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# How partners' knowledge base and complexity are related to innovative project success: The roles of trust and trust capability of partners

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## ABSTRACT

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Competitive pressures and the need for innovation are shaping strategic partnerships. Participants involved in these partnerships share knowledge, collaborate in project activities, and make joint decisions to achieve complex project objectives. However, achieving effective collaboration in partnerships is challenging due to miscommunication, missing skills, missing resources, and lack of trust. This study develops a conceptual model based on existing literature, to investigate the effect of partners' knowledge bases, project complexity, and trust between partners on innovation and project success. We analyze the model using a survey of managers of European research projects and Partial Least Squares Structural Equation Modeling (PLS-SEM). Our results show the significant impact of changes in a project itself on its success, and the considerable impact of project complexity and trust on the ability of partners to alter the project itself. We also observe the significant impacts of similarity and complementarity of knowledge on trust between partners, and introduce the issue of whether partners jointly command the knowledge needed to complete the project, showing its importance in determining project success.

## 1. Introduction

Under current pressures from globalization and competition, increasingly firms look to innovation to satisfy their customers. Projects to develop new products and processes become more common among firms as they seek innovations that will keep them competitive. (Porter, 1998).

Whether or not a project results in significant innovation is closely related to the knowledge involved: innovation performance is driven to a great extent by the way different types of knowledge are integrated (Rundquist, 2012). Hence, there is also growing attention to the relationships between a firm's innovativeness and its knowledge, skills, and competencies. For instance, Robertson, Caruana and Ferreira (2021) studied the effect of knowledge creation; knowledge diffusion; knowledge absorption; and knowledge impact on innovation performance in developed and devel-

oping market economies. Among the four factors, knowledge creation had the highest effect on innovation performance. Islam and Chadee (2021) proposed a model to analyze the role of tacit and explicit knowledge on the innovation of developing-country suppliers in value chains. Their results indicated that both tacit and explicit knowledge make important contributions to innovation. Freel (2005) has demonstrated empirically a strong relationship between a firm's characteristics —firm size, age, financial, but most notably technological skills — and its innovativeness.

One issue that begins to attract attention is the complexity of the innovation project itself, as opposed to the complexity of the technology that is the subject of the project. Complex projects are typically identified with features such as technological (and other) uncertainty, stakeholder interests, interdependencies, and risk. Firms face difficulties in achieving innovation autonomously when their products, processes, or projects become complex. Natural limitations of a firm's internal knowledge and competence can hinder the production of relevant technological discoveries or the creation of new knowledge required for generating novelty (Fleming, 2001). When this is the case firms look to partnerships to manage complex innovation projects (Belderbos, Carree and Lokshin, 2004; Drejer and Jørgensen, 2005; Cowan and Jonard, 2008). One advantage of a partnership, as opposed to an acquisition is that a partnership permits the firms to share different types of knowledge to reach common objectives while simultaneously maintaining their independence (Chung, Singh and Lee, 2000; Chen and Goh, 2019).

Although many scholars discuss the bright side of partnerships, it should be noted that more than 60% of partnerships fail (Bruner and Spekman, 1998), where success is typically defined in terms of the development of operational value and also strategic compatibility of the project's outcomes with organizational and stakeholder benefits (Scheepers, McLoughlin and Wijesinghe, 2022). Flyvbjerg (2014) estimates that 25% of complex projects in the construction field do finally have a positive outcome, but less than 1% of them are finished on time, on budget, and with pre-defined benefits. While it is acknowledged that failure seems to be an inseparable part of partnerships, studying the reasons behind the poor performance of partnerships is vital to increasing the success rate (Rosas, Urze, Tenera, Abreu and Camarinha-Matos, 2017).

One of the most commonly documented factors behind project partnership failure is the lack of trust between partners, leading to a lack of knowledge sharing (Das and Teng, 2001a, 1998; Maurer, 2010). Park and Lee (2014) investigated the role of trust and dependency in sharing knowledge, concluding that collaborators share their knowledge when they trust each other and feel dependent. They also found that feelings of trust are affected by the frequency of communication, the similarity in the value placed on the projects by the partners, and also the similarities in their competencies.

Although there is a growing interest in partnerships there is still a large space for research. According to Varajãčo, Magalhães, Freitas and Rocha (2022), one of the principles in success management guidelines is to consider various factors associated with project success. Addressing appropriate factors, increases the likelihood of project success. Identified success factors can influence the project's success either directly or indirectly. However, to gain an understanding of project success and improve the success chance of future projects, we still need more knowledge of the actual results of projects and their influential factors (Volden and Welde, 2022).

This paper fills a gap in the literature by providing data-based insights into project success and factors that contribute to it, particularly in projects involving multiple partners. Specifically, the study identifies new aspects of both knowledge and complexity that are relevant to the success of partnership projects, and investigates the interplay between knowledge, trust, and project complexity, and their influence both on innovations within the partnership (one might say malleability of the project) and on the success of complex projects. We develop a novel conceptual model to examine the role of knowledge in trust, the impact of trust and complexity on project innovation, and the effects of innovation and knowledge coverage on complex project success.

The remaining sections of this paper are as follows: Section 2 presents the relevant literature discussing different criteria of success, and three factors thought to lead to it: the complexity of the project; changes (innovations) to the project during its progress; and trust among partners, and indeed the partners' natural inclination to trust (which we refer to as trust capability). From this discussion we develop several hypotheses regarding how these things interact to influence the success of a project. In Figure 1 we display the structural model on which we base the discussion

and analysis. In Section 3 we discuss the research design: the structure of the survey we develop to gather data, how the survey captures our variables of interest, and data collection. Here we also introduce the modelling strategy: partial least squares-structural equation modelling (PLS-SEM), explaining why it is a relevant tool for this situation. Section 4 presents standard prior data analysis tests used in PLS-SEM to ensure the quality, validity, and reliability of the collected data, showing that our analysis begins with good data. Section 5 gives our results: making changes to the organization or structure of the project itself supports its success; and trust among partners facilitates these changes. Different aspects of the combined knowledge stocks of partners affect levels of trust and so indirectly project success, but also have a direct effect on success. Finally, trust capability moderates some of these relationships, as we hypothesize. A discussion of the results is given in Section 6. The paper ends with a conclusion in Section 7.

## **2. Literature review and hypotheses**

### **2.1. Project success**

Alongside countless studies on the cause of failures in projects, many researchers have looked for the factors that determine a project's success. Measuring project success is complicated and challenging. In traditional project management, the fundamental factors to evaluate success were restricted to the iron triangle of cost, time, and quality (Atkinson, 1999). In recent decades project management has turned to a wider domain because of an increasing number of firms involved in projects at the national or international level, and have concluded that project success needs to be assessed in richer ways than has been done (VarajĂčo et al., 2022). Consequently, researchers argue that success is multi-dimensional, and must be measured accordingly. If we only consider the iron triangle, we restrict attention to the tangible dimensions of the final result of each project. However, developments in project management indicate that new models for measuring project performance should include the quality of the process as well as the quality of final results (De Wit, 1988; Todorović, Petrović, Mihić, Obradović and Bushuyev, 2015; Van Der Westhuizen and Fitzgerald, 2005; Ahmed and Azmi bin Mohamad, 2016). This evolution in our ideas about project success

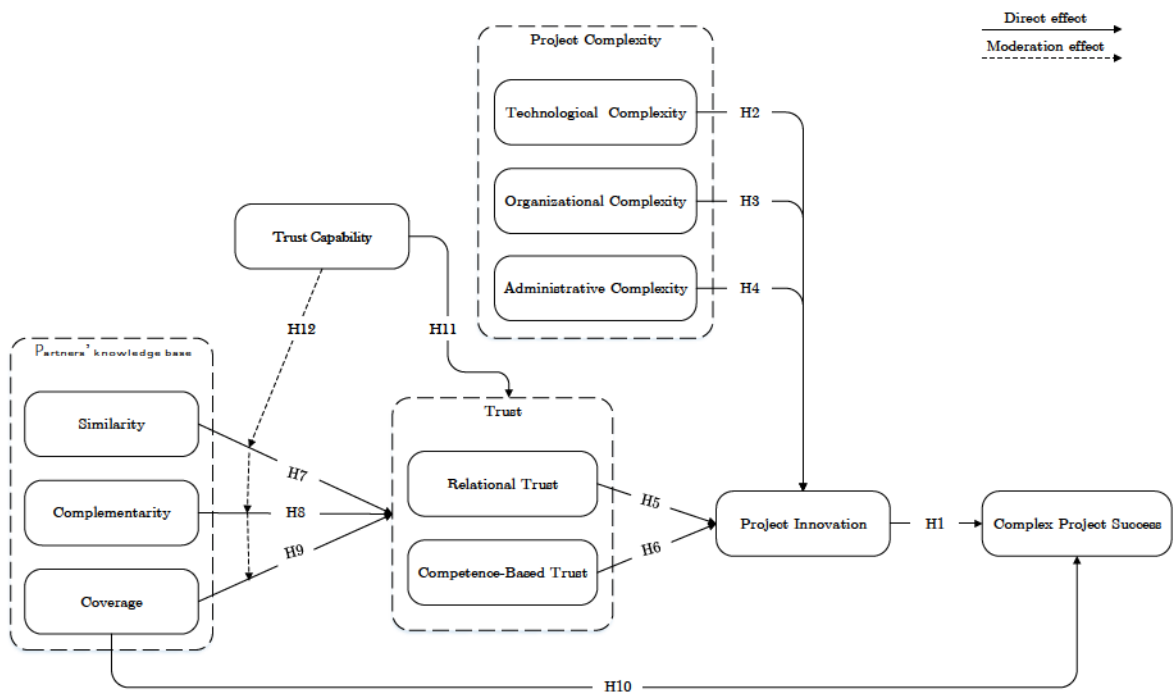
originated from the development of more universal understanding of project performance, focusing on organizational value creation. Thus project performance is now considered a multi-dimensional concept that includes both project management success and project success (Scheepers et al., 2022). One of the reasons for highlighting the importance of determining a precise meaning of project success is that without clear criteria for evaluating success, it becomes a situation subject to “who you ask and when” (Ika and Pinto, 2022). It is also important to note that measuring a project’s success could also be dependent on the nature of the project, for instance, organizational, team, communication, and technical factors have been considered critical success factors in construction-based renewable energy projects (Zaman, Wang, Rasool, uz Zaman and Raza, 2022).

According to a comprehensive study by Baccarini (1999); cost, time, and quality (factors in the iron triangle), which are objective and tangible, can be considered as *hard* dimensions, but there are also *soft* dimensions which are subjective, intangible, and hard to evaluate, such as project reputation and beneficiary satisfaction. Customer satisfaction, stakeholder satisfaction, project reputation in its domain, and many other factors have been introduced by recent researchers to highlight the critical role of human factors in project performance (Gunduz and Yahya, 2018; Un-terhitzenberger and Bryde, 2019). The importance of convergence in project representations and stakeholders’ desires is also emphasized in a process-oriented framework proposed by Abdallah, El-Boukri, Floricel, Hudon, Brunet, Petit and Aubry (2022) to measure the performance and success of the megaproject in its development phase. Moreover, success can be differentiated by long and short term factors. In the short term, fulfillment of time, cost, quality objectives, and customer satisfaction demand attention; in the longer run we can consider the fulfillment of objectives that will be judged later by different stakeholders (Müller and Martinsuo, 2015). In addition, considering only the iron triangle is not only insufficient for project management but, given its tendency to focus attention on shorter term objectives, it has the potential to over-look the longer-term organizational success, and thus in fact reduce the overall success of a project (Korhonen, Jääskeläinen, Laine and Saukkonen, 2023).

