DISTRIBUTED COGNITION MODEL FOR PROJECT MANAGEMENT

MODELO DE COGNIÇÃO DISTRIBUÍDA PARA GESTÃO DE PROJETOS

MODELO DE COGNICIÓN DISTRIBUIDA PARA LA GESTIÓN DE PROYECTOS

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Abstract:
Objective – The purpose of this paper is to present a model of distributed cognition based on project management literature.
Methodology – Utilising the SCOPUS and Web of Science databases, a qualitative and exploratory-descriptive approach was used to conduct a systematic literature review of 138 scientific articles on cognition in projects.
Originality/relevance – This study presents how the field of project management has approached the cognition issues and how cognition can be applied collectively in project teams.
Results – The findings of the synthesis of study results point to four categories (with sixteen subcategories) relate to cognition in project management, and they are as follows: distributed team cognition; cognitive style of leadership; stakeholder relationship and tension; and learning, as well as is presented a cognition model based on the categories and subcategories found.
Contribution – Understand how aspects of cognition can impact the behaviours of the project professional and contribute to problem-solving in the project environment.

Keywords: Project Management. Distributed Team Cognition. Cognitive Style of Leadership. Stakeholder Relationship and Tension. Learning.

Resumo:
Objetivo – Apresentar um modelo de cognição distribuída baseado na literatura sobre o gerenciamento de projetos.
Metodologia – Revisão Sistemática da Literatura de 138 artigos científicos sobre a cognição em projetos, com o uso das bases de dados SCOPUS e Web of Science, na abordagem qualitativa e exploratória-descritiva.
Originalidade/relevância – Este estudo apresenta como o tema da cognição tem sido abordada pela área da gestão de projetos e como a cognação pode ser utilizada coletivamente nas equipes em projetos.
Resultados – Os achados da síntese dos resultados do estudo apontam para quatro categorias e dezesseis subcategorias relacionadas à cognição em gerenciamento de projetos, sendo elas: cognição distribuída de equipe; estilo cognitivo de liderança; relacionamento e tensão entre *stakeholders*; e aprendizagem, bem como é apresentado um modelo de cognição baseado nas categorias e subcategorias encontradas.
Contribuição – Compreender como os aspectos da cognição podem impactar os comportamentos do profissional de projetos e contribuir para a resolução de problemas no ambiente de projetos.

Palavras-chave: Gerenciamento de Projetos. Cognição Distribuída de Equipe. Estilo Cognitivo de Liderança. Relacionamento e Tensão com *stakeholders*. Aprendizado.

Resumen:
Objetivo – Presentar un modelo de cognición distribuida basado en la literatura sobre gestión de proyectos.

Metodología – Revisión Sistemática de Literatura de 138 artículos científicos sobre cognición en proyectos, utilizando las bases de datos SCOPUS y Web of Science, en un enfoque cualitativo y exploratorio-descriptivo.
Originalidad/relevancia – Este estudio presenta cómo el área de gestión de proyectos ha abordado el tema de la cognición y cómo la cognición se puede utilizar colectivamente en los equipos de proyecto.
Resultados – Los hallazgos del resumen de los resultados del estudio apuntan a cuatro categorías y dieciséis subcategorías relacionadas con la cognición en la gestión de proyectos, a saber: cognición distribuida de equipo; estilo cognitivo de liderazgo; relación y tensión entre *stakeholders*; y aprendizaje, así como un modelo de cognición basado en las categorías y subcategorías encontradas.
Contribución – Comprender cómo los elementos de la cognición pueden influir en el comportamiento de los profesionales de proyectos y contribuir a la resolución de problemas de manera colaborativa.

Palabras-clave: Gestión de Proyectos. Cognición distribuida de equipo. Estilo de liderazgo cognitivo. Relación y tensión entre *stakeholders*. Aprendizaje.

1 INTRODUCTION

Previous research has validated cognition in project management (PMgmt) on an individual level to explain some phenomenon, but without attempting to understand how that finding could be used to compose and explain human cognition, comprehensively, resulting in output behaviour. For example, the study of Shealy e Hu (2018), applied cognition to investigate decision-making in the trust aspect, which identified that cognitive behaviour produces judgments and decisions that can overcome the learning curve. Di Filippo *et al.* (2019) analysed the cognition of project and program management teams, focusing on the success of complex PMgmt and leadership teams.

From a team cognition perspective, Abankwa (2019) study investigated the importance of team adaptability in ensuring the success of complex projects. Still, in team cognition, Yue *et al.* (2019) compared collaboration versus team competition in uncertain environments. In this context, understanding cognitive aspects enable the project manager (PM) to anticipate and coordinate events inherent in each member of the project team, and in this sense, the study of Aggarwal and Woolleyb (2019) indicates that cognitive diversity affects a team's ability to promote creativity when considering collective deliveries, therefore, according to Niler *et al.* (2021), the team cognition is the most critical factor affecting team performance.

The cognition of each member of the project team can be defined as the process of acquiring knowledge and understanding through thought, experience, and the senses. Thus, mental processes associated with cognition refer to the capacity to perceive and react, process, and comprehend, store and retrieve information, and make decisions to generate appropriate responses to the environment that guide behaviour (Cambridge Cognition, 2015). Cognition is constantly changing, adapting to the contexts in which individuals find themselves, and regulating behaviour throughout the lifespan, influenced by genetic and environmental factors (Fernandes and Cohen, 2020). Team cognition scaffolding describes how cognition occurs between team-members and their interaction with the environment in the context of people, tools, artefacts, and society – in both local and remote contexts (Sangwan *et al.*, 2020).

According to Schlindwein e Geppert (2020), addressing the theme of cognition is to analyse the issues of human abilities, which comprises the sets of practices and thoughts with their mental states, which shape individual human behaviour, in the business context. Although the PMgmt Institute (PMI), through the PMBOK guide, does not address the topic of cognition in-depth, it expresses its concern with the topic in section three "Performing Integration" by highlighting that integration is a primary skill of the PM and it has three levels, namely: cognitive; context, and complexity (PMI, 2017). The same is true for the seventh edition, which mentions the (meta)cognition exclusively in terms of critical thinking, "thinking about thinking and being aware of one's awareness," and a brief passage explaining confirmation bias – pre-existing beliefs and/or hypotheses (PMI, 2021).

While methodological advances in PMgmt research have occurred, the human behaviour of project team-members has not. This study aims to assess how much cognition has been addressed in scientific publications on PMgmt. Whether using agile or traditional methods, the individual should approach cognitive and technical PMgmt in the same way. This article describes a qualitative study based on the premise that human behaviour is related to professional performance and thus project success. Given the foregoing and an increasingly complex context, this research describes how the PMgmt literature has approached the theme of cognition. To do so, studies on PMgmt from a cognitive perspective were analysed.

The research method used to accomplish the objective was a Systematic Literature Review (SLR), by the model established by (Pollock and Berge, 2018). According to Pollock and Berge (2018), the SLR provides clear answers to research questions through replicable modelling, as well as critical analysis and the use of primary data studies. In this sense, the authors establish a protocol that facilitates comprehension of both the research process and the documentation of the findings. This article contributes to understanding how various aspects of cognition can influence the project professionally and help to solve project-related problems. In this sense, the study clarifies the approach to cognition and proposes a model for team performance in projects.

2 MATERIALS AND METHOD

This study followed the SLR methodology, adhering to Pollock and Berge (2018). According to Galvão and Ricarte (2019), the SLR procedure establishes the necessary conditions for the construction of coherent documents through the use of a large collection of texts that are presumably selected and representative of the subject under review. In this sense, Pollock and Berge (2018) establish that such aspects are organized into six key phases, namely: 1 – clarify goals and objectives; 2 – conduct relevant research; 3 – collect data; 4 – assess the quality of the studies found; 5 – organize the data, and 6 – interpret the findings of the studies.

The first phase was guided by the research objective. Two research databases were accessed to search for scientific articles published in the field of PMgmt. The String = (("cogniti*") AND ("project manage*") was used in both databases. The search was conducted for words written in the English language and no temporal filter was used – additionally, only the article publication filter was selected, allowing for a search of all production in the two databases of knowledge. After completing the first phase, which included establishing objectives, it was possible to apply the search string to both databases; the results obtained are shown in Figure 1, along with the additional criteria established by Pollock and Berge (2018), which are: 1 – identification; 2 – screening; 3 – eligibility; and 4 – included.

The second phase involved results screening to find articles that matched the research. A selection of texts representative of the research theme at the time was established to conclude

the third phase. The inclusion criteria were non-time-limited scientific articles on the theme of cognition in projects. Articles from congresses, journals, and fields of knowledge unrelated to PMgmt were excluded, as were articles written in languages other than the researchers' native and fluency languages.

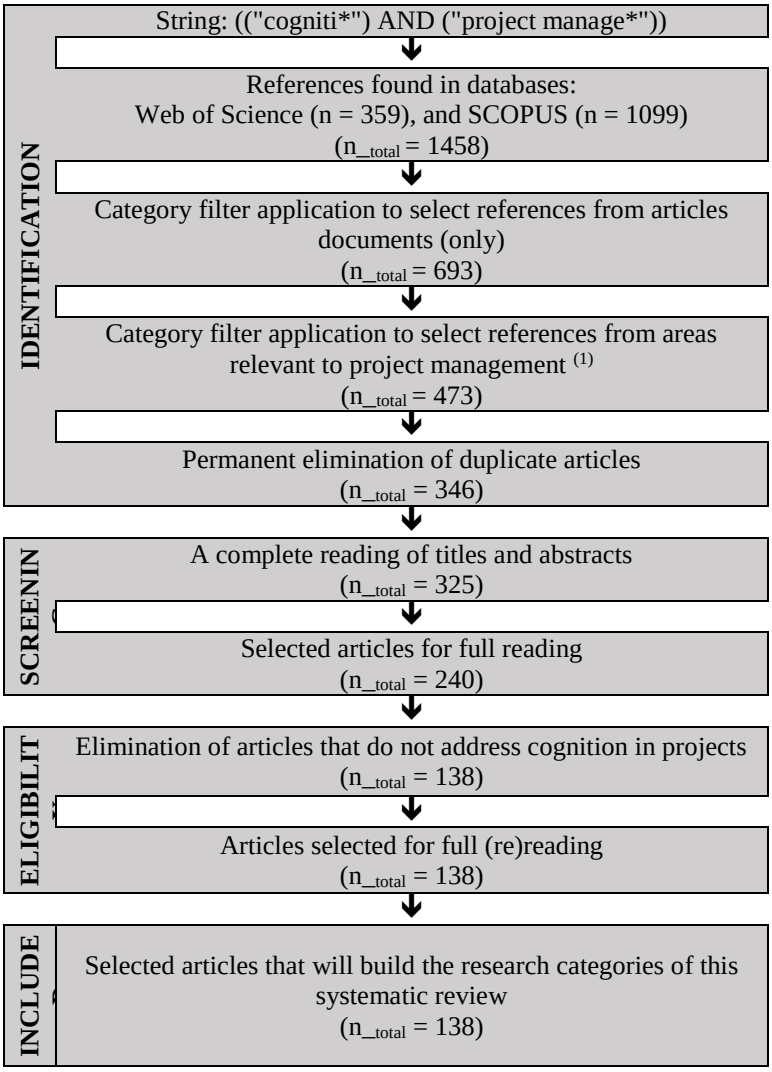

Figure 1 – Schematic representation of phasing for choosing articles for the study

Source: Elaborated by the authors based on Pollock and Berge (2018), 2023.

Notes: (1) It was only project management related.

Before analysing the selected texts with Microsoft Excel, was used the free online version of the Ryyan software to eliminate duplicate articles (available at www.rayyan.ai), thereby

enabling a preliminary analysis. Selected texts were treated with MS Excel software, enabling data analysis such as temporal analysis of journal publications (Figure 2). After this, the study's content could be analysed.

The final stage of analysis involved a thorough reading of the 138 articles that were selected to represent the research topic. This allowed the study's findings and contents to be grouped, compared, and presented using Microsoft Excel. The activities in this phase were guided by Pollock and Berge (2018), criteria and prescriptions, more precisely by meeting the phases of: 4 – assess the quality of the studies found; 5 – organize the data.

3 ANALYSIS OF RESULTS

This section presents the analysis results for this Web of Science (WoS). The first section maps the eligibility phase articles (see Figure 1). The second section explains how to categorize and analyse the articles.

3.1 Articles Mapping

The SCOPUS and WoS databases were consulted, which resulted in the volume of articles treated in the identification and triage stages. Following the reading of the titles and abstracts, 138 articles were chosen by the eligibility and inclusion criteria. These articles allowed us to understand how cognition is handled in PMgmt. The articles range from 1992 to 2022 (end date of data collection on February 26, 2023). Figure 2 illustrates a temporal analysis of journal articles.

