

SINA MORADI

Project Managers' Competencies in Collaborative Construction Projects

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ACADEMIC DISSERTATION

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ACADEMIC DISSERTATION

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PunaMusta Oy – Yliopistopaino
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To

My dear parents and my dear wife

For their unconditional support, generosity, and patience

From Sina Moradi

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This study was carried out at the Department of Civil Engineering at Tampere University (prior to 1.1.2019, at Tampere University of Technology (TUT), which became a part of Tampere University). The research was supervised by Professor Kalle Kähkönen and co-supervised by Associate Professor Kirsi Aaltonen.

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Tampere, 29 January 2021

Sina Moradi

ABSTRACT

Competent project managers contribute to the successful delivery of construction projects in a considerable manner. The delivery models of construction projects have been subjects of striking changes during the recent three decades. These changes, in the big picture, comprise shifting from traditional delivery models (e.g., design-bid-build, design-build) toward the collaborative ones (e.g., partnering, alliance, integrated project delivery and traditional construction deliveries equipped with collaborative work practices). Consequently, there is currently limited research-based knowledge concerning the competencies required for the project managers of collaborative construction projects. This dissertation is based on a study aimed to understand the changes in the spectrum of the required competencies for the project managers of traditional and collaborative construction projects.

To that end, a comprehensive literature study was undertaken to develop the theoretical framework concerning the project managers' competencies and their effects on the project success. This was followed by conducting two field surveys in Finland and Norway with a behavioral approach where project managers' behavior in their everyday work was the main source for understanding their competencies. Finally, analyzing the obtained research data from the field surveys provided a basis for the constructive research, resulting in the development of a competency model.

The dissertation presents those competencies, which significantly contribute to the successful performance of the project managers of collaborative construction projects. These identified competencies, e.g., trustworthiness, initiative, conflict management, which have been structured in a matrix model, can be employed for the right selection of the project managers for collaborative construction projects and for improving the performance of the existing ones. Finally, the changes in the spectrum of the required competencies for the project managers of traditional and collaborative construction projects are explained and discussed.

The dissertation provides novel academic and practical insights toward the competence-based selection and performance improvement of the project managers in collaborative construction projects. Moreover, it reveals how the changes in the delivery models of construction projects have affected the competencies required for the successful performance of the construction project managers.

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LIST OF KEY TERMS AND CONCEPTS

The list of key terms and/or concepts, utilized in this dissertation, are explained in the following order based on the conceptual importance and relevance.

Key term/concept	Explanation
Competency	Underlying characteristics (motives, traits, self-image, skills and knowledge), which cause different kinds of actions while being combined with an intent, which is situation-oriented. The resultant action in a given situation is called competency. Competency, due to its behavioral nature, can predict and cause successful performance in a consistent manner. The mentioned underlying characteristics can be categorized in three groups of highly personality-oriented (motives and traits), knowledge and skill-oriented, and somewhat personality-oriented (self-image).
Project manager	Leads the project team to meet the project's objectives and stakeholders' expectations and works to balance the competing constraints on the project with the resources available. The project manager also performs communication roles between the project sponsor, team members, and other stakeholders.
Project success	A concept comprised of four components which include: (i) Project management success: meeting time, cost, scope, and quality, (ii) Project execution success: meeting technical requirements and safety goals, (iii) Business success: reoccurring business and meeting expected commercial success, (iv) Stakeholder satisfaction: meeting various expectations of different project stakeholders.
Success factor	Set of circumstances, facts, or influences which contribute to the performance result of the projects.
Success criteria	Set of principles or standards which are utilized for measuring project success. Project success criteria present a setting that is always project specific and it depends on the nature of project in question.

Collaborative construction projects	All parties, with aligned interests and mutual trust, work together (collaboration) and exchange information (cooperation) for the best of the project. Construction projects with collaborative delivery models (e.g., alliance, partnering, integrated project delivery) and/or traditional delivery models (e.g., design-build) equipped with collaborative practices (e.g., integrated team) represent collaborative construction projects.
Collaborative delivery models of construction projects (e.g., alliance, partnering, integrated project delivery)	Joint design, planning, management, and governance of construction projects by the key parties based on their early involvement in the project, trust-based relationships, open communication, and shared risk-reward systems. Collaborative delivery models are different from the traditional ones (e.g., design-bid-build, design-build) in: (i) Focus (on the production system, not the transactions and contracts), (ii) Design and planning (product and process are designed together, not separately; activities are performed at the last responsible moment, not as soon as possible; buffers are used to absorb system variability, not for the local optimization), (iii) Decision making (unanimous, not divided), (iv) Learning (occurs continuously throughout the project, not sporadically), (v) Stakeholder interests (aligned).
Alliance	A multiparty contracting arrangement between two or more parties, undertaking the project cooperatively on a shared risk and reward basis for the purpose of achieving agreed outcomes based on principles of mutual trust, open-book approach toward project costs, a commitment to no-disputes, best-for-project, unanimous decision-making processes, a no fault-no blame culture and a joint management structure.
Integrated project delivery (IPD)	A multiparty/polyparty agreement and trust-based collaboration among project parties, which seeks to improve project outcome in result of aligning incentives and goals of the project team through early involvement of them in the project and a shared risk-reward approach.
Partnering	Formation of a project team to deliver a construction project; the team commits to open communications in a spirit of trust, and works to accomplish mutual project goals. Partnering itself is not a contract. Partnering focuses on improving traditional contractual frameworks such as traditional contracting and design and build. Partnering is a collaborative

	<p>procedure and is not legally binding. A partnering charter is developed to run in parallel with a traditional construction contract to provide guidelines to the relationship among the organizations. Parties agree to act reasonably and fairly. Partnering relies solely on the commitment of individuals, as the partnering charter is not legally binding—and this can be its best or worst feature.</p>
Traditional construction projects	<p>Construction projects with traditional delivery models. Traditional delivery models are explained in the following.</p>
Traditional delivery models of construction projects (e.g., design build, design-bid-build)	<p>Traditional models and processes for design, planning, management and governance of construction projects, where there is usually a clear separation between design and construction phases which isolates the contractor from the design process. Moreover, the lowest construction price is usually the most important criteria for selecting the contractor which represents the potential ability, in theory, for delivering a low cost project.</p>
Design-Bid-Build (DBB)	<p>The most frequently used type of delivery model for construction projects, where the project parties are the owner, the designer and the contractor. The owner conceptualizes the project, and planning as well as programming are carried out by the agents of the owner (such as architects/engineers or construction managers) based on the objectives to be met. Consequently, the scope of the project, preliminary budget, and schedule are derived. The detailed design is usually undertaken in stages, resulting in the preparation of completed drawings and specifications, representing bid documents as well as detailed cost estimates. Bid analysis is carried out and a legally binding contract is then awarded. The contractor is given access to the site and instructed to proceed, based on legally established time frames. A contract may contain incentives for timely completion, as well as penalties for avoidable delays or cost overruns. At completion, there are acceptance inspections, leading to the commissioning of the facility for the owner's use. Finally, the project is turned over to the owner.</p>
Design-Build (DB)	<p>Accelerates project delivery through concurrent design and construction activities. A DB project, like DBB ones, is conceptualized by the owner; planning is carried out based on the</p>

	<p>objectives to be met, and on the economic and technical feasibility of the project. The best time for site acquisition is as early as possible to ensure that the design will not have to be aborted. Planning and schematic design are undertaken by the owner's design professional. This information allows construction to start shortly after contract award, while the design builder continues the preliminary design to obtain a final design. Typically, the design professional develops a preliminary design and cost and schedule proposals for the overall project. The design builder is given access to the site and instructions to proceed, based on legally established time frames. This type of contract may also contain incentives for timely completion, as well as penalties for avoidable delays or cost overruns.</p>
Engineering-Procurement-Construction (EPC)	<p>Like DB projects, most of the design and construction functions are performed or managed by one organization. This model, however, is used primarily for industrial projects that emphasize engineering design, as opposed to architectural design. The EPC projects typically have commissioning and maintenance phases included to allow for a plant to reach its designed operating capacity after acceptance.</p>
Construction Management (CM)-at-risk	<p>Facilitates improved quality in project delivery through a selection process based on factors other than the low bid. The construction manager in this type of delivery model assumes the risk of pricing, and contracting directly with the respective trade contractors. A scoring system is utilized to consider the previous performance of a contractor, based on various criteria. It is not the cheapest method—it is best used where there is uncertainty, such as renovation projects where the current state of a facility or its infrastructure may not be entirely known. This uncertainty is reduced by having the CM involved in managing the design phases of a project, in the selection of sub or specialty contractors, and then assuming the risk for successful completion. Bidders tend to build in safety cushions for unforeseens, but a guaranteed maximum price (GMP) approach may be used to set a specific limit to the owner's project cost. Consequently, project budgets for CM at Risk are somewhat</p>

	generous, resulting on less emphasis by contractors on cost reduction, and fewer compromises in the area of quality.
Design- Construction Managemnet (CM)	The owner typically hires a CM organization, for a fee, to provide professional management services. Trade contractors contract directly with the owner on an individual basis and not through the construction manager, although the CM advises the owner on the formation and conduct of those contracts. The owner also contracts separately with an architectural/engineering (A/E) firm to obtain the design documents. In some instances, the A/E firm may play the role of the CM. This form of contracting places a heavy responsibility on the owner to coordinate the work, as the trade contractors do not have contracts with each other and have no contractual obligation to cooperate.
Design–agency Construction Management (CM)	The owner hires a design team to prepare project construction documents, and also hires a construction manager (CM) to oversee the construction phase of the project. This is often done on the basis of a lump-sum or fixed-price contract. The CM may act as an agent of the owner, contracting directly with all the trade contractors. The CM prepares bid packages that are priced competitively by the trade contractors, and reviews these bids to select the most appropriate ones.
Fast-Track Construction	Valuable in meeting accelerated schedules demanded by the owner. It allows a contractor to commence construction immediately after contract award, while a designer simultaneously completes the construction documents. It may be carried out with or without a design builder.

