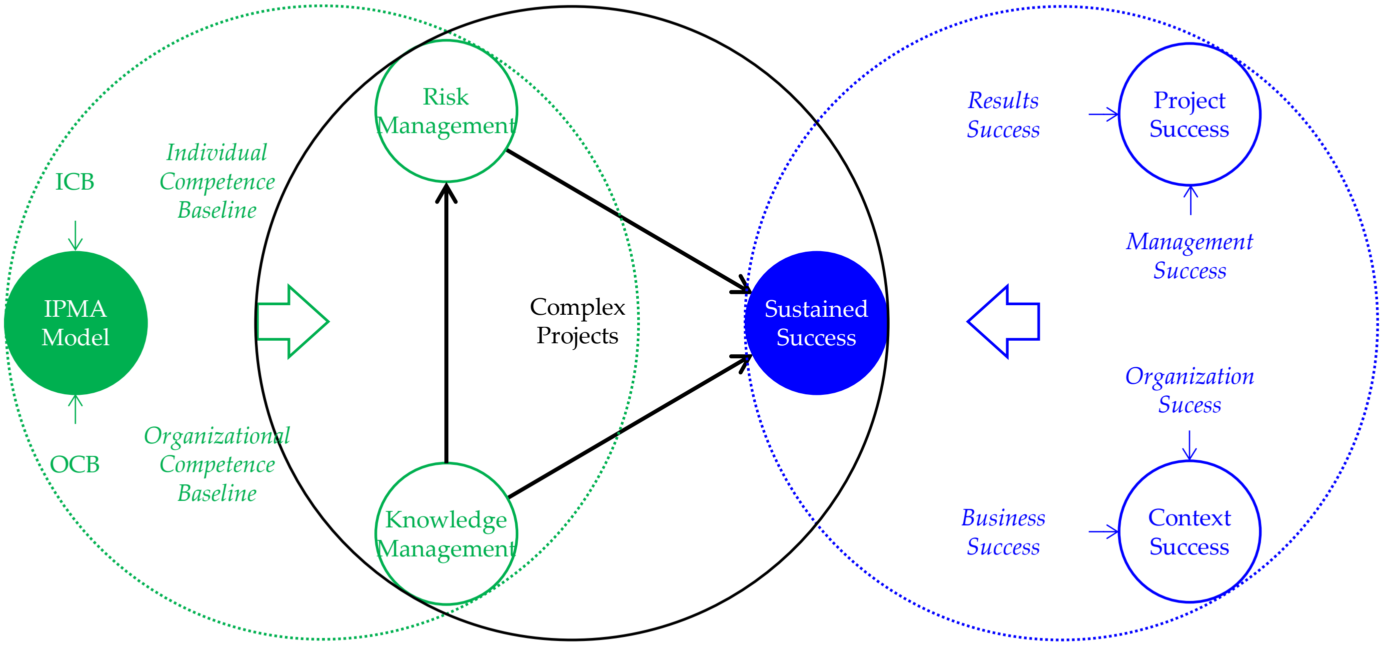


Figure 1. Research approach.

The rest of the paper is structured as follows. Section 2 analyzes the scenario in which knowledge has become a key factor in facing uncertain contexts in which organizations develop complex projects in risky environments. In addition, the most extended PM professional proposals are presented, stressing the IPMA model. Section 3 justifies the selected methodology, which identifies the factors that interrelate KM, RM and the criteria that allow them to exert their influence to be successful, by means of a questionnaire responded to by construction agents. The confirmation of these relationships is validated by means of structural equation modeling (SEM). Section 4 deals with the results obtained, discussing the contributions made. Finally, Section 5 presents the main conclusions.

2. Framework

This paper studies the feasibility of using a professional PM model rather than proposing a new theoretical one. It intends prove that the use of a contrasted PM model, which has been applied by a multitude of practitioners and managers and has been consolidated in various sectors and different cultures, enriches organizational KM and improves RM, influencing the assurance of PM results in organizations that manage complex projects in the construction industry. To begin with, national and international standards related to RM are reviewed, as well as consolidated methodologies proposed by the community. This will allow stressing the main processes to be considered to properly manage RM in projects. Then, different KM models are analyzed in order to highlight how strategic surveillance and competitive intelligence provide organizations with enough knowledge to face their projects in an advantageous position. Finally, most extended PM approaches are considered, weighting their usefulness to deal with complex projects.

2.1. Risk Management (RM)

In project environments, RM consists of considering all factors that can affect the achievement of their objectives. Therefore, RM represents a key issue in any organization that manages projects [66,67]. Threats can negatively impact project results and affect project satisfaction. In addition, an efficient RM approach requires organizational knowledge that provides an adequate and systematic methodology to be applied by experienced staff [68]. In this regard, KM capabilities can weaken these negative effects [62] and increase positive ones [69]. This potential has been collected in numerous standards and guidelines, as summarized in Table 1, which propose the basic RM principles and procedures.

These standards can be applied in both public administrations and private organizations, providing a comprehensive and useful set of tools and techniques for RM. They also provide a common language that facilitates communication [70], which helps organizations to achieve their objectives and build resilience when facing uncertainty [71], thanks to their guidance and support. In addition, they propose a series of interrelated and interactive activities, in which the establishment of a context and the assessment, treatment, monitoring, review and communication must be emphasized.

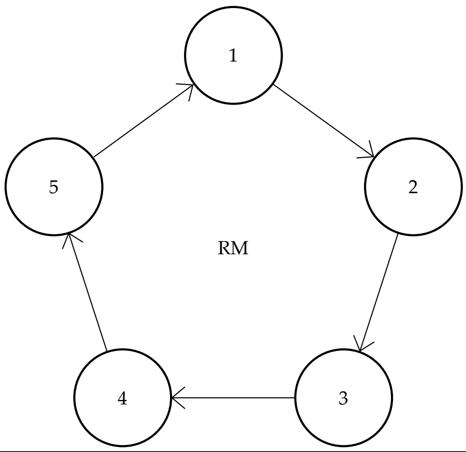
Table 1. RM standards review.

Ref	Code	Title	Scope	Version		
				1st	Last	
[72]	NS 5814	Requirements for Risk Assessment	Norway	1991	2008	
[73]	AS/NZS 4360	Risk Management	Australia New Zealand	1995	2004	*
[74]	BS 8444-3:1996	Risk management. Guide to Risk Analysis of Technological Systems	UK	1996	1996	
[75]	PRAM Guide	Project Risk Analysis and Management Guide	UK	1997	2004	*
[76]	CAN/CSA-Q850	Risk Management. Guideline for Decision-Makers	Canada	1997	2009	*
[77]	BS 6079-3	Project Management. Guide to the Management of Business Project Risk	UK	2000	2019	**
[78]	JIS Q2001	Guidelines for Development and Implementation of Risk Management System	Japan	2001	2007	*
[79]	BS/IEC 62198	Project Risk Management. Application Guidelines	UK	2001	2014	
[80]	ANSI/IEEE 1540	Standard for Software Life Cycle Processes. Risk Management	USA	2001	2006	***
[81]	BSI/PD ISO/IEC Guide 73	Risk Management. Vocabulary. Guidelines for Use in Standards	UK	2002	2009	
[82]	IRM/AIRMIC/ALARM	Risk Management Standard	UK	2002	2002	
[83]	ONR 49000	Risk Management for Organizations and Systems: Concepts and Foundations	Austria	2004	2014	
[84]	COSO ERM	Enterprise Risk Management. Integrated Framework	USA	2004	2017	
[85]	ISO/IEC 16085	Systems and software engineering. Life cycle processes. Risk management	International	2004	2020	
[86]	BS 31100	Risk management. Code of Practice	UK	2008	2011	
[87]	ISO 31000	Risk Management	International	2009	2018	
[88]	ISO/IEC 31010	Risk management. Risk Assessment Techniques	International	2009	2019	

* Converged in ISO 31000; ** Converged in BS 6079; *** Converged in ISO/IEC 16085.