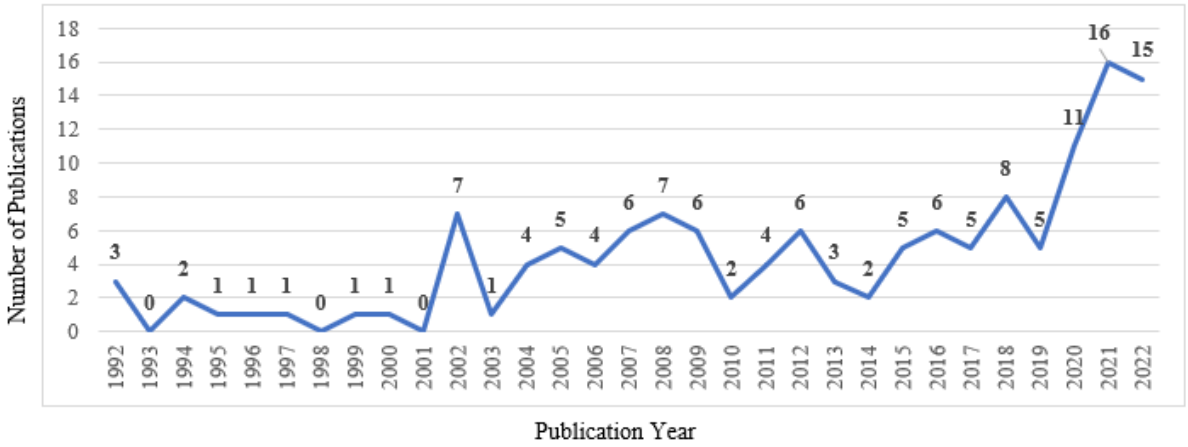

Figure 2 – Temporal analysis of journal publications (total articles n=138)
Source: Elaborated by the authors, 2023.

Figure 2 shows a significant increase in the publication of articles on PMgmt cognition over the last two decades. Over 55% were published in the last decade. There are a couple of peaks in the publication, which may have been caused by global economic crises and recessions that occurred not too long ago. Thus, Yang *et al.* (2022) emphasise that economic crises, political issues, and natural disasters pose a challenge to the risk management and control of these projects, and that the larger the project, the more sensitive it will be and the more resilience it will require. Regarding the peak of 2021, during the COVID-19 pandemic, a large number of publications, such as (Yang *et al.*, 2022), were observed. Following the mapping of the text collection's articles, the contents were thoroughly examined and classified into four categories; Table 1 shows more details of the articles for each category.

Table 1 shows the author-category relationship. The following sections will explain each of the categories identified by the articles. The categorization criterion was applied by the cognition lens.

Table 1
Category list and their respective authors

Category	Articles	Authors
Distributed Team Cognition (DTC)	66	Ajayi *et al.*, 2016; Anvuur and Kumaraswamy, 2012; Bai and Qian, 2021; Bizarrias *et al.*, 2020; Bondar *et al.*, 2022; Buffinton *et al.*, 2002; Caughron and Mumford, 2008; Chak *et al.*, 2022; Chang, 2017; Chang *et al.*, 2013; Chen and Wei, 2009; Choi and Lee, 2018; Daniel *et al.*, 2022; Daniel and Daniel, 2018; Defranco-tommarello and Deek, 2004; Detzen *et al.*, 2018; Drury-Grogan, 2021; Dwivedula and Bredillet, 2010; Farooq *et al.*, 2018; Fellows and Liu, 2016; Forgues and Koskela, 2009; Gavrilova *et al.*, 2015; Habouba-Belinky and Parush, 2020; Han and Hovav, 2016; Han *et al.*, 2020; He, 2012; Hekkala *et al.*, 2018; Heldal *et al.*, 2020; Hilary and Menzly, 2006; Hsu *et al.*, 2020; Hyldegård, 2006; Julsrud, 2008; Leung *et al.*, 2002; Leung and Liu, 2003; Levitt *et al.*, 1999; Li *et al.*, 2022; Ligorio *et al.*, 2005; Lin *et al.*, 2012; Ling, 2002; Liu and Yetton, 2007; Loch, 2017; Moore, 2002; Patanakul, 2022; Pavez *et al.*, 2021; Rave *et al.*, 2022; Pietras and Coury, 1994; Poirier *et al.*, 2017; Robinson *et al.*, 2005; Sangwan *et al.*, 2020; Schultz *et al.*, 2021; Seus *et al.*, 2020; Small and Walker, 2011; Smith, 1992; Smulders *et al.*, 2008; Tuuli and Rowlinson, 2009; Um and Oh, 2021; Upadhayay and Guragin, 2014; Vaux and Kirk, 2018; Vlaar *et al.*, 2008; Wang *et al.*, 2021; Wei *et al.*, 2022; Weiss *et al.*, 2011; Williams, 2019; Williams *et al.*, 1995; Wilson *et al.*, 2007; Zhang *et al.*, 2021
Cognitive Style of Leadership (CSL)	30	Ahmad *et al.*, 2022; Ahmadi Eftekhari *et al.*, 2022; Akman *et al.*, 2011; Aretoulis *et al.*, 2017; Cheung and Chuah, 2000; Du *et al.*, 2005; Edkins *et al.*, 2007; Elbanna, 2015; Espinosa *et al.*, 2006; Floris and Cuganesan, 2019;

		Friedman *et al.*, 1992; Gallagher *et al.*, 2015; Giannoccaro and Nair, 2016; Green, 2004; Hanna *et al.*, 2016; Haynes and Love, 2004; Kamhawi, 2008; Keane, 2022; Liu *et al.*, 2015; Maytorena *et al.*, 2007; Mubarak *et al.*, 2021; Prince, 1992; Rashid and Boussabiane, 2021; Shipley and Johnson, 2009; Simon, 2006; Strang and Vajjhala, 2022; Thomas and Buckle-Henning, 2007; Tullett, 1996; Yang *et al.*, 2022; Zheng *et al.*, 2019
Stakeholders' Relationship and Tension (SRT)	24	Barrett and Sutrisna, 2009; Burstrom and Wilson, 2018; Cheung *et al.*, 2011; Chua *et al.*, 2012; Collinge and Harty, 2014; Cuganesan and Floris, 2020; Flyvbjerg, 2021; Ghaleenoei *et al.*, 2021; Globerson, 1997; Guo *et al.*, 2021; Jenkin *et al.*, 2019; Kahvandi *et al.*, 2018; Kwak *et al.*, 2012; Loosemore *et al.*, 2020; Lu and Hao, 2013; Lu and Yan, 2016; Manu *et al.*, 2013; Qian *et al.*, 2020; Shand, 1994; Sperry and Jetter, 2019; Ugwu *et al.*, 2004; Wang *et al.*, 2021; Wong *et al.*, 2008; Yang *et al.*, 2022
Learning (L)	18	Bhowmick *et al.*, 2015; Chan *et al.*, 2021; Chang *et al.*, 2021; Daradoumis *et al.*, 2002; Florén, 2005; Hanakawa *et al.*, 2002; Jääskä and Aaltonen, 2022; Khedhaouria *et al.*, 2017; Loosemore and Chandra, 2012; Majchrzak *et al.*, 2005; Marshall, 2008; Nembhard *et al.*, 2009; Sense, 2007; Sergeeva and Duryan, 2021; Smyth *et al.*, 2010; Song *et al.*, 2022; Whelton *et al.*, 2002; Wiewiora *et al.*, 2020

Source: Elaborated by the authors, 2023.

The four categories identified here are an abstraction of selected article readings and form the basis for this study. It began with an analysis of each article, which was then categorised by a common interest. Cognition is a critical component of team performance and decision-making (Grand *et al.*, 2016). So, the search for a possible categorization that illustrates cognition in human interaction is justified. The following section will be discussing on each category to explain the research findings.

3.2 Analysis and discussion of the discovered categories

The human brain, according to Rouleau *et al.* (2021), is divided into two complex processes: cognition and behaviour. Cognition is in charge of input and processing, which includes the processes of thought, experience, and sensation that occur as a result of the cognitive functions of perception, attention, memory, problem-solving, decision-making, and language encoding (Barrett, 2018; Rouleau *et al.*, 2021). Behaviour occurs following the decision-making process, which serves as an exit mechanism, materializing human desire (Rouleau *et al.*, 2021).

3.2.1 Distributed team cognition

People and artefacts interact inside and outside organisational structures (sociocultural context), and processes distributed across time, space, society, and its artefacts show how distributed cognition occurs (Hutchins, 2000; Rogers, 1997). Understanding team-member cognition, their interaction with the environment (people, tools, artefacts, and society), and their relationship with the PM is relevant to the project's success.

Hutchins (1995) established a framework for understanding cognition through extended cognitive systems, distancing isolated theories of individual cognition from each other. These findings pioneered a systematic approach to the methodological foundations underlying human-artefact interactions. With the theory of distributed cognition, it is possible to comprehend how team-members interact with the environment to perform a task (Seel, 2012). According to Hollan *et al.* (2000), cognitive processes can be grouped into three categories: social, temporal, and environmental. In practice, distributed cognition occurs when people and objects interact, involving time, place, society, and its objects.

3.2.1.1 Collaborative behaviour

In the context of collaboration, cognitive determinants are influenced by the team's expectations, intentions, and incentives, as well as by the project's technical requirements and capabilities (Poirier *et al.*, 2017). Collaborative behavioural competence is a result of variables such as personality and cognition (Ajayi *et al.*, 2016), and refers to an individual's capacity to contribute, represent, and be subordinated (Ligorio *et al.*, 2005). As an illustration of this, subordination does not refer to agreeing on something; rather, it refers to the fact that only individual understanding can reduce tensions, facilitate collaboration, and produce positive results (Zhang *et al.*, 2021).

Collaboration is a competence that relates to PMgmt, conflict resolution, and communication, and it should be established through dialogue and, when appropriate, narrative structure (Ligorio *et al.*, 2005). Collaboration should be the goal of management, with actions that prioritize collaborative planning, because doing so enhances shared perception (Schultz *et al.*, 2021) and reduces cognitive distancing, which interferes with cognitive focus and negatively affects the capacity for collaboration (Sangwan *et al.*, 2020). In this way, the findings

by Chak *et al.*, (2022) demonstrates that hope, in conjunction with adequate financial resources and collaborative leadership, has a positive effect on commitment, collaboration, and performance.

3.2.1.2 Reasoning and problem-solving ability

To develop a team structure capable of high levels of reasoning and problem-solving, it is necessary to develop teams that are adaptable, communicative, and capable of managing conflict effectively (Detzen *et al.*, 2018; Smulders *et al.*, 2008). The required behavioural performance necessitates the development of a shared mental model among team-members (Han and Hovav, 2016). The shared mental models consider cognitive maps influenced by prior experiences and represent shared cognition between groups of individuals within the cognitive perception process, which has a positive relationship with individual perception and translates into output behaviour (Han and Hovav, 2016).

Communication and feedback between team-members improve team cognition and performance at the team and task levels, both of which contribute to mitigating conflict (Habouba-Belinky and Parush, 2020; Smulders *et al.*, 2008). Conflict can take on a variety of shapes, internal or external, and can be triggered by cognitive, occupational, or individual factors (Williams, 2019), tasks and contexts (Detzen *et al.*, 2018) – it directly affects the cognition and efforts of collaboration, communication, trust and morale (Vaux and Kirk, 2018), or by cognitive differences that can arise as a result of the association of prior experiences and training, resulting in conflicts (Hilary and Menzly, 2006). In this sense, Patanakul, (2022) argues that the efficacy of decision-making is correlated with a high capacity for cognitive integration – in this concept, the resultant combination of rational and emotional cognition is considered.

3.2.1.3 Communication and collective interaction

Communication and frequent interactions between team-members improve the relationship, allowing it to progress from an individual to a social level (Drury-Grogan, 2021). Motivation is a result of both formal and informal communication processes (Dwivedula and Bredillet, 2010). Communication competence aids in the resolution of conflicts and, when

combined with feedback, elevates the team's cognition, which has a positive effect on the team and task performance (Dwivedula and Bredillet, 2010; Habouba-Belinky and Parush, 2020).

Communication competence and trust-building enable problem–solving abilities in this context, as well as have a positive effect on morale and motivation (Vaux and Kirk, 2018). Just as the affective relationship mediates between social capital and behavioural integration, the cognitive structure of social capital has a beneficial effect on behavioural integration (Wang *et al.*, 2021). Interpersonal communication, as well as emotions, all reflect the capacity for integrated work (Wang *et al.*, 2021).

3.2.1.4 Trust building

Trust has two components: cognitive and affective (Julsrud, 2008). When applied to tasks in an organizational context, trust can be reduced if there is uncertainty about how to interact and collaborate with others. Trust is critical in knowledge sharing, and it is built on strong internal ties and social norms (Han and Hovav, 2016). Interpersonal trust, which encompasses both cognitive and affective trust, when combined with the team's ability to interact, can increase perceived resilience and influence team trust in a variety of projects (Pavez *et al.*, 2021). Affection-based trust and team capability mediate the relationship between cognition-based trust and project team resilience (Pavez *et al.*, 2021).

Wei *et al.* (2022) contribute with findings that allow us to positively correlate trust with resilience in the context of project teams operating in uncertain, complex, and sometimes turbulent environments. Diversity of its composition, which emerges in social proximity and cognitive proximity, influences resilience. In general, the greater the similarity of knowledge, experience, and training, the greater the chances of improved communication, decreased conflict, and increased team cohesion and resilience.