ORIGINAL PAPERS

- Paper I Moradi, S., Kähkönen, K. and Aaltonen, K. (2019). Comparison of Research and Industry Views on Project Managers' Competencies. *International Journal of Managing Projects in Business*, Vol. 13 No. 3, pp. 543-572.
- Paper II Moradi, S., Kähkönen, K., & Aaltonen, K. (2020). From Past to Present- the Development of Project Success Research. *The Journal of Modern Project Management*, 8(1).
- Paper III Moradi, S.; Kähkönen, K.; Aaltonen, K. (2020). Project Managers' Competencies in Collaborative Construction Projects. *Buildings*, 10, 50.
- Paper IV Moradi, S.; Kähkönen, K.; Klakegg, O.J.; Aaltonen, K. (2021). A Competency Model for the Selection and Performance Improvement of Project Managers in Collaborative Construction Projects: Behavioral Studies in Norway and Finland. *Buildings*, 11, 4.
- Paper V Moradi, S.; Kähkönen, K.; Klakegg, O., & Aaltonen, K. (2021). Profile of Project Managers' Competencies for Collaborative Construction Projects. 37th Conference and Annual General Meeting of Association of Researchers of Construction Management (ARCOM), 6th-8th September 2021, Glasgow Caledonian University, Glasgow (abstract accepted on 14 February 2021, full paper submission date: 15 March 2021).

AUTHOR'S CONTRIBUTION TO THE PAPERS

- I The author was responsible for conducting the research and wrote the manuscript as the corresponding author. The co-authors provided valuable comments and suggestions to improve the paper.
- II The author was responsible for carrying out the research and wrote the article as the corresponding author. The co-authors provided insightful contributions to improve the paper.
- III The author was responsible for planning the research, gathering and analyzing data, and wrote the manuscript as the corresponding author. The co-authors provided valuable comments and suggestions to improve the paper.
- IV The author was responsible for planning the research, gathering and analyzing data and wrote the manuscript as the corresponding author. The co-authors provided valuable comments and suggestions to improve the paper.
- V The author was responsible for gathering and analyzing data and wrote the manuscript as the corresponding author. The co-authors provided valuable comments and suggestions to improve the paper.

1 INTRODUCTION

1.1 Background and knowledge gap

The successful delivery of construction projects has been a long-term challenge for the research community and the construction industry. In a holistic view, delivery models of construction projects can be classified into two main groups: (i) traditional (design-bid-build, design-build, engineering-procurement-construction, design-construction management, design-agency construction management, fast-track construction), and (ii) collaborative (alliance, partnering, integrated project delivery, lean project delivery) (Engebø et al., 2020; Forbes and Ahmed, 2010).

Traditional delivery models of construction projects represent the working environment in which the key parties of the project, often with adversarial relationships, mainly try to secure their own interests rather than paying more attention to the project efficiency as the common goal (for instance, Forbes and Ahmed, 2010; Hauck et al., 2004). Conversely, in collaborative construction projects, characteristics and elements such as trust-based relationships and shared risk-reward systems direct collaboration and cooperation of the key parties, integrated within a single team, toward the good of the project (for instance, Fischer et al., 2017; Oakland and Marosszeky, 2017). In this dissertation, “traditional construction projects” and “collaborative construction projects” represent construction projects with traditional and collaborative delivery models, respectively.

Project managers, as the leaders, play an important role in the successful delivery of construction projects (Crawford, 2000). According to the previous studies on the competency and project success, project managers’ competencies considerably contribute to the success of different types of projects as well as construction projects (for instance, Abdullah et al., 2018; Alvarenga et al., 2019; Chan et al., 2004; Duy Nguyen et al., 2004; Mutijwaa and Rwelaimila, 2007; Mavi and Standing, 2018; Omran et al., 2012; Panas et al., 2014; Saqib et al., 2008; Toney, 2001). Moreover, it has been shown that the required competencies for project managers are affected by the project type (for instance, Muller and Turner, 2007; Shenhar, 2001). Hence, different types of projects have been addressed for understanding project managers’

competencies of which construction projects have received remarkable attention (for instance, Crawford, 2000; Cheng et al., 2005; Fisher, 2011; Kasvi et al., 2003; laili Jabar et al., 2013; Shah and Prakash, 2018; Walker and Lloyd-Walker, 2011).

However, most of these studies have addressed the subject of interest mainly in traditional construction projects. Thus, there is no clear evidence in the literature implying that the identified competencies for the project managers of traditional construction projects can also be useful and effective in collaborative construction projects. Therefore, there is very little research-based knowledge at present concerning project managers' competencies in collaborative construction projects. The explained knowledge gap makes it imperative to study and understand the evolution in the spectrum of the required competencies for the project managers of traditional and collaborative construction projects.

The dissertation is structured in five chapters. The next two sub-chapters present the research questions and objectives as well as the research process and philosophy. This is followed by the theoretical background chapter. Then, the research design and data analysis procedures are explained in Chapter 3. Chapter 4 includes summaries of the published papers. Finally, Chapter 5 presents summary of the results, contributions of the research, and suggestions for the future studies.

1.2 Research questions and objectives

According to the explained knowledge gap, the research questions and objectives of this study are presented in the following Table 1.

Table 1. Research Questions and Objectives	
Research question	Research objective
I. What are the main sources and perspectives behind the evolution of project managers' competency research in general and in the context of construction projects?	I. Reaching a profound understanding over the evolution of the project managers' competency research in general and in the context of construction projects
II. What are the required competencies for the successful performance of project managers in collaborative construction projects?	II. Identifying the required competencies for project managers of collaborative construction projects
III. How has the evolution of construction project delivery models affected the spectrum of required competencies for the project managers?	III. Reaching an advanced stage in the theory of diversity among project managers' competencies for construction projects with different delivery models

1.3 Research process and structure

This sub-chapter presents the schedule of data collection and analysis as well as the resultant papers. Figure 1 illustrates how the collection of the research data was connected to each paper.

Data collection and Papers	Targeted RQs	2018		2019				2020			
		Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Literature Study	I										
- Paper I											
- Paper II											
Survey 1 & Interview Analysis	II & III										
- Paper III											
Survey 2	II & III										
- Paper IV											
- Paper V											

Figure 1. Research Process

Saunders et al. (2019) stated that a topic on which there is wealth of literature from which a theoretical framework can be developed, lends itself more readily to the deduction. Accordingly, this research, as it relies on deductive approach, was started with reviewing the literature on project managers' competencies. The conducted literature study resulted in the first paper (I). In Paper I, the purpose was to identify and compare project managers' competencies mentioned by the relevant standards of practice and the research community. Moreover, this paper aimed to reach an understanding concerning the identified competencies by previous studies for construction project managers. Besides the obtained results, the literature study also led to the identification of a self-evaluation survey tool on project managers' behavioral competencies (Liikamaa, 2015), which was utilized later for the data collection in Papers III-V.

In addition, another literature study was carried out, focusing on the project success, which resulted in Paper II. Paper II aimed to map the evolution of the project success research through identifying the nature of the success research, leading research questions and the main outcomes. Moreover, this study identified the most frequently mentioned success factors and criteria for various types of projects (in general). The complementary purpose of Paper II was to clarify whether there is an evidence in the project success literature implying project managers' competencies as a critical success factor for construction projects. This evidence was

discovered, where six out of 11 studies mentioning project managers' competencies as a critical success factor, were focused on construction projects.