The establishment of an organizational system based on successful RM policies such as those summarized in Table 1 brings value to organizations, which directly influences their performance. However, it can be noted that the balance between the investment in developing and implementing measures provided by an RM system versus the impact on costs, delays and rejections of these inactions should be positive [89]. This benefit is evidenced by the reduction in threats, as well as in the generation of favorable conditions for the development of opportunities, enabling organizations to improve their internal control and their projected reputation with clients [90].

In the context of permanent organizations, these standards establish the need to face risks, identify them, plan actions for their elimination or reduction, assess the effectiveness of the measures taken and register them. This makes RM an essential tool to be considered. In addition, in project environments [91], risk complements the triangle of success (time, cost and quality) [92]. Consequently, its management becomes a critical factor for the fulfillment of the project's goals and, indirectly, of the objectives set by organizations. According to previous literature reviews [93–96], RM can be methodologically treated [97], the stages of which are summarized in Figure 2. In this regard, methodologies such as Total Risk Management (TRM) [98], Integrated Risk Management (IRM) [99], Holistic Risk Management (HRM) [100] and Enterprise Risk Management (ERM) [101], describe how risks can be managed in an organization.



Method	1	2	3	4	5
TRM	Identify Risks	Consider Risks	Examine Solutions	Implement Solutions	Monitor Results
IRM	Detect Risks	Analyze Risks	Estimate Data	Respond Risks	Assess and Learn
HRM	Recognize Risks	Explore Special Areas	Quantify and Filter Risks	Develop Strategies	Put Risk under Control
ERM	Define Risks	Measure Risks	Retain and Transfer Risks	Align Responses	Evaluate Settings

Figure 2. Stages of RM.

TRM assesses what could occur differently from the intended course of action. By challenging the attitudes, values and behaviors of individuals working on a project, TRM encourages a plan that will produce the best business solution that identifies and measures risks, examines and implements solutions, and monitors the results obtained. On the other hand, IRM focuses on evaluating risks in the context of business strategy, contributing security to strategic decisions by deploying a set of proactive practices. To achieve this, IRM detects and analyzes risks, estimates data, develops responses, evaluates the results and learns for future challenges. In the same vein, HRM provides an in-depth understanding of how the risk components fit together and how the grouping of these parts affects the project as a whole. Moreover, HRM embraces all the key risks, investigating their full spectrum, including areas of general concern, developing cost-effective strategies to respond to significant risks and reaching arrangements to protect organizations from the most serious ones. Finally, ERM proposes a holistic, strategic and integrated approach that enables organizations to take advantage of their opportunities to achieve the objectives they have set, balancing them and risks. However, this requires there to be systems in place to make organizations more resilient and adaptable to major changes, providing a coherent framework for facing risks. In this context, ERM defines, measures, retains and transfers risks, aligning responses to organizational objectives and evaluating organizational settings.

2.2. Knowledge Management (KM)

In permanent organizations, KM includes the planning, execution and control of activities to enhance knowledge and increase competitiveness through the best use of individual and organizational knowledge [102]. In this context, KM involves both the creation of an appropriate organizational culture and the development of mechanisms for knowledge to flow through organizations [103]. However, for this knowledge to really circulate, the processes that compose it must be considered. Once these processes are defined, the knowledge required to manage and improve them must be established. Furthermore, as the processes are executed and controlled, records with potentially valuable data emerge, which can later be transformed into new knowledge [104]. This enables private organizations and public administrations to increase their capacity for innovation [105,106]. This interest is leading to the emergence of different models of KM, which allow a simplified representation of how knowledge can be managed. These models provide the structures and processes that transmit information, as well as the transformation of data into knowledge [107]. Table 2 presents a brief review of KM models, classifying them into four major groups:

- Storage, access and transfer. They focus on the application of methods, strategies, techniques and tools that provide the storage of knowledge and facilitate its access and transfer within organizations.
- Technology. They focus on the use of computer systems to support the deployment of technological tools that facilitate decision-making in organizational processes.
- Socio-culture. They encourage an organizational culture that promotes the generation of knowledge linking social processes and organizational learning by means of building confidence, enabling resourcefulness, fostering communication and emphasizing collaboration.
- Holism. They integrate the sustainable improvement in handling the knowledge on all levels of organizations, supporting business viability, competitiveness and growth through the identification, capture, transformation, consolidation, evaluation and dissemination of knowledge.

In this study, holistic models are chosen over the others reviewed because they integrate their main advantages. In detail, these models support organizations in achieving objectives and in reaching a higher level of competitiveness [108], which is accomplished through the integration of three elements [109]: human, technological and organizational issues. Furthermore, this approach also takes into account both the context and the specific needs of each organization in the processes related to knowledge [110]. This provides the proper circumstances that facilitate and promote participation in the processes of recovery and transfer. In addition, this implicit knowledge (summarized in skills, expertise, experience, culture, values and attitudes) must be merged with explicit knowledge (summarized in policies, procedures, guides, databases and records) [111] in order to compose the organizational know-how [112]. Another important consideration is that holistic models promote competitive development through the creation of stakeholder networks and innovation processes [113,114].

On the other hand, holistic models also connect the cultural and technological dimensions of organizations [115], aligning operational activities with strategy and integrating key performance factors in a systematic way. This increases the interest in using them because of their broad applicability [116], including PM environments [117], as well as for analyzing and influencing risk scenarios [118]. These organizations may benefit from local environment (such as perceptions and memories), experienced people (such as scientists and technicians) and rising factors (such as regulation and collectives). In summary, the design of RM strategies that fit specific project contexts and organization dynamics is enriched by the contribution of local agents, expert judgements and emerging circumstances.

Therefore, this integration requires an interdisciplinary approach, as anticipated by the practical guidance on knowledge management UNE 412001 [119].

Table 2. KM models review. Enhanced from [108].

Model	Features
[1] Wiig [120]	Construction and Use: Construction, Retention, Staging and Application Dimensions: Integrity, Connection, Congruence and Perspective
[1] Nonaka and Takeuchi [121]	Principles: Epistemology and Ontology Cyclical Processes: Socialization, Externalization, Combination, and Internalization
[1] Bustelo and Amarilla [122]	Practical Initiatives: Information Management, HR Management, Measurement of Intangible Assets
[2] BSC [123]	Levels: Corporation, Business and Function Areas: Learning and Growth, Business Process, Customer View and Financial Data
[2] IAM [124]	Intagible Assets: External Structure, Internal Structure and Staff Competence Tangible Assets: Growth, Innovation, Efficiency and Stability
[2] PTCC [125]	Enhanced Performance: Managing Knowledge Asset, Getting the Organization Ready, Leveraging Knowledge
[2] Technological [126]	Process Layers: Acquisition, Refinement, Storage and Retrieval, Distribution and Presentation
[3] KPMG Consulting [127]	Factors: Commitment to Learning, Development of Mechanisms and Infrastructures
[3] Skandia Navigator [128]	Levels: 1: Renewal and Development. 2: Process, Human and Customer. 3: Financial
[3] APQC (KMAT) [129]	Benchmarking: Competition, Compromise, Cooperation and Collaboration Sections: Leadership, Culture, Technology, Measurement and Process
[3] Arthur Andersen [130]	Individuals: Experiment, Learn, Create, Cooperate and Innovate (Capture, Distribute) Organization: Analyze, Synthesize, Apply, Assess and Innovate (Capture, Distribute)
[3] IADE (Intellectus) [131]	Capital: Staff, Organization, Technology, Business, Society, Entrepreneurship and Innovation
[3] STAR [132]	Elements: Strategy (Direction), People, Structure (Power), Rewards (Motivation) and Processes
[4] Dynamic-Rotational [133]	Spiral Processes: Acquisition, Socialization, Structuring, Integration, Valuation and Detection
[4] Organizational [134]	Agents: Strategy, Organizational Learning, Intellectual Capital, Frontiers (Environment)
[4] Generational [135]	Nested Domains for Production, Integration and Business Process Environment: Individuals, Groups and Organization
[4] Integrated-Situational [136]	Stages for Relational, Business and Intellectual Capital: Acquisition, Storage, Transformation, Distribution and Usage
[4] Jashapara [137]	Elements: Strategy, Systems and Technologies, Culture, Organizational Learning
[4] Holistic [138]	Processes: Socialization, Creation, Adaptation (Modeling), Dissemination and Application
[4] EKMM + SERM [139]	Elements: ERP System, Strategy, Technology, Planning and Monitoring, Organization, Culture
[4] GKMF [140]	Processes: Business, Knowledge and Context Stakeholders: Individual, Organizational and Cultural (Communities)
[4] Hamburg [141]	Spheres: Influence (Actors, Context), Development (Culture, Processes, Structures) and Action
[4] Marketing [142]	Levels: I (Cooperation), II (Promotion), III (Synergy), IV (Interprocessing Networks)
[4] NUSANTARA [143]	Levels: Vision and Mission, CSFs, Processes, Information, Cycles, Structures and Services