3.2.1.5 Sociocognitive and knowledge building

Cognitive, contextual, and social factors all influence team-members' behaviour and cognitive and emotional experiences during project assignments and knowledge building (Hyldegård, 2006; Liu *et al.*, 2022). The maintenance of strong informal relationships increased task dependency, and commitment among team-members can all contribute to the support of

knowledge-exchange interactions (Liu *et al.*, 2022). Sociocognitive problems affect team efficiency, and efficiency is context-dependent rather than process-dependent (Forgues and Koskela, 2009).

Cognitive biases are one of the cognitive factors that can influence knowledge building (Loch, 2017). Consciousness also acts as a moderator in the relationships between socially prescribed motivation and knowledge building – individual cognitive and social factors influence knowledge exchange connections. (Chang *et al.*, 2013; Small and Walker, 2011). Table 2 provides a summary of the key elements found in the literature regarding the findings of the articles that comprised this research.

Table 2

Subcategory's contribution to the category of DTC and their respective authors

Subcategory	Subcategory's contribution to the category	Authors
Collaborative behaviour	— **affects** conflict resolution — **affects** shared perception — **affects** cognitive distancing, cognitive focus — **affects** commitment and performance — **affected** by collaborative leadership — **affected** by hope in conjunction with financial resources	Ligorio *et al.*, 2005; Schultz *et al.*, 2021; Sangwan *et al.*, 2020; Chak *et al.*, 2022
Reasoning and problem-solving ability	— **affected** by flexible, communicative, conflict-managing teams — **affected** by shared cognition and individual perception — **affected** by the communication and feedback — **affected** by the cognitive integration (rational and emotional cognition) — **affect** team cognition and performance, mitigating conflicts — **affect** teamwork, communication, trust, and morale	Detzen *et al.*, 2018; Han and Hovav, 2016; Habouba-Belinky and Parush, 2020; Vaux and Kirk, 2018; Patanakul, 2022
Communication and collective interaction	— **affected** by frequent interactions — **affect** the relationship from an individual to a social level — **affect** problem–solving, positive effect on morale and motivation — **affect** the capacity for integrated work	Drury-Grogan, 2021; Vaux and Kirk, 2018; Dwivedula and Bredillet, 2010; Wang *et al.*, 2021
Trust building	— **affected** if there is uncertainty how to interact and collaborate — **affected** by context of uncertain, complex, and turbulent environment — **affects** knowledge sharing — **affects** team's ability to interact, and resilience	Julsrud, 2008; Han and Hovav, 2016; Pavez *et al.*, 2021; 2021; Wei *et al.*, 2022
Sociocognition and knowledge building	— sociocognition **affects** team-members' behaviour — sociocognitive problems **affect** team efficiency — knowledge building **affected** by cognitive biases — knowledge building **affected** by informal relationships — **affected** by consciousness (socially motivation/ knowledge building)	Hyldegård, 2006; Liu *et al.*, 2022; Liu *et al.*, 2022; Forgues and Koskela, 2009; Loch, 2017; Chang *et al.*, 2013; Small and Walker, 2011

Source: Elaborated by the authors, 2023.

As important as understanding which categories point to cognition in projects is the intention of identifying which subcategories underpin the category, as well as whether the findings of the selected studies identify elements that enable comprehension of the lessons inside each category. In this context, the middle column of Table 2 uses the terms 'affected' and 'affect' as synonyms for 'influenced' and 'influencer' respectively. The same applies to the other categories.

3.2.2 Cognitive style of leadership

Individuals' perceptions, conceptualizations, and solutions to problems differ, according to Asch and Witkin (1948). The cognitive strategy takes the form of distinct cognitive styles that can be classified as intuitive (field-dependent) or analytical (field-independent). According to Cuneo *et al.* (2018), in human interaction, one cognitive style may be more adaptive than another depending on the context. In 1966, the researchers Weissenberg and Gruenfeld (1966) already discussed that individuals classified as intermediate to both groups had a higher methodological analysis factor than co-workers.

3.2.2.1 Cognitive complexity

Cognitive complexity refers to an individual's capacity for understanding nuances and small distinctions. The capacity for cognitive differentiation explains how social objects are perceived as different, separate, and/or independent. Integrative capacity, explains how social objects are perceived as similar, connected, and/or interdependent (Green, 2004). In PMgmt, cognitive complexity, a low level of cognitive differentiation ability, and a high level of integrative cognitive ability all correlate significantly with performance (Green, 2004).

Cognitive complexity differs significantly according to the role played on the team. Human cognition and cognitive complexity can be developed through regular and continuing education (Prince, 1992). Technical cognitive abilities, knowledge, and experience are more evident when integrated with cognitive abilities (Green, 2004). Cognition improves critical aspects of human behaviour, such as being energetic, enthusiastic, assertive, aggressive, results-oriented, decisive, and altruistic, dividing high-performing professionals from average performers (Hanna *et al.*, 2016).

In a good example of application, the study by Yang *et al.* (2022) demonstrates that moral sensitivity (MS) has a significant impact on team management at the cognitive level, manifesting in the behavioural responses (MS: ability of an individual to recognise the impact of his behaviour on others, considering the relevant moral issues). Thus, team-members with a high MS can pay better attention to moral issues, provide more relevant feedback, and deal more effectively with self-perceptions resulting from the environment and its contexts.

3.2.2.2 Ability to lead

Management requires cognitive and interpersonal skills when managing a team (Friedman *et al.*, 1992). Effective management requires consideration of a variety of factors, including cognitive style, age, previous experience, and level of education (Kamhawi, 2008; Mubarak *et al.*, 2021). Motivation has a positive effect on cognition via meaning, competence, and self-determination (Mubarak *et al.*, 2021). When considering the factors that contribute to someone's ability to lead, the most significant factor is the conscientious personality trait, followed by cognitive abilities, extroversion, and agreeableness (Aretoulis *et al.*, 2017). These factors are linked to cognitive and emotional complexity, which influences leadership capacity, which is established by orchestrating the dialogue and ensuring the project's success based on the concept of value (Floris and Cuganesan, 2019).

In this sense, according to Ahmadi Eftekhari *et al.* (2022), a PM's leadership abilities consist both of individual skills (IS) and social skills (SS). According to these authors, IS consists of PM knowledge, interpersonal skills and attributes, professionalism, and experience, whereas SS includes management skills, cognitive skills, influencing skills, contextual skills, emotional skills, and teamwork. This study revealed that among all of them, leadership skills are the most essential (which is within the group of influencing skills). On the cognitive side, this study demonstrates that problem-solving and systems-thinking abilities are the most essential for leadership.

Uncertain and high-pressure environments can result in coercive or abusive performance management, thereby compromising human and professional relationships with team-members and stakeholders (Gallagher *et al.*, 2015). Ethical leaderships are associated with cognitive assessment ability, besides correlates positively with integrated project teams,

favouring the team's psychological empowerment through social learning (Mubarak *et al.*, 2021). According to Ahmad *et al.* (2022), transformational leadership (TL) seems to be a key element of a PM's leadership capacity that achieves results, with TL arising both directly and indirectly through the self-leadership of team-members.

3.2.2.3 Conflicts and problem-solving

Conflict in PMgmt can take two forms: task and emotional oriented (Cheung and Chuah, 2000). Task conflict can be used to improve the cohesion and performance of project teams. Emotional conflicts develop as a result of the individual's emotional influences, personality, and preconceptions, and can develop into cognitive-affective conflicts (Cheung and Chuah, 2000). Human behaviour is governed by a formula that integrates cognition and emotion and takes context and situational factors into account (Cheung and Chuah, 2000). Cognitive style influences how a person acquires and evaluates information and, as a result, how a person develops problem-solving abilities and competencies (Shipley and Johnson, 2009).

Individuals do not typically adapt their cognitive styles to the type of problem at hand, but rather employ their cognitive style and mental models in all possible situations (Tullett, 1996). Individuals' preferred method of utilizing their intelligence, skill, knowledge, and abilities when making decisions and solving problems is determined by their thinking style (Tullett, 1996). Collaborative learning benefits this context by promoting self-reflection and joint knowledge building (Du *et al.*, 2005). The complexity of the environment also impairs intuition influenced by beliefs, assumptions, and background knowledge promotes team reflexivity (Edkins *et al.*, 2007; Elbanna, 2015).

In risk identification, cognitive traits are critical components, as they contribute to the behavioural response, together with the influence of individual perceptions, attitudes and interference from the context's complexity and uncertainty (Maytorena *et al.*, 2007). Conflict management and decision-making should be simple for an experienced PM (Strang and Vajjhala, 2022). Thus, integrating cognition and emotion never runs away his table, and this includes cognitive biases, which also emerge from the rational and/or the emotional and influence the risk of result-adjusted decision-making (Strang and Vajjhala, 2022). Table 3

provides a summary of the key elements found in the literature regarding the findings of the articles that comprised this research.

Table 3
Subcategory's contribution to the category of CSL and their respective authors

Subcategory	Subcategory's contribution to the category	Authors
Cognitive complexity	— **affects** by individual's capacity for understanding and perceiving — **affects** performance — **affects** moral sensitivity and behavioural response — **affected** according to the role played on the team — **affected** through regular and continuing education	Green, 2004; Prince, 1992; Hanna *et al.*, 2016; Yang *et al.*, 2022
Ability to lead	— **affected** by cognitive style, age, experience, and education — **affected** by conscientiousness, extroversion, and agreeableness — **affected** by cognitive abilities and emotional complexity — **affected** by essential competencies (skills, abilities and knowledge) — **affected** by transformational leadership through team-member self-leadership — **affects** trust — **affects** coercive or abusive behaviour for uncertain and high-pressure environmental — **affects** ethical leadership and cognitive assessment ability — **affects** psychological empowerment through social learning	Kamhawi, 2008; Mubarak *et al.*, 2021; Aretoulis *et al.*, 2017; Floris and Cuganesan, 2019; Gallagher *et al.*, 2015; Ahmandi *et al.*, 2022; Ahmad *et al.*, 2022
Conflicts and problem-solving	— conflicts **affected** by task and emotional conflicted oriented — emotional conflict **affected** by individual's influences — emotional conflict **affected** by personality, and preconceptions — task conflict **affects** the cohesion and performance of teamwork — problem-solving **affected** by cognitive bias of team-member decision-making — problem-solving **affected** by cognitive style — **affected** by perceptions, attitudes, context complexity and uncertainty — **affected** by collaborative learning and self-reflection	Cheung and Chuah, 2000; Du *et al.*, 2005; Edkins *et al.*, 2007; Elbanna, 2015; Maytorena *et al.*, 2007; Strang *et al.* 2022

Source: Elaborated by the authors, 2023.

3.2.3 Learning

Individuals acquire knowledge according to their preferences. Everyone has a distinctive learning style of acquiring, processing, and retaining new information, which can be turned into abilities. Acquisition or modification of prior knowledge is referred to as "new information". Situations and tasks, such as contexts, places, and time, can affect a person's learning style (Hatami, 2013).

3.2.3.1 Cognitive learning

The improvement of learning is a result of the individual's cognitive structure, which also considers the interaction with the environment (Bhowmick *et al.*, 2015) and prior experiences

(Florén, 2005). For the reason that mental models are related to meaning attribution and/or construction, cognitive learning uses them to restructure and/or elaborate acquired knowledge during activity (Bhowmick *et al.*, 2015). Since collaborative learning reduces total individual cognitive load, it outperforms individual learning. The collective's cognitive efforts are directed toward achieving mental representation affinity and thus processing the task's cognitive load (Bhowmick *et al.*, 2015).

Individual learning is associated with cognitive motivation, intuition, interpretation, and integration, as well as the need for cognition. Individuals with a high need for cognition perform better under cognitive load (Bhowmick *et al.*, 2015; Chan *et al.*, 2021), as well as have a higher level of cognitive motivation (Chan *et al.*, 2021), which enhances learning. Individual cognition is enhanced in this context by reflection and the process of constructive feedback (Chang *et al.*, 2021). Trust, which is cognitive and emotional, influences intuition and contributes to the emotional and experiential learning processes (Smyth *et al.*, 2010).

A good example of this is reported in the study by Jääskä and Aaltonen, (2022). Cognitive learning, according to these authors, provides a deeper level of learning compared to other methodologies, as evidenced by the game - based learning methodology. This is since games facilitate a more intense involvement on the part of the individual, and therefore have an effect on learning and motivation through engagement, as this form of learning has roots in the cognitive, affective-emotional, and sociocultural domains.

3.2.3.2 The manager in learning

Management has a significant cognitive role in organisations' two-stage learning processes. To influence team-members' performance, managers first interpret the external environment and then interpret the internal organisational contexts. (Florén, 2005; Majchrzak *et al.*, 2005). The manager promotes creativity, motivation, and collaboration while managing time-pressure (Khedhaouria *et al.*, 2017), and balances collaboration-competition (Nembhard *et al.*, 2009). In addition, there is evidence of the relationship between existing schemas and organizational contexts in situated cognition, which has implications for the comprehension of managerial and organizational cognition (Elsbach *et al.*, 2005).

3.2.3.3 Sociocognitive learning

According to the sociocognitive perspective, learning occurs through the reduction of individual mental models, since members have different origins, training, knowledge, and skills (Chang *et al.*, 2021), and they strive to attribute meaning to artefacts through communication, interaction, and negotiation (Loosemore and Chandra, 2012). Individual cognition provides a framework for organizational learning, as behaviour is the result of individual cognition combined with situational factors (Chang *et al.*, 2021; Loosemore and Chandra, 2012; Sense, 2007). The development of team-based learning may benefit from cognitive style incompatibility if managed properly (Sense, 2007).