After the completion of the literature studies and developing the theoretical framework, a field study (Paper III) was undertaken to identify project managers' appropriate competencies for collaborative construction projects. This study also aimed to find out whether there is any difference between the required competencies for the project managers in traditional and in collaborative construction projects. Data collection was carried out in two steps. First, a web-based questionnaire was sent to 24 project managers of ongoing and/or recently completed collaborative construction projects in Finland. Then, the transcripts of 17 interviews were analysed. These interviews were carried out in 2014 and 2015 with the key practitioners of two successful collaborative construction projects in Finland. These semi-structured interviews addressed management of collaborative construction projects, overall, and the perceived required competencies of project managers in alliance construction projects, in particular.

Another field study was also conducted in order to reach a saturation on the findings from the survey 1 and to enrich the reliability and external validity (generalisability) of the results. This field study (Papers IV-V) was performed through the survey strategy, where the web-based questionnaire (utilized in survey 1) was sent to 33 project managers of ongoing and/or recently completed collaborative construction projects in Norway and Finland. The aim of Paper IV was to develop a competency model for the project managers, structured based on the contribution of competencies to the successful performance of the project managers, and the difficulty of improvement. The aim of Paper V was to identify the required competencies for project managers of collaborative construction projects through detecting those competencies, which contribute to their individual and team performance.

1.4 Research philosophy and approach

The term *research philosophy* refers to those beliefs and assumptions that guide the development of knowledge when the research is accomplished in a particular field (Saunders et al., 2019). The mentioned assumptions include ontology (the nature of reality), epistemology (what constitutes acceptable, valid, and legitimate knowledge), and axiology (the role of values and ethics). According to Saunders et al. (2019), the business and management research philosophies are scattered along between two

opposing extremes of objectivism and subjectivism, which are distinguished based on the three types of ontological, epistemological, and axiological assumptions that are explained in the following within the context of this research.

According to the research questions, the ontological assumption, here, is that the nature of reality concerning the competencies of collaborative construction project managers is external to the researcher (Gustomo et al., 2017). Accordingly, the research is value-free, meaning that axiologically the researcher is detached from the values of the research participants. For the epistemological question of how we know about the competencies of collaborative construction projects managers, the answer is constrained by the explained ontological and axiological assumptions. Knowledge about the subject of interest is objective and deductively generated from the theoretical background concerning the behavioral approach toward competencies.

Deductive approach, as explained earlier, is characterized by development of a theoretical framework and a hypothesis/question(s) concerning a topic (e.g., project managers' competencies in this research) on which there is a wealth of literature (Saunders et al., 2019). Accordingly, the methodological approach of this dissertation is deductive.

Objectivism incorporates the assumptions of the natural sciences, arguing that the social reality which we research (e.g., project managers' competencies in this research) is external to us and others (Saunders et al., 2019). "Objectivists seek to discover the truth about the social world through the medium of observable and measurable fact, from which law like generalizations can be drawn about the universal social reality" (Saunders et al. 2019, p. 136).

According to the earlier explanations, the research philosophy of this dissertation relies on positivism in results of employing those ontological, epistemological and axiological assumptions which represent the objectivism and regulation perspectives. These perspectives, in turn, represent the functionalist paradigm (Saunders et al., 2019).

According to Saunders et al. (2019, p. 144), "the *positivist* focus is on strictly scientific empiricist method designed to yield pure data and facts uninfluenced by human interpretation or bias. Positivist researchers are likely to use a highly structured methodology in order to facilitate replication" (Saunders et al. 2019, p. 147). Although the emphasis is usually on quantifiable observations that lend themselves to statistical analysis, sometimes positivist research extends itself to other data collection methods and seeks to quantify qualitative data (Saunders et al., 2019).

The regulation of societies and human behavior is the main purpose of the researchers working with the *regulation* perspective (Saunders et al., 2019). "Much of

business and management research can be classed as regulation research that seeks to suggest how organizational affairs may be improved within the framework of how things are at present, rather than radically challenging the current position” (Saunders et al. 2019, p.139).

According to Saunders et al., 2019, most business and management research operates within the *Functionalist* paradigm. Research in this paradigm is primarily focused on providing rational explanations and developing sets of recommendation within the existing structures. The positivist research philosophy is usually the basis for much of the research, which is carried out within the functionalist paradigm (Saunders et al., 2019).

2 THEORETICAL BACKGROUND

2.1 Definition of competency

Spencer and Spencer (1993, p.9) defined competency as “an underlying characteristic of an individual that is causally related to criterion-referenced effective and/or successful performance in a job or situation.” *Underlying characteristics*, here, include motives (the things that a person consistently think about or wants that cause action), traits (physical characteristics and consistent responses to situations or information), self-concept (a person’s attitudes, values or self-image), knowledge (the information a person has in a specific content area) and skills (the ability to perform a certain physical or mental task). According to the Iceberg Model (Spencer and Spencer, 1993), knowledge and skill competencies tend to be visible, and relatively surface, and subsequently easy to develop through training which is the most cost-effective way. Conversely, self-concept, trait and motive competencies are more hidden and central to the personality and consequently more difficult to improve; this is the most cost-effective way for employers to hire those people which already have these competencies.

Zwell (2000) defined competency as an enduring trait or characteristic that is behind certain job performance. Boyatzis (2009) defined competency as a situation-oriented behavior underpinned by an underlying construct called the intent. Crawford (2000) stated that competencies of the project managers is a factor in successful delivery of projects, and the project managers need to have competency in those areas that have the most positive impact on project outcomes. Abraham et al. (2001) defined competencies as a range of different characteristics, behaviors, and traits that are required for effective job performance. According to the Paper I of this dissertation (Moradi et al. 2019, p.544), “competency means the capability to use skills, knowledge and personal characteristics that enhance efficiency and effectiveness of project managers in their job performance and subsequently increase the likelihood of the project success.” Here, the given definition in the Paper IV of this dissertation is adopted, where it has been stated that “competencies are the underlying characteristics (motives, traits, self-image, skills and knowledge) which cause different kinds of actions while being combined with an intent, which is

situation-oriented. The resultant action in a given situation is called competency. Competency, due to its behavioral nature, can predict and cause successful performance in a consistent manner” (Moradi et al. 2021, p.3).

2.2 Evolution of the research on construction project managers’ competencies

Research on the competency subject has been popular since 1950s. A paper by Gaddis (Gaddis, 1959), a Harvard business review article by Lawrence and Lorsch (1967), titled “The integrator,” and “Testing for Competence Rather Than for Intelligence” by McClelland (1973) can be considered as the starting points in this research field (Moradi et al., 2021). Since then, several scholars have been active in studying project managers’ competencies. Powers (1987) carried out a study which resulted in identification of a group of managerial competencies, representing characteristics of superior performance. These competencies were then categorized into four clusters including goal and action management, directing subordinates, human resource management and leadership (Powers, 1987). The efforts of the pioneers in the competency research, particularly those behavioristic ones (e.g., McClelland, 1973), were continued with a study undertaken by Spencer and Spencer (1993), emphasizing the significance of behavioral approach for the competency studies and presented the Iceberg Model. Zwell’s (2000) book entitled “Creating a Culture of Competency” is another contribution to the literature concerning the competency subject, which its categorization of competencies, in terms of improvability, seems to follow the theory of the Iceberg Model (Spencer and Spencer, 1993).

Project managers’ competencies have been addressed in several studies from general and context-specific perspectives since 2000. Edum-Fotwe and McCaffer (2000), and Crawford (2000) conducted studies to address project managers’ competencies in construction projects and to explore the correlation of project managers’ competency with project success. Then, in the conducted study by Shenhar (2001) entitled “one size does not fit all projects: exploring classical contingency domains;” he stated that a specific project type affects the selection of project managers, project team members and skill development needs. This finding over the significance of the contingent thinking can be considered as the starting point for the next context-specific studies concerning the competency subject. Consequently, several scholars tried to study project managers’ competencies in

different contexts such as construction, IT, organizational change, and metallurgical projects (for instance, Chen et al., 2008; Klendauer et al., 2012; Kostalova et al., 2018; Müller and Turner, 2007; Patanakul and Milosevic, 2008; Stevenson and Starkweather, 2010).

Competency research concerning construction projects were continued by different scholars such as Abraham et al. (2001), El-Sabaa (2001), Kasvi et al. (2003) and Ruuska and Vartiainen (2003), and competencies such as leadership, communication, and goal-orientation were found of importance for the project managers. These efforts were followed by researchers such as Dainty et al. (2004), Cheng et al. (2005), Gillard and Price (2005), Brill et al. (2006), and Suikki et al. (2006), and new competencies of importance were identified such as analytical thinking, flexibility, and adaptability.

Regional and cultural differences in the context of construction projects have also provided sources for competencies such as contract management and conflict management (for instance, Ahadzie et al., 2008 and 2009; Dogbegah et al., 2011; Fisher, 2011; Hwang and Ng, 2013; Lee et al., 2011; laili Jabar et al., 2013; Liyana Othman and Jaafar, 2013; Trivellas and Drimoussis, 2013; Walker and Lloyd-Walker, 2011; Zhang et al., 2013). The recent studies suggest that addressing project managers' competencies in construction projects (mainly in the traditional ones) has been continued as a popular research topic (for instance, Ahadzie et al., 2014; Crayon et al., 2017; De los Ríos-Carmenado and Rahoveanu, 2014; Dziekonski, 2017; Omar and Fayek, 2016; Takey and de Carvalho, 2015; Tabassi et al., 2016; Shah and Prakash, 2018). Table 2 presents the literature-based competencies of project managers for traditional construction projects.