Models: [1] Storage, Access and Transfer; [2] Technological; [3] Socio-Cultural; [4] Holistic.

Planned risk responses must take into account how RM processes must be developed in order to consider their integration with other PM processes [144]. This ensures that risks are identified, analyzed, responded to, monitored, controlled, reviewed and recorded in accordance with project requirements [82]. In addition, it can be noted that these RM processes are supported by the same three pillars of holistic KM models: leadership, technology and organization [145]. This learning process introduces the project context, which facilitates defining the level of risk tolerance. However, the holistic approach that enables the deployment of risk and knowledge processes in PM depends on [108]:

- Value generation: KM feeds RM processes, reducing negative impacts of threats and preventing unforeseen events in project environments.
- Open communication: Barriers that interfere with communication hinder KM results, reducing the RM effectiveness, which affects the project performance.
- Individual commitment: The whole organization must maintain both KM and RM.
- Organizational commitment: Both KM and RM strategies must be aligned with the organizational values and culture so that all areas can participate proactively.

2.3. The IPMA Model in Project Management (PM)

Projects are becoming a common way of organizing work in any economic and/or social environment [146]. The growing projectification of economies underlines the importance of PM both for research and practice [147]. In dynamic contexts, such as those arising in the construction industry, organizations are facing a multitude of challenges, which increasingly occurs through projects, which in turn are becoming more complex [148]. In this context, many institutions at the international level have been working for years to propose standards, methodologies and frameworks for the community. Among other institutions, IPMA [149–151], PMI [152–154], the International Organization for Standardization (ISO) [48] and the European Union (EU) [155] are steering their foundational standards, guidelines, bodies of knowledge, methodologies and baselines around three approaches [43]: people, organizations and projects, as represented in Figure 3.

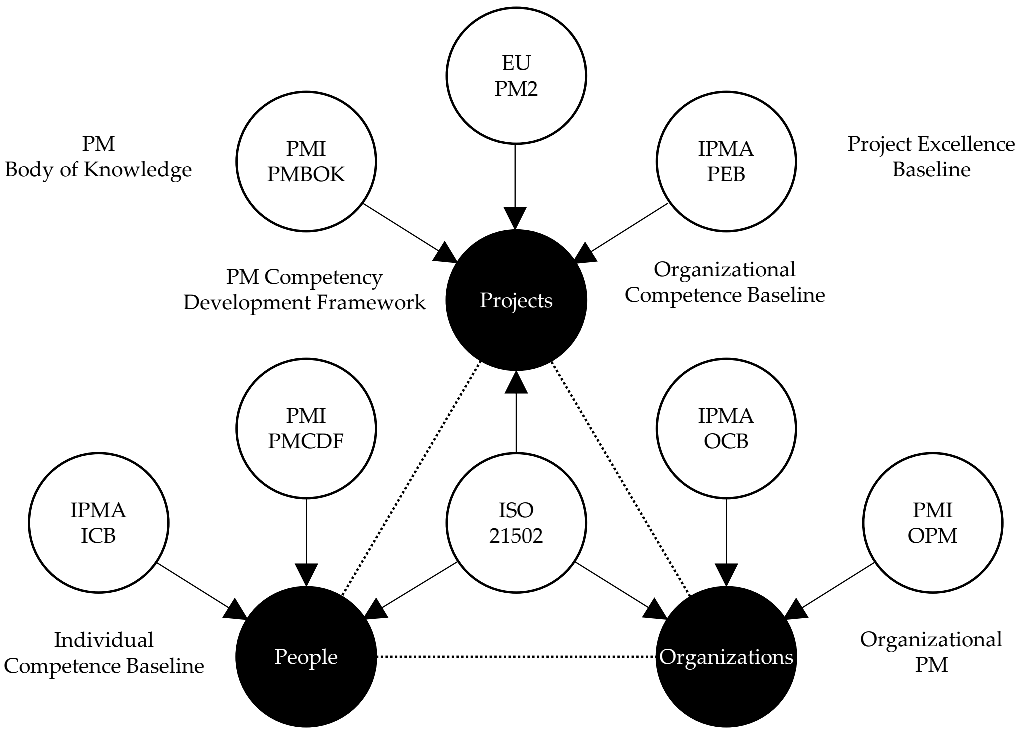


Figure 3. International PM approaches based on projects, organizations and people. Based on [43].

It can be noted that the comprehension and application of knowledge, techniques and tools usually considered as good practices may not always be enough to properly manage projects [156]. In this context, specific abilities and general capabilities are also regularly required. However, almost all PM proposals are process-oriented. On the contrary, very few are competence-based, although this would foster the right conditions for good performance [157]. Whereas the first group of proposals prescribes procedures and methods, guaranteeing organizations a universal approach to PM, the second group presents a broad set of knowledge, skills and abilities relevant to the achievement of project objectives [158]. From this point of view, the development of competencies by individuals and organizations facilitates undertaking projects and businesses involved [159]. These managerial competencies (and not just technical knowledge) can be incorporated to transform the role of technicians into that of managers [160,161].

Managing complex projects requires a set of competencies, including expertise to mobilize knowledge, intrapersonal and interpersonal skills [162], technical abilities, cognitive aptitudes and general capabilities [163], as well as the integration of resources, to achieve the performance expected [163–168]. In brief, work-related elements (skills, abilities, expertise, experience and knowledge) are complemented with personal attributes (attitudes, behaviors, motivations and values) [169]. In this context, personal traits and managerial skills are essential to perform complex projects [170], which are often characterized by change and uncertainty [158]. Although these affect the relationship between competencies on projects' success [171], if PM tools and techniques are used in combination with a set of alternative skills and abilities [172], this condition can be mitigated [173].

According to the IPMA Individual Competence Baseline (ICB) [149], competencies are grouped around three related domains (eye of competence): people (intrapersonal and interpersonal skills needed for successful management), practical (technical issues of PM) and perspective (internal and external project environment). The IPMA ICB helps to establish the abilities, knowledge and skills required for the proper performance of the processes described in other guides such as PMI PMBOK [174], ISO 21502 [48] and EU PM2 [155]. This structure has been proposed subsequently by several researchers: occupational, understanding and attitudinal [175]; input, personal and output [176]; social, functional and cognitive [177]; living in the world; tools for work and ways of thinking [178]; compliant, professional and attitudinal [179]; contextual, occupational and personal [180]; instrumental, interpersonal and systemic [181]; or experienced, managerial and personal [158]. As shown in Figure 4, this vision has also been integrated into the ISO 21500:2012 standard (contextual, technical and behavioral competences) [182] and incorporated by the PMI in both its talent triangle proposal (technical, strategy and business management and leadership) [156] and its PMCDF3 framework (knowledge, performance and personal competences) [152]. Therefore, this structure is widely recognized in PM [183,184].