Since this study is focused on complex projects and the different partners involved, in order

to find a better measurement of project performance, we begin with the model previously used by Wang, Fu and Fang (2019); Khan, Turner and Maqsood (2013). This model is mostly based on a literature review of project success factors over recent years. It suggests that to measure project success not only is it essential that all the objectives of the project are accomplished while respecting the allocated budget on time, but it is also important both to have team members and stakeholders satisfied and to create or maintain a good reputation for the project in its domain. Achieving success in a complex project executed within a partnership hinges upon a multitude of factors, including, for example, project complexity, the project's malleability and changes to it (project innovation), trust levels among partners, and the knowledge base of these partners.

To focus ideas on what follows, in Figure 1 we present our conceptual model, as it serves as a central component of this study. It captures the influence of these factors identified as important in the success of complex projects. The rationale underpinning this conceptual model is elaborated in subsequent subsections.



**Figure 1:** Conceptual model.

This figure represents the conceptual model we develop and test in the subsequent sections.



## 2.2. Project innovation

In this section, we draw attention to a distinction that is not commonly made in the literature. Innovation, in the sense of creating a new source of revenue or a reduction of costs has been well studied. This “innovation” refers to the output of the project. However, there can be innovation within the project itself: changes in organization, in goals, in task assignment, and so on. Innovation in this sense — changing aspects of the project in response to challenges or opportunities that arise, taking advantage of its malleability — can be crucial to a project’s success.

### 2.2.1. Types of innovation

Both the classification of innovation type, and finding a model to evaluate a firm’s innovativeness have received considerable attention. One of the early models of innovation dimensions was proposed by Knight (1967) and used later as a model with which to measure innovation (Rowley, Baregheh and Sambrook, 2011; Jimenez and Jimenez and Sanz Valle, 2011; Aragn-Correa, Garca-Morales and Cordn-Pozo, 2007). Knight proposed that there are four different dimensions of innovation:

- *Product or service innovation*: depending on the field of activity of an organization, it refers to novelty in products or services that are provided.
- *Production-process innovation*: concerning changes in organizational operations and production, it originates largely in technological improvements.
- *Organizational structure innovation*: relating to innovations in the organization’s management systems, communication relations, or formal reward systems.
- *People innovation*: referring to changes in people (employees) within an organization, including changes in employees’ levels, managers, job functions, cultures, and human behaviors.

More recent studies of innovation types have tended towards a binary focus: product/ process, administrative/ technical (Damanpour and Evan, 1984; Cantarelli, 2022) and radical/ incremental

One of the potential challenges in the identification of dimensions of innovation arises from the reality that innovations are not isolated from the system in which they are embedded, any artefact or process typically has several aspects, and so one dimension of innovation is probably to be associated with other dimensions. Moreover, process/product innovation and administrative/ technical innovation can be included in the four dimensions of Knight (1967)'s model, and radical/ incremental innovation can be considered as attributes of innovation rather than dimensions of innovation (Rowley et al., 2011). Hence, for this study, we use the above four dimensions of innovation to measure project innovation.

### ***2.2.2. Innovation and complex project success***

Schumpeter argued that innovation is mostly the result of recombination in existing knowledge. It follows that if firms expand their access to (varied) information and knowledge, they increase their innovation potential. As technologies, products and production become more complex, firms seek opportunities through partnerships. But partnerships for innovation must be structured into projects that aim at some goal, which typically involves expansion of the partners' resources or opportunities. Often the projects themselves are complex, in the sense of involving many different "parts" which all interact.<sup>1</sup> Complex operations can be difficult to manage, and in particular are often not easy to change in response to unexpected turns of events. The ability to change the project, or innovate within the project itself can be crucial.

In this regard, several things can be seen in the literature. Benitez-Avila, Hartmann, Dewulf and Henseler (2018) proposed a conceptual model of contractual and relational governance. Using survey data from public-private partnerships in The Netherlands, they found significant improvement in project performance when partners trust each other. Trust facilitates a looser formal coordination which increases the malleability of a project and so permits innovation within it. Davies and Hobday (2005) studied dynamic innovation in complex products and systems. Analyzing partnerships between suppliers and customers, they found that system integration is a strong competitive

<sup>1</sup>"Parts" is in quotation marks to indicate a wide interpretation, including people, organizations, goals, social customs, legal practices and so on.

advantage. Practical research showed a positive effect of co-innovation in complex challenges as partners applied innovative approaches to five research projects. Their result confirmed that project innovation leads to performance improvement, especially in complex problems (Vereijssen, Srinivasan, Dirks, Fielke, Jongmans, Agnew, Klerkx, Pinxterhuis, Moore, Edwards et al., 2017). An empirical study of innovation resilience behavior, (that is, the ability and tendency to change a project in response to new information), project adversities, and project success in a sample of 87 innovation project teams, found that there is a positive association between innovation resilience behavior and project success. Furthermore, the study provides evidence that the significance of innovation resilience behavior increases when project adversities are higher (Fey and Kock, 2022). Barlow (2000), studying innovation and knowledge management in complex offshore construction projects, demonstrated the positive effects of the malleability of a project, and specifically the ability of managers to change the project itself, on project success.

The relationship between innovation and project success is nuanced and contingent upon the definitions and measures employed for each concept. Simply prioritizing the innovative output of a project, without ensuring the necessary infrastructure and resources for innovation, can ultimately result in project failure. Furthermore, innovative projects tend to be more complex, which can decrease the likelihood of success. However, if malleability is also integrated into the organizational structure and managerial methods of a project, in addition to the innovation in output or process, the potential for maximum innovation space can be achieved, thereby increasing the likelihood of project success.

In this study, considering the aforementioned measurement model for innovation and project success, and the theoretical relationship between innovation and success in complex projects derived from the related studies, we make the following hypothesis:

**Hypothesis 1.** Innovation in the project itself (for example new management methods, new dynamics in organizational operations and production, supporting new ideas for the final product or service) is positively associated with complex project success.

### 2.3. Project complexity and innovation

A project can be considered complex if it involves a high degree of interdependence among its various components making it difficult to predict and manage the outcome. One of the challenges in studying project complexity is its breadth and variety. The most common classification for complexity in project management research involves both technological and organizational complexity. Technological complexity refers to the complexity of transformation procedures, which transform inputs into outputs. Organizational complexity deals with interdependent operations and interactions between elements involved (such as the number of structural levels, units, groups, departments, division of tasks, etc.) (Baccarini, 1996).

Both types of complexity can be measured along four dimensions: size, variety, interdependency, and elements of context (Vidal and Marle, 2008). The degree of interaction between the organizational elements involved changes the degree of organizational complexity. In the factors presented by Vidal and Marle (2008), elements related to the different legal systems and geographical distance are a part of organizational complexity. We introduce here a third type of complexity, which is sometimes subsumed within organizational complexity. The point is to capture a distinction between collaborations among firms with similarities in culture, geography, and legal systems (i.e. national projects), and those among firms with different legal systems, cultures and geography (i.e. international projects). Because projects have become more international in recent decades, partnerships must deal with different legal and administrative systems. In consequence building on Vidal and Marle (2008), we introduce *Administrative Complexity*. With this we refer to the variety and diversity of the different legal systems and institutional configurations involved in the project. This permits us to ask whether there is any significant difference between organizational complexity and administrative complexity.

Technological complexity can be defined as product and process complexity that is directly associated with the nature of the project and arises in the way different parts of the technologies involved are coupled with each other (including the level of resources and technological skills needed, as well as the level of creativity demanded in different parts of the technology) (Chapman

and Hyland, 2004). The degree of technological innovation and demand for creativity are two elements of context in technological complexity (Vidal and Marle, 2008).

Projects involving more technological complexity are harder to manage, and accordingly, innovation is comparatively harder to understand, achieve, and use. Frenken (2006) argues that more intricate partnerships tend to foster increased innovation collectively through collaboration. But Rowley et al. (2011) point out that the more complex the technology at issue (involving a diversity of interlinked expertise, knowledge, and resources), the more likely it is that the project itself will have to change over time to accommodate (technological) surprises. The effects of technological complexity on innovation performance are studied by Yayavaram and Chen (2015). They conclude that high complexity can significantly moderate the effect of knowledge on innovation performance. Based on these arguments, it can be concluded that more complexity in the nature of the project's final output as a product or service requires more creativity and changes to the project as it progresses. The current study is looking at the relationship between a project's technological complexity and the degree to which innovation takes place within the structure of the project; the following hypothesis is proposed:

**Hypothesis 2.** Projects concerned with complex technologies are associated with a larger amount of innovation within the project itself.

The relationship between organizational complexity and innovation has been discussed from different angles in the literature. Benitez-Avila et al. (2018) build a structural model in which complexity in the legal system is considered as a moderator for governance of collaborations since it can negatively affect the relationship between governance and the different elements involved in the project. In the model relational norms, partners' trust, and partners' contributions are affected by this type of complexity. Using this model the authors examine the relationship between project management effort and project profitability in engineer-to-order projects with varying degrees of complexity, finding that higher project complexity poses a risk to project profitability. Nevertheless, Kaufmann and Kock (2022) argue that the impact of project management on profitability

becomes more significant as project complexity increases, ultimately resulting in higher returns for more complex projects. An empirical study of the Hong Kong-Zhuhai-Macao Bridge project (Qiu, Chen, Sheng and Cheng, 2019) to investigate the emergence and impact of institutional complexity on project outcomes and actors' behavior identifies regulatory, political, social, cultural, evolutionary, and relational complexity as sources of institutional complexity. The study reveals that macro-level institutional or administrative complexity creates constraint conflicts within megaproject organizations, while micro-level institutional complexity results in organizational conflicts arising from diverse practices and identities of project actors. In similar contexts to those in which legal complexity matters, cultural discrepancies can also negatively affect knowledge sharing between partners (Sunardi, Tjakraatmadja and Bangun, 2015).

On the other hand, however, some research reports a positive effect of organizational complexity on innovation. For instance, Ewens and van der Voet (2019) analyzed the relationship between organizational complexity and the occurrence of participatory innovation with data on German municipal governments. Their result revealed that functional differentiation as a part of organizational complexity positively affected the occurrence of participatory innovation. Winch and Maytorena-Sanchez (2020) explained that projects can serve as a complementary organizational form to hybrid organizations when it comes to addressing institutional complexity, especially in situations where the complexity is volatile, and creating a standalone hybrid organization is not feasible.

Moreover, in a study of EU funded multi-partner projects, Ruoslahti (2020), finds that looking at different elements of complexity can provide insights into communication and collaboration dynamics in innovation projects. The findings suggest that overall, complexity poses significant challenges in innovation projects, but that certain aspects of complexity may hold greater significance than others. Connectivity and interdependence are primary attributes of such projects that may cause difficulties when partners refuse to share information due to competitive concerns. However, complexity can also offer advantages in terms of creating new solutions. When multiple stakeholders with diverse perspectives are involved in addressing complex problems, the time-to-innovation can be reduced, leading to faster and more effective outcomes. Cantarelli (2022) looks

at megaprojects and observes that they often explicitly incorporate innovative strategies to manage complexity and enhance project delivery. The analysis identifies interdependent relationships among various innovation dimensions and finds that project complexity is a contingency factor affecting the impact of innovation on project performance. Policy recommendations emphasize the need to evaluate the trade-off between innovation and complexity reduction and promote better integration of innovative practices in megaproject planning.