Literature analysis shows that project managers' competencies in collaborative construction projects have been limitedly addressed by the research community. This knowledge gap is to be fulfilled in this dissertation through the behavioral approach which has been frequently utilized in the previous competency studies (for instance, Chang et al., 2009; Liikamaa 2015; Nurminen, 2003; Spencer and Spencer, 1993; Zwell, 2000). In the behavioral approach, the type and frequency of individuals' (here the project managers') behavior in their everyday work is the main source for understanding their competencies.

Table 2. Project Managers' Competencies for Traditional Construction Projects		
Competency	Reference	Appearance
Teamwork and cooperation	(Ahadzie et al., 2008; Ahadzie et al., 2009; Cheng et al., 2005; Dainty et al., 2004; Dziekoński, 2017; Lee et al., 2011; Omar and Fayek, 2016; Shah and Prakash, 2018; Zhang et al., 2013)	9
Cost management	(Abdullah et al., 2018; Cheng et al., 2005; Dogbegah et al., 2011; Dziekoński, 2017; Hwang and Ng, 2013; Lee et al., 2011; Moradi et al., 2018; Mutijwaa and Rwelamila., 2007; Omar and Fayek, 2016)	
Communication	(Cheng et al., 2005; Chen et al., 2008; Dogbegah et al., 2011; Dziekoński, 2017; Hwang and Ng, 2013; Omar and Fayek, 2016; Shah and Prakash, 2018)	7
Leadership	(Cheng et al., 2005; Dainty et al., 2004; Moradi et al., 2018; Omar and Fayek, 2016; Tabassi et al., 2016; Zhang et al., 2013)	6
Time management	(Ahadzie et al., 2008; Ahadzie et al., 2009; Dziekoński, 2017; Hwang and Ng, 2013; Omar and Fayek, 2016; Shah and Prakash, 2018)	
Quality management	(Abdullah et al., 2018; Cheng et al., 2005; Dogbegah et al., 2011; Lee et al., 2011; Omar and Fayek, 2016; Shah and Prakash, 2018)	
Knowledge of construction	(Chen et al., 2008; Ahadzie et al., 2008, Ahadzie et al., 2009; Iaili Jabar et al., 2013; Shah and Prakash, 2018)	5
Flexibility and adaptability	(Cheng et al., 2005; Dainty et al., 2004; Dziekoński, 2017; Omar and Fayek, 2016; Shah and Prakash, 2018;)	
Resource management	(Abdullah et al., 2018; Dogbegah et al., 2011; Hwang and Ng, 2013; Mutijwaa and Rwelamila, 2007; Omar and Fayek, 2016)	
HSE (health, safety and environment)	(Abdullah et al., 2018; Cheng et al., 2005; Lee et al., 2011; Omar and Fayek, 2016; Shah and Prakash, 2018)	
Experience	(Dziekoński, 2017; Edum-Fotwe and McCaffer, 2000; Lee et al., 2011; Liyana Othman and Jaafar, 2013; Tabassi et al., 2016)	
Ethics	(Dogbegah et al., 2011; Dziekoński, 2017; Liyana Othman and Jaafar 2013; Omar and Fayek, 2016; Shah and Prakash, 2018)	
Problem solving	(Dziekoński, 2017; Iaili Jabar et al., 2013; Omar and Fayek, 2016; Panas et al., 2014; Shah and Prakash, 2018)	
Impact and influence	(Cheng et al., 2005; Dainty et al., 2004; Lee et al., 2011; Omar and Fayek, 2016; Zhang et al., 2013)	
Team management	(Abdullah et al., 2018; Cheng et al., 2005; Chen et al., 2008 ; Lee et al., 2011 ; Omar and Fayek, 2016)	
Project management	(Dziekoński, 2017; Dogbegah et al., 2011; Iaili Jabar et al., 2013; Mutijwaa and Rwelamila, 2007)	4
Achievement orientation	(Cheng et al., 2005; Dainty et al., 2004; Dziekoński, 2017; Moradi et al., 2018)	
Conflict management	(Ahadzie et al., 2008; Ahadzie et al., 2009; Dziekoński, 2017; Zhang et al., 2013)	
Stakeholder management	(Hwang and Ng, 2013; Lee et al., 2011; Moradi et al., 2018; Omar and Fayek, 2016)	
Innovation	(Dogbegah et al., 2011; Dziekoński, 2017; Omar and Fayek, 2016; Shah and Prakash, 2018)	

Decision-making	(Dziekoński, 2017; Liyana Othman and Jafar, 2013; Omar and Fayek, 2016; Panas et al., 2014)	
Analytical thinking	(Cheng et al., 2005; Dainty et al., 2004; Dziekoński, 2017; Omar and Fayek, 2016)	
Risk management	(Dogbegah et al., 2011; Hwang and Ng, 2013; Omar and Fayek, 2016)	3
Procurement management	(Abdullah et al., 2018; Dziekoński, 2017; Omar and Fayek, 2016)	
Initiative	(Cheng et al., 2005; Dainty et al., 2004; Omar and Fayek, 2016)	
Information seeking	(Cheng et al., 2005; Dainty et al., 2004; Shah and Prakash, 2018)	
Scope management	(Cheng et al., 2005; Dziekoński, 2017; Omar and Fayek, 2016)	
Motivation	(Dziekoński, 2017; Omar and Fayek, 2016; Shah and Prakash, 2018)	
Negotiation	(Dziekoński, 2017; Omar and Fayek, 2016; Shah and Prakash, 2018)	
Commitment	(Omar and Fayek, 2016; Moradi et al., 2018; Shah and Prakash, 2018)	
Developing others	(Cheng et al., 2005; Omar and Fayek, 2016)	
Conceptual thinking	(Cheng et al., 2005; Dainty et al., 2004)	2
Planning	(Chen et al., 2008; Hwang and Ng, 2013)	
Directiveness	(Cheng et al., 2005; Dainty et al., 2004)	
Change management	(Shah and Prakash, 2018; Zhang et al., 2013)	
Project integration management	(Omar and Fayek, 2016; Moradi et al., 2018)	
Assertiveness	(Dziekoński, 2017; Shah and Prakash, 2018)	
Self-control	(Omar and Fayek, 2016; Shah and Prakash, 2018)	
Reliability	(Shah and Prakash, 2018; Omar and Fayek, 2016)	
Relationship building	(Chen et al., 2008; Zhang et al., 2013)	
Interpersonal understanding	(Omar and Fayek, 2016; Zhang et al., 2013)	
Customer focused	(Cheng et al., 2005; Dainty et al., 2004)	1
Self-confidence	(Dziekoński, 2017)	
Tendering	(Mutijwaa and Rwelamila, 2007)	
Knowledge management	(Cheng et al., 2005)	
Operation management	(Mutijwaa and Rwelamila, 2007)	
Estimating	(Mutijwaa and Rwelamila, 2007)	
General business management	(Mutijwaa and Rwelamila, 2007)	
Judgment	(Lee et al., 2011)	
Professionalism	(Lee et al., 2011)	
Management	(Lee et al., 2011)	
Alertness and quickness	(Liyana Othman and Jafar, 2013)	

Organizational awareness	(Zhang et al., 2013)	
Ability to deal with stress	(Dziekoński, 2017)	
Ability to formulate goals	(Dziekoński, 2017)	
Sensitivity	(Shah and Prakash, 2018)	
Cultural competence	(Omar and Fayek, 2016)	
Mental agility	(Shah and Prakash, 2018)	
Positive outlook	(Shah and Prakash, 2018)	
Consciousness	(Shah and Prakash, 2018)	
Learning oriented	(Shah and Prakash, 2018)	
Empathy and Aspiration	(Dziekoński, 2017)	
Emotional resilience	(Shah and Prakash, 2018)	
High energy level	(Shah and Prakash, 2018)	
Information technology skills	(Shah and Prakash, 2018)	

2.3 Project managers' competencies in the view of standards of practice

In addition to the research community, there are also some standards of practice, which have been interested in addressing project managers' competencies. The Individual Competency Baseline (ICB.4) defines the individual competency as the application of knowledge, skills and abilities for achieving the desired results, and introduces 28 competencies of project managers in three groups of people, practice, and perspective (IPMA, 2015). The APM (Association for Project Management) Body of Knowledge classifies 11 competencies in two groups, interpersonal and professional (APM, 2012). Project Manager Competency Development framework (PMCD) introduces 16 competencies that are divided into two groups, performance and personal competencies (PMI, 2017a). Finally, the Guide to the Project Management Body of Knowledge (PMBOK Guide) has introduced a framework entitled PMI Talent Triangle which presents three types of project managers' skills (PMI, 2017b). Although these standards of practice have a common interest, which is the competency subject, the background and thinking models behind them are uneven and thus they are not comparable with each other (see Table 3 for details).