The development of organizational competencies is a key element of knowledge, which must be maintained and made available whenever necessary. From an integrative approach, this enhances organizations' abilities to achieve their objectives by aligning a set of available individual, strategic, structural and cultural attributes, as well as deploying their assets [26,27]. In short, if organizations adapt the way they work in projects to include professional recommendations, coordination is facilitated and performance is improved [185]. On the basis of the alignment of organizational objectives [186] and influence on individual effectiveness [187], the approach based on contrasted models has proven its validity for projects.

The organizational approach in PM encompasses strategies, selection criteria and project prioritization, to check how the work performed is embedded in the organizational culture to improve its efficiency [188]. In this regard, the PMI model stresses a framework that uses both PM and organizational practices to deliver a strategy that consistently and predictably produces improved performance, better results and sustainable competitive advantage [153]. In addition to this, the IPMA model also highlights the ability to integrate individuals, resources, processes, policies, procedures, structures, strategies and cultural diversity in projects, integrating them into programs and portfolios aligned with the organizational mission and vision. This enables organizations to achieve results and ensure continuous development [150]. In summary, based on each context (especially considering the market and the environment) and thanks to adaptive structures, competent staff and a project-oriented culture [189], organizational strategies can be developed and project business can be aligned, enabling the organizational objectives to be achieved.

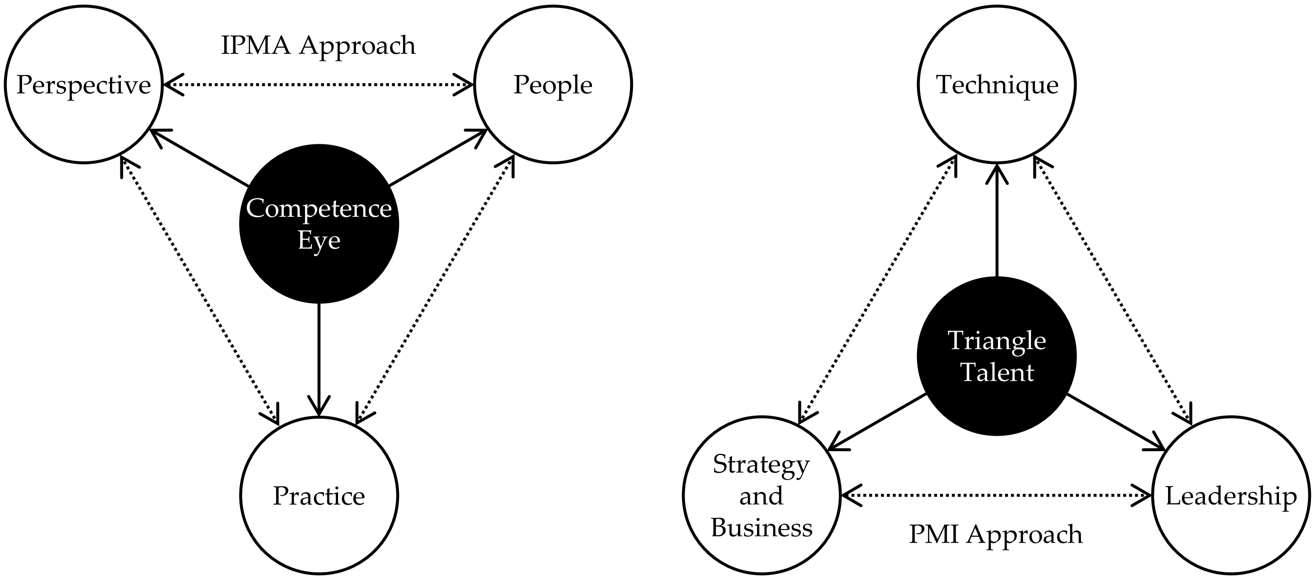


Figure 4. International PM approaches based on domains of competence.

As suggested in the ISO 9004 standard [47], if organizations set KM as a strategic objective to drive competence development in project environments, then both implicit and explicit knowledge can be vehicles for improving PM competencies and striving for sustained organizational success. Among the professional models analyzed, those provided by the IPMA [190] represent more applicable and resilient approaches than other frameworks [191] because they consider the diversity of contexts. Using the IPMA approach, action plans can be designed to promote the competence, as there are direct and cross-cutting relationships. The understanding of the knowledge involved in the influences of the relations between RM and all other competences enables them to anticipate and predict situations and take control before they become a problem. This enables them to act on them quickly and accurately, getting to their core through analysis and presenting solutions, influencing others by listening, assimilating, communicating and providing precise information to key stakeholders. In addition, in order to facilitate a better understanding of the knowledge involved with each of the competencies based on the IPMA baselines that are related to RM, Tables A1–A3 for each of the three domains (perspective, people and practice) in Appendix A are included.

2.4. Sustained Success (SS)

Elements that make a business successful [192,193] and areas where satisfactory return is essential to achieve organizational goals [194,195] must be pointed out. In project environments, a wide range of factors can influence project success, which, if neglected, can undermine its results [196]. These factors have been previously reviewed by a large number of researchers. Lists including them have been identified, but there is no general agreement. In order to approach the problem, the Scopus database has been used. The search was carried out using the terms "literature review", "critical success factors" and "construction industry", discarding references older than 10 years but selecting those with the greatest impact [197], as summarized in Table 3. Dealing with these factors involves an organizational strategy to face their challenges [198], improving their efficiency (management performance) and effectiveness (usability of results) [199], ensuring their competitiveness (impact on the organization) [200] and ensuring that expectations of the main stakeholders are duly satisfied and that future demands are properly considered (replicability of success) [6].

Table 3. Literature review on critical factors for success in the construction industry.

Dimension:	Criteria:	Factors:	[201] 2012 Chen et al.	[202] 2013 Norizam and Malek	[203] 2013 Yong & Mustaffa	[204] 2014 Alias et al.	[205] 2014 Gudienė wt al.	[206] 2015 Nilashi et al.	[207] 2015 Ngacho & Das	[208] 2017 Banihashemi et al.	[209] 2018 Maghsoodi and Khalilzadeh	[210] 2018 Sohu et al.	[211] 2018 Kiani Mavi and St&ing	[212] 2019 Li et al.	[213] 2019 Pham et al.	[214] 2019 Shayan, Pyung Kim & Tam	[215] 2020 Wuni and Shen	[216] 2020 Mathar et al.
Context	Replicability	Strategy		×		×		×		×	×		×			×		×
		Definition of objectives and priorities	×		×	×	×		×	×	×	×	×	×			×	×
		Alignment of needs with goals	×			×			×	×								
		Environment management	×	×		×	×	×	×	×		×	×		×	×		×
		Contextual stability	×							×			×		×			
		Share of Knowledge	×	×	×		×	×	×	×	×		×	×		×	×	×
	Impact	Organizational support	×	×	×	×	×	×		×	×	×	×	×	×	×	×	×
		PM methodology		×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
		Effective decision-making process		×	×		×	×	×	×					×			
		Use of lessons learned	×	×	×		×	×	×	×			×	×	×	×	×	×
		Responsiveness of client	×		×		×	×			×			×			×	×
		Trust among stakeholders			×	×	×			×	×	×	×	×				×
Project	Effectiveness	Scope of work and constraints	×		×		×		×	×			×		×		×	×
		Compliance with rules and regulations	×				×			×	×		×					×
		Effective change management	×				×	×	×	×			×					×
		Effective communication protocol	×		×	×	×	×	×	×				×	×	×	×	×
		Effective tendering process	×	×			×	×	×	×	×	×		×		×	×	×
		Effective risk management	×	×	×	×	×	×	×	×	×	×	×	×		×	×	×
	Efficiency	Commitment to project delivery	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
		Reliable estimates		×	×	×	×		×		×	×	×	×	×	×	×	×
		Availability of resources	×	×	×	×	×	×	×	×	×	×	×	×		×	×	×
		Allocation of roles and responsibilities	×		×		×	×	×	×	×	×	×	×	×	×	×	×
		Team building and motivation	×	×	×		×	×			×	×		×	×			×
		Staff competence	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×

×: critical success factors considered by author.