Based on the review above, complexity can either increase or decrease innovation in a project depending on the specific context. While it may present new opportunities for creative problem-solving, it may also limit the ability to experiment and take risks due to increased management requirements, especially in cases of administrative complexity. Considering the lack of consensus in the research regarding organizational complexity, and the new dimension (administrative complexity) that is proposed here, we propose to analyze it in two different aspects. Thus, the larger the project in terms of organizational complexity (number of activities involved, investment size, staff diversity, and information system diversity), the greater the potential for innovation within the project itself, but involving different legal systems (administrative complexity) would result in a decrease project innovation. Accordingly, the following hypotheses are proposed:

**Hypothesis 3.** Projects that are organizationally complex (in terms of the number of activities, size of the investment, diversity of staff, diversity of information system and etc.) are associated with a larger amount of innovation within the project itself.

**Hypothesis 4.** Projects that are administratively complex (in terms of the number of different legal systems involved, local environment complexity, etc.) are associated with a smaller amount of innovation within the project.

### ***2.3.1. Trust and innovation***

Trust is a psychological condition of individual partners in the project partnership (Kadefors, 2004), and the fundamental question in this regard is whether to trust someone or something or not. A substantial criterion in trusting is the acceptance of taking risks or being vulnerable (Becker,



1996). Most studies of trust in the management literature are in the domain of inter-firm relationships, partnerships, and alliances. There are different classifications for trust dimensions in the literature. For instance, Ring (1996) proposed two types of trust — fragile and resilient. Fragile trust is trusting someone based on tangible facts, whereas resilient trust is more based on an understanding of goodwill. Kadefors (2004) and Rousseau, Sitkin, Burt and Camerer (1998) suggested three types of trust — relational, calculus-based and institution-based. Das and Teng (2001b); Wang et al. (2019) classify trust based on the ability to carry out an agreement — competence-based trust, and on the intention to do as you agreed — relational trust. Competence-based trust is based on some tangible information — it is possible to have it from the beginning of the collaboration, but relational trust increases or decreases after successful or unsuccessful collaborations. When it comes to trust, both expectations and actions seem to be important, so in this study, we are focusing on both relational and competence-based trust.

Relational trust refers to the belief that partners will act in a reliable manner, while competence-based trust relates to making rational choices about whether to trust someone or not. In this case, relational trust emerges when an individual believes that his partners will take actions in a reliable manner that is beneficial to him, based on successful collaboration. Competence-based trust is based not only on the existence of motivation but also on reliable information about the intentions and qualifications of others.

Interactions and exchanges between partners are key factors in sharing knowledge and increasing innovation, especially in projects with multiple partners. Nicolaou, Ibrahim and Van Heck (2013) investigated the effect of information quality on relational trust and competence trust in performance involving electronic data exchange. Their evidence confirmed that information quality has a remarkable positive effect on both kinds of trust. Pavez, Gómez, Laulié and González (2021) examined how trust and group potency affect team resilience in project team members. The study differentiated two types of trust: cognition-based (based on capability and reliability) and affect-based (based on good intentions). The research involved 214 construction project management team members from 50 teams. The findings showed that group potency and affect-based



trust played a mediating role in the relationship between cognition-based trust and project team resilience.

There is a tight relationship between trust, information sharing, and innovation. Cai, Goh, De Souza and Li (2013) studied knowledge sharing in the supply chain performance of logistics firms in Singapore and found significant effects of trust on technology transfer and technical sharing. Others, for example, Sridharan and Simatupang (2013) discussed the key role of trust in value creation through knowledge sharing and process integration. Also, Sunardi et al. (2015) suggested that employee skills, experiences, and educational background can increase informal knowledge sharing through mutual trust between partners. Taking a slightly different tack, Imam and Zaheer (2021) looked at the mediating role of trust in teams. Data at two points in time from 236 members of Information technology project teams were collected and analyzed using the conditional process model. They found that trust within a team has an interactive impact on both cohesion and knowledge sharing, ultimately influencing the success of the project. Thus, considering the effect of trust in knowledge sharing and innovation, the following hypotheses are proposed:

**Hypothesis 5.** Relational trust is positively associated with project innovation.

**Hypothesis 6.** Competence-based trust is positively associated with project innovation.

### *2.3.2. Partners' knowledge base and trust*

In this paper, innovative partnerships are the object of study, that is, complex projects that are managed by different partners aimed at sharing knowledge, learning, and producing new knowledge. Collaboration is an effective way to obtain knowledge both within an existing knowledge space and beyond its boundaries. Because sharing knowledge in a competitive environment is inherently risky, how trust is created becomes central. Hence we examine the role of partners' knowledge bases and their effect on relational trust and competence-based trust.

Efficient communication is a basic necessity for successful collaboration between partners. Similarity in knowledge is one of the most important factors in avoiding miscommunication and thereby helps minimize the risk of failure in complex projects (Vaez-Alaei, Deniaud, Marmier,

Gourc and Cowan, 2021). The existence of similarity in professional training, communication skills, values, and mindsets provides a common basis on which it is possible to establish trust and a low-risk environment for solving problems (Wilson and Johnson, 2007).

At the same time, though, complementarity in partnerships is a way to eliminate deficiencies in resources and reinforce each firm's ability to achieve a project's objectives. Resource complementarity was identified as the most influential factor enhancing stability and trust in ongoing collaboration (Deitz, Tokman, Richey and Morgan, 2010). A study of joint venture performance by Huang, Hsiung and Lu (2015) found that the value gap and information asymmetry mediate the relationship between control variables and performance. A model was presented to demonstrate how knowledge complementarity and joint innovation capabilities relate to service innovation. Results indicate significant and positive relationships between the complementarity of knowledge and joint innovation capabilities, and between joint innovation capabilities and service innovation. Joint innovation capabilities also have a positive and full mediation effect on the relationship between complementarity of knowledge and service innovation (Ndubisi, Dayan, Yeniaras and Al-hawari, 2020). Jin and Wang (2021) studied the impact of partner differences on the benefits of resource complementarity in 200 international joint ventures in China. Results show that cultural distance and control asymmetry has a negative moderating effect, while partner market overlap has an inverted U-shaped effect on international joint venture performance.

Though similarity and complementarity have been widely discussed, we observe that the knowledge held by partner firms can be classified into three categories (Vaez-Alaei, Deniaud, Marmier, Gourc and Cowan, 2019; Vaez-Alaei et al., 2021; Deniaud, Marmier, Gourc and Labaume, 2017): similarity, complementarity, and coverage. Similarity refers to knowledge known by all partners. Complementarity refers to knowledge that is known by only one or other of the firms and compensates for the deficiency of a partner. Coverage refers to the part of the knowledge required to finish the project that is covered by the partnership. To measure the partners' knowledge base, we consider all of similarity, complementarity, and coverage for all the skills, resources, services, and

languages of partners.<sup>2</sup>

Following the above discussion it can be concluded that trust between partners may be increased by similarity, complementarity, and coverage of knowledge. The following hypotheses are proposed:

**Hypothesis 7.** Similarity in knowledge is positively associated with trust between partners.

**Hypothesis 8.** Complementarity in knowledge is positively associated with trust between partners.

**Hypothesis 9.** Coverage of project knowledge is positively associated with trust between partners.

As discussed above, in this study trust between partners is considered as both relational and competence-based. Hence hypotheses 7 to 9 will be analyzed for both types of trust.

In addition, although all partners' knowledge base dimensions are expected to have an indirect effect on complex project success, coverage, as a criterion that defines all the knowledge required to finish a project, can affect project success directly. Considering the fact that projects need sufficient knowledge and resources to survive until their tasks are completed (Gemünden, Salomo and Krieger, 2005), the following hypothesis is proposed:

**Hypothesis 10.** Coverage of project knowledge has a positive effect on complex project success.

#### **2.4. A moderator called trust capability**

Alongside the tangible information or good behavior of partners in a partnership, the personal characteristics of the individual are an essential factor regarding whether to trust someone or something. Acceptance of the risk of being vulnerable by trusting someone is related to the psychological state of each individual as well as other specifications related to the project and partnership (Becker, 1996). The trust capability or trust propensity of an individual refers to his or her tolerance for accepting the risk of being vulnerable by trusting others. Empirical analysis has shown that trust propensity is positively related to knowledge-sharing behavior, organic organizational structure,

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<sup>2</sup>All the survey questions relating to or partners' knowledge base measurement are available in Figure 8.

and service innovation. Trust propensity is also the most important predictor of service innovation, while knowledge sharing is the best performance factor for service innovation (Ogunmokun, Eluwole, Avci, Lasisi and Ikhide, 2020). Istanbuluoglu and Sakman (2022) examined how trust affects the relationship between repurchase intention and complaint handling dimensions (timeliness, redress, apology, credibility, and attentiveness) in influencing consumers' trust in a company. The findings reveal that customers with low trust tendencies are more likely to repurchase when they perceive the company as credible in addressing complaints. To measure the trust capability of people there are standard questions based on the General Social Survey (GSS) (Glaeser, Laibson, Scheinkman and Soutter, 2000), *Generally Speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people?*

Although the effect of the trust capability of individuals seems to be critical to the trust that will form between partners, it has not yet received much attention in the literature. Accordingly, hypothesis 10 addresses the direct effect of trust capability on relational trust and competence-based trust, as well as its moderation effect:

**Hypothesis 11.** Trust capability is positively associated with trust between partners.

**Hypothesis 12.** Trust capability moderates the relationship between partners' knowledge base and trust between partners.

For hypotheses 11 and 12, trust between partners in this study is relational trust and competence-based trust, and partners' knowledge base in hypothesis 12 refers to similarity, complementarity, and coverage.

Table 1 summarizes some of the related research that considers trust as a variable (i.e. independent variable, dependent variable, and moderator variable) in partnerships.

Our conceptual model showing all the proposed hypotheses is seen earlier in Figure 1. This model is created to investigate the role of innovation and coverage on complex project success, the role of complexity and trust on innovation, and the role of knowledge on trust. It acknowledges also that trust capability could moderate the effect of knowledge on trust between partners.