Table 3. Project Managers' Competencies in the Standards of Practice					
Competency	Reference and frequency of appearance	Rank	Competency	Reference and frequency of appearance	Rank
Leadership	(ICB.4, APM, PMBOK, PMCD.3)	1	Result orientation	(ICB.4)	4
Communication	(ICB.4, APM, PMCD.3)	2	Project design	(ICB.4)	
Resource management	(ICB.4, APM, PMCD.3)		Requirement and objectives	(ICB.4)	
Teamwork	(ICB.4, APM)	3	Organization and information	(ICB.4)	
Conflict management	(ICB.4, APM)		Change and transformation	(ICB.4)	
Negotiation	(ICB.4, APM)		Governance, structures and processes	(ICB.4)	
Project scope management	(ICB.4, PMCD.3)		Cultures and values	(ICB.4)	
Project quality management	(ICB.4, PMCD.3)		Compliance, standard and regulation	(ICB.4)	
Project cost management	(ICB.4, PMCD.3)		Managing	(PMCD.3)	
Project procurement management	(ICB.4, PMCD.3)		Cognitive ability	(PMCD.3)	
Project integration management	(ICB.4, PMCD.3)		Effectiveness	(PMCD.3)	
Project risk management	(ICB.4, PMCD.3)		Professionalism	(PMCD.3)	
Project stakeholder management	(ICB.4, PMCD.3)		Influencing	(APM)	
Strategic and business management skills	(PMBOK, ICB.4)		Delegation	(APM)	
Self-reflection and self-management	(ICB.4)	4	Ethics framework	(APM)	
Personal integrity and reliability	(ICB.4)		Learning and development	(APM)	
Relationship and engagement	(ICB.4)		Technical project management skills	(PMBOK)	

3 METHODOLOGY

3.1 Research design

The research is carried out to identify project managers' competencies in the context of collaborative construction projects. Consequently, the research purpose here is descriptive, as it aims to portray an accurate competency profile of the project managers. According to the adopted research philosophy (explained in sub-chapter 1-3), after the pre-study and formulating research questions as well as the research design, the literature study in phase 1 was carried out, which was followed by the field surveys to fulfill the intended purpose of this study (see Figure 2 in the following page).

According to Saunders et al. (2019, p.193), "the survey strategy is associated with the deductive approach. It is a popular and common strategy in business and management research and is most frequently utilized to answer who, what, where, how much and how many questions. It therefore tends to be employed for exploratory and descriptive research. Surveys are popular as they allow collecting data in a highly economical way."

Accordingly, in phase 2, a web-based self-evaluation questionnaire, comprising 60 linguistic statements, representing 30 behavioral competencies, was sent to 24 project managers of ongoing and/or recently completed collaborative construction projects in Finland and a response rate of 21% was achieved. Moreover, the transcripts of 17 interviews were also analyzed through content analysis to compare them with the competencies identified from the survey. Those interviews were conducted in 2014 and 2015 with the key practitioners of two successfully completed collaborative construction projects in Finland. In phase 3, the survey was expanded, and the questionnaire was sent to 33 project managers of collaborative construction projects in Norway and Finland and a response rate of 73% was achieved. Data collection in survey 1 & 2 was carried out through non-probability volunteer sampling, as there was no sampling frame available, data could be collected from the entire target population, and there was no need for statistical inferences from the sample (Saunders et al., 2019). The demographic information concerning the

interviewees, the case projects, and the participants in the surveys 1 & 2 can be seen in paper III (Figure 1 & Table 3) and paper IV (Figure 1).

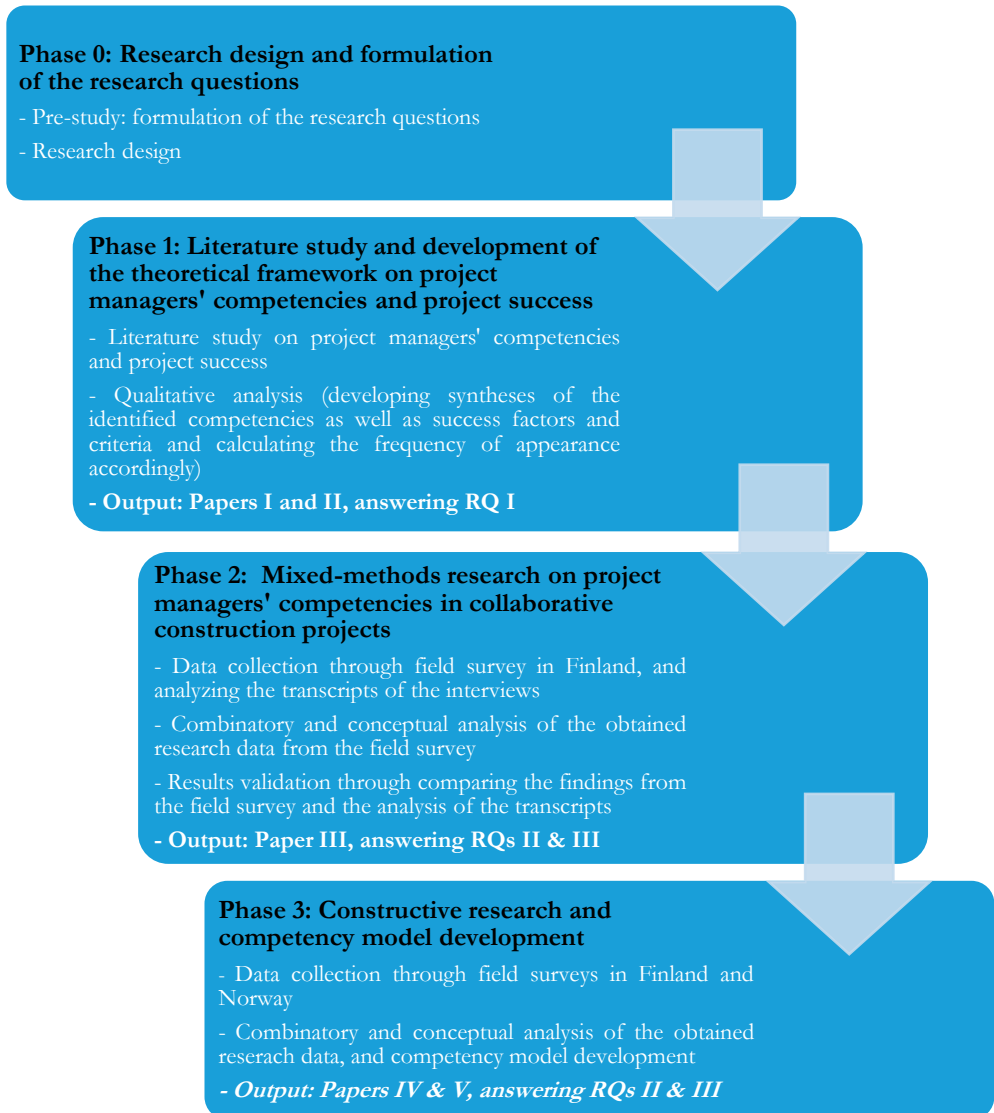


Figure 2. The Phases of the Research

The utilized web-based questionnaire “Cycloid”, by Evolute Technology, focuses on the evaluation of key behavioral competencies of project managers based on their current state (reality), target state (vision), and creative tension. The gap between personal vision and current reality forms an individual’s creative tension (Chang et

al., 2009; Liikamaa, 2015; Senge, 1990). If there is no gap between the reality and the vision, the motivation will not begin because of the lack of the perceived need to move toward the vision. Accordingly, 30 behavioral competencies of project managers were evaluated through 60 linguistic statements (Appendix B of Paper IV), two statement per competency.

The self-evaluation of project managers' behavior is an efficient method for a competency study due to the behavioral nature of the competency and the ability of the project manager to evaluate his/her behavior in the everyday work (Liikamaa 2015; Nurminen, 2003). In this study, Cycloid, as a web-based self-evaluation questionnaire, was selected for data collection because of its substantial theoretical support, the alignment of its content with the previous competency research on construction projects, having a record for being utilized in numerous competency studies since 2006, and providing the possibility of using the behavioral approach in a reliable and highly economical way. The other complementary motives for selecting Cycloid were its availability in several languages (e.g., English, Finnish, Norwegian) and revealing the gap between the current and target state of the project managers' different behaviors, thereby providing a useful source of information for the performance improvement.

In this study, the respondents were asked to choose and determine the frequency of their behaviors in the situations presented by each linguistic statement on a scale: never/seldom/often/always in their current state and target state. The frequency of appearances of various behaviors in the representing statements of each competency were evaluated both in the current and target states through analyzing the numeric values of the current and target states of the self-evaluation results.