Critical success factors in the construction industry reviewed have been grouped into two dimensions (context and project), as shown in Figure 1 and compiled in Table 3. Each of these two dimensions groups together two criteria: results success (effectiveness) and management success (efficiency), for project success, and organization success (impact) and business success (replicability), for context success.

3. Methodology

This research intends to prove the influence of managing organizational knowledge on risk management and the impact of both the success of the project and the business associated, in accordance with Figure 5. To confirm these hypotheses, structural equation modeling (SEM) [217] is used to represent, estimate and test these relationships. Data collection was performed by means of a structured questionnaire [218], which was presented to construction agents.

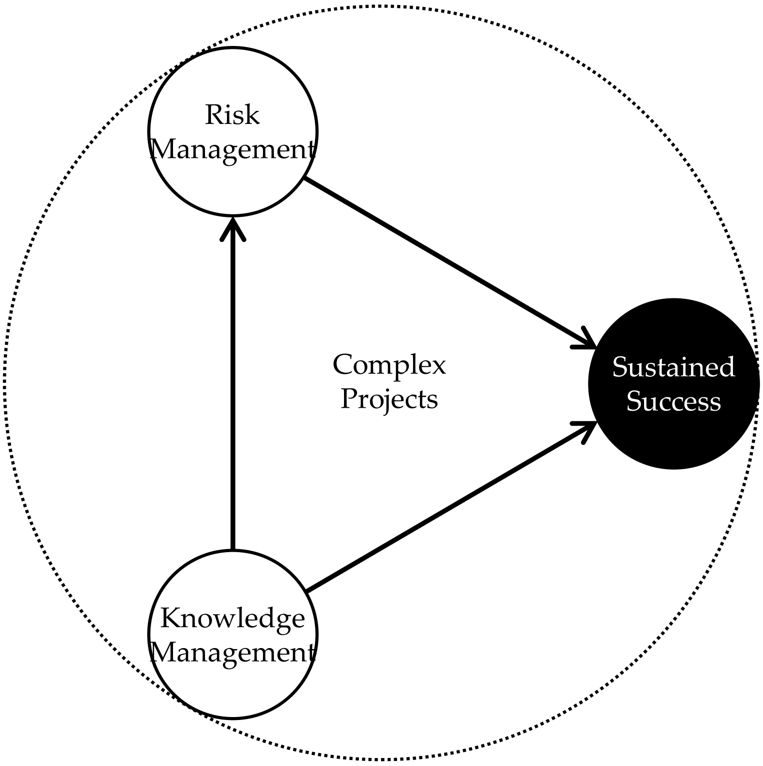


Figure 5. Dimensions to be evaluated in the conceptual model of influences.

3.1. Questionnaire Design

The questionnaire consists of three parts. The first part includes a single question, to select respondents that are currently working in the construction industry (excluding those who are not from further assessment). Although, in the distribution of the questionnaire, it is explicitly stated that it is addressed to construction agents, it can also reach professionals who work indirectly with the sector (clients or suppliers), who have worked (occasionally) or who have no relationship with it.

The second part is used to characterize the remaining sample. To begin with, three questions of a personal nature were asked (age of respondents, size of the company in which they usually work and typical size, in terms of schedule and budget, of the projects in which they are commonly involved in, which serves as a simplified measure of the complexity of the projects they usually undertake). Then, three more questions are asked with the aim of considering respondents as managers in the construction industry: first, the organizational role played in the projects in which they normally participate; second, the training they have received in PM (distinguishing between graduate (bachelor), postgraduate (specialist or expert), master and doctorate degrees), which provides knowledge of the relation of respondents with PM context (command of vocabulary, knowledge of main methodologies, standards, bodies of knowledge, baselines, guidelines, application of techniques and tools, etc.); third, their experience (as managers) in the construction industry. These six control questions are codified in Table 4.

Lastly, in the third part, those in the final sample were invited to respond on a specific five-item scale about the degree of importance given to each of the items that are presented, ranging from 1 (completely marginal or irrelevant) to 5 (completely crucial or critical). This enables us to define the alignment of respondents with the proposed statements [219], capturing their intensity.

Table 4. Control questions for sample characterization.

Scale (1–5 Likert)	1	2	3	4	5
Age (in years)	<25	25–30	31–45	46–60	>60
Company size (staff)	Freelance (0)	Micro (1–9)	Small (10–49)	Medium (50–249)	Large (>250)
Project complexity (time in months, cost in EUR)	very simple <4, <100 k	simple 4–12, 100–500 k	normal 13–24, 500 k–2 M	complex 25–48, 2 M–5 M	very complex >48, >5 M
PM training degree	Undergraduate	Graduate	Postgraduate	Master	PhD
Experience in PM (in years)	<1	1–5	6–10	11–20	>20
Organizational role (management function)	engineer or technician	project team member	project manager	program manager	portfolio manager

Based on the analysis of the responses collected, the model is characterized by means of SEM, which measures the direct and indirect relationships established among the variables of interest, statistically confirming them (or, if not, disconfirming them). It can be noted that the SEM technique is increasingly being used to test and evaluate multivariate causal relationships by means of combining confirmatory factor analysis and path analysis [220]. If compared with other multivariate analysis methods, such as multiple linear regression, multiple logistic regression, multivariate analysis of variance, neural network, factor analysis, and cluster analysis, the SEM provides a series of advantages [219,221], among which are the following:

- Establishing causal relationships in paths with multiple variables.
- Verifying data fit.
- Assessing measurement error.
- Estimating latent variables via observed variables.

To select the items included, a two-stage structured approach is adopted [25–27]:

- First step. From the literature sources, a list is composed (and refined later) of
  - Features of knowledge and risk management, filtered by critical success factors required for knowledge and risk management.
  - Criteria for managing knowledge and risk, filtered by success criteria in construction projects, businesses and organizations.
- Second step. From IPMA baselines proposed, the previous list is compared with key competence indicators proposed by the IPMA ICB [149], prerequisites developed for the IPMA OCB [150], and the philosophy driven by the IPMA PEB [151].

After the search, analysis and evaluation of the available sources of information about RM, KM, PM and SS, which have been reviewed in the previous section, as well as the IPMA approach, the questionnaire was prepared. Although clustering variables by groups of three is commonly recommended [221], latent variables can be extracted using fewer than five factors if there are enough respondents [222]. This study selected four factors by the dimension to be assessed. Respondents were asked about the consideration they attach to each of the items listed below, using the relative scale 1–5 previously defined:

- Risk Management (RM), considering risk identification, backup strategy design, periodic evaluation and forecast of alternative scenarios and routes:
  - RM1. Identification of sources of threats and opportunities.
  - RM2. Assessment of probability and severity of threats and opportunities.
  - RM3. Selection of strategies for addressing risks.
  - RM4. Monitoring and evaluation of implemented risk responses.
- Knowledge management (KM), considering multidisciplinarity, compilation of lessons learned, value creation, and competence and process approaches:
  - KM1. Research, development, innovation and improvement.

- KM2. Alignment of project goals with organizational vision and mission.
- KM3. Establishment of project management policies and procedures.
- KM4. Adequacy of roles and responsibilities of people involved.

- Sustained Success (SS), considering effectiveness, efficiency, impact and replicability (management, results, business and organization):
  - SS1. Project baseline accomplishment, including project results.
  - SS2. Organizational prosperity, including performance and scalability.
  - SS3. Client satisfaction, including flexibility and consistency.
  - SS4. Business continuity assurance, including reliability and sustainability.