Table 1: Selected studies based on trust in partnership context

No.	Publication	Context	Affecting on trust	Affected by trust	Moderator
1	Moorman, Deshpande and Zaltman (1993)	Market research relationships	(Individual, organizational, project) characteristics,	Utilization of market research information	None
2	Aulakh, Kotabe and Sahay (1996)	Cross-Border marketing partnerships	Continuity expectation, flexibility, information exchange	Partnership performance	Asset specificity, host market unpredictability
3	Das and Teng (2001a)	Strategic alliances	None	Relational risk, performance risk	None
4	Leonidou, Talias and Leonidou (2008)	Industrial buyer-seller relationships	Conflict, satisfaction	Commitment	None
5	Ke, Liu, Wei, Gu and Chen (2009)	Electronic supply chains	Mediated power, non-mediated power	Adoption intention	Firms size, mimetic pressures, dependence
6	Doloi (2009)	Construction industries	None	Relational partnering success	None
7	Wu, Chen and Chung (2010)	Transaction communities	Shared values, privacy policy, satisfaction	Commitment, stickiness	None
8	Deitz et al. (2010)	Joint venture alliances	Resource complementarities	Intent to remain in joint venture without changes, cooperative intent	Termination costs, size
9	Hernandez-Ortega (2011)	Acceptance of a technology	Ease of use, compatibility, security, partner's influence, manager's attitude	Performance, continuity intentions	None
10	Bazaryar, Teimoury, Fesharaki, Moini and Mohammadi (2013)	New product development relationships	Relational risk perception	None	None
11	Cai et al. (2013)	collaborative supply chains	None	Technical Exchange, Technology transfer	None
12	Sridharan and Simatupang (2013)	Supply chain collaborations	Cooperative norms	Performance accountability, information sharing, decision synchronization, process integration, incentive alignment	None
13	Nicolaou et al. (2013)	Electronic data exchanges	Information quality	Expected transaction performance, Intent for continued use	None

*Continued on next page*

*Continued from previous page*

No.Publication	Context	Affecting on trust	Affected by trust	Moderator
14 Chen, Lin and Yen (2014)	Industrial parks' knowledge sharing	Shared goals, relational embeddedness, influence strategy	Collaboration, knowledge sharing	None
15 Abu-Shanab (2014)	E-government services	Information quality, familiarity with the internet, privacy and security concerns	Intention to use E-government	None
16 Capaldo and Giannoccaro (2015)	Supply chains	None	Supply chain performance	Degree of interdependence, interdependence pattern
17 Huo, Ye and Zhao (2015)	Third-party logistic industries	None	Detailed contract, contract application, opportunism	Demand uncertainty, company size
18 Sunardi et al. (2015)	Collaborations	Employee experience	Reciprocity norm, knowledge sharing	None
19 Shahmehar, Khaksar, Zafarian and Talebi (2015)	Small and medium enterprises	Personal Relations, economic interactions, social capital	Business performance	None
20 Singh and Teng (2016)	Supply chains	None	Relational governance, IT integration, performance	None
21 Alsaad, Mohamad and Ismail (2017)	Business to business electronic commerce	None	Benevolence, integrity, competency	Trust
22 Alharbi (2017)	Technology acceptance	None	Behavioral intention	None
23 Benitez-Avila et al. (2018)	Public-private partnerships	Relational norms	Partners' contribution	Project complexity, contractual governance
24 Yuan, Feng, Lai and Collins (2018)	Logistic service	Learning orientation	Commitment, effectiveness	Ownership, firm size
25 Wang et al. (2019)	Megaprojects	None	Relational quality, megaproject success	Incentive
26 Ahlf, Horak, Klein and Yoon (2019)	Business relationships	Demographic homophily, interpersonal communication	Perceived relationship quality, relationship quality	None
27 Imam and Zaheer (2021)	Team members in IT projects	None	Project success	Trust
28 This study 2022	Complex projects	Project complexity, partners' knowledge base	Innovation potential, project success	Trust capability

### **3. Research methodology**

Our conceptual model is analysed with a propositional testing method based on statistics to test the hypotheses. A Survey was created out of concepts and relations drawn from the literature above. The conceptual model (seen in Figure 1) includes the relationship between innovation and complex project success as well as the factors that affect trust and innovation and the moderating effects of trust capability level of project managers. The characteristics of innovative complex projects and participants in these projects are the units of analysis, and the project managers who have participated in managing innovative complex projects with more than one partner are the unit of our observation. The methodology of this research has been designed in accordance with the recommendations put forth by Pesämaa, Zwikael, HairJr, Huemann et al. (2021).

#### **3.1. Survey design and measures**

In order to examine the conceptual model relationships, the survey design was adopted from (Wang et al., 2019) for data collection from innovative project managers. The survey was designed, pre-tested with a small sample, and validated by expert opinion in project management and innovation before sending it to the final respondents. The final survey (survey is accessible in the following link: <https://www.surveymonkey.com/r/X6WMSPV>) includes 44 questions categorized to measure 11 dependent and independent variables. For all the variables, a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree) was used, following common practice (Farooq and Radovic-Markovic, 2016; Farooq, Salam, Fayolle, Jaafar and Ayupp, 2018). Furthermore, to validate the questions in the survey, first, expert opinion was taken into account, and second, a pre-tested round was conducted with a small sample of 15 volunteers among colleagues. Some minor modifications were made in the survey to make it reliable and valid for data collection. The complete survey is available in Table 8 (Appendix A).

### ***3.1.1. Dependent variables***

The dependent variables in our model are Complex Project Success (CPS), Project Innovation (PI)<sup>3</sup>

Relational Trust (RT), and Competence-Based Trust (CBT). To measure complex project success, we used 6 questions based on the six dimensions of project success developed by Baccarini (1999) and previously used by several researchers, for instance: Wang et al. (2019); Khan et al. (2013). To measure project innovation, we used 4 questions based on the 4 dimensions of innovation developed by Knight (1967) and previously used by Rowley et al. (2011). Four questions are used to measure each relational and competence-based trust. These questions are developed based on the definitions developed by Kadefors (2004) and previously used by Das and Teng (2001b); Wang et al. (2019).

### ***3.1.2. Independent variables***

The independent variables in our model are Technological Complexity (TC), Organizational Complexity (OC), Administrative Complexity (AC), Similarity (Sim), Complementarity (Com), Coverage (Cov), and Trust Capability (TrC). To measure the technological, organizational, and administrative complexity, a set of 4, 5, and 4 questions respectively, were used. These questions were developed based on complexity factors presented by Vidal and Marle (2008). In addition, 4 questions are used to measure each of similarity, complementarity, and coverage. These questions are developed based on the definition partners' knowledge base developed by Vaez-Alaei et al. (2021). To measure trust capability, one question is used in the survey which is proposed by Glaeser et al. (2000) and previously used by Istanbuluoglu and Sakman (2022).

## **3.2. Sampling and data collection**

To analyze the data we use partial least square structural equation modeling (PLS-SEM). Following Hair, Ringle and Sarstedt (2011), the minimum sample size in PLS-SEM analysis is based

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<sup>3</sup>By “project innovation” we refer not to the innovation that the project is trying to produce as output, but rather changes to the project itself: responses to opportunities or set-backs, changes in management or organization of the project, its tasks and assignments, and so on.



on the 10 times rule: the minimum sample size should be equal to the larger of the following: 1) *Ten times the largest number of formative indicators used to measure one variable*; 2) *Ten times of the largest number of structural paths directed at a particular latent variable in the structural model*. In this study, the largest number of formative indicators is 6 and the minimum sample size should be 60 respondents.

However, we addressed more respondents to get as large a sample as possible to ensure a more rigorous result (Farooq et al., 2018). Accordingly, we first selected European project managers from the ANR (Agence Nationale de la Recherche) website and the survey was sent to them by email. Then we used snowball sampling to obtain more responses, which means we asked people who answered the questionnaire to send it to their network to increase the sample size. Unfortunately, the data gathering phase of this study started during the period of confinement due to the Covid-19 pandemic, hence the authors lost the opportunity to interview managers face-to-face and to use the maximum potential of networking to find more project managers. It is not possible to determine the exact response rate of this study since emails have been sent to potential respondents from different people, but we estimate that the response rate was roughly 10%. Nonetheless, in the end we obtained 172 responses.

### **3.3. Data screening and pre-analysis**

The analysis is based on the data collected from project managers of complex innovative projects. 172 respondents completed the survey. Screening for missing values is not required, since respondents had to answer all questions in order to submit the survey. Hence, the analysis begins here with a concise description of the demographic characteristics of survey respondents in terms of gender, age, educational level, work experience and job title, as seen in table 2.

Regarding the number of projects that are managed by each respondent: out of all respondents, 46% managed fewer than 10 projects, whereas 54% managed more than 10 projects. The majority of respondents were from France (76%) and the majority of projects were research projects (80%). Out of the 172 total responses, that 96 projects (55.8%) had fewer than five partners, while 40

**Table 2**

Demographic characteristic of the respondents

Attributes	Type	%
Gender	Male	74%
	Female	25%
	Prefer not to say	less than 1%
Age	20 -29 years	4%
	30 - 39 years	19%
	40 - 49 years	35%
	50 -59 years	34%
	Above 60 years	7%
Education	High school degree	less than 1%
	Bachelor's degree	5%
	Master's degree	17%
	Doctorate	78%
Work experience	Less than 5 years	6%
	Between 5 to 10 years	10%
	Between 11 to 15 years	16%
	Between 16 to 20 years	16%
	More than 20 years	50%
Job title	Professor	31%
	Associate professor	20%
	Researcher	19%
	Research director	6%
	Lecturer	2%
	Project manager	5%
	Others	17%

projects (23.3%) had more than five but fewer than ten partners. Additionally, 27 projects (15.7%) had more than ten but fewer than twenty partners, and only nine projects (5.2%) had more than twenty partners involved.

#### 4. Data analysis

To analyze the cause-and-effect relations between latent variables (variables that are not directly observed but are rather inferred from other variables that are observed), structural Equation Modeling (SEM) has become a standard tool. There are two common approaches to SEM, Covariance-based SEM (CB-SEM) and Partial Least Squares (PLS-SEM). CB-SEM is based on

accurately estimating the observed covariance matrix, while PLS-SEM is based upon accounting for explained variance in the latent variables (Hair et al., 2011).

PLS-SEM is used to analyze the data in this study. The reason is that first, PLS-SEM requires a smaller sample size than CB-SEM; and second, it can handle a formative structural model, such as the conceptual model of this study, while CB-SEM is typically appropriate for reflective models. The differentiation between formative and reflective models is as follows:

- In a formative structural model, formative indicators are assumed to define a latent variable (or make up its constituent parts), and changes in the indicators determine changes in the value of the latent variables.
- In a reflective structural model, reflective indicators are seen as functions of the latent variable, and changes in the latent variable are reflected in changes in the indicator.

Moreover, in the the body of research on complex projects, knowledge and innovation are still in the development phase, and PLS-SEM has the advantage of being useful for theory development while CB-SEM is mostly used for theory confirmation (Hair et al., 2011; Hair Jr, Hult, Ringle and Sarstedt, 2016).

Accordingly, we use PLS-SEM to analyze the data for this study. The analysis is done using IBM SPSS Statistics version 26 and SmartPLS version 3.

It is essential to apply prior data analysis tests to ensure the quality, validity, and reliability of the collected data. These prior data analysis steps as well as details of latent variables in PLS-SEM are explained in detail in the following subsections.

#### **4.1. Analysis of the measurement model**

A conceptual model with latent variables has two components. The first is the *inner model* which shows the type of relationship between the latent variables. The relationship in conceptual models can only be in a single direction. Hence, in a structural model, there are two kinds of latent variables: dependent and independent. Independent variables are latent variables that do not have

any path relationships pointing at them. By contrast, dependent variables are latent variables that are explained by other latent variables (Hair et al., 2011).

The second component is the *outer model*, referring to the relationships between each latent variable and its related indicators. The outer model can be either formative or reflective, both of which can be handled by PLS-SEM. Reflective indicators are defined as a function of the latent variable, and formative indicators are considered to cause a latent variable (Hair et al., 2011).

PLS-SEM mainly evaluates the direct relationships between latent variables. However, in theory, moderator variables might exist and modify, strengthen or weaken, the relationship between latent variables in conceptual models (Becker, Ringle and Sarstedt, 2018).