Those 30 competencies and 60 linguistic statements originate from the research by Kirsi Liikamaa (2006). Later these competencies have been categorized into two main groups and five subgroups (Liikamaa, 2015), (see Table 4). Liikamaa's (2015) categorization is based on the Goleman's (1998) ontology of the five components of emotional intelligence at work, which include personal competencies, (including self-awareness, self-management and motivation) and social competencies (including social awareness and relationship management). Cycloid has been utilized in several studies for evaluating project managers' competencies in different contexts (for instance, Bikfalvi et al., 2007; Chang et al., 2009; Liikamaa, 2015; Paaanen et al., 2009).

Table 4. Categorization of Project Managers' Competencies in the Cycloid		
Group	Subgroup	Competency
Personal competencies	Self-awareness	Emotional awareness, Self-assessment, Self-confidence
	Self-control	Trustworthiness, Maintaining order, Flexibility, Innovation, Responsibility, Seeking information, Production efficiency, Decision quality, Stress tolerance
	Cognitive ability	Analytical thinking, Conceptual thinking, Language proficiency
	Motivation	Achievement orientation, Commitment, Initiative, Optimism
Social competencies	Empathy	Understanding others, Developing others, Leveraging diversity, Organizational savvy
	Social skills	Communication, Conflict management, Management, Leadership, Relationship building, Collaboration, Group capabilities

In general, “self-evaluation can be considered as an efficient and effective method to develop oneself, manage personal growth, clarify roles, and commit to project-related tasks” (Chang et al. 2009, p.530). However, this type of evaluation also has a disadvantage. Self-evaluation is less reliable in the evaluation of work performance as people prefer to evaluate their own performance as better than that of others (Dessler, 2001; Stone, 1998). The effectiveness of the self-evaluation is higher in examining the relationship between different items, such as competencies, than comparing an individual’s performance to others (Chang et al., 2009).

In the selected approach for this study, the significance of different competencies in the current state and the target state were evaluated through statements related to the individual’s behavior in their everyday work. Therefore, individuals directly evaluated their own behavior instead of their own performance. Additionally, the futuristic viewpoint includes the concept of creative tension (Senge, 1990). To that end, the self-evaluation can be considered as an efficient way to reveal individuals’ intentions and aspirations (Chang et al., 2009; Moradi et al., 2021).

3.2 Data analysis

Table 5 presents the utilized data analysis procedures for papers I-V. In papers I-II, the qualitative analysis was employed to make syntheses of the identified competencies (paper I), and success factors as well as criteria (paper II). Then, the frequency of appearance was utilized to calculate the rankings and to select the weighty competencies (in paper I), and critical success factors and criteria (in paper II).

Table 5. Data Collection and Analysis Techniques		
Paper	Data collection technique(s) and/or source	Data analysis procedure
Paper I	Literature study	Qualitative analysis
Paper II	Literature study	Qualitative analysis
Paper III	Survey, Interviews transcripts	Quantitative and qualitative survey analyses, qualitative content analysis of the transcripts of the interviews
Paper IV & V	Survey	Quantitative and qualitative survey data analyses

In paper III, the 10 highest significant competencies in the target state and creative tension (excluding similarities) formed the profile of competencies for the project managers. The top 10 competencies in the target state and creative tension as well as current state are seen as the most important ones among the total 30 competencies for contributing to the successful performance of the project managers. Then, the transcripts of the interviews were analyzed through content analysis to identify the competencies. The analysis was carried out in three steps. First, the transcripts of the conducted interviews were translated from Finnish language to English language. Second, the translated transcripts were investigated and coded for any competencies representing the current literature or any new theme which could lead to identifying new competencies. The developed competency dictionaries by Spencer and Spencer (1993) and Zwell (2000) were utilized as the main references for identifying the competencies. Finally, results of the efforts in the second step were compiled in a table, which its concise version containing only the identified competencies can be seen in Table 9 of paper III. Finally, the identified competencies from the survey and the interviews were compared for the results validation, and it became clear that there was over 70% overlap between those findings.

In paper IV, the high overlap between the findings (the 10 highest significant competencies in the current state, target state and creative tension) from the two respondent groups (Norwegian and Finnish project managers) was seen as a basis for carrying out a qualitative analysis. This analysis was performed through creating a synthesis of the obtained results and developing a competency model for the project managers. The development of this model was conducted based on the two

important aspects of competencies: (i) contribution to project managers' successful performance, and (ii) the difficulty of improvement.

The structuring of competencies according to their contribution to the successful performance was undertaken based on the common and uncommon competencies among the 10 highest significant ones in the target state, the current state, and creative tension of the both respondent groups. This structuring was performed through developing a three points scale (1–3), where:

- (i) those competencies *common* in the *target state* of the *both respondent groups* were qualified as the highest (3);
- (ii) those competencies *common* in the *current state and creative tension* of the *both respondent groups* were qualified as the medium (2);
- (iii) those competencies *specific* in the *target state and/or creative tension* of *each respondent group* were qualified as the lowest (1).

This developed scale represents the extent to which competencies contribute to the successful performance of the project managers. Therefore, it was entitled as CSP (contribution on successful performance) (see Table 3 of Paper IV for details). The top 10 competencies in the target state and creative tension as well as current state are seen as the most important ones among total 30 competencies for contributing to the successful performance of the project managers. Moreover, the reason for which the common target state competencies were outweighed was that these competencies, as can be understood from their title, are the visionary and the most appropriate ones for the project managers.

Second, the competencies were also structured based on the degree to which project managers have difficulty to improve their competencies. This structuring was carried out through determining difficulty of improvement of those competencies (from the previous step) with high, medium and low contribution to the successful performance. This means that in a three points scale (1-3),

- (i) the *most difficult to improve* competencies were qualified as *the highest point* (3);
- (ii) *somewhat difficult to improve* competencies were qualified as *the medium point* (2); and
- (iii) *easy to improve* competencies were qualified as *the lowest point* (1).

This developed scale represents the extent to which project managers can improve their competencies. Therefore, it was entitled DAI (difficulty of improvement) (see Table 3 of Paper IV for details). This structuring of competencies was undertaken based on the relevant classifications made by Zwell (2000) and

Spencer and Spencer (1993), where skill and knowledge competencies are relatively easy to develop, motive and trait competencies are hard to develop, and finally the self-concept competencies lie somewhere between and are somewhat hard to develop.

Third, the 3x3 matrix was developed based on the structuring of competencies in the previous steps. This was conducted by creating a table (see Table 3 of Paper IV for details) and multiplying CSP (contribution to the successful performance) and DAI (difficulty of improvement) values of each competency and placing the competencies within the matrix accordingly. The definitions and behavioral indicators of the listed competencies in the model can be found in Appendix B of paper IV.

In paper V, developing the competency profile of the project managers was undertaken based on two perspectives concerning the common 10 highest significance competencies in the target state and creative tension of the project managers: (i) which competencies mostly contribute to the individual performance of the project managers?, and (ii) which competencies mostly contribute to their team performance? Individual performance, here, represent those tasks, which project managers need to perform alone. Group/team performance represent those tasks that project managers need to perform in collaboration and cooperation with their team members. The identification of the competencies, representing the above perspectives, was performed based on their meaning (definition) and behavioral indicators (the linguistic statements representing each competency).

The explained data collection process and analysis procedures in phases 2 & 3, in the big picture, characterize a mixed-methods research design for this study where both quantitative and qualitative methods for data collection and analysis were utilized (Saunders et al., 2019).

4 SUMMARIES OF THE PAPERS

4.1 Paper I

The first paper, as a literature study, investigated the viewpoints of the relevant standards of practice and the research community concerning project managers' competencies. Moreover, this study aimed to identify the contexts and/or project types of the mentioned competencies by the research community. Accordingly, the purpose of this paper was to answer the following research questions:

RQ1. Are there discrepancies between research results and standards of practice addressing project managers' competencies?

RQ2. What are the contexts of the identified competencies in the literature?

In order to answer the above questions, first, the relevant standards of practice were reviewed and those ones addressing project managers' competencies (ICB.4, PMCD.3, APM, PMBOK) were identified. Then, a synthesis of the 58 mentioned competencies in those standards of practice was developed.

Second, previous studies on project managers' competencies were reviewed and 381 mentioned competencies were identified, and a synthesis of those competencies was developed as well. This synthesis, later, provided a basis for developing a list of competencies (Table 9 of paper I) representing different contexts and/project types, addressed in the previous competency studies.

Third, the developed syntheses in the previous steps were compared to identify any discrepancy between the research results and the standards of practice. This comparison was made based on the similarity or sameness in title or meaning of the competencies mentioned by the above sources.