3.2. Model Validation

The SEM model, which is summarized in Figure 6, is the combination of two primary components: the measurement model and the structural model. The measurement model describes the relationships between observed variables (RM1 to RM4, KM1 to KM4 and SS1 to SS4) and the constructs those variables are hypothesized to measure (RM, KM and SS). In contrast, the structural model describes the interrelationships among constructs (arrows), recognizing its complexity and multidimensionality. In addition, the scores of each dimension depend not only on the main constructs but also on the residual error terms (d01 to d02 for latent variables and e01 to e12 for observed variables). Consequently, they do not present measurement errors, as they differ from the variables with which they are associated. On the other hand, the model presents suggested adjustments, in which an improvement is obtained (through the modification indexes of the Lagrange multipliers test) by adding a series of covariances (double arrows) between errors of the theoretical model inside the same latent variable, but proposing only those operations that are statistically significant, with a basic theoretical justification (RM1 with RM3, RM1 with RM4, RM2 with RM3, KM1 with KM4 and SS2 with SS3).

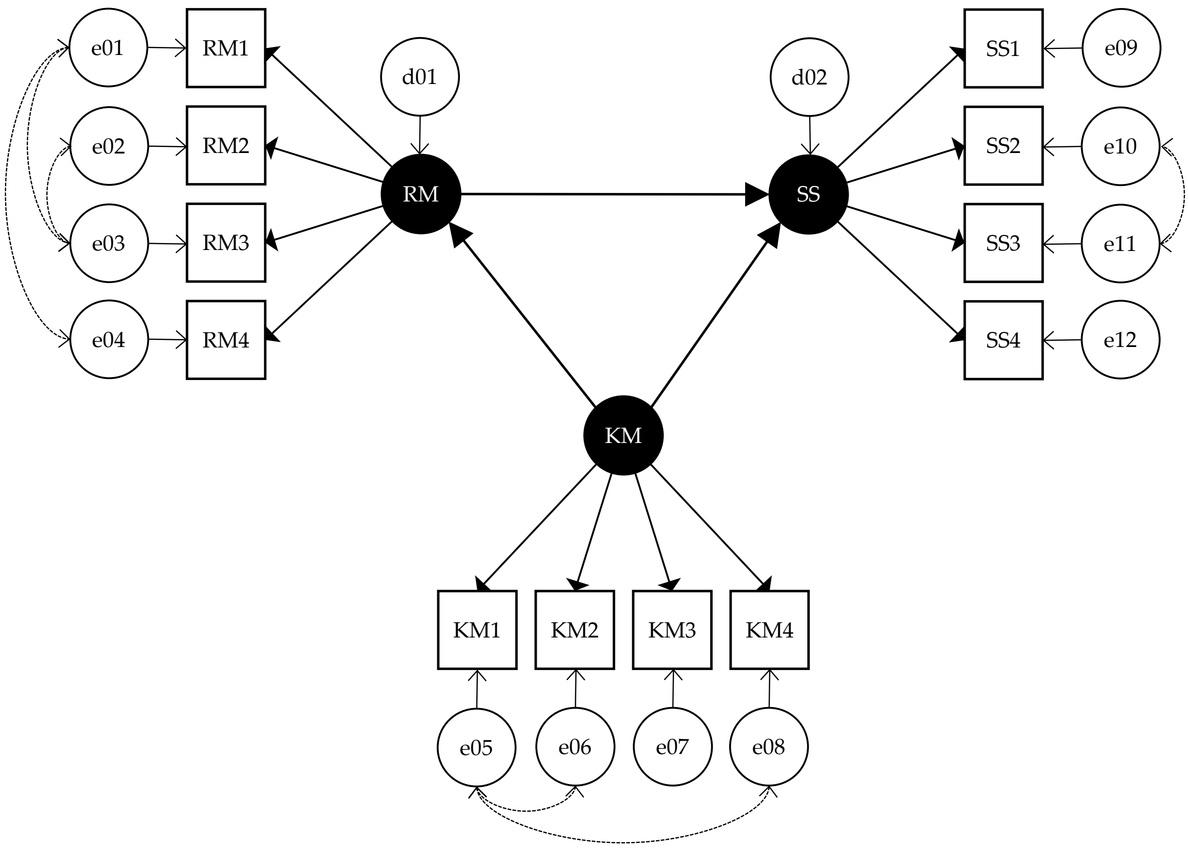


Figure 6. Structural equation modeling (SEM).

The research results are intended to be applicable to organizations managing complex construction projects. For this purpose, the questionnaire is distributed among construction technicians, practitioners and managers in order to assess the importance of KM and RM factors and SS criteria, as well as to test and validate their relationships by means of an SEM model. The survey remained open at least three months or until the confidence interval and statistical errors were narrow enough to draw valid conclusions. Within a normal confidence interval (a level of 95.45%) and considering a standard deviation of 50% of the scale ($(5 - 1)/2$) at worst, a sample of 246 respondents as needed in order not to exceed a standard error of 5%. After that, once the sample is accepted, its reliability (consistency), goodness and validity still need to be checked.

First, the reliability is measured with the Cronbach's alpha ($C\alpha$), testing the consistency of the hypothesized construct based on the data [25–27]. Values higher than 0.9 are considered excellent in most situations [223,224]. Second, the goodness is tested by means of absolute fit measures (AFM), such as χ^2/DF (chi-square divided by the degree of freedom), RMSEA (root mean square error of approximation) and GFI (goodness of fit index) and of incremental fit measures (IFM), such as CFI (comparative fit index) [225]. Values of χ^2/DF lower than 3 [226], RMSEA lower than 0.08 [227], GFI higher than 0.9 [228] and CFI higher than 0.9 [229] are acceptable. Third, the validity is measured with the standardized regression weight (SRW). Values of 0.5 or higher indicate good validity, suggesting adequate convergence [224], by predicting at least half of its variance [230]. In addition, indirect effects can also be considered if the Sobel test is significant [231].

Once the questionnaire is prepared, it is distributed through three channels:

1. Official associations of technicians with legal attributions for the design, supervision and coordination of construction works, such as:
    - CSCAE (Higher Council of Architects of Spain)
    - CGATE (Spanish General Council of Technical Architecture)
    - CICCP (College of Roads, Canals and Ports Engineers of Spain)
    - CITOP (College of Technical Engineers in Public Works of Spain)
    - CGCOII (Higher Council of Industrial Engineers of Spain)
    - COGITI (Spanish General Council of Technical Industrial Engineering)
2. PM professional associations, such as:
    - AEIPRO (Spanish Project Management and Engineering Association)
    - PMI Spanish Chapters (Andalusia, Balearics, Barcelona, Madrid and Valencia)
3. Working PM groups in social networks, such as:
    - AECMA (Spanish Association of Construction Management)
    - AEGC (Spanish Construction Management Association)
    - AEPDP (Spanish Association of Project Management Practitioners)
    - CCPM (Construction Certified Project Managers)
    - CMAS (Construction Management Association of Spain)
    - DIP (Integrated Project Management)

4. Results

When the exhibition period had ended (after three months), 640 responses were received. The first part of the questionnaire enabled respondents to be selected on the condition that the construction industry is their present occupational activity. Although the survey was distributed through associations related to the construction industry, 140 respondents were excluded because they actually came from other industrial sectors (they were asked which was the current sector they worked in), so the preliminary sample comprised 500 respondents from the construction industry. Next, the second part allowed us to discard technicians without PM training or experience in complex projects. This process excluded 120 other respondents because they were unable to prove either specific knowledge and skills in PM (training in PM) nor relevant experience in managerial activities. As the final sample was larger than 246, additional time was not required.

Thanks to the questionnaire design, competent PM practitioners and professionals in the construction industry were considered for the final sample. After the two steps of filtering the sample population, this was composed of 380 construction respondents, as summarized in Table 5. Then, once representativeness has been tested, the significance of the sample was obtained by achieving an error of less than 5% under normal conditions. Within a confidence interval of 95.45% and a heterogeneity of 23.90%, the final population sample contained a statistical error of 4.38%, lower than 5% (which is the upper limit proposed in the research). In addition, the reliability (internal consistency) was 0.915 (higher than 0.9), according to the Cronbach test. Therefore, the accuracy and reliability of the measuring instrument can be guaranteed and the results can be ensured.