Following the above discussion, regarding the conceptual model of this paper, out of eleven latent variables, six (i.e. organizational complexity, technological complexity, administrative complexity, similarity, complementarity, coverage) are independent, and four (i.e. complex project success, project innovation, relational trust, competence-based trust) are dependent variables. Moreover, there is one moderator variable (viz. trust capability) that moderates the effect between some of the latent variables. Based on the nature of the variables and their related indicators (questions in the survey), all the latent variables in this study are formative.

According to the guideline which is presented by Hair Jr et al. (2016), the formative measurement model should be analyzed for convergent validity and discriminant validity.

#### **4.2. Common-method variance bias test**

A survey often provides data used to measure both dependent and independent variables, and the same respondent replies to both variable questions. In this case, the estimated impact of the independent variable on the dependent variable is at risk of being biased owing to common method variance (CMV) (Jakobsen and Jensen, 2015), due to respondents' tendency to evaluate themselves in a positive way or in a way that would indicate social desirability. According to Richardson, Simmering and Sturman (2009), CMV is a systematic bias that is shared between variables that are measured with the same method and source.

In this study, testing and controlling for CMV have been considered in two phases, as proposed by Tehseen, Ramayah, Sajilan et al. (2017). First, in the survey design we 1) protect the anonymity of the respondents, and 2) randomize the order of the independent and dependent questions. Second, we apply the Harman (1976) single-factor test to the collected data to check for any CMV. In this method, all indicators from every variable are entered into a single factor analysis to investigate whether one single factor could be identified or whether a single factor captures the majority of the covariance among all the measures. If no single factor accounts for the majority of the covariance, this implies that CMV is not an issue for the study.

This test is applied by using principal component analysis in SPSS. The results extracted 11 different factors from 44 items of measurement variables (i.e. Complex Project Success, Project Innovation, Organizational Complexity, Technological Complexity, Administrative Complexity, Relational Trust, Competence-Based Trust, Trust Capability, Similarity, Complementarity, and Coverage). The result disclosed 11 different factors accounting for 55% of the variance of collected data. The first unrotated factor accounts for only 16% of the total variance. This indicates that the data do not display common method bias, since the total variance extracted by one factor is less than the recommended threshold of 50% (Tehseen et al., 2017).

#### **4.3. Reliability and validity of the data**

Reliability in statistics refers to the overall consistency of a measure and reflects the integrity and consistency of the data (Bonett and Wright, 2015). Cronbach's alpha is the most widely used method for estimating internal consistency and is used in this paper. In reliability tests, the total value of Cronbach's alpha for all 44 questions is 87.8%, which is admissible since the minimum acceptable value is 70% (Santos, 1999). Cronbach's alpha for each factor is reported in Table 3. For the factors that are measured with fewer than 10 questions, alpha above 0.5 is acceptable. Accordingly, the reliability test implies the reliability of all factors.

Validity in statistics refers to whether a measure corresponds accurately to the real world. To test the validity of the collected data, it is most common to check if there is a significant difference

**Table 3**

Reliability of latent variables

Latent variables	Cronbach's Alpha
Complex project success	0.740
Project innovation	0.577
Complexity (all indicators)	0.849
Organizational complexity	0.722
Technological complexity	0.637
Administrative complexity	0.845
Knowledge (all indicators)	0.715
Similarity	0.702
Complementarity	0.756
Coverage	0.802
Trust (all indicators)	0.818
Relational Trust	0.856
Competence-based Trust	0.642

between the responses of respondents (Armstrong and Overton, 1977). To do so, an independent t-test is applied using the first 50 and last 50 responses to compare if there is any significant difference between the means of answering of these two groups. The results of these analyses have shown that there is no significant difference in the 0.05 level (all the p-values are above 0.05) between the means of the two groups. The result of the validity test is shown in Table 4. Hence, based on these findings, it is concluded that the collected data is reliable and validated.

#### 4.4. Analysis of formative measurement model

The structural model of this study is formative, and the assessment of a formative model is different from that of a reflective model. The idea behind a formative model is that all the indicators (questions) represent independent causes for the latent variable. So, formative indicators do not need to have a high correlation, and omitting one indicator is omitting a part of a variable (Hair et al., 2011; Hair Jr et al., 2016).

Since the indicators must be independent and non-inter-changeable, they should not have significant overlap. The variance inflation factor (VIF) is checked through the collinearity statistics test. Table 9 (in Appendix) shows that all the VIFs are less than 5 which is acceptable (Hair et al.,

**Table 4**

Validity of indicators

Indicator	<i>p</i> -value	Indicator	<i>p</i> -value	Indicator	<i>p</i> -value	Indicator	<i>p</i> -value
<i>CPS</i> <sub>1</sub> *	0.922	<i>OC</i> <sub>12</sub>	0.904	<i>SC</i> <sub>23</sub>	0.335	<i>Cov</i> <sub>34</sub>	0.690
<i>CPS</i> <sub>2</sub>	0.354	<i>OC</i> <sub>13</sub>	0.796	<i>Sim</i> <sub>24</sub>	0.487	<i>Cov</i> <sub>35</sub>	0.615
<i>CPS</i> <sub>3</sub>	0.064	<i>OC</i> <sub>14</sub>	0.435	<i>Sim</i> <sub>25</sub>	0.268	<i>TrC</i> <sub>36</sub>	0.391
<i>CPS</i> <sub>4</sub>	0.095	<i>OC</i> <sub>15</sub>	0.734	<i>Sim</i> <sub>26</sub>	0.677	<i>RT</i> <sub>37</sub>	0.524
<i>CPS</i> <sub>5</sub>	0.583	<i>TC</i> <sub>16</sub>	0.146	<i>Sim</i> <sub>27</sub>	0.812	<i>RT</i> <sub>38</sub>	0.940
<i>CPS</i> <sub>6</sub>	0.159	<i>TC</i> <sub>17</sub>	1.000	<i>Com</i> <sub>28</sub>	0.448	<i>RT</i> <sub>39</sub>	0.513
<i>PI</i> <sub>7</sub>	0.057	<i>TC</i> <sub>18</sub>	0.237	<i>Com</i> <sub>29</sub>	0.770	<i>RT</i> <sub>40</sub>	0.135
<i>PI</i> <sub>8</sub>	0.244	<i>TC</i> <sub>19</sub>	0.903	<i>Com</i> <sub>30</sub>	0.581	<i>CBT</i> <sub>41</sub>	0.301
<i>PI</i> <sub>9</sub>	0.892	<i>SC</i> <sub>20</sub>	0.764	<i>Com</i> <sub>31</sub>	0.962	<i>CBT</i> <sub>42</sub>	0.828
<i>PI</i> <sub>10</sub>	0.237	<i>SC</i> <sub>21</sub>	0.839	<i>Cov</i> <sub>32</sub>	0.544	<i>CBT</i> <sub>43</sub>	0.508
<i>OC</i> <sub>11</sub>	0.136	<i>SC</i> <sub>22</sub>	1.000	<i>Cov</i> <sub>33</sub>	0.851	<i>CBT</i> <sub>44</sub>	0.441

\*i.e. *CPS*<sub>1</sub> refers to the question 1, which measures Complex Project Success (CPS)

2011).

In addition, considering the guideline of (Hair Jr et al., 2016) each indicator's outer weight is calculated to check if it has a significant effect on each latent variable. A summarized overview of these findings is presented in Table 10 (in Appendix). If the *p*-value is below 0.05 and the t-statistic is above 1.95, the indicator has a significant effect on the latent variable (*TrC*<sub>36</sub> has no value since trust capability is measured with one indicator). For *p*-values above 0.05, it is advised to choose a more liberal approach for the formative measurement model, since statistically, the observed variable might have a low effect on the latent variable, but deleting an indicator might delete a part of the variable in the formative measurement. Hence, we keep all the indicators for the PLS-SEM analysis.

## 5. Results

Having done the prior analysis above, we turn now to the main PLS-SEM results. In addition, to gain more insight from the PLS-SEM analysis, some latent analyses are applied. These are explained in detail in the following subsections. Several variables can be considered as controls: regarding the manager, age, gender, education level, experience; regarding the project, whether

research or not. In all of the analysis that follows we include these as controls for project success in the usual way.

## 5.1. Analysis

In this section, we move to the analysis of the model itself. We assess the extent of the explanatory power of latent variables in our model using multiple evaluation metrics. The  $R^2$  measures the proportion of the dependent variable's variation explained by the independent variables. A  $t$ -statistic is used to determine the statistical significance of each relationship between variables in the model, and the  $\beta$ -values (standardized regression weights) are employed to quantify the strength and direction of the relationship between variables. Collectively, these metrics provide insight into the predictive relevance and overall performance of the model. The main results are presented in Figure 2. Here we do not include interaction effects; we discuss them below.

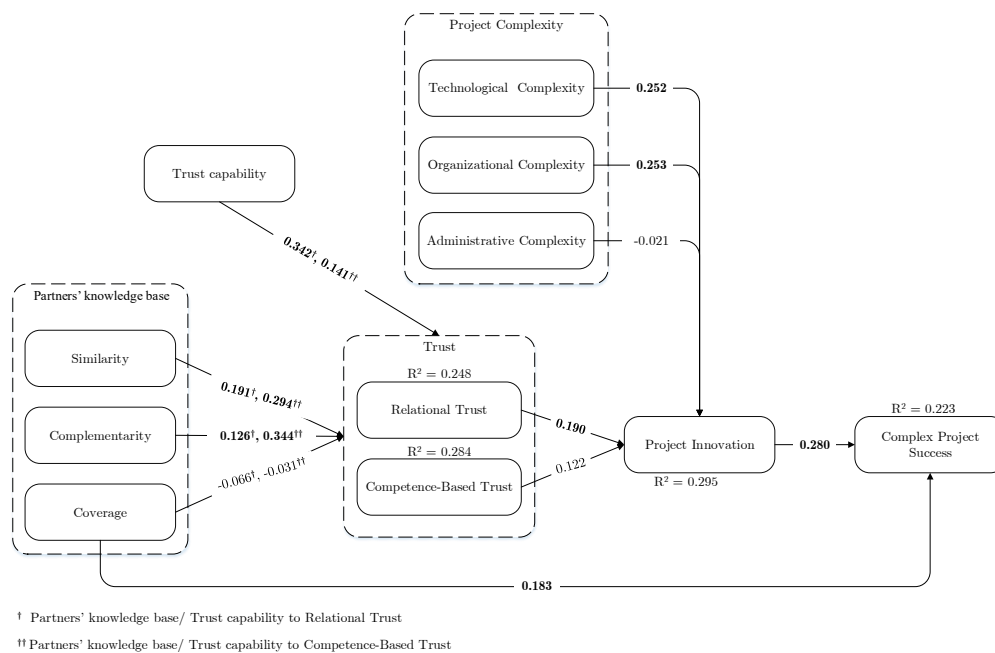
These values demonstrate the model's ability in general to predict outcomes and explain variance in factors relevant to understanding how complex projects involving several participants function.

Turning now specifically to the hypotheses: Firstly, Project Innovation (PI) and Coverage (Cov) show a significant positive effect on Complex Project Success (CPS):  $H1$  and  $H10$  are supported. Additionally, Organizational Complexity (OC), Technological Complexity (TC), and Relational Trust (RT) have a significant positive effect on project innovation (PI):  $H2$ ,  $H3$  and  $H5$  are supported. Conversely, the effects of Administrative Complexity (AC) and Competence-Based Trust (CBT) are not significantly different from zero:  $H4$  and  $H6$  are not supported.