It is relevant to manage diversity to promote learning and collaboration. Cognitive conflict can help members learn and generate knowledge in sociocognitive learning by reducing cognitive differences between mental models and developing perception (Chang *et al.*, 2021; Loosemore and Chandra, 2012). When cognitive conflict is resolved, learning occurs through collaboration (Chang *et al.*, 2021; Wiewiora *et al.*, 2020).

3.2.3.4 Organizational learning from projects

Project-based learning correlates positively with cognitive processes, interpretation, and integration at the project team level (Chang *et al.*, 2021; Wiewiora *et al.*, 2020). In this sense, the organizational competencies, through their routines and practices, institutionalize learning within and between projects (Chan *et al.*, 2021; Chang *et al.*, 2021), whether by introducing new practices or improving existing ones (Chang *et al.*, 2021). Organizational learning requires individuals to be able to recognise cognitive differences between themselves and their teammates' mental models, as well as invest in collective problem-solving (Chang *et al.*, 2021; Sergeeva and Duryan, 2021).

A company's culture impacts three levels. The first level of shared cognition impacts active collaboration, where knowledge is developed through behaviour, perception, and problem-solving (Loosemore and Chandra, 2012; Majchrzak *et al.*, 2005). Explicit values, social norms, and beliefs are considered second. Individual cognition, or how members perceive and interpret their environment, has third-level impacts (Loosemore and Chandra, 2012). Table

4 provides a summary of the key elements found in the literature regarding the findings of the articles that comprised this research.

Table 4
Subcategory's contribution to the category of Learning and their respective authors

Subcategory	contribution elements to the subcategory	Authors
Cognitive learning	— **affected** by cognitive structure and mental models — **affected** by prior experiences and interaction with environment — **affected** by collaborative learning, reduces individual-cognition load — **affected** by team-member learning, motivation, and engagement — **affected** by the difference in perception from individual — **affected** by high need-for-cognition perform better under cognitive load — **affected** by team-member cognition, enhanced by reflection and feedback — **affected** by trust, influences intuition and experiential learning	Bhowmick *et al.*, 2015; Florén, 2005; Chan *et al.*, 2021; Smyth *et al.*, 2010; Jääskä and Aaltonen, 2022; Song *et al.*, 2022
The manager in learning	— **affects** team-member to learning — **affects** team-member to interpret internal organisational contexts — **affects** team-member to promote creativity and motivation — **affects** team-member for collaboration while managing time-pressure — **affects** team-member to balances collaboration-competition	Florén, 2005; Majchrzak *et al.*, 2005; Khedhaouria *et al.*, 2017; Nembhard *et al.*, 2009; Elsbach *et al.*, 2005
Sociocognitive learning	— **affected** by the reduction of the team-member mental models — **affected** by the team-member origins, training, knowledge, and skills — **affected** by the individual-cognition — **affected** by the communication, interaction, and negotiation — **affected** by diversity to promote learning and collaboration — **affected** by cognitive conflict to learn and generate knowledge	Chang *et al.*, 2021; Loosemore and Chandra, 2012; Sense, 2007; Wiewiora *et al.*, 2020
Organizational learning from projects	— **affected** by project-based and cross-project learning — **affected** by team-member who can recognise cognitive differences — **affected** by the company culture — **affected** by team-member who invest in collective problem-solving — **affected** by team-member behaviour, perception and problem-solving — **affected** by explicit values, social norms, and beliefs — **affected** by individual-cognition, perception, and environmental interpretation	Chang *et al.*, 2021; Wiewiora *et al.*, 2020; Chan *et al.*, 2021; Loosemore and Chandra, 2012; Majchrzak *et al.*, 2005

Source: Elaborated by the authors, 2023.

3.2.4 Stakeholders' relationship and tension

In 1963, the Stanford Research Institute defined a stakeholder as any group or individual important to an organization's survival (Freeman, 1984). Understanding stakeholder dynamics requires an understanding of business-related human behaviour issues. In this sense, Freeman *et al.* (2020) argue that the main issue is the distinction between a value chain – which focuses on financial value and the desired outcome for shareholders – and a value network, which

includes shared purposes and values. Thus, everyone else besides shareholders helps achieve success.

3.2.4.1 Social capital

Social capital is the emergence of structural, cognitive, and relational bonds based on shared values and beliefs, as well as peer norms. Thus, it can be developed from the perspective of stakeholders through perception, experience, and the ability to influence and lead (Chua *et al.*, 2012). Social capital can be classified as structural, cognitive, or relational. On the structural level, there are pre-existing interpersonal bonds and factors that either facilitate or inhibit bond formation (Chua *et al.*, 2012). Individuals can provide shared representations, interpretations, and meanings in the cognitive domain. Finally, there is the relational dimension, which refers to the bonding strength of relationships (e.g., professional relationships that extend into friendship) (Chua *et al.*, 2012).

Management and socio-environmental factors affecting human behaviour can act differently on different classes of stakeholders, beginning with the communication process, which has cognitive unfolding in perception (Kwak *et al.*, 2012). Affection (attitudes), health and well-being (physical/mental), cognition (abilities), behavioural (professional/personal), and situational (personal circumstances) factors may all contribute to the measurement of social capital (Chua *et al.*, 2012; Loosemore *et al.*, 2020).

3.2.4.2 Cognitive involvement

Stakeholder involvement occurs via communication and the creation of project artefacts (Collinge and Harty, 2014). Thus, cognitive knowledge is manifested through interpretation and meaning attribution, and it varies according to the stakeholder type (Collinge and Harty, 2014). In this context, interpretation positively correlates with involvement, and narrative communication is critical in the design of communicative signals and artefacts to substitute individual cognitive understandings with shared understanding (Collinge and Harty, 2014).

Stakeholder understandings can shift over time, both within and across projects (Jenkin *et al.*, 2019). For the reason that cognitive processes such as meaning attribution (sensegiving / sensemaking), artefacts (such as planning), and involvement (communication and artefacts) all

have an effect on this (Jenkin *et al.*, 2019). The sooner all necessary stakeholders are integrated, the better the chances of success (Kahvandi *et al.*, 2018). In this sense, the research by Yang *et al.* (2022) organises knowledge or understanding by establishing separate management for stakeholders with pre-existing relationships and for new stakeholders without pre-existing relations between members. According to Yang *et al.* (2022), ties (well-resolved) between stakeholders with an existing relationship contribute significantly to resilience and solidarity in the face of adversity. As for stakeholders without a prior relationship, the ideal scenario is to establish a relational norm of trust, which, in addition to cultivating resilience, and mitigates potential opportunistic behaviours.

3.2.4.3 Affective and cognitive trust

Trust may have cognitive and/or affective origins (Cheung *et al.*, 2011). If cognition is the origin, it is founded on knowledge and comprehension (rational basis) (Cheung *et al.*, 2011). When it comes to affection, it considers feelings and emotions (emotional basis), both coexist in individuals (Cheung *et al.*, 2011). Trust enhances collaboration, which is necessary for collaborative problem-solving (CPS), communication, and affectionate relationships. Additionally, ethical leadership is associated with an increase in affective (emotional) and cognitive (rational) trust (Guo *et al.*, 2021).

While trust is necessary to maintain interpersonal relationships, its development can be hampered by stakeholders' divergent interests (Wong *et al.*, 2008). Trust contributes to the expansion of affirmative will, expectation, belief, and behaviour, as well as the ability to overcome risks and uncertainties (Wong *et al.*, 2008). Trust can act as a mediator between power and collaborative performance (Lu and Yan, 2016). When compared to cognitive trust, affect-based trust has a positive effect on cooperative performance in this context (Lu and Hao, 2013; Lu and Yan, 2016). Cognitive trust enables cooperative behaviour and communication, which influences affective trust. Trust is also affected by cognitive and behavioural biases (Flyvbjerg, 2021).

3.2.4.4 Tension and cognition

Tension can be managed cognitively and emotionally (Burstrom and Wilson, 2018). Tension arises from a variety of reasons, including cognitive tension between groups, differences in organizational principles, which can result in increased misunderstanding and uncertainty, and emotional tension, which increases complexity, uncertainty, and misunderstanding (Burstrom and Wilson, 2018; Cuganesan and Floris, 2020). The ability to balance contradictions in team integration responses is correlated with PMs' mental models (Cuganesan and Floris, 2020).

On the team level, the relationship between emotional tension and value creation is inverted-U in terms of collaboration and competition (rivalry) (Qian *et al.*, 2020). Mental models influence decision-making strategies for both managers and team-members (Cuganesan and Floris, 2020; Shand, 1994). Thus, understanding how stakeholders perceive and empathise with the project is relevant to engagement (Sperry and Jetter, 2019). Low-level engagements increase emotional tension and decrease value creation and success (Ugwu *et al.*, 2004). Table 5 provides a summary of the key elements found in the literature regarding the findings of the articles that comprised this research.

Table 5
Subcategory's contribution to the category of SRT and their respective authors

Subcategory	Subcategory's contribution to the category	Authors
Social capital	— **affected** by cognitive-bonds and relational-bonds — **affected by** cognitive-bonds, through shared-representations, interpretations, and meanings — **affected by** relational-bonds, strength of relationships (including personal) — **affected** by each class of stakeholders — **affected** by stakeholders' communication and perception — **affected** by stakeholders' experience and influence — a**ffected** by affect, well-being, cognition, behaviour, and situational	Chua *et al.*, 2012; Kwak *et al.*, 2012; Loosemore *et al.*, 2020
Cognitive involvement	— **affects** stakeholders communication and perception — **affected** by cognitive knowledge (interpretation and meaning) — **affected** by interpretation that pushes the involvement — **affected** by interpretation that pushes communication, cognitive-understands, and shared-understands — **affected** by stakeholders meaning attribution (within/ across projects) — **affected** by accuracy of time/phase of stakeholders' involvement — **affected** by previous relationships (professional and personal)	Collinge and Harty, 2014; Jenkin *et al.*, 2019; Kahvandi *et al.*, 2018; Yang *et al.* 2022

Affective and cognitive trust	— **affects** collaborative performance — collaboration **affects** CPS, communication, and affectionate relationships — **affects** the ability to overcome risks and uncertainties — affective trust **affects** cooperative performance — cognitive trust **affects** cooperative behaviour and communication — affective is **affected** by feelings, emotions, and ethical leadership — ethical leadership **affects** affective and cognitive trust — **affected** by cognitive and behaviour biases — a**ffected** by the divergent interests of the stakeholders	Cheung *et al.*, 2011; Guo *et al.*, 2021; Wong *et al.*, 2008; Lu and Yan, 2016; Lu and Hao, 2013; Flyvbjerg, 2021
Tension and cognition	— **affected** by cognition and emotionality — **affected** by cognitive tension between team-member groups — **affected** by differences in organizational principles — organisational differences are **affected** by emotional-tension and interpretation — organisational differences are **affected** by complexity and uncertainty — **affected** by the PM's leadership ability (mental models) — PM's mental models **affect** decision-making — **affected** by the inverted-U relationship between emotional-tension and value-creation — emotional-tension **affects** collaboration and is **affected** by engagement — rivalry **affects** value creation and is **affected** by engagement	Burstrom and Wilson, 2018; Cuganesan and Floris, 2020; Qian *et al.*, 2020; Shand, 1994; Shand, 1994; Ugwu *et al.*, 2004

Source: Elaborated by the authors, 2023.

4 CONCLUSION AND FINAL CONSIDERATIONS

The purpose of this article was to examine how the cognition topic was addressed in publications on PMgmt field. The findings of the synthesis of the study results pointed to four categories – with sixteen subcategories. For each category, a summary table correlating the contribution of each subcategory with the reference category was compiled.

By identifying how cognition has been researched and reported within the context of projects, the aim was achieved. Thus, in the first instance, it is presented, that even though being organised into four categories, there is the same direction, which recognises the relevance and significance of the collaborative search for problem-solving, and thus the delivery of value and success in PMgmt.

Based on the discovered categories, we identified the Cognitive Style of Leadership, Stakeholders' Relationship and Tension, and Integrative Learning as possible precursors to Distributed Team Cognition. Consequently, when analysing the subcategories of Distributed Team Cognition, we discovered indications that Collaborative Behaviour, Communication and Collective Interaction, Trust Building, and Sociocognitive and Knowledge Building significantly point to Collaborative Problem-solving, which influences decision-making and,

consequently, leads to value delivery and project success. Based on our findings, we propose a model, as shown in Figure 3.