Next, the developed syntheses were merged and a synthesis of all the mentioned competencies (in the standards of practice and previous studies) was developed which led to a final list of 98 competencies for project managers. In this list, those competencies with more than one appearance were qualified as the weighty and those ones with only one appearance were qualified as the notable competencies. Those competencies with more than 10 appearances were qualified as the key ones.

Finally, based on the final synthesis, a categorization of project managers' weighty competencies was developed. This categorization was carried out in two steps. First, a comparison was made in terms of meaning and skill match between project managers' weighty competencies and the categories of project managers' competencies presented by the reviewed standards of practice. Then, the categories, best representing the weighty competencies, were selected based on the made comparison in the first step.

According to the conducted analyses, four groups of results were obtained in paper I which are as follows:

- **There are four discrepancies between the research results and the standards of practice over project managers' competencies:** (i) some competencies are missing in the standards of practice, (ii) there is a qualitative mismatch between research results and standards of practice concerning priority of some project managers' competencies, (iii) there is uneven degree of consensus over the importance of some project managers' competencies between the research results and the standards of practice, and (iv) research results are more context-oriented than the standards of practice over project managers' competencies.
- **There are 98 mentioned competencies for project managers of which 30 ones have one appearance and 68 ones have more than one appearance.** On the top of this list, there are 11 competencies (called key competencies) with more than 10 appearances in the previous studies. These are *communication, leadership, teamwork and cooperation, flexibility, problem solving, goal orientation, developing others, impact and influence, stakeholder management, cost management and resource management*.
- **A categorization of project manager' weighty competencies was developed** which includes four categories: personal, performance, perspective, and interpersonal (see Table 8 of paper I).
- **A list of different contexts and/or project types addressed in the previous studies and their representing competencies was developed.** Organizational change projects, construction projects, engineering projects (all fields), IT projects, metallurgical projects, international projects conducted by NGOs and public service projects were the addressed contexts in the previous competency studies. Among these project types, it seems that construction projects have received more attention.

The findings of this study provide knowledge contribution by revealing certain discrepancies between research results and the standards of practice which can lead to new insights for project managers, researchers and providers of standards of practice. Another contribution of this study is the presented comprehensive list of project managers' competencies and clarification about the project types of the mentioned competencies by the research community.

4.2 Paper II

The second paper, as a literature study, aimed at **understanding the longitudinal developments in the project success research field and identifying critical project success factors and criteria mentioned in the previous studies.**

In order to fulfill the intended purpose of this study, the previous studies concerning project success was searched, reviewed and analyzed. In the first step, the nature of project success research, the leading research questions, the main targets, and the main outcomes were identified and analyzed. In the second step, several success factors and success criteria were extracted from the previous studies. According to the identified project success factors and project success criteria, two matrixes of them and their references were developed.

Due to a few similarities among identified project success factors and project success criteria, two syntheses of them were developed with a ranking column based on the frequency of appearance. The development of those syntheses was conducted by identifying those project success factors or criteria which had very close or similar meaning or title. In this study, the identified success factors and criteria with more than one frequency of appearance were qualified as the weighty ones, and those with only one frequency of appearance qualified as the notable ones.

Three groups of results were obtained in paper II which are as follows:

The first group of results was the evolution process of project success research (Figure 3) mapped through discovering and depicting leading research questions, main targets, and outcomes over the conducted studies. It seems that project success research has been interested in increasing the success chance of projects through an improved understanding on the project success concept and its different components. Hence, three groups of leading research questions have been adopted. These questions are related to the concept of project success, viewpoints on that, measurement of project success, and finally, success factors that would be useful and helpful for realizing project goals and benefits. In other words, those three groups of leading research questions account for understanding the definition of project success, project success criteria, and project success factors.

Due to the undertaken research in the area of project success, three main outcomes have been achieved. These are: (i) the increasing maturity of adapted definitions for project success and its components, (ii) development of understandings toward expected common (general) and unique (context-oriented) goals and benefits of projects as a measurement way to judge project success, and (iii) identification of project success factors generally (for all types of projects) and

particularly (for specific project type, context or target). Additionally, the mentioned growing trend toward the context-oriented studies has consequently led to gradual customization of project success knowledge for specific targets and contexts. For instance, considerable improvements have been obtained in our understandings of the different aspects of success in the construction and information technology projects.

The second group of results was the list of weighty and notable success factors. Based on this list, there are 65 weighty success factors that contribute to the project success. Among those weighty factors, there are six ones with equal to or more than 10 appearances in the previous studies, which were found to be the critical success factors for projects. These are *communication, top management support, project manager's competency, clear objectives and realistic obligations, monitoring and feedback, and risk management*.

The third group of results was the list of weighty and notable success criteria. The findings show that there are 13 weighty project success criteria where *meeting cost, meeting time, customer satisfaction, meeting quality, business success, and acceptable technical performance* are the top 5 ones in the ranking.

The mapped evolution process of project success research shows that general findings of project success have had limited explanatory power, mainly because of the uniqueness of the project that imposes many challenges and issues to project performance and subsequently its success, and general knowledge of project success is insufficient to overcome those challenges. Hence, customization of project success knowledge has been emerged as a requirement for each specific project type or context to overcome barriers and increase the success potential of projects. Accordingly, the contingency theory for projects developed by Shenhar (2001) can be expanded; Project type not only affects the selection of the project human resources and their required competencies but also requires defining specific criteria, for measuring project success, and identifying certain factors, for facilitating the realization of project success criteria.

The findings can provide new insights for project managers, project team members, project owners, and other stakeholders of the project to increase the success chance of the project by explaining the weighty success factors and criteria. As the limitation of this study, it should be acknowledged that certain keywords were used in a couple of databases (ScienceDirect and Emerald) for literature study, which subsequently narrowed the scope of the study.

Nature of project success research: To increase success chance of projects through improving understandings of project success concept, its different components and enablers						
Leading research questions						
<i>What</i> would be the appropriate definition of project success?		<i>What</i> a project should deliver and how it can be considered as a successful maneuver?		<i>What</i> can be helpful for a project to reach its goals and benefits? <i>What</i> are the enablers of project success?		
<i>What</i> are the different aspects of project success?		<i>How</i> can we judge the project success?		A growing trend towards context-oriented research from past to the present		
Main research targets						
Identifying success enablers over the stages of project life cycle (Pinto and Slevin 1987; Pinto and Prescott, 1988) Starting point	Developing a universal framework to measure project success (Freeman and Bale, 1992; Shenhar et al., 1997) Significant step towards success measurement	Identifying success factor of construction project based on objectives of budget, time, and quality (Chua et al., 1997 and 1999) Starting point of context-oriented studies	Defining project success (Baccarini, 1999) The only focused study to define project success	Addressing success enablers, way of judging success and causes of failure in general (Lin and Mohamed 1999; Cozijnsen et al., 2000; and Cooke-Davies, 2002) Paying attention to failure causes	Identifying success factor in construction projects (Duy Nguyen et al., 2004; Chan et al., 2004) Growing interest	Assessing our evolving understanding of success factors and frameworks in the past 40 years (Jugdev and Muller, 2005) A Review
				Addressing different aspects of project success in general and in specific contexts such as construction and IT projects (Alzahrani, 2013; Serrador, 2014; Alnaami, 2017) Taking deeper in success aspects of construction and IT industry		
Other researchers such as Shenhar et al. (2001), Muller and Turner (2007) and Mertens et al. (2018) have also adapted other definitions of project success in their studies.						
Main outcomes						
<i>Increasing maturity of adapted definitions for project success and its components</i>		<i>Development of understandings towards expected common (general) and unique (context-oriented) goals and benefits of projects as a measurement way to judge project success</i>				
Chronological presentation of outcomes						
Gradual customization of project success knowledge for specific targets and contexts		Discovery of				
Discovery of success factors in different stages of project life cycle	Adaption of several definitions of project success and identifying new success factors	Picture of different aspects of project success and showing the importance of post-project outcomes on its success	Identification of effects of leadership, competency and teamwork shortages in project failure	Highlight importance of satisfaction and business success in project success	Discovery of weighty factors of construction project's success such as enough funding and resources,	Clarification of contribution of some factors such as cultural differences and competent project manager on project success
1985-1990	1991-2000	2000-2003	2004-2005	2006-2010	2011-2018	Adaption of success criteria for specific project types and contexts such as PPP, BOT, PPP, information system and toll road projects

4.3 Paper III

Paper III, as a field study, addressed project managers' competencies. In particular, **this paper aimed to identify project managers' appropriate competencies for collaborative construction projects. The second purpose of the paper was to find out whether there is difference between the required competencies for project managers in traditional and in collaborative construction projects.**

First, a literature study was undertaken and the mentioned competencies for project managers of traditional construction projects were identified. Then, due to a few similarities, a synthesis of the discovered competencies was developed and ranking of each competency was calculated based on the frequency of appearance (see Table 1 of paper III).