Table 5. Responses to control questions by the final sample.

Questions	Responses	Units	%
Organizational Size	Self-employment	79	20.79
	Micro	107	28.16
	Small	61	16.05
	Medium	46	12.11
	Large	87	22.89
Project Complexity	Very Simple	33	8.68
	Simple	44	11.58
	Normal	122	32.11
	Complex	97	25.53
	Very Complex	84	22.11
Organizational Role	Technician/Engineer	92	24.21
	Member Project Team	70	18.42
	Project Manager	156	41.05
	Program Manager	35	9.21
	Portfolio Manager	27	7.11
Age	<25 years	2	0.53
	25–30 years	28	7.37
	31–45 years	245	64.47
	46–60 years	90	23.68
	>60 years	15	3.95
Training in PM (Degree)	Neither/Undergraduate	74	19.47
	Graduate	75	19.74
	Postgraduate	119	31.32
	Master	97	25.53
	Doctorate	15	3.95
Experience in PM	<1 year	39	10.26
	1–5 years	66	17.37
	6–10 years	105	27.63
	11–20 years	124	32.63
	>20 years	46	12.11

If control questions are analyzed, some findings can be highlighted. The average profile of the sample respondent is that of a project manager or project assistant, with postgraduate training in PM, working on not very complex projects (two-year duration and one million euros in budget) in a small company (between ten and fifty employees), with about ten years of experience in the construction industry. More than half of them worked in small or medium-sized companies at the management level. In contrast, almost half had no specialized PM training but worked on complex or very complex projects and had more than ten years of experience.

The response values assigned to the questions, according to the 1–5 scale provided, are analyzed below in Table 6, which shows the mean (μ), standard deviation (σ) and corrected item-total correlation ($r_{i\text{-}t}$) for each factor/criterion, as well as their theoretical grouping into dimensions. If the third part of the questionnaire is analyzed, SS is found to be a construct that exceeds 85% of the maximum scores (with no value under 80% of the maximum score), whereas the RM and KM constructs remain between 75% and 80% (with no value under 70% of the maximum score). To facilitate the replicability and comparability of the research, the third part of the questionnaire is included as Supplementary Material.

Table 6. Statistical results.

Dimension	Factor/Criterion	μ	σ	$r_{i\text{-}t}$
Knowledge Management	KM1	3.62	1.18	0.76
	KM2	3.84	0.97	0.65
	KM3	3.83	1.13	0.56
	KM4	4.12	0.89	0.70
	KM	3.85	1.06	0.92
Risk Management	RM1	3.84	0.85	0.64
	RM2	3.88	0.82	0.61
	RM3	3.83	0.88	0.66
	RM4	3.70	1.00	0.68
	RM	3.81	0.89	0.89
Sustained Success	SS1	4.23	0.85	0.63
	SS2	4.11	0.82	0.70
	SS3	4.65	0.61	0.56
	SS4	4.22	0.89	0.74
	SS	4.30	0.82	0.90

In addition, Table 7 shows the SEM goodness indicators. As all four criteria are satisfied, the model is validated.

Table 7. SEM indicators.

Model	Parameter	Measurement	Criterion	Status
AFM	χ^2/DF	82.941/45 = 1.843	<3	Ok
	RMSEA	0.047	<0.08	
	GFI	0.975	>0.9	
IFM	CFI	0.974	>0.9	

When dimensions are modeled, the relationships among them may be specified. Figure 7 shows them, as well as the normalized values of their components (SRW), which are higher than 0.5. Measurement errors are not shown to simplify the representation. As the main objective of this research is proving the utility and applicability of the IPMA model managing complex construction projects in risky environments, through the management of the individual and organizational knowledge, these statements can be supported:

- The relationship between knowledge management and risk management (influence of KM on RM) reaches 0.892, which means that knowledge management positively justifies 79.6% of the variance in risk management. It can be noted that this result is higher than 75% of the total.
- The relationship between risk management and sustained success (influence of RM on SS) reaches 0.751, which means that risk management positively justifies 56.4% of the variance in sustained success. It can be noted that this result is higher than 50% of the total.
- The relationship between knowledge management and sustained success (influence of KM on SS) reaches 0.339, which means that risk management positively justifies 11.5% of the variance in the sustained success by a direct effect. In addition, knowledge management also positively justifies 44.9% of the variance in sustained success by an

indirect effect, summing up to 56.4%. It can be noted that this result is higher than 50% of the total. However, to consider the indirect effect, the Sobel test must be significant:

- ○ KM (independent variable) predicts SS (dependent variable).
- ○ KM (independent variable) predicts RM (mediator).
- ○ RM (mediator) predicts SS (dependent variable).

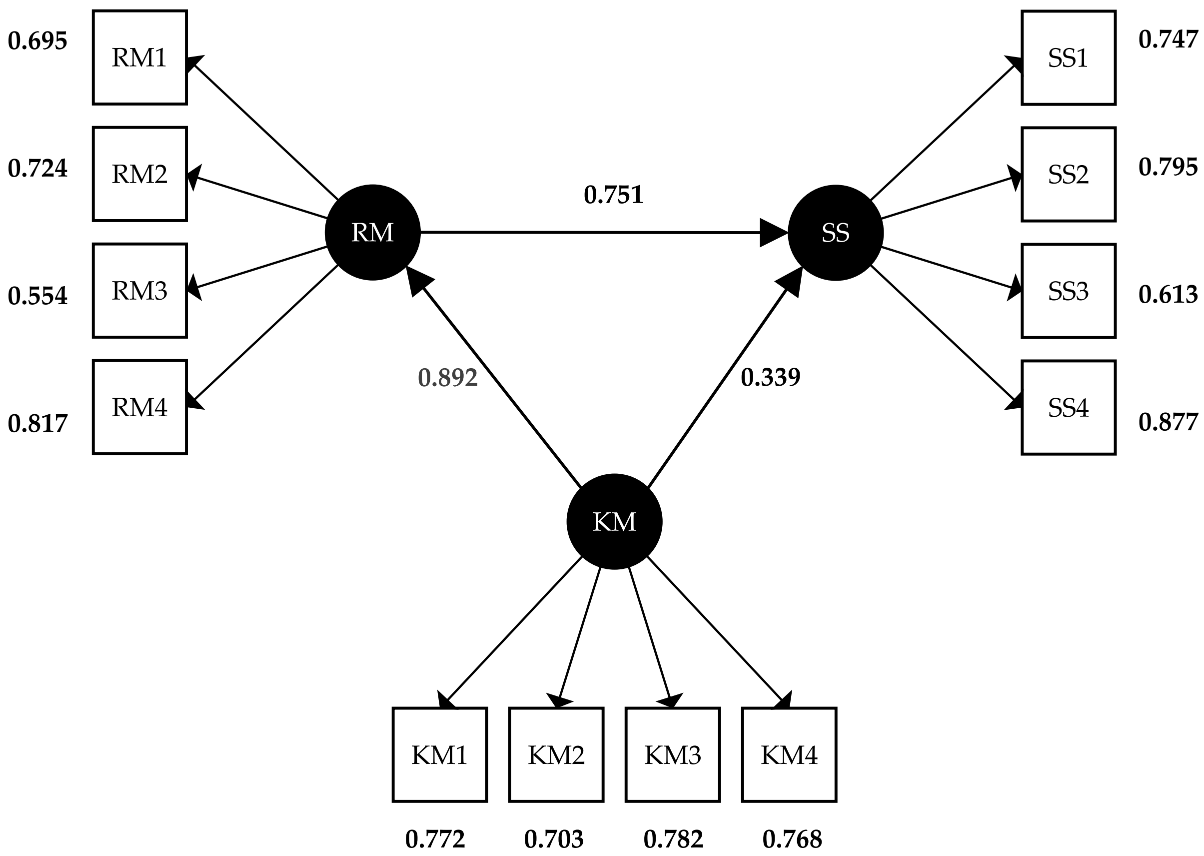


Figure 7. SEM results.