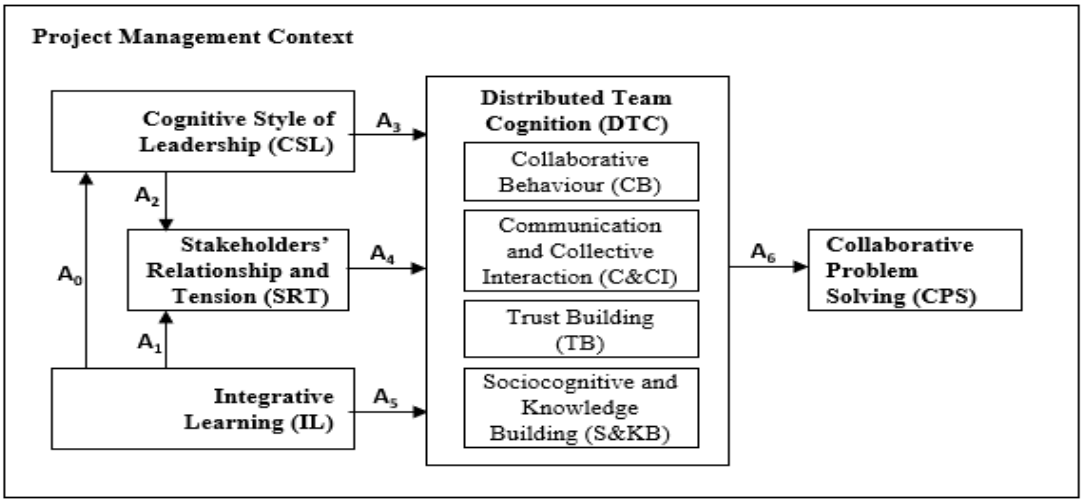

Figure 3 – Distributed Team Cognition model for Collaborative Problem-solving in the context of projects

Source: Elaborated by the authors.

In accordance with the contribution of the findings of the reference authors, each box in Figure 3 represents a category and/or subcategory established based on this research. The importance, significance, and relevance are supported in each preceding section; however, clarification is required when proposing this conceptual model. First, this model emphasises the DTC category because, it is the category that most contributes to achieving the research's objective. Secondly, we highlight the indications of the connections between the categories, and thus, it is appropriate to provide some additional clarifications here. Based on the results, we provide an overview of each connection.

The connection **A_5:IL→DTC,** refers to the understanding that the findings indicate that learning contributes positively to the CB of the DTC in both directions: Collaborating to learn and learning to collaborate (Liu *et al.*, 2021), since the CB competence is fundamentally the result of personality and cognition (Ajayi *et al.*, 2016). Still in A_5:IL→DTC(CB), the collaborative learning encourages self-reflection and joint knowledge creation (Du *et al.*, 2005). In addition, learning influences C&CI with a focus on enhancing competence (Yap *et al.*, 2017), TB and S&KB (Chang *et al.*, 2021; Loosemore and Chandra, 2012). Still in TB, there is

evidence of a two-way, in that trust building is required to generate learning, and learning is required to generate trust building (Shealy e Hu, 2018).

The connection **A_1:IL→SRT,** refers to the understanding that learning contributes to the development and improvement of cognitive intelligence and emotional intelligence, that can be developed through practical and experiential training (Xiang *et al.*, 2016). Stakeholders must be integrated and involved in the appropriate phases of each project (Kahvandi *et al.*, 2018), as the processes of meaning attribution (sensegiving / sensemaking), artefacts (such as planning), and involvement (communication and artefacts) all have an impact on this (Jenkin *et al.*, 2019). Even more so, it is a category that employs cognition and affectivity-emotionality to a high degree (Burstrom and Wilson, 2018; Cuganesan and Floris, 2020).

The connection **A_0:IL→CSL**, the PM acts with his ability to lead, as well as the role of collaboration, and cognition plays a significant role, as it improves essential aspects of human behaviour, such as enthusiastic, assertive, aggressive, results-oriented, decisive, and altruistic, which distinguish high-performing professionals from average performers (Hanna *et al.*, 2016). The capacity to lead requires cognitive and interpersonal skills when managing a team (Friedman *et al.*, 1992). Thus, cognitive style, age, previous experience, and level of education (Kamhawi, 2008; Mubarak *et al.*, 2021), so learning can take different forms, such as: Project-based learning (Chang *et al.*, 2021; Wiewiora et al., 2020); Organizational-based learning, through their routines and practices; Learning within and between projects (Chan *et al.*, 2021; Chang *et al.*, 2021), whether by introducing new practices or improving existing ones (Chang *et al.*, 2021).

The connection **A_3:CSL→DTC**, establishes the significance of the management capacity. Considering the collaborate team through the DTC lens, the CB, among others, is affected by collaborative leadership (Schultz *et al.*, 2021) and is able of overcoming adversities (Sangwan *et al.*, 2020). In the case of hope, management is crucial, and the theory demonstrates that rationality is intertwined with affectivity and emotion (Chak *et al.*, 2022). In C&CI, the management capacity must include mental models that promote the perception that it has a significant impact on behaviour (Han and Hovav, 2016), as well as directed communication that is capable of instructing, empowering, collaborating, and effectively mitigating conflicts

(Detzen *et al.*, 2018; Smulders *et al.*, 2008). Even the PM must motivate and empower a self-managed channel of communication and feedback between team-members, as the constant practise of communication and feedback improves relationships (Drury-Grogan, 2021), increases cognition, moderates emotionality, and reduces conflicts (Dwivedula and Bredillet, 2010; Habouba-Belinky and Parush, 2020).

In TB, similar to what is observed in learning, everything related to TB is a two-way street: the PM must take the first step and promote TB, and along the learning curve, his posture added to experientiality with the team, TB improves (Han and Hovav, 2016). The same is true for resilience resulting from TB (Pavez *et al.*, 2021). At S&KB, if cognitive, contextual, and social factors all influence team-members' behaviour and cognitive and emotional experiences during projects (Hyldegård, 2006; Liu *et al.*, 2022), the PM must deliver management strategies that cover the efficient handling of cognitive biases (Loch, 2017), environmental control (Forgues and Koskela, 2009), and social bias (Drury-Grogan, 2021), conscientiousness moderation (Chang *et al.*, 2013; Small and Walker, 2011), cognitive emotional support (Patanakul, 2022), and knowledge building (Chang *et al.*, 2013; Small and Walker, 2011).

The connection **A_2:CSL→SRT**, reinforces the PM's unconditional need for management skills and cognitive and emotional leadership over stakeholders (Burstrom and Wilson, 2018), as well as the PM's capacity to integrate these competencies (Cuganesan and Floris, 2020). Individuals create their own cognitive domain representations, interpretations, and significance in the same way that they learn based on their own preferences and choices (Hatami, 2013; Chua *et al.*, 2012). In addition, collaboration is also a personality variable of trait (Ajayi *et al.*, 2016). And regarding personality, the cognitive domain is influenced by expectations, intentions, and incentives in the context of collaboration (Poirier *et al.*, 2017). Thus, the ideal PM must combine cognitive and interpersonal skills for leadership (Friedman *et al.*, 1992), and other research shows that in human interaction, one cognitive style may be more adaptive than another depending on the context (Cuneo *et al.*, 2018).

The connection **A_4:SRT→DTC**: the strengths that underlie this connection are the elements of effective communication and perception that emerge in involvement (Collinge and Harty, 2014; Loosemore *et al.*, 2020), as well as conflict management that can be triggered by

cognitive, occupational, or individual factors (Williams, 2019), tasks and contexts (Detzen *et al.*, 2018), and directly affects the cognition and efforts of collaboration, communication, trust, and morale (Vaux and Kirk, 2018). Thus, the PM must deliver strategies that ensure the recruitment of each stakeholder class at the appropriate time (Kahvandi *et al.*, 2018), including collaborative participation and with the correct shared vision of the project to achieve the expected results (Jenkin *et al.*, 2019), building trust that is tri-directional (PM – stakeholders – project team) (Julsrud, 2008; Han and Horav, 2016; Pavez *et al.*, 2021), controlling cognitive biases (Loch, 2017; Wang *et al.*, 2021), which considers the control of emotionality (Cheung *et al.*, 2011; Guo *et al.*, 2022), and tension between groups that can go beyond stakeholder classes (Burstrom and Wilson, 2018), and with the project team (Cuganesan and Floris, 2020), control of previous experiences (Chua *et al.*, 2012; Yang *et al.*, 2022), and control of rivalry and resilience that affects value creation and engagement (Yang *et al.*, 2022; Qian *et al.*, 2022).

The connection **A_6:DTC→CPS**, reveals relevant elements that originate in an individual's attention, perception, and consciousness level (Barrett, 2018; Rouleau *et al.*, 2021). A relevant level of CPS is generated by the individual and achieved by the group (Drury-Grogan, 2021). In addition to efficient management, efficient individuals enable effective decisions and CPS reach (Daniel and Daniel, 2018; Han and Horav, 2016). In general, the main elements that must be built are: collaborative behaviour (Ajayi *et al.*, 2016; Zhang *et al.*, 2021), through the management of tension and conflicts (Strang and Vajjhala, 2022); communication and collective integration (Drury-Grogan, 2021), through frequent interactions and empowerment (Dwivedula and Bredillet, 2010) and motivation (Tuuli and Rowlinson, 2009); building cognitive and emotional confidence (Pavez *et al.*, 2021); and attention to the effects of sociocognition that directly affect the behaviour and performance of MTs (Forgues and Koskela, 2009), related to complex, uncertain and turbulent environments (Wei *et al.*, 2022). Regarding the knowledge building process, the shared vision of the CB, the interactions and the effect of morale and motivation of the C&CI, added to the BT and moderated by Sociocognition, each have a significant impact (Hyldegård, 2006; Liu *et al.*, 2022).

The findings of this study suggest that an increase in DTC has a proportional and positive effect on the capacity for CPS in the project environment. Since the environment in projects is

correlated with factors such as complexity (Hekkala *et al.*, 2018), uncertainties and high-pressure (Gallagher *et al.*, 2015), unstable and ambiguous (Sergeeva and Duryan, 2021), and technically turbulent (Dayan and Di Benedetto, 2011), in contexts that even take into account relevant technological advances, and that require the development and management of new soft-skills, we suggest that the DTC category is more relevant than the other categories revealed in this study.

As a recommendation for future research, additional studies could be conducted to validate the identified categories and the proposed model. One suggestion would be to conduct exploratory field experimental studies with PMs and project team-members to validate and improve the proposed cognitive model presented in this research.

As a limitation, we primarily lack the resources and time to conduct the research, which drives us to generalise the findings, which were compiled from multiple studies and for research purposes. Regarding the 2022 publications, nine studies were inaccessible and not included in this research. A further point is that some articles reported that the samples were small, or that they were required through a simple case study, or that they were conducted by cross-section and not longitudinal studies, in addition to the fact that various studies also reported time, investment, and resource constraints.

REFERENCES

Aggarwal, I., & Woolleyb, A. W. (2019). Team creativity, cognition, and cognitive style diversity. *Management Science*, 65(4), 1586–1599. https://doi.org/10.1287/mnsc.2017.3001

Ahmad, M. K., Abdulhamid, A. B., Wahab, S. A., & Nazir, M. U. (2022). Impact of the project manager's transformational leadership, influenced by mediation of self-leadership and moderation of empowerment, on project success. *International Journal of Managing Projects in Business*, 15(5), 842–864. https://doi.org/10.1108/IJMPB-03-2021-0066

Ahmadi Eftekhari, N., Mani, S., Bakhshi, J., Mani, S., Eftekhari, N. A., Mani, S., Bakhshi, J., & Mani, S. (2022). Project Manager Competencies for Dealing with Socio-Technical Complexity: A Grounded Theory Construction. *Systems*, 10(5). https://doi.org/10.3390/systems10050161

Ajayi, S. O., Oyedele, L. O., Kadiri, K. O., Akinade, O. O., Bilal, M., Owolabi, H. A., & Alaka, H. A. (2016). Competency-based measures for designing out construction waste: task and contextual attributes. *Engineering Construction and Architectural Management*, 23(4), 464–490. https://doi.org/10.1108/ECAM-06-2015-0095

Akman, I., Misra, S., & Altindag, T. (2011). The impact of cognitive and socio-demographic

factors at meetings during software development process. *Tehnicki Vjesnik-Technical Gazette*, 18(1), 51–56.