Regarding the three aspects of knowledge, similarity (Sim) demonstrates a significant positive effect on both relational trust and competence-based trust:  $H7$  is supported. Complementarity (Com) has a significant positive effect on both competence-based and relational:  $H8$  is supported. However, no significant effect has been found from coverage (Cov) on relational and competence-based trust:  $H9$  is not supported.

A summary of the findings is presented in Table 5.





**Figure 2:** Coefficient estimates in the SEM model. Bold face coefficients are significant at least the 10% level. Moderating effects are not shown to make the figure more readable. Controls affecting project success directly (not shown): manager's age, experience, education, gender; whether research project or not.

**Table 5**  
Hypothesis assessment

Proposed path	$\beta$ -value	Std. dev.	<i>p</i> -value	Decision
H1 Project Innovation $\Rightarrow$ Complex project success	0.280	0.076	0.000	Supported
H10 Coverage $\Rightarrow$ Complex project success	0.183	0.077	0.017	Supported
H2 Technological Complexity $\Rightarrow$ Project Innovation	0.252	0.105	0.016	Supported
H3 Organizational Complexity $\Rightarrow$ Project Innovation	0.253	0.093	0.006	Supported
H4 Administrative Complexity $\Rightarrow$ Project Innovation	-0.021	0.082	0.802	Unsupported
H5 Relational Trust $\Rightarrow$ Project Innovation	0.190	0.088	0.030	Supported
H6 Competence-Based Trust $\Rightarrow$ Project Innovation	0.122	0.080	0.129	Unsupported
H7 Similarity $\Rightarrow$ Competence-Based Trust	0.294	0.079	0.000	Supported
H7 Similarity $\Rightarrow$ Relational Trust	0.191	0.078	0.015	Supported
H8 Complementarity $\Rightarrow$ Competence-Based Trust	0.344	0.069	0.000	Supported
H8 Complementarity $\Rightarrow$ Relational Trust	0.126	0.072	0.077	Supported
H9 Coverage $\Rightarrow$ Competence-Based Trust	-0.031	0.071	0.666	Unsupported
H9 Coverage $\Rightarrow$ Relational Trust	-0.066	0.071	0.356	Unsupported

Controls, with direct effect on project success: manager's age, experience, education, gender; whether research project or not.

Note: Standard deviation is that observed in 10000 bootstraps.

## 5.2. Moderating effects of Trust Capability

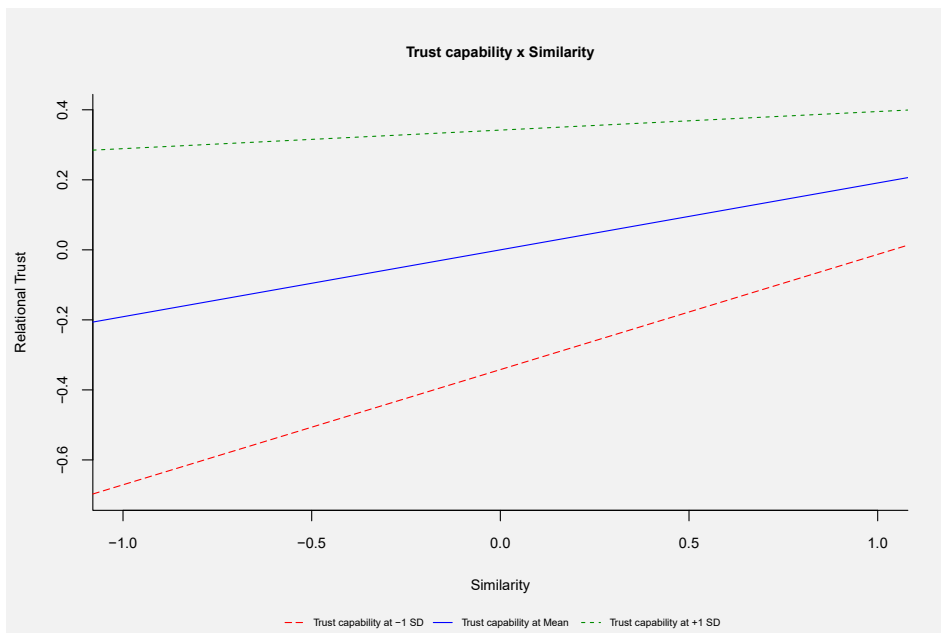
The direct effects of Trust Capability on the two types of trust are both statistically significant, providing support to H11. We also evaluated the role of respondents' trust capability as a continuous moderator of the relationship between partners' knowledge bases and trust. Table 6 provides a summary. Using bias-corrected estimates (as presented in the table), we find that two moderation effects are (weakly) statistically significant: Trust Capability appears to moderate the relationship between Similarity and the two types of trust, Relational and Competence-Based. People tend to trust those who are similar to them, and higher trust capability makes this effect even stronger. However, the results do not support the hypothesis of the moderating effect of trust capability on the relationships between complementarity and coverage, and relational trust and competence-based trust (only one part of H12 is supported).

Figure 3 shows the changes in the relationship between similarity and relational trust for dif-

**Table 6**  
Moderator assessment

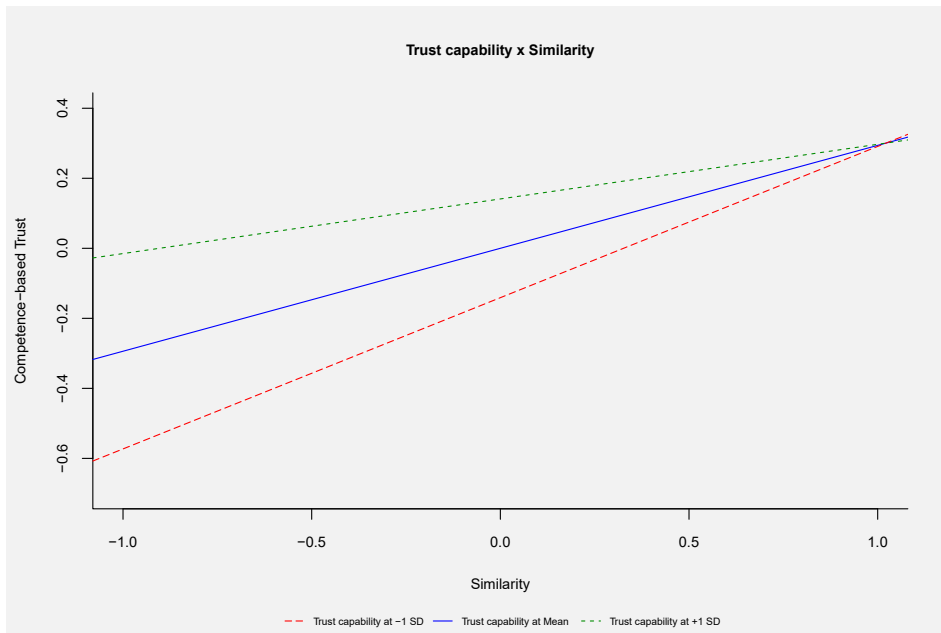
Proposed path	$\beta$ -value	$p$ -value	Decision
H11 Trust Capability $\Rightarrow$ Competence-Based Trust	0.141	0.068	Supported
H11 Trust Capability $\Rightarrow$ Relational Trust	0.342	0.000	Supported
H12 Complementarity $\times$ Trust Capability $\Rightarrow$ Competence-Based Trust	0.050	0.442	Unsupported
H12 Complementarity $\times$ Trust Capability $\Rightarrow$ Relational Trust	0.074	0.290	Unsupported
H12 Coverage $\times$ Trust Capability $\Rightarrow$ Competence-Based Trust	-0.010	0.886	Unsupported
H12 Coverage $\times$ Trust Capability $\Rightarrow$ Relational Trust	0.039	0.546	Unsupported
H12 Similarity $\times$ Trust Capability $\Rightarrow$ Competence-Based Trust	-0.132	0.078	Supported
H12 Similarity $\times$ Trust Capability $\Rightarrow$ Relational Trust	-0.138	0.043	Supported

Note: Standard deviation is that observed in 10000 bootstraps.



**Figure 3:** Simple slope analysis for moderation effect of Trust Capability (TrC) on the relationship between Similarity (Sim) and Relational Trust (RT)

ferent values of trust capability. The blue, red and green curves represent the relationship between similarity and relational trust at respectively low, mean and high levels of trust capability. To interpret this figure, start with the red line which indicates at the mean trust capability level increasing similarity has a positive effect on increasing the relational trust. When trust capability is low (blue curve) this positive effect is stronger. However, when trust capability is high (green curve), not only does similarity fail to positively affect relational trust, the results suggest the effect may even be negative (though the coefficient is not statistically significant).



**Figure 4:** Simple slope analysis for moderation effect of Trust Capability (TrC) on the relationship between Similarity (Sim) and Competence-Based Trust (CBT)

Figure 4 shows the changes in the relationship between similarity and competence-based trust based on different values of trust capability. Taking the same approach, this figure shows that similarity has a positive effect on competence-based trust at all levels of trust capability. However, with a low level of trust capability, this positive effect is stronger; with high levels of trust capability, it is weaker.

## 6. Discussion

The present study examined the relationship between innovation and complex project success, focusing on the impact of complexity on project partnership innovation. To bring out some factors that have been overlooked in the literature we include the effect of trust between partners on innovation within the project, and the role of partners' knowledge bases, specifically similarity, complementarity, and coverage, in building trust between partners. We also considered trust capability as a moderator of the relationship between partners' knowledge bases and trust between partners, asking whether trust capability moderates any of the relationships between features of the knowledge bases (similarity, complementarity and coverage) and trust between partners.

## 6.1. General observations

Trust is a key factor that directly affects project success (Jiang, Zhao and Zuo, 2017; Majeed, Kayani and Haider, 2021), and our study affirms that a collaborative approach to enhancing trust between partners is crucial for the success of complex projects. Such an approach would facilitate knowledge sharing and promote transparency in collaboration, as validated by previous studies (Sridharan and Simatupang, 2013; Sunardi et al., 2015; Imam and Zaheer, 2021). We also investigate the indirect effect of trust on project success through the channel whereby trust among partners permits innovations within the project itself. The findings confirm the theoretical argument presented by Imam and Zaheer (2021) that increasing trust fosters project malleability and innovation, and thus improves project success. Further, though, it appears that in this regard relational trust, namely that arising from past interactions, is more important than is the trust that arises from the (mutual) observation of competence relevant to the current project. The trust that matters seems to be the longer-lasting trust embedded in ongoing relationships. This suggests that if partners trust each other due to experience, they are more willing to believe that any immediate shortcomings in competence will be overcome.

To the discussion on partners' knowledge bases and innovation in partnership projects, this study makes three notable contributions. First, it refines the notions of types of knowledge that might be relevant to a project's success. Beside the widely discussed similarity and complementarity, we add a third notion, namely "coverage", referring to the knowledge required to finish the project that is covered by the partnership. Second, we add granularity to the notion of trust. Jin and Wang (2021); Ndubisi et al. (2020) for example, discuss the trust within a partnership as related to similarity and complementarity of partners' knowledge stocks. One might expect though that features of the knowledge stocks will interact differently with different types of trust. Indeed, we find that similarity between partners has positive impact on both types of trust while complementarity has positive effect only on competence-based trust, namely trust that is based on tangible information about the partner's properties. Third, while trust capability had been previously studied as the most important predictor of service innovation (Ogunmokun et al., 2020), it has not been examined

in the context of partnerships more generally. We introduce it here in this broader context and find that indeed it has important effects levels of trust in general (not surprisingly) but also has effects on other relationships in the model: when trust capability is low, the positive effect of similarity on relational trust is stronger. This seems reasonable: when a person is skeptical, past relationships become more important. However, when trust capability is high, there is essentially no (and possibly even negative) effect of similarity on relational trust. Again, to argue using extremes, if a person trusts everyone (extreme trust capability) then nothing can affect the amount of trust he or she feels.