5. Conclusions

In the construction industry, a variety of challenges are faced when undertaking complex projects, many of which can be addressed by the way knowledge and risks are managed. Despite the existence of many PM proposals, none have been satisfactorily updated to integrate knowledge and risk to organizational needs in the construction industry. This may be due to the complexity and uniqueness of the projects managed by these construction organizations. However, as the management of threats and opportunities is derived from implicit and tacit knowledge, checking their relationships is required. Structural equation analysis has proven that these two management systems are strongly related.

On the one hand, applying the professional IPMA model becomes a crucial element for managing knowledge in organizations dealing with complex projects in risky environments. This model is not a PM guide because it does not describe the processes that must be performed, but instead focuses on the competencies that must be developed by the managers involved. With the taxonomic considerations analyzed, the IPMA model globally defines the knowledge involved in the competencies related to the management of risks, so that both the individual and the organization increase their knowledge as they accumulate experience, making holistic spiral models suitable for enhancing individual, group and organizational knowledge. This is part of all PM competence elements and can take different forms through processes, tools and techniques. In this way, its management is identified, transformed and applied, becoming a strategic advantage for other current or future projects, positioning as a critical intangible asset.

On the other hand, key competence indicators provided by the IPMA model can be used to measure how KM identifies, controls, mitigates or eliminates threats (or enhances opportunities) in projects. In this context, the development of skills, abilities, aptitudes and attitudes in managing risks reciprocally increases the PM competence of individuals and organizations involved. According to the results obtained, there are causal relationships between the management of threats and opportunities through individual and organizational knowledge, and the success of the projects in which these systems are being applied, thanks to the implementation of PM competencies of the IPMA model.

Because risk is measurable, variations and deviations that occur in projects can be analyzed through different existing methods. Dealing with threats and opportunities is a fundamental tool for knowledge generation and dissemination. However, the results obtained also depend on sound RM policies. Therefore, RM is positioned as a source of organizational knowledge, which can also support organizational growth and higher organizational maturity. Structural equation analysis has again proven that both systems are strongly related to organizational success in project contexts. This approach is a novelty that is not present in almost any PM model either.

Based on the importance achieved by KM and RM variables, it can be concluded that the IPMA model prevents potential conflicts arising from stakeholders' needs and expectations, assesses current performance, understands root causes of past problems, provides necessary resources, keeps stakeholders informed and ensures results are consistent with strategy, among other considerations. Both KM and RM systems can be postulated as robust factors to be considered for achieving sustained success. The IPMA model enables project objectives to be aligned with the organizational mission, vision and strategy. However, the statistical validation provided is a limitation of the research, which can be partially mitigated by analyzing relevant case studies and applying the IPMA model in organizations managing complex projects in the construction industry, strengthening this proposal. This will hopefully be addressed in future research. In this regard, this model is already being successfully implemented (projectified) in construction organizations all around the world, so it is expected that data will be available for processing in the medium term.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su14159711/s1. Third part of the questionnaire: responses.

Author Contributions: Conceptualization, A.C.-N.; methodology, A.C.-N., A.P.-F. and M.O.-M.; validation, P.B.-P.; formal analysis, A.C.-N. and P.B.-P.; investigation, A.C.-N., A.P.-F. and M.O.-M.; resources, A.C.-N.; data curation, A.C.-N.; writing A.C.-N. and P.B.-P.; original draft preparation, A.C.-N., A.P.-F. and M.O.-M.; writing—review and editing, A.C.-N. and P.B.-P.; supervision, A.P.-F. and M.O.-M.; funding acquisition, A.C.-N. and P.B.-P. All authors have read and agreed to the published version of the manuscript.

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Appendix A

Table A1. Knowledge involved in competencies related to RM (domain of perspective).

Element of Competence	Knowledge Involved
Strategy:	Critical success factors. Management control systems.
Governance, structures and processes:	Basic principles and characteristics of management by projects.
Compliance, standards and regulations:	Professional standards and norms.

Table A2. Knowledge involved in competencies related to RM (domain of people).

Element of Competence	Knowledge Involved
Personal communication:	Communication technologies.
Relationships and engagement:	Network theories.
Conflict and crisis:	Creativity techniques. Conflict stage models. Crisis plans. Worst case scenarios.
Resourcefulness:	Techniques to solicit views of others. Conceptual thinking. Abstraction techniques. Strategic thinking methods. Analytic techniques. Convergent and divergent thinking. Creativity methods. Innovation processes and techniques. Lateral thinking. Systems thinking. Synergy and holistic thinking. Scenario analyses. SWOT techniques. Creativity theories. Brainstorming techniques. Converging techniques.
Result orientation:	Organization theories. Efficiency principles. Effectiveness principles.

Table A3. Knowledge involved in competences related to RM (domain of practice).

Element of Competence	Knowledge Involved
Design:	Critical success factors and success criteria. Lessons learned. Benchmarking. Complexity. Project, program, and portfolio success. Project, program, and portfolio management success. Leadership styles. Strategies. Performance management. Organization project design rules and methodologies. Specific methodologies related to business and context. Organizational models. Theory of change.

Table A3. *Cont.*

Element of Competence	Knowledge Involved
Requirements, objectives, and benefits:	Expectations, needs and requirements. Fit for use, fit for purpose. Value management. Acceptance criteria. Benefits mapping. Goal analyses. Strategy setting.
Scope:	Configuration management. Hierarchical and non-hierarchical structures. Planning packages. Scope creep. Constraints. Work breakdown structure (WBS) and product breakdown structure (PBS). Work packages.
Time:	Planning types. Estimation methods. Levelling. Scheduling methods. Resource allocation. Network analyses. Baselines. Phases. Milestones. Fast modeling and prototyping. Spiral/iterative/agile development processes.
Organization and information:	Organizational models. Document management systems. Information and documentation systems. Information plans. Regulatory requirements. Information security.
Quality:	Validation and verification. Process quality management tools Product quality management. Cost of quality. Quality management standards Organizational quality analysis tools. Standard operating procedures. Policies implementation. Inspection methods and techniques. Risk-based testing.
Finance:	Financial accounting basics. Cost estimating methods. Cost calculation techniques. Design-to-cost/target costing. Processes and governance for cost management. Methods for monitoring and controlling expenditures. Performance indicators. Reporting standards. Forecasting methods. Financing options. Financial management concepts and terms. Relevant conventions, agreements, legislation, and regulations.

Table A3. *Cont.*

Element of Competence	Knowledge Involved
Resources:	Resource allocation methods. Resource assessment. Resource utilization calculations and collection techniques. Competence management. Procurement processes, supply, and demand concepts. Training.
Procurement and partnership:	Sourcing strategies. Make/buy analyses. Supplier development methodologies. Organizational procurement policies, procedures, and practices. Procurement methods. Contract types. Claim management processes, methods, and tools. Tender procedures and practices. Contractual judicial knowledge. Contractual terms and conditions. Supply chain management.
Plan and control:	Phase/stage transitions. Reporting. Project office. Deming cycle: plan-do-check-act. Requests for change. Management by objectives. Management by exception. Lessons learned reports. Phase/stage/sprint/release planning. Decisions to fund and make or buy. Exception reports. Issue reports. Project management plans. Project (phase) evaluation. Discharges. Decision making authorities.
Stakeholders:	Stakeholder interests. Stakeholder influences. Engagement strategies. Communication plans. Collaborative agreements and alliances. External environment scanning relating to contextual development.
Change and transformation:	Learning styles for individuals and organizations. Organizational change management theories. Impact of change on individuals. Personal change management techniques. Group dynamics. Impact analyses. Actor analyses. Motivation theories. Theories of change.

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