Anvuur, A. M., & Kumaraswamy, M. M. (2012). Measurement and Antecedents of Cooperation in Construction. *Journal of Construction Engineering and Management*, 138(7), 797–810. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000498

Aretoulis, G. N., Papathanasiou, J. B., Zapounidis, K., & Seridou, A. A. (2017). Conscientiousness personality trait defines the competent Greek project manager. *International Journal of Business Performance Management*, 18(3), 350–380. https://doi.org/10.1504/IJBPM.2017.084857

Asch, S. E., & Witkin, H. A. (1948). Studies in space orientation: I. Perception of the upright with displaced visual fields. *Journal of Experimental Psychology*, 38(3), 325–337. https://doi.org/10.1037/h0057855

Bai, X.-P., & Qian, C. (2021). Factor validity and reliability performance analysis of human behavior in green architecture construction engineering. *Ain Shams Engineering Journal*. https://doi.org/10.1016/j.asej.2021.04.009

Barrett, L. (2018). The Evolution of Cognition. *The Oxford Handbook of 4E Cognition*, 718–734. https://doi.org/10.1093/oxfordhb/9780198735410.013.38

Barrett, P., & Sutrisna, M. (2009). Methodological strategies to gain insights into informality and emergence in construction project case studies. *Construction Management and Economics*, 27(10), 935–948. https://doi.org/10.1080/01446190903273943

Bhowmick, S., Chandra, A., Harper, J. S., & Sweetin, V. (2015). Collaborative Learning Using a Project across Multiple Business Courses: A Cognitive Load and Knowledge Convergence Approach. *Decision Sciences-Journal of Innovative Education*, 13(2), 197–219. https://doi.org/10.1111/dsji.12060

Bizarrias, F. S., Da Silva, L. F., Penha, R., & Russo, R. (2020). Relationship Between Marketing and Project Management Success Through Cognitive Process Lens. *IEEE Access*, 8, 169810–169821. https://doi.org/10.1109/ACCESS.2020.3023897

Bondar, O., Petrenko, G., Khalilov, A., Vahonova, O., Akimova, L., & Akimov, O. (2022). Construction Project Management Based on the Circular Economy. *International Journal of Computer Science And Network Security*, 22(9), 630–635. https://doi.org/10.22937/IJCSNS.2022.22.9.82

Buffinton, K. W., Martin, K. A., & Jablokow, K. W. (2002). Project team dynamics and cognitive style. *EMJ - Engineering Management Journal*, 14(3), 25–33. https://doi.org/10.1080/10429247.2002.11415170

Burstrom, T., & Wilson, T. L. (2018). The texture of tension: complexity, uncertainty and equivocality. *International Journal of Managing Projects in Business*, 11(2), 458–485. https://doi.org/10.1108/IJMPB-01-2017-0005

Cambridge Cognition. (2015). What Is Cognition & Cognitive Behaviour. *Cambridge Cognition*. https://www.cambridgecognition.com/blog/entry/what-is-cognition

Caughron, J. J., & Mumford, M. D. (2008). Project planning: The effects of using formal planning techniques on creative problem-solving. *Creativity and Innovation Management*, 17(3), 204–215. https://doi.org/10.1111/j.1467-8691.2008.00484.x

Chak, C. M., Carminati, L., & Wilderom, C. P. M. (2022). Hope, goal-commitment and -stress mediating between collaborative leadership, financial resources and performance. *International Journal of Productivity and Performance Management*. https://doi.org/10.1108/IJPPM-05-2021-0280

Chan, K.-Y., Oerlemans, L., & Meslec, N. (2021). The impact of multiple project team membership on individual and team learning: A micro-meso multi-level empirical study. *International Journal of Project Management*, 39(3), 308–320. https://doi.org/10.1016/j.ijproman.2020.11.002

Chang, A., Wiewiora, A., & Liu, Y. (2021). A socio-cognitive approach to leading a learning project team: A proposed model and scale development. *International Journal of Project Management*, 39(6), 646–657. https://doi.org/10.1016/j.ijproman.2021.05.003

Chang, J. Y. T. (2017). Mutual Monitoring of Resources in an Enterprise Systems Program. *Project Management Journal*, 48(1), 100–115. https://doi.org/10.1177/875697281704800107

Chang, K.-C., Yen, H.-W., Chiang, C.-C., & Parolia, N. (2013). Knowledge contribution in information system development teams: An empirical research from a social cognitive perspective. *International Journal of Project Management*, 31(2), 252–263. https://doi.org/10.1016/j.ijproman.2012.06.005

Chen, Y. M., & Wei, C.-W. (2009). Multiagent approach to solve project team work allocation problems. *International Journal of Production Research*, 47(13), 3453–3470. https://doi.org/10.1080/00207540802356754

Cheung, C. C., & Chuah, K. B. (2000). Intergroup conflict management framework for hong kong's manufacturing industry. *EMJ - Engineering Management Journal*, 12(3), 26–33. https://doi.org/10.1080/10429247.2000.11415079

Cheung, S. O., Wong, W. K., Yiu, T. W., & Pang, H. Y. (2011). Developing a trust inventory for construction contracting. *International Journal of Project Management*, 29(2), 184–196. https://doi.org/10.1016/j.ijproman.2010.02.007

Choi, B., & Lee, S. (2018). An Empirically Based Agent-Based Model of the Sociocognitive Process of Construction Workers' Safety Behavior. Journal of Construction Engineering and Management, 144(2). https://doi.org/10.1061/(ASCE)CO.1943-7862.0001421

Chua, C. E. H., Lim, W. K., Soh, C., & Sia, S. K. (2012). Enacting clan control in complex it projects: a social capital perspective. *Mis Quarterly*, 36(2), 577–600. https://doi.org/10.2307/41703468

Collinge, W. H., & Harty, C. F. (2014). Stakeholder interpretations of design: semiotic insights into the briefing process. *Construction Management and Economics*, 32(7–8), 760–772. https://doi.org/10.1080/01446193.2014.894247

Cuganesan, S., & Floris, M. (2020). Investigating perspective taking when infrastructure megaproject teams engage local communities: Navigating tensions and balancing perspectives. *International Journal of Project Management*, 38(3), 153–164. https://doi.org/10.1016/j.ijproman.2020.01.006

Cuneo, F., Antonietti, J. P., & Mohr, C. (2018). Unkept promises of cognitive styles: A new look at old measurements. *PLoS ONE*, 13(8). https://doi.org/10.1371/journal.pone.0203115

Daniel, C., Daniel, P. A., & Smyth, H. (2022). The role of mindfulness in the management of projects: Potential opportunities in research and practice. *International Journal of Project Management*, 40(7), 849–864. https://doi.org/10.1016/j.ijproman.2022.07.003

Daniel, P. A., & Daniel, C. (2018). Complexity, uncertainty and mental models: From a paradigm of regulation to a paradigm of emergence in project management. *International Journal of Project Management*, 36(1), 184–197. https://doi.org/10.1016/j.ijproman.2017.07.004

Daradoumis, T., Xhafa, F., & Marquès, J. M. (2002). A methodological framework for project-based collaborative learning in a networked environment. *International Journal of Continuing Engineering Education and Life-Long Learning*, 12(5–6), 389–402. https://www.scopus.com/inward/record.uri?eid=2-s2.0-0036941907&partnerID=40&md5=cb259f40a6537bb36944e685372953e7

Dayan, M., & Di Benedetto, C. A. (2011). Team intuition as a continuum construct and new product creativity: The role of environmental turbulence, team experience, and stress. *Research Policy*, 40(2), 276–286. https://doi.org/10.1016/j.respol.2010.10.002

Defranco-tommarello, J., & Deek, F. P. (2004). Collaborative problem solving and groupware for software development. *Information Systems Management*, 21(1), 67–80. https://doi.org/10.1201/1078/43877.21.1.20041201/78987.7

Detzen, N., Verbeeten, F. H. M., Gamm, N., & Moller, K. (2018). Formal controls and team adaptability in new product development projects. *Management Decision*, 56(7), 1541–1558. https://doi.org/10.1108/MD-07-2017-0692

Di Filippo, D., Di Filippo, I., & Winston, R. (2019). From Mindfulness to Action: Applying Augmented Cognition to Project Management. Cognitive Readiness in Project Teams, 1–42. https://doi.org/10.4324/9780429490057-6

Drury-Grogan, M. L. (2021). The Changes in Team Cognition and Cognitive Artifact Use During Agile Software Development Project Management. *Project Management Journal*, 52(2), 127–145. https://doi.org/10.1177/8756972820960301

Du, J., Havard, B., Adams, J., & Li, H. (2005). A Project-Based Learning Approach: Online Group Collaborative Learning. *International Journal of Information and Communication Technology Education (IJICTE)*, 1(4), 13–24. https://doi.org/10.4018/jicte.2005100102

Dwivedula, R., & Bredillet, C. N. (2010). Profiling work motivation of project workers. *International Journal of Project Management*, 28(2), 158–165. https://doi.org/10.1016/j.ijproman.2009.09.001

Edkins, A. J., Kurul, E., Maytorena-Sanchez, E., & Rintala, K. (2007). The application of cognitive mapping methodologies in project management research. *International Journal of Project Management*, 25(8), 762–772. https://doi.org/10.1016/j.ijproman.2007.04.003

Elbanna, S. (2015). Intuition in project management and missing links: Analyzing the predicating effects of environment and the mediating role of reflexivity. *International Journal of Project Management*, 33(6), 1236–1248. https://doi.org/10.1016/j.ijproman.2015.02.004

Elsbach, K. D., Barr, P. S., & Hargadon, A. B. (2005). Identifying situated cognition in organizations. *Organization Science*, 16(4), 422–433. https://doi.org/10.1287/orsc.1050.0138

Espinosa, J. A., DeLone, W., & Lee, G. (2006). Global boundaries, task processes and IS project success: A field study. *Information Technology and People*, 19(4), 345–370. https://doi.org/10.1108/09593840610718036

Farooq, M. U., Thaheem, M. J., & Arshad, H. (2018). Improving the risk quantification under behavioural tendencies: A tale of construction projects. *International Journal of Project Management*, 36(3), 414–428. https://doi.org/10.1016/j.ijproman.2017.12.004

Fellows, R., & Liu, A. (2016). Sensemaking in the cross-cultural contexts of projects. *International Journal of Project Management*, 34(2), 246–257. https://doi.org/10.1016/j.ijproman.2015.03.010

Fernandes, R. G., & Cohen, E. D. (2020). Conexões entre o julgamento moral e determinantes biológicos do comportamento na governança corporativa. *Revista de Gestão e Projetos*, 11(3), 155–184. https://doi.org/10.5585/gep.v11i3.18463

Florén, H. (2005). Managerial work and learning in small firms (PhD Dissertation, Chalmers University of Technology). Retrieved from https://urn.kb.se/resolve?urn=urn:nbn:se:hh:diva-555

Floris, M., & Cuganesan, S. (2019). Project leaders in transition: Manifestations of cognitive and emotional capacity. *International Journal of Project Management*, 37(3), 517–532. https://doi.org/10.1016/j.ijproman.2019.02.003

Flyvbjerg, B. (2021). Top Ten Behavioral Biases in Project Management: An Overview. *Project Management Journal*, 52(6), 531–546. https://doi.org/10.1177/87569728211049046

Forgues, D., & Koskela, L. (2009). The influence of a collaborative procurement approach using integrated design in construction on project team performance. *International Journal of Managing Projects in Business*, 2(3), 370–385. https://doi.org/10.1108/17538370910971036

Freeman, R. E. (1984). Strategic Management: A Stakeholder Approach. Pitman.

Freeman, R. E., Phillips, R., & Sisodia, R. (2020). Tensions in Stakeholder Theory. *Business and Society*, 59(2), 213–231. https://doi.org/10.1177/0007650318773750

Friedman, L., Fleishman, E. A., & Fletcher, J. M. (1992). Cognitive and interpersonal abilities related to the primary activities of R&D managers. *Journal of Engineering and Technology*

Management, 9(3–4), 211–242. https://doi.org/10.1016/0923-4748(92)90017-Y

Gallagher, E. C., Mazur, A. K., & Ashkanasy, N. M. (2015). Rallying the troops or beating the horses? How project-related demands can lead to either high-performance or abusive supervision. *Project Management Journal*, 46(3), 10–24. https://doi.org/10.1002/pmj.21500

Galvão, M. C. B., & Ricarte, I. L. M. (2019). Revisão Sistemática Da Literatura: Conceituação, Produção E Publicação. *Logeion: Filosofia Da Informação*, 6(1), 57–73. https://doi.org/10.21728/logeion.2019v6n1.p57-73

Gavrilova, T., Leshcheva, I., & Strakhovich, E. (2015). Gestalt principles of creating learning business ontologies for knowledge codification. *Knowledge Management Research and Practice*, 13(4), 418–428. https://doi.org/10.1057/kmrp.2013.60

Ghaleenoei, N. K., Saghatforoush, E., Mansouri, T., & Zareravasan, A. (2021). An FCM-based Dynamic Modeling of Operability and Maintainability Barriers in Road Projects. *International Journal of Pavement Research and Technology*. https://doi.org/10.1007/s42947-021-00027-z

Giannoccaro, I., & Nair, A. (2016). Examining the Roles of Product Complexity and Manager Behavior on Product Design Decisions: An Agent-Based Study Using NK Simulation. *IEEE Transactions on Engineering Management*, 63(2), 237–247. https://doi.org/10.1109/TEM.2015.2510031

Globerson, S. (1997). Discrepancies between customer expectations and product configuration. *International Journal of Project Management*, 15(4), 199–203. https://doi.org/10.1016/S0263-7863(96)00065-8

Grand, J. A., Braun, M. T., Kuljanin, G., Kozlowski, S. W. J., & Chao, G. T. (2016). The dynamics of team cognition: A process-oriented theory of knowledge emergence in teams. *Journal of Applied Psychology*, 101(10), 1353–1385. https://doi.org/10.1037/apl0000136

Green, G. C. (2004). The impact of cognitive complexity on project leadership performance. *Information and Software Technology*, 46(3), 165–172. https://doi.org/10.1016/S0950-5849(03)00125-3

Guo, W., Lu, W., Gao, X., & Cai, F. (2021). How interpersonal ties affect interorganizational trust in construction projects: role differences and cross-level effects. *Construction Management and Economics*, 39(11), 912–931. https://doi.org/10.1080/01446193.2021.1994148