Several studies argue that that the ability to make changes to the project structure as it progresses is conducive to project success (Davies and Hobday, 2005; Chancellor, Abbott, Carson et al., 2015; Fey and Kock, 2022). Consistent with that view, we found a positive relationship between innovation within the project and project success. But some previous research has shown that there exists a conflicting association between this sort of malleability and project success. Malleability, for example, permits “mission drift” which counts against project success (Edeh, Obodoechi and Ramos-Hidalgo, 2020; Amaya, Wu and Liao, 2022). One possible explanation for why we find a positive result is that the majority of our projects are research projects, and research is a context in which changes are welcomed, and even seen as a sign of success in themselves (if for example the change is through an unexpected finding which changes the orientation of the project).

In addition, there exist conflicting views regarding the impact of project complexity on project innovation. Although complexity may provide new avenues for creative problem-solving Camisón-Zornoza, Lapiedra-Alcamí, Segarra-Ciprés and Boronat-Navarro (2004); Ewens and van der Voet (2019), it may also curtail the capacity to experiment and undertake risks due to amplified management demands, particularly in cases of administrative complexity Ruoslahti (2020). Furthermore, there has been a debate regarding the role of project complexity as a direct or moderating variable. As a direct influence variable, scholars have examined how project complexity directly affects project success by investigating the underlying mechanisms (Luo, He, Xie, Yang and Wu, 2017; Ma and Fu, 2020). On the other hand, as a moderating variable, scholars have explored the impact

of project complexity on the relationship between project managers' leadership and project success (Müller, Geraldi and Turner, 2011). In addition, complexity has been considered as a moderating factor in the impact of innovation on project performance (Cantarelli, 2022) and the relationship between knowledge sharing and project success (Jiao, Saeed, Fu and Wang, 2020). Here we have focused on the direct effect of project complexity, again adding granularity to the concept. In addition to the common technological and organizational complexity Vidal and Marle (2008), we add administrative complexity, to include possible difficulties arising from working in more than one legal environment for example. Here, while our results on organization and technological complexity conform to those in the literature, the challenges of administrative complexity seem not as severe as we had expected. Administrative complexity seems to have no effect on the ability of a project to change to meet unexpected challenges.

## **6.2. Indirect effects**

Many factors contribute to (or hamper) the success of any project: the level of its ambition; internal support from management in the participating organizations; resources available; enthusiasm or commitment of the team and so on. These are all things that are extremely difficult to measure and often, as is the case here, can only be included as “noise” in the estimations, and are the likely explanation for the relatively low (as measured statistically) explanatory power of the model, with  $R^2$ s in the neighbourhood of 0.3. Nonetheless, the model does indicate many things that do contribute to project success, directly and indirectly. Some are relatively “obvious” and direct, such as the ability of the partnership to “cover” all the knowledge needed for the project, even though, surprisingly, this is largely absent in the literature. Without coverage, any project is likely to run into difficulties. Others, such as trust capability, work through indirect channels, facilitating the kind of trust that permits project managers to change the project as it encounters (unexpected) obstacles or opportunities.

Structural equation models such the one we have developed here have the advantage of observing both direct and indirect effects of factors that might influence the outcome of interest. In

Factor	Indirect effects on project success
Organizational Complexity	0.071
Technological Complexity	0.071
Relational Trust	0.053
Competence-based Trust	0.034
Knowledge Similarity	0.020
Knowledge Complementarity	0.018
Knowledge Coverage	0.004
Trust Capability	0.23

**Table 7**

Total indirect effects on project success.

particular partners' trust and knowledge affect the success of complex, multi-partner projects both directly and indirectly. Looking at indirect effects of variables on project success (essentially the product of the coefficients on the path(s) between the variable and success), two stand out: Organizational and Technological complexity (See table 7). Project complexity induces project innovation, which itself is a strong indicator of success. Again, the challenges posed by complexity can be met with a malleable project structure and management. The other factor with large indirect effects is trust, and in particular relational trust. Long term relationships, the main source of this type of trust, again work by facilitating innovations to the project that permit the partnership to meet the challenges of the project.

### **6.3. Implications for practice**

Consistent with theoretical insights, this paper highlights several practical implications for innovative complex projects, their managers, and partners. It is worth noting that most of the data we gathered for this study were from research projects and were provided by French project managers. As previous research has suggested, national culture may serve as a moderating variable for organizational innovation and project success in many ways (Unger, Rank and Gemünden, 2014). Moreover, the project's performance may vary depending on its type (Müller and Turner, 2007). Consequently, one should exercise caution when generalizing the findings of this study to different types of projects or countries.

First, our findings show that in complex projects, supporting innovation within the project itself



increases project success. Hence, project managers are advised to support innovative ideas, new management methods, and changes in organizational operations and production processes as much as innovation in the final product or service. This suggests that diversity among the organizations taking part in the project need not cause difficulties, and may indirectly support project success, provided that the project's management is flexible and willing to make changes while the project proceeds.

Second, we observe a significant positive effect of coverage of knowledge in a partnership on the success of the project. Thus one can recommend that the selection of partners for complex projects should include a strong focus on the collective knowledge base of the partnership, ensuring that it holds all the knowledge necessary to complete the project.

Finally, we see that relational trust, (trust that forms during cooperation), has a significant positive effect on partners' willingness to make changes to the project, while no such effect is shown regarding competence-based trust, (trust that firms have at the beginning of collaboration based on tangible information). This suggests that managers of complex projects might be well advised to invest in increasing relational trust among partners, particularly in cases where the project does not initially have a clearly defined path to success and so might demand changes to its structure as it progresses. Also, considering the moderating effects, especially when the people involved have a low level of trust capability, an increasing similarity in knowledge between partners can increase trust between them and thus have a positive impact on the innovation and success of the project. Again this has clear implications for partner choice.

#### **6.4. Limitations and future research**

Although the findings of this study have revealed several important causes and effects of factors related to the complex project success and its managerial aspects, there are some limitations that should be mentioned.

Firstly, there are some limitations considering the proposed conceptual model. The model for measuring trust and its different dimensions in this study is one of several in the literature.

Considering other classifications in future studies and comparing them with the results of this paper could yield further insight into other dimensions of trust. This consideration is also related to the classification of innovation. Limitations in designing a survey to make it as short as possible and easy to answer meant it was not possible to ask about other aspects of innovation that projects are trying to achieve (eg. radical or incremental innovation) (Cantarelli, 2022). Hence, there are other classifications for factors that could be considered in future studies.

Secondly, it is essential to note that the relationships between the factors studied in this research are limited to those we have identified and developed. Therefore, in future conceptual models, other moderating or direct effects may be considered, along with additional relationships between project success factors. For instance, future studies could examine the direct relationship between leadership and project success (Bhatti, Kiyani, Dust and Zakariya, 2021).

Thirdly, it is critical to note that this study measures project success using six measurement dimensions: objectives, time, budget, team satisfaction, stakeholder satisfaction, and reputation within its domain. However, the construct items used to measure project success are diverse (Müller and Turner, 2007), and it is important to recognize that different stakeholders may have varying opinions about the degree of project success or reputation in its domain. Each stakeholder may evaluate project success based on their own ideas and convenience, and there is a need for comprehensive criteria that reflect the interests and perspectives of all stakeholders involved in the project (Dvir, Lipovetsky, Shenhar and Tishler, 1998). In this study, due to limitations in accessing other members or stakeholders of the projects, we relied on the opinion of a single project manager to evaluate the degree of success for each dimension of project success. Thus, in future research, it may be helpful to interview multiple stakeholders instead of relying solely on the opinion of a single project manager (who may, after all, not be completely unbiased) to obtain a more accurate measurement of project success (Dvir et al., 1998).

Finally, our data were collected mostly from European research projects. Hence, one must be careful in generalizing the conclusions to countries and projects with different domains and configurations. It is worth mentioning that Delios, Clemente, Wu, Tan, Wang, Gordon, Viganola,

Chen, Dreber, Johannesson et al. (2022) conducted a comprehensive investigation to determine if the findings in strategic management remained consistent across various periods and geographic regions. They found that original statistically reliable results were consistently replicated in new tests, suggesting that the specific context did not significantly influence the observed outcomes. This indicates that for certain social scientific domains, the conclusions drawn from a particular time and place can serve as meaningful indicators for broader, more general patterns. It is not guaranteed, however, so future studies using data from other kinds of projects and countries might indicate whether the results of the current paper can be generalized.

## **7. Conclusion**

This study proposes a new conceptual model to understand the influence of partners' knowledge bases, trust, complexity, and innovation on project success. In a landscape where partnerships are increasingly important for pushing innovation and other firm activities, this study illustrates factors that contribute to project success, through the understanding the interplay between knowledge, trust, and innovation within collaborative attempts.

Our findings not only confirm the positive influence of innovation within the project itself and a comprehensive knowledge base on project success, but also highlight the key role of trust in fostering a productive environment in which innovative ideas can grow. Most importantly, we reveal how technological and organizational complexities act to support flexibility in project management and implementation, thereby emphasizing the importance of skilled management in navigating complex projects.

Furthermore, our study underlines the role of trust capability as a moderator, explaining that while partners' shared knowledge base can strengthen trust under certain circumstances, excessive reliance on similarity between partners might reduce the development of trust under different conditions. These insights emphasize the need for a balance between fostering similarity and embracing the complementarity of knowledge in the pursuit of successful partnerships.

We believe that these findings can serve as a guide for those pursuing participation in collab-

orative projects, encouraging them to build an environment where novel ideas can flourish, and where partnerships can thrive in an environment of mutual trust and shared knowledge.