Habouba-Belinky, I., & Parush, A. (2020). Simulator-triggered debriefing facilitates team cognition and performance in simulator-based training. *Journal of Interactive Learning Research*, 31(1), 29–48. Waynesville, NC: Association for the Advancement of Computing in Education (AACE). Retrieved from https://www.learntechlib.org/primary/p/210322/

Han, J., & Hovav, A. (2016). Dimensionality of social capital and organizational citizenship behavior in information systems project teams. *Journal of Computer Information Systems*, 56(3), 218–227. https://doi.org/10.1080/08874417.2016.1153910

Han, Y., Yin, Z., Zhang, J., Jin, R., & Yang, T. (2020). Eye-Tracking Experimental Study

Investigating the Influence Factors of Construction Safety Hazard Recognition. *Journal of Construction Engineering and Management*, 146(8). https://doi.org/10.1061/(ASCE)CO.1943-7862.0001884

Hanakawa, N., Matsumoto, K.-I., & Torji, K. (2002). A knowledge-based software process simulation model. *Annals of Software Engineering*, 14(1–4), 383–406. https://doi.org/10.1023/A:1020574228799

Hanna, A. S., Ibrahim, M. W., Lotfallah, W., Iskandar, K. A., & Russell, J. S. (2016). Modeling Project Manager Competency: An Integrated Mathematical Approach. *Journal Of Construction Engineering and Management*, 142(8). https://doi.org/10.1061/(ASCE)CO.1943-7862.0001141

Hatami, S. (2013). Learning styles. ELT Journal, 67(4), 488–490. https://doi.org/10.1093/elt/ccs083

Haynes, N. S., & Love, P. E. D. (2004). Psychological adjustment and coping among construction project managers. *Construction Management and Economics*, 22(2), 129–140. https://doi.org/10.1080/0144619042000201330

He, J. (2012). Counteracting Free-Riding With Team MoraleuAn Experimental Study. *Project Management Journal*, 43(3), 62–75. https://doi.org/10.1002/pmj.21272

Hekkala, R., Stein, M. K., & Rossi, M. (2018). Metaphors in managerial and employee sensemaking in an information systems project. *Information Systems Journal*, 28(1), 142–174. https://doi.org/10.1111/isj.12133

Heldal, F., Sjovold, E., & Stalsett, K. (2020). Shared cognition in intercultural teams: collaborating without understanding each other. *Team Performance Management*, 26(3/4), 211–226. https://doi.org/10.1108/TPM-06-2019-0051

Hilary, G., & Menzly, L. (2006). Does past success lead analysts to become overconfident? *Management Science*, 52(4), 489–500. https://doi.org/10.1287/mnsc.1050.0485

Hollan, J., Hutchins, E., & Kirsh, D. (2000). Distributed Cognition: Toward a New Foundation for Human-Computer Interaction Research. *ACM Transactions on Computer-Human Interaction*, 7(2), 174–196. https://doi.org/10.1145/353485.353487

Hsu, H.-C., Chang, S., Chen, C.-C., & Wu, I.-C. (2020). Knowledge-based system for resolving design clashes in building information models. *Automation in Construction*, 110. https://doi.org/10.1016/j.autcon.2019.103001

Hutchins, E. (1995). Cognition in the Wild. Cognition in the Wild. https://doi.org/10.7551/mitpress/1881.003.0001

Hutchins, E. (2000). Distributed Cognition. IESBS Distributed Cognition, 1–10. https://arl.human.cornell.edu/linked docs/Hutchins_Distributed_Cognition.pdf

Hyldegård, J. (2006). Collaborative information behaviour-exploring Kuhlthau's Information Search Process model in a group-based educational setting. *Information Processing and Management*, 42(1 SPEC. ISS), 276–298. https://doi.org/10.1016/j.ipm.2004.06.013

Jääskä, E., & Aaltonen, K. (2022). Teachers' experiences of using game-based learning methods in project management higher education. *Project Leadership and Society*, 3. https://doi.org/10.1016/j.plas.2022.100041

Jenkin, T. A., Chan, Y. E., & Sabherwal, R. (2019). Mutual understanding in information systems development: Changes within and across projects. *MIS Quarterly: Management Information Systems*, 43(2), 649–671. https://doi.org/10.25300/MISQ/2019/13980

Julsrud, T. E. (2008). Flows, bridges and brokers: Exploring the development of trust relations in a distributed work group. *International Journal of Networking and Virtual Organisations*, 5(1), 83–102. https://doi.org/10.1504/IJNVO.2008.016004

Kahvandi, Z., Saghatforoush, E., Ravasan, A. Z., & Mansouri, T. (2018). An FCM-based dynamic modelling of integrated project delivery implementation challenges in construction projects. *Lean Construction Journal*, 2018, 63–87

Kamhawi, E. M. (2008). Determinants of Bahraini managers' acceptance of business process reengineering. *Business Process Management Journal*, 14(2), 166–187. https://doi.org/10.1108/14637150810864916

Keane, S. F. (2022). Becoming a project manager: A social cognitive perspective. *Project Leadership and Society*, 3. https://doi.org/10.1016/j.plas.2022.100051

Khedhaouria, A., Montani, F., & Thurik, R. (2017). Time pressure and team member creativity within R&D projects: The role of learning orientation and knowledge sourcing. *International Journal of Project Management*, 35(6), 942–954. https://doi.org/10.1016/j.ijproman.2017.04.002

Kwak, Y. H., Park, J., Chung, B. Y., & Ghosh, S. (2012). Understanding End-Users' Acceptance of Enterprise Resource Planning (ERP) System in Project-Based Sectors. *IEEE Transactions on Engineering Management*, 59(2), 266–277. https://doi.org/10.1109/TEM.2011.2111456

Leung, M.-Y., & Liu, A. M. M. (2003). Analysis of value and project goal specificity in value management. *Construction Management and Economics*, 21(1), 11–19. https://doi.org/10.1080/0144619032000065081

Leung, M.-Y., Ng, S. T., & Cheung, S.-O. (2002). Improving satisfaction through conflict stimulation and resolution in value management in construction projects. *Journal of Management in Engineering*, 18(2), 68–75. https://doi.org/10.1061/(ASCE)0742-597X(2002)18:2(68)

Levitt, R. E., Thomsen, J., Christiansen, T. R., Kunz, J. C., Jin, Y., & Nass, C. (1999). Simulating project work processes and organizations: Toward a micro-contingency theory of organizational design. *Management Science*, 45(11), 1479–1495. https://doi.org/10.1287/mnsc.45.11.1479

Li, K. Y., Wang, D., Sheng, Z. T., & Griffin, M. A. (2022). A Deep Dive into Worker Psychological Well-Being in the Construction Industry: A Systematic Review and Conceptual Framework. *Journal of Management in Engineering*, 38(5). https://doi.org/10.1061/(ASCE)ME.1943-5479.0001074

Ligorio, M. B., Talamo, A., & Pontecorvo, C. (2005). Building intersubjectivity at a distance during the collaborative writing of fairytales. *Computers and Education*, 45(3), 357–374. https://doi.org/10.1016/j.compedu.2005.04.013

Lin, T.-C., Hsu, J. S.-C., Cheng, K.-T., & Wu, S. (2012). Understanding the role of behavioural integration in ISD teams: An extension of transactive memory systems concept. *Information Systems Journal*, 22(3), 211–234. https://doi.org/10.1111/j.1365-2575.2011.00383.x

Ling, Y. Y. (2002). Model for predicting performance of architects and engineers. *Journal of Construction Engineering and Management*, 128(5), 446–455. https://doi.org/10.1061/(ASCE)0733-9364(2002)128:5(446)

Liu, G. H. W., Wang, E. T. G., & Chua, C. E. H. (2015). Persuasion and management support for IT projects. *International Journal of Project Management*, 33(6), 1249–1261. https://doi.org/10.1016/j.ijproman.2015.03.009

Liu, K., Su, Y., Pollack, J., Liang, H., & Zhang, S. (2022). Explaining the Formation Mechanism of Intrateam Knowledge Exchange Network in Offsite Construction Projects: A Social Cognitive Perspective. *Journal of Construction Engineering and Management*, 148(2). https://doi.org/10.1061/(asce)co.1943-7862.0002190

Liu, L., & Yetton, P. (2007). The contingent effects on project performance of conducting project reviews and deploying project management offices. *IEEE Transactions on Engineering Management*, 54(4), 789–799. https://doi.org/10.1109/TEM.2007.906852

Liu, Y., Amini-Abyaneh, A., Hertogh, M., Houwing, E. J., & Bakker, H. (2021). Collaborate to learn and learn to collaborate: a case of exploitative learning in the inter-organizational project. Engineering, *Construction and Architectural Management*, 28(3), 809–830. https://doi.org/10.1108/ECAM-01-2020-0078

Loch, C. H. (2017). Creativity and Risk Taking Aren't Rational: Behavioral Operations in MOT. *Production And Operations Management*, 26(4), 591–604. https://doi.org/10.1111/poms.12666

Loosemore, M., & Chandra, V. (2012). Learning through briefing: For strategic facilities management in the health sector. *Built Environment Project and Asset Management*, 2(1), 103–117. https://doi.org/10.1108/20441241211235080

Loosemore, M., Higgon, D., & Osborne, J. (2020). Managing new social procurement imperatives in the Australian construction industry. *Engineering Construction and Architectural Management*, 27(10), 3075–3093. https://doi.org/10.1108/ECAM-11-2019-0643

Lu, S., & Hao, G. (2013). The influence of owner power in fostering contractor cooperation: Evidence from China. *International Journal of Project Management*, 31(4), 522–531. https://doi.org/10.1016/j.ijproman.2012.10.008

Lu, S. K., & Yan, H. (2016). Contractual control, the propensity to trust, active trust development: construction industry. *Journal of Business and Industrial Marketing*, 31(4), 459–471. https://doi.org/10.1108/JBIM-10-2014-0200

Majchrzak, A., Beath, C. M., Lim, R. A., & Chin, W. W. (2005). Managing client dialogues during information systems design to facilitate client learning. *MIS Quarterly: Management Information Systems*, 29(4), 653–672. https://doi.org/10.2307/25148704

Manu, E., Ankrah, N., Chinyio, E., & Proverbs, D. (2013). A cognitive approach to trust management in construction. *Proceedings of Institution of Civil Engineers: Management, Procurement and Law*, 166(5), 232–239. https://doi.org/10.1680/mpal.12.00006

Marshall, N. (2008). Cognitive and practice-based theories of organizational knowledge and learning: Incompatible or complementary? *Management Learning*, 39(4), 413–435. https://doi.org/10.1177/1350507608093712

Maytorena, E., Winch, G. M., Freeman, J., & Kiely, T. (2007). The influence of experience and information search styles on project risk identification performance. *IEEE Transactions on Engineering Management*, 54(2), 315–326. https://doi.org/10.1109/TEM.2007.893993

Moore, D. R. (2002). Perception "noise" in the cognition of visualised construction process concepts. Electronic *Journal of Information Technology in Construction*, 7, 157–166. https://www.scopus.com/inward/record.uri?eid=2-s2.0-3042601682&partnerID=40&md5=e3ed840a07ce6af92f88172d24fa05cb

Mubarak, N., Khan, J., Safdar, S., Muhammad, S., & Riaz, A. (2021). Ethical leadership in project-based organizations of Pakistan: the role of psychological empowerment and Islamic work ethics. *Management Research Review*. https://doi.org/10.1108/MRR-08-2020-0536

Nembhard, D., Yip, K., & Shtub, A. (2009). Comparing Competitive and Cooperative Strategies for Learning Project Management. *Journal Of Engineering Education*, 98(2), 181–192. https://doi.org/10.1002/j.2168-9830.2009.tb01016.x

Niler, A. A., Mesmer-Magnus, J. R., Larson, L. E., Plummer, G., DeChurch, L. A., & Contractor, N. S. (2021). Conditioning team cognition: A meta-analysis. *Organizational Psychology Review*, 11(2), 144–174. https://doi.org/10.1177/2041386620972112

Patanakul, P. (2022). How to Achieve Effectiveness in Project Portfolio Management. *IEEE Transactions on Engineering Management*, 69(4), 987–999. https://doi.org/10.1109/TEM.2020.2964316

Pavez, I., Gómez, H., Laulié, L., & González, V. A. (2021). Project team resilience: The effect of group potency and interpersonal trust. *International Journal of Project Management*, 39(6), 697–708. https://doi.org/10.1016/j.ijproman.2021.06.004

PIETRAS, C. M., & COURY, B. G. (1994). The development of cognitive models of planning for use in the design of project-management systems. *International Journal of Human-Computer Studies*, 40(1), 5–30. https://doi.org/10.1006/ijhc.1994.1002

PMI. (2017). A guide to the Project Management Body of Knowledge | PMBOK Guide - 6th Edition.

PMI. (2021). The Standard for Project Management and A Guide to the Project Management Body of Knowledge (7th ed.). Project Management Institute.

Poirier, E. A., Forgues, D., & Staub-French, S. (2017). Understanding the impact of BIM on

collaboration: a Canadian case study. *Building Research and Information*, 45(6), 681–695. https://doi.org/10.1080/09613218.2017.1324724

Pollock, A., & Berge, E. (2018). How to do a systematic review. *International Journal of Stroke*, 13(2), 138–156. https://doi.org/10.1177/1747493017743796

Prince, M. W. (1992). Implications of perception and strategy for engineers in construction management. *Construction Management and Economics*, 10(2), 93–105. https://doi.org/10.1080/01446199200000010

Qian, Q., Zhang, L., & Cao, T. (2020). Effect of Behavior Tension on Value Creation in Owner–Contractor Relationships: Moderating Role of Dependence Asymmetry. *EMJ - Engineering Management Journal*. https://doi.org/10.1080/10429247.2020.1796173

Rashid, A., & Boussabiane, H. (2021). Conceptualizing the influence of personality and cognitive traits on project managers' risk-taking behaviour. *International Journal of Managing Projects in Business*, 14(2), 472–496. https://doi.org/10.1108/IJMPB-11-2017-0138

Rave, J. I. P., Guerrero, R. F., Vallina, A. S., Echavarría, F. G. (2022). Critical thinking, dynamic capabilities, and project performance: empirical evidence in the continuous improvement project domain. *Total Quality Management & Business Excellence*, 34:5-6, 768–790 https://doi.org/10.1080/14783363.2022.2111994

Robinson, M. A., Sparrow, P. R., Clegg, C., & Birdi, K. (2005). Design engineering competencies: future requirements and predicted. changes in forthcoming decade. *Design Studies*, 26(2), 123–153. https://doi.org/10.1016/j.destud.2004.09.004

Rogers, Y. (1997). A brief introduction to distributed cognition. Retrieved from http://www.cogs.susx.ac.uk/users/yvonner/dcog.html

Rouleau, N., Murugan, N. J., & Kaplan, D. L. (2021). Toward Studying Cognition in a Dish. Trends in *Cognitive Sciences*, 25(4), 294–304. https://doi.org/10.1016/j.tics.2021.01.005

Sangwan, R. S., Jablokow, K. W., & Defranco, J. F. (2020). Asynchronous Collaboration: Bridging the Cognitive Distance in Global Software Development Projects. *IEEE Transactions on Professional Communication*, 63(4), 361–371. https://doi.org/10.1109/TPC.2020.3029674

Schlindwein, E., & Geppert, M. (2020). Towards a process model of emotional sensemaking in post-merger integration: linking cognitive and affective dimensions. *Critical Perspectives on International Business*. https://doi.org/10.1108/cpoib-02-2020-0008

Schultz, C., Gretsch, O., & Kock, A. (2021). The influence of shared R&D-project innovativeness perceptions on university-industry collaboration performance. *Journal of Technology Transfer*, 46(4), 1144–1172. https://doi.org/10.1007/s10961-020-09818-1

Seel, N. M. (2012). Encyclopedia of the Sciences of Learning. In N. M. Seel (Ed.), Choice Reviews Online (Vol. 50, Issue 03). Springer New York Dordrecht Heidelberg London. https://doi.org/10.5860/choice.50-1234

Sense, A. J. (2007). Learning within project practice: Cognitive styles exposed. *International*

Journal of Project Management, 25(1), 33–40. https://doi.org/10.1016/j.ijproman.2006.06.004

Sergeeva, N., & Duryan, M. (2021). Reflecting on knowledge management as an enabler of innovation in project-based construction firms. *Construction Innovation-England*. https://doi.org/10.1108/CI-09-2020-0148

Seus, F., Weissenberger-Eibl, M. A., & Zern-Breuer, R. (2020). Considering representational gaps - How subsidiaries' relationship affects multi-location project management. International Journal of *Project Organisation and Management*, 12(4), 321–345. https://doi.org/10.1504/IJPOM.2020.111068

Shand, R. M. (1994). User Manuals as Project Management Tools: Part II—Practical Applications. *IEEE Transactions on Professional Communication*, 37(3), 123–142. https://doi.org/10.1109/47.317478

Shealy, T., & Hu, M. (2018). Opportunities to advance engineering cognition and project level decision making by adopting emergent methods from neuroscience. *Construction Research Congress 2018: Construction Information Technology* - Selected Papers from the Construction Research Congress 2018, 2018-April, 127–136. https://doi.org/10.1061/9780784481264.013

Shipley, M. F., & Johnson, M. (2009). A fuzzy approach for selecting project membership to achieve cognitive style goals. *European Journal of Operational Research*, 192(3), 918–928. https://doi.org/10.1016/j.ejor.2007.10.006

Simon, L. (2006). Managing creative projects: An empirical synthesis of activities. *International Journal of Project Management*, 24(2), 116–126. https://doi.org/10.1016/j.ijproman.2005.09.002

Small, J., & Walker, D. (2011). Providing structural openness to connect with context: Seeing the project entity as a human activity system and social process. *International Journal of Managing Projects in Business*, 4(3), 389–411. https://doi.org/10.1108/17538371111144148

Smith, P. L. (1992). Professionalism: Cornerstone of engineering. *Journal of Professional Issues in Engineering Education and Practice*, 118(3), 258–260. https://doi.org/10.1061/(ASCE)1052-3928(1992)118:3(258)

Smulders, F., Lousberg, L., & Dorst, K. (2008). Towards different communication in collaborative design. *International Journal of Managing Projects in Business*, 1(3), 352–367. https://doi.org/10.1108/17538370810883819

Smyth, H., Gustafsson, M., & Ganskau, E. (2010). The value of trust in project business. *International Journal of Project Management*, 28(2), 117–129. https://doi.org/10.1016/j.ijproman.2009.11.007

Song, H., Hou, J., Yang, X., & Zhang, Y. (2022). The Impact of Risk Perception Difference of Members of a Scientific Research Project Team on Information Adoption: The Moderating Effect of Knowledge Inertia. *Sustainability (Switzerland)*, 14(13). https://doi.org/10.3390/su14137749

Sperry, R. C., & Jetter, A. J. (2019). A Systems Approach to Project Stakeholder Management: Fuzzy Cognitive Map Modeling. *Project Management Journal*, 50(6), 699–715. https://doi.org/10.1177/8756972819847870

Strang, K. D., & Vajjhala, N. R. (2022). Testing Risk Management Decision Making Competency of Project Managers In A Crisis. *Journal of Modern Project Management*, 10(1), 53–71. https://doi.org/10.19255/JMPM02904

Thomas, J. L., & Buckle-Henning, P. (2007). Dancing in the white spaces: Exploring gendered assumptions in successful project managers' discourse about their work. *International Journal of Project Management*, 25(6), 552–559. https://doi.org/10.1016/j.ijproman.2007.05.001

Tullett, A. D. (1996). The thinking style of the managers of multiple projects: Implications for problem solving when managing change. *International Journal of Project Management*, 14(5), 281–287. https://doi.org/10.1016/0263-7863(96)84511-X

Tuuli, M. M., & Rowlinson, S. (2009). Empowerment in project teams: A multilevel examination of the job performance implications. *Construction Management and Economics*, 27(5), 473–498. https://doi.org/10.1080/01446190902729713

Ugwu, O. O., Anumba, C. J., & Thorpe, A. (2004). The development of cognitive models for constructability assessment in steel frame structures. *Advances In Engineering Software*, 35(3–4), 191–203. https://doi.org/10.1016/j.advengsoft.2004.02.001

Um, K.-H., & Oh, J.-Y. (2021). The mediating effects of cognitive conflict and affective conflict on the relationship between new product development task uncertainty and performance. *International Journal of Project Management*, 39(1), 85–95. https://doi.org/10.1016/j.ijproman.2020.11.003

Upadhayay, N., & Guragin, S. (2014). Comparison of cognitive functions between male and female medical students: A pilot study. *Journal of Clinical and Diagnostic Research*, 8(6). https://doi.org/10.7860/JCDR/2014/7490.4449

Vaux, J. S., & Kirk, W. M. (2018). Relationship Conflict in Construction Management: Performance and Productivity Problem. *Journal oOf Construction Engineering and Management*, 144(6). https://doi.org/10.1061/(ASCE)CO.1943-7862.0001478

Vlaar, P. W. L., Van Fenema, P. C., & Tiwari, V. (2008). Cocreating understanding and value in distributed work: How members of onsite and offshore vendor teams give, make, demand, and break sense. *MIS Quarterly: Management Information Systems*, 32(2), 227–255. https://doi.org/10.2307/25148839

Wang, G., Locatelli, G., Wan, J., Li, Y., & Le, Y. (2021). Governing behavioral integration of top management team in megaprojects: A social capital perspective. *International Journal of Project Management*, 39(4), 365–376. https://doi.org/10.1016/j.ijproman.2020.11.005

Wang, W. S., Fu, Y. T., Gao, J., Shang, K., Gao, S. L., Xing, J. W., Ni, G. D., Yuan, Z. M., Qiao, Y. N., & Mi, L. Y. (2021). How the COVID-19 Outbreak Affected Organizational Citizenship Behavior in Emergency Construction Megaprojects: Case Study from Two Emergency Hospital Projects in Wuhan, China. *Journal of Management in Engineering*,

37(3). https://doi.org/10.1061/(ASCE)ME.1943-5479.0000922

Wei, M., Hao, S., & Ren, X. (2022). Nonspatial Proximity and Project Team Resilience: The Role of Knowledge Sharing and Team Cohesion. *Discrete Dynamics in Nature and Society*, 2022. https://doi.org/10.1155/2022/8614056

Weiss, M., Hoegl, M., & Gibbert, M. (2011). Making virtue of necessity: The role of team climate for innovation in resource-constrained innovation projects. *Journal of Product Innovation Management*, 28(SUPPL. 1), 196–207. https://doi.org/10.1111/j.1540-5885.2011.00870.x

Weissenberg, P., & Gruenfeld, L. W. (1966). Relationships among leadership dimensions and cognitive style. *Journal of Applied Psychology*, 50(5), 392–395. https://doi.org/10.1037/h0023854

Whelton, M., Ballard, G., & Tommelein, I. D. (2002). A knowledge management framework for project definition, ITcon Vol. 7, Special issue *ICT for Knowledge Management in Construction*, 197-212, https://www.itcon.org/2002/13

Wiewiora, A., Chang, A., & Smidt, M. (2020). Individual, project and organizational learning flows within a global project-based organization: exploring what, how and who. *International Journal of Project Management*, 38(4), 201–214. https://doi.org/10.1016/j.ijproman.2020.03.005

Williams, R. A. (2019). Conflict Propagation Within Large Technology and Software Engineering Programmes: A Multi-Partner Enterprise System Implementation as Case Study. *IEEE Access*, 7, 167696–167713. https://doi.org/10.1109/ACCESS.2019.2953952

Williams, T., Eden, C., Ackermann, F., & Tait, A. (1995). Vicious circles of parallelism. *International Journal of Project Management*, 13(3), 151–155. https://doi.org/10.1016/0263-7863(95)00034-N

Wilson, J. R., Farrington-Darby, T., Cox, G., Bye, R., & Hockey, G. R. J. (2007). The railway as a socio-technical system: Human factors at the heart of successful rail engineering. Proceedings of the Institution of Mechanical Engineers, Part F: *Journal of Rail and Rapid Transit*, 221(1), 101–115. https://doi.org/10.1243/09544097JRRT78

Wong, W. K., Cheung, S. O., Yiu, T. W., & Pang, H. Y. (2008). A framework for trust in construction contracting. *International Journal of Project Management*, 26(8), 821–829. https://doi.org/10.1016/j.ijproman.2007.11.004

Xiang, C., Yang, Z., & Zhang, L. (2016). Improving IS development teams' performance during requirement analysis in project—The perspectives from shared mental model and emotional intelligence. *International Journal of Project Management*, 34(7), 1266–1279. https://doi.org/10.1016/j.ijproman.2016.06.009

Yang, X., Wang, L., Zhu, F., & Müller, R. (2022). Prior and governed stakeholder relationships: The key to resilience of inter-organizational projects. *International Journal of Project Management*, 40(1), 64–75. https://doi.org/10.1016/j.ijproman.2021.10.001

Yang, Y. X., Huang, J. Y., Wu, P. P., Zheng, X. J., Lin, H., & Ji, S. L. (2022). Responsible

leadership and project citizenship behavior: A cross-level investigation. *Frontiers in Psychology*, 13. https://doi.org/10.3389/fpsyg.2022.960290

Yap, J. B. H., Abdul-Rahman, H., & Chen, W. (2017). Collaborative model: Managing design changes with reusable project experiences through project learning and effective communication. *International Journal of Project Management*, 35(7), 1253–1271. https://doi.org/10.1016/j.ijproman.2017.04.010

Yue, C., Fong, P. S. W., & Li, T. (2019). Meeting the challenge of workplace change: Team cooperation outperforms team competition. *Social Behavior and Personality*, 47(7). https://doi.org/10.2224/sbp.7997

Zhang, L., Yuan, J., Ning, Y., Xia, N., & Zhang, G. (2021). Enhancing the impacts of absorptive capacity on interorganizational collaboration in BIM-enabled construction projects – an SLT perspective. *Engineering, Construction and Architectural Management*. https://doi.org/10.1108/ECAM-11-2020-0931

Zheng, J. W., Wu, G. D., Xie, H. T., & Li, H. Y. (2019). Leadership, organizational culture, and innovative behavior in construction projects: The perspective of behavior-value congruence. *International Journal of Managing Projects in Business*, 12(4), 888–918. https://doi.org/10.1108/IJMPB-04-2018-0068