## A. Appendix

Table 8: A survey on the impact of partners' knowledge base and complexity level on the success of innovative complex projects

<p><b>Respondent information</b></p> <p>Age:</p> <p>Gender:</p> <p>Educational background:</p> <p>Country of origin:</p> <p>Work experience (years):</p> <p>Job title:</p> <p>Institution:</p> <p>Number of projects you have been involved in so far:</p>
<p><b>Project Information</b></p> <p>Field of the last project you were involved in:</p> <p>Type of the last project you were involved in: (Research, Manufacturing,...)</p> <p>Most important objective of the last project you were involved in:</p> <p>In the last project you were involved in the number of partners was ..... With how many of them you had a previous collaboration in last 5 years? .....</p>
<p>Please respond to the following statements by indicating the <u>extent to which you agree or disagree</u> with the statement <u>based on the experience in your last project</u>. Circle the appropriate number that most closely corresponds to your choice:</p> <p>1 Strongly Disagree</p> <p>2 Disagree</p> <p>3 Somewhat Disagree</p> <p>4 Neutral or Undecided</p> <p>5 Somewhat Agree</p>

*Continued on next page*

6	Agree									
7	Strongly Agree									
<b>Project success:</b> My last project was successful in terms of ...										
1	Respecting the allocated budget	1	2	3	4	5	6	7		
2	Meeting organizational objectives	1	2	3	4	5	6	7		
3	Achieving objectives on time	1	2	3	4	5	6	7		
4	The project had a positive national impact	1	2	3	4	5	6	7		
5	Project team satisfaction	1	2	3	4	5	6	7		
6	Stakeholders receiving satisfactory benefits	1	2	3	4	5	6	7		
<b>Project innovation:</b> In the last project I was involved with ...										
7	Our new products/ services were often considered as very novel by customers	1	2	3	4	5	6	7		
8	New tools/ technologies and approaches were used to reach project objectives	1	2	3	4	5	6	7		
9	Project managers supported innovative ideas, experimentation and creative processes	1	2	3	4	5	6	7		
10	Changes in staffing levels, job roles and behaviours were welcomed in the project	1	2	3	4	5	6	7		
<b>Project complexity:</b> My last project was complex in terms of ...										
<i>Organisational complexity</i>										
11	Number of activities or objectives	1	2	3	4	5	6	7		
12	Duration of the project or size of capital investment	1	2	3	4	5	6	7		
13	Either diversity of staff, geographic location or information systems	1	2	3	4	5	6	7		
14	Interconnectivity and feedback loops in the task and project networks	1	2	3	4	5	6	7		
15	Variety of cultural and institutional configurations	1	2	3	4	5	6	7		
<i>Technological complexity</i>										
16	Number of resources or domains involved (manufacturing, R&D, marketing etc.)	1	2	3	4	5	6	7		
17	Variety of resources and technological skills needed	1	2	3	4	5	6	7		
18	Interdependency between the components of the project or technological process	1	2	3	4	5	6	7		
19	Demand for creativity and scope of development	1	2	3	4	5	6	7		
<i>Administrative complexity</i>										
20	Number of different legal systems involved (Countries, cities, etc.)	1	2	3	4	5	6	7		
21	Variety in local laws and regulation	1	2	3	4	5	6	7		
22	Interdependency between different institutional configurations	1	2	3	4	5	6	7		

23	Local environment complexity (working hours, administrative process etc.)	1	2	3	4	5	6	7
<b>Partners' knowledge base:</b> Considering knowledge that was needed in the project, in the last project I was involved with ...								
<i>Similarity</i>								
24	The set of our partners skills and technologies was similar to our own	1	2	3	4	5	6	7
25	The set of our partners resources and equipment was similar to our own	1	2	3	4	5	6	7
26	The set of our partners services was similar to our own	1	2	3	4	5	6	7
27	Our partner had the same language/ culture as we do	1	2	3	4	5	6	7
<i>Complementarity</i>								
28	Our partners had skills or technologies that compensated for our deficiencies	1	2	3	4	5	6	7
29	Our partners had resources or equipment that compensated for our deficiencies	1	2	3	4	5	6	7
30	Our partner could provide services that we could not	1	2	3	4	5	6	7
31	The difference between language and culture between our partner and us was helpful in some ways	1	2	3	4	5	6	7
<i>Coverage</i>								
32	There were some skills/ technology needed which none of us could provide	1	2	3	4	5	6	7
33	There were some resources and equipment needed which none of us could provide	1	2	3	4	5	6	7
34	There were some services needed which none of us could provide	1	2	3	4	5	6	7
35	We had some difficulty to communicate with our partner	1	2	3	4	5	6	7
<b>Trust capability</b>								
36	Generally speaking, most people can be trusted?	1	2	3	4	5	6	7
<b>Trust:</b> In the last project I was involved with ...								
<i>Relational trust</i>								
37	Our partners were very honest	1	2	3	4	5	6	7
38	Our partners kept their promises all the time	1	2	3	4	5	6	7
39	Our partners were trustworthy	1	2	3	4	5	6	7
40	Our partners considered our benefits when making decisions	1	2	3	4	5	6	7
<i>Calculus based-trust</i>								
41	Our partners had a good reputation in their domain	1	2	3	4	5	6	7

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42	I did not doubt capabilities of our partners because of their reputation and qualifications	1	2	3	4	5	6	7
43	Our partners are known to be accredited with quality control standards (e.g. ISO 9000 etc.)	1	2	3	4	5	6	7
44	I felt very confident about the skills, personnel, and capital of our partners based on some tangible information (proof of resources, certificates etc.)	1	2	3	4	5	6	7

**Table 9**

Collinearity statistics (VIF) of indicators

Question	VIF	Question	VIF	Question	VIF	Question	VIF
<i>CPS</i> <sub>1</sub>	1.240	<i>OC</i> <sub>12</sub>	1.389	<i>SC</i> <sub>23</sub>	1.336	<i>Cov</i> <sub>34</sub>	3.579
<i>CPS</i> <sub>2</sub>	1.992	<i>OC</i> <sub>13</sub>	1.536	<i>Sim</i> <sub>24</sub>	1.763	<i>Cov</i> <sub>35</sub>	1.082
<i>CPS</i> <sub>3</sub>	1.473	<i>OC</i> <sub>14</sub>	1.247	<i>Sim</i> <sub>25</sub>	2.464	<i>TrC</i> <sub>36</sub>	1.000
<i>CPS</i> <sub>4</sub>	1.304	<i>OC</i> <sub>15</sub>	1.492	<i>Sim</i> <sub>26</sub>	1.952	<i>RT</i> <sub>37</sub>	3.416
<i>CPS</i> <sub>5</sub>	1.905	<i>TC</i> <sub>16</sub>	1.190	<i>Sim</i> <sub>27</sub>	1.060	<i>RT</i> <sub>38</sub>	2.556
<i>CPS</i> <sub>6</sub>	1.321	<i>TC</i> <sub>17</sub>	1.534	<i>Com</i> <sub>28</sub>	2.486	<i>RT</i> <sub>39</sub>	4.353
<i>PI</i> <sub>7</sub>	1.239	<i>TC</i> <sub>18</sub>	1.325	<i>Com</i> <sub>29</sub>	2.228	<i>RT</i> <sub>40</sub>	1.410
<i>PI</i> <sub>8</sub>	1.246	<i>TC</i> <sub>19</sub>	1.212	<i>Com</i> <sub>30</sub>	2.139	<i>CBT</i> <sub>41</sub>	1.572
<i>PI</i> <sub>9</sub>	1.181	<i>SC</i> <sub>20</sub>	2.837	<i>Com</i> <sub>31</sub>	1.099	<i>CBT</i> <sub>42</sub>	1.760
<i>PI</i> <sub>10</sub>	1.149	<i>SC</i> <sub>21</sub>	3.055	<i>Cov</i> <sub>32</sub>	2.219	<i>CBT</i> <sub>43</sub>	1.161
<i>OC</i> <sub>11</sub>	1.291	<i>SC</i> <sub>22</sub>	2.032	<i>Cov</i> <sub>33</sub>	3.952	<i>CBT</i> <sub>44</sub>	1.287

Table 10: Outer weights

	Outer weights	T Statistics	<i>p</i> -value
<i>CPS</i> <sub>1</sub> → <i>CPS</i>	0.37	1.42	0.12
<i>CPS</i> <sub>2</sub> → <i>CPS</i>	0.46	2.06	0.04**
<i>CPS</i> <sub>3</sub> → <i>CPS</i>	0.61	3.00	0.00***
<i>CPS</i> <sub>4</sub> → <i>CPS</i>	0.85	4.00	0.00***
<i>CPS</i> <sub>5</sub> → <i>CPS</i>	0.66	2.43	0.01**
<i>CPS</i> <sub>6</sub> → <i>CPS</i>	0.53	2.43	0.01**
<i>PI</i> <sub>7</sub> → <i>PI</i>	0.77	6.39	0.00***
<i>PI</i> <sub>8</sub> → <i>PI</i>	0.67	6.40	0.00***
<i>PI</i> <sub>9</sub> → <i>PI</i>	0.52	3.55	0.00***
<i>PI</i> <sub>10</sub> → <i>PI</i>	0.67	4.70	0.00***
<i>OC</i> <sub>11</sub> → <i>OC</i>	0.47	3.29	0.00***
<i>OC</i> <sub>12</sub> → <i>OC</i>	0.76	5.13	0.00***
<i>OC</i> <sub>13</sub> → <i>OC</i>	0.52	3.13	0.00***
<i>OC</i> <sub>14</sub> → <i>OC</i>	0.80	6.20	0.00***
<i>OC</i> <sub>15</sub> → <i>OC</i>	0.66	3.90	0.00***
<i>TC</i> <sub>16</sub> → <i>TC</i>	0.29	1.78	0.07*
<i>TC</i> <sub>17</sub> → <i>TC</i>	0.70	5.19	0.00***
<i>TC</i> <sub>18</sub> → <i>TC</i>	0.62	4.59	0.00***
<i>TC</i> <sub>19</sub> → <i>TC</i>	0.85	6.93	0.00***
<i>SC</i> <sub>20</sub> → <i>SC</i>	0.85	6.18	0.00***
<i>SC</i> <sub>21</sub> → <i>SC</i>	0.64	3.54	0.00***
<i>SC</i> <sub>22</sub> → <i>SC</i>	0.89	6.78	0.00***
<i>SC</i> <sub>23</sub> → <i>SC</i>	0.36	1.36	0.17

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	Outer weights	T Statistics	<i>p</i> -value
<i>Sim</i> <sub>24</sub> → <i>Sim</i>	0.91	9.46	0.00***
<i>Sim</i> <sub>25</sub> → <i>Sim</i>	0.82	5.46	0.00***
<i>Sim</i> <sub>26</sub> → <i>Sim</i>	0.65	3.43	0.00***
<i>Sim</i> <sub>27</sub> → <i>Sim</i>	0.47	2.53	0.01**
<i>Com</i> <sub>28</sub> → <i>Com</i>	0.87	5.44	0.00***
<i>Com</i> <sub>29</sub> → <i>Com</i>	0.77	4.43	0.00***
<i>Com</i> <sub>30</sub> → <i>Com</i>	0.84	5.49	0.00***
<i>Com</i> <sub>31</sub> → <i>Com</i>	0.59	2.23	0.02**
<i>Cov</i> <sub>32</sub> → <i>Cov</i>	0.31	1.80	0.06*
<i>Cov</i> <sub>33</sub> → <i>Cov</i>	0.60	2.24	0.02**
<i>Cov</i> <sub>34</sub> → <i>Cov</i>	0.39	1.45	0.10
<i>Cov</i> <sub>35</sub> → <i>Cov</i>	0.92	1.92	0.06*
<i>TrC</i> <sub>36</sub> → <i>TrC</i>	-	-	-
<i>RT</i> <sub>37</sub> → <i>RT</i>	0.85	5.81	0.00***
<i>RT</i> <sub>38</sub> → <i>RT</i>	0.88	7.87	0.00***
<i>RT</i> <sub>39</sub> → <i>RT</i>	0.81	6.62	0.00***
<i>RT</i> <sub>40</sub> → <i>RT</i>	0.74	4.52	0.00***
<i>CBT</i> <sub>41</sub> → <i>CBT</i>	0.51	3.30	0.00***
<i>CBT</i> <sub>42</sub> → <i>CBT</i>	0.79	5.63	0.00***
<i>CBT</i> <sub>43</sub> → <i>CBT</i>	0.38	3.00	0.00***
<i>CBT</i> <sub>44</sub> → <i>CBT</i>	0.87	7.80	0.00***

Note: \*P < 0.1, \*\*P < 0.05, \*\*\*P < 0.01

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