Next, regarding the first purpose of this paper, the survey strategy was employed with a behavioral approach where project managers' behavior in their everyday work was the main source for understanding their competencies. Semi-structured interviews and the self-evaluation web-based questionnaire (Cycloid) were utilized for data collection.

In the survey, the respondents were asked to choose and determine the frequency of their behaviors in the situations presented by each linguistic statement on a scale: never/seldom/often/always in their current and target state. How often these behaviors occur in the representing statements of each competency were evaluated both in the current and target states through analyzing the numeric values of the current and target states of the self-evaluation results.

The questionnaire was sent to 24 project managers of ongoing or recently completed collaborative construction projects in Finland and a response rate of 21% was achieved. Due to the low response rate, transcripts of 17 semi-structured interviews were then analyzed. Those interviews were conducted in 2014 and 2015 with the key practitioners of two successful collaborative construction projects in Finland. The analysis of the transcripts was undertaken through content analysis, where the developed competency dictionaries by Spencer and Spencer (1993) and Zwell (2000) were employed as the main sources for coding and identifying the competencies.

Next, the identified competencies from the survey was compared to those ones identified from interviews for results validation and 70% overlap was detected between two groups of the findings. It was interpreted as the indication of match between the obtained results from the two sources and a clue for reliability of the findings from the survey.

This study presents four groups of findings concerning project managers' competencies in collaborative construction projects which are as follows:

- **Group 1 presents the significance of different competencies in the current state.** Accordingly, *group capabilities, trustworthiness, leveraging diversity, leadership and responsibility* were the five highest significant ones in the current state. Conversely, *innovativeness, conceptual thinking, emotional awareness, analytical thinking, and initiative* were identified as the five least significant competencies of the project managers in the current state.
- **Group 2 presents the significance of different competencies in the target state.** These competencies are the most appropriate ones for the Finnish project managers. The five highest significant competencies in the target state were *group capabilities, language proficiency, leveraging diversity, stress tolerance and flexibility*. These competencies, in this study, were called core competencies; the competencies that are required and necessary for everybody who is going to manage a collaborative construction project, particularly in the Finnish context.
- **Group 3 presents the competencies that the project managers have the most willingness to improve them (creative tension).** Top five competencies in this list were *emotional awareness, communication, understanding others, innovativeness, and language proficiency*. These competencies, in this study, were called supportive competencies; their presence can be supplementary for the core competencies.
- **Group 4, as one of the main results, presents the profile of project managers' competencies for collaborative construction projects** (see Figure 4). This profile was consisted of the 10 highest significant competencies in the target state and creative tension of the project managers (excluding similarities). This competency profile of the project managers contributes to the existing knowledge and brings new insights on the project managers' competencies, particularly in the Finnish context.

The profile of project managers' competencies in collaborative construction projects			
Competence Category	Description	Competency (ranked based on importance)	Competency definition
Core Competencies	Necessary and required for superior performance	Group capabilities	The ability of working with others toward common goals.
		Language proficiency	Ability and courage to use foreign languages.
		Leveraging diversity	Appreciative attitude towards others. Respecting people from different backgrounds.
		Stress tolerance (management)	To maintain performance when facing workload pressures and/or organizational impediments.
		Flexibility	To be open to new experiences and viewpoints.
		Relationship building	Building or maintaining friendly relationships or networks of contacts with people who are or might be useful in achieving work-related goals.
		Leadership	Management activities that are centered upon human beings.
		Maintaining order	Concern for order, quality, and accuracy.
		Achievement orientation	The drive towards a high standard of excellence. Setting challenging goals and working hard to achieve them.
		Understanding others	The ability to sense the feelings and perspectives of other people.
Supportive Competencies	Competitive advantage and supplementary for superior performance	Emotional awareness	The ability to recognize, understand, and analyze one's own feelings.
		Communication	The ability to listen to others. The ability to openly express one's feelings, ideas, and opinions. The ability to read non-verbal cues.
		Innovativeness	Natural and open attitude towards new ideas, attitudes, and information.
		Developing others	Noticing other people's needs for development and promotion of their abilities.
		Initiative	The ability to see new possibilities and to seize opportunities. To do more than what is expected.
		Organizational savvy	Understanding and utilizing organizational dynamics in order to achieve objectives.
		Management	Management activities that are centered upon matters and things.

Figure 4. Profile of Project Managers' Competencies for Collaborative Construction Projects

Finally, the identified competencies in this study were compared to the ones identified from the literature, and it became clear that there are differences between the required competencies for the project managers in traditional and in collaborative construction projects. Whereas the managerial competencies for traditional construction projects highlight the significance of systems and methods, the recognized competencies of relevance for collaborative construction projects draw attention to human issues and management. This argument can be supported from two aspects. First, looking at top 10 competencies identified from literature and those competencies from survey and interviews, competencies such as time management, quality management, and human resource management, which have been important in traditional construction projects, are no longer effective in collaborative construction projects. Second, looking at the competencies detected in this study, it seems that the importance of competencies (such as understanding others and stress management) related to human issues and in particular, behavior of project managers in collaborative construction projects, have increased.

Moreover, the body of needed competencies in traditional and in collaborative construction projects may well emanate from the differences between the working culture, management style, and business model of traditional and collaborative construction projects. The working culture in collaborative construction projects is based on trust, cooperation, effective communication, and teamwork whereas traditional construction projects often suffer from mistrust, adversarial relationships, and ineffective communication (Forbes and Ahmed, 2010; Fischer et al., 2017). The type of culture in collaborative construction projects needs a project manager whose management style helps him/her to trust project team members and foster teamwork and effective communication (Oakland and Marosszeky, 2017). To that end, competencies such as group capabilities, language proficiency, leveraging diversity, flexibility, relationship building, and understanding others are here characterizing the needed culture as mentioned by this study (Figure 4).

Then, a business model comprising elements such as fixed profit and profit based on project outcome (shared risk/reward system) needs a project manager who can lead all project practitioners toward a common goal by aligning their commercial interests toward project efficiency as a whole. Such a project manager needs competencies such as leadership, management, and developing others (see Figure 4). In other words, project managers in collaborative construction projects are managers of people rather than managers of systems and technology. Therefore, in

collaborative construction projects the behavioral competencies related to human issues are of prime importance, whereas in traditional construction projects the key competences are around systems and methods.

These findings provide new insights for the project managers in terms of possessing the competencies necessary for their successful performance, and their employers to be aware of the project managers' core and supportive competencies. Since 2011, the total value of launched alliance-type construction projects in Finland is more than EUR 3 billion. This highlights the importance of this study's findings for contributing to the existing knowledge on the project managers' competencies. Finally, it should be acknowledged that the generalizability of the findings of this study is rather limited due to its scope, which includes project managers of collaborative construction projects in Finland.

4.4 Paper IV

Paper IV aimed **to identify the appropriate competencies of project managers in collaborative construction projects and to develop a model of the competencies accordingly.**

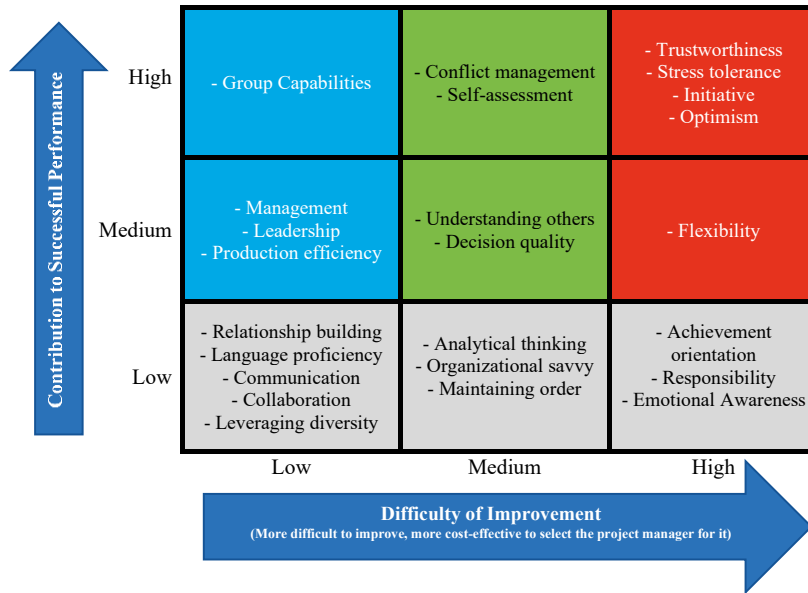
To that end, the survey strategy was employed with a behavioral approach where project managers' behavior in their everyday work was the main source for understanding their competencies. The self-evaluation web-based questionnaire (Cycloid) was utilized for data collection.

In this study, respondents were asked to choose and determine the frequency of their behaviors in the situations presented by each linguistic statement on a scale: never/seldom/often/always in their current and target state. How often these behaviors occur in the representing statements of each competency were evaluated both in the current and target states through analyzing the numeric values of the current and target states of the self-evaluation results. The questionnaire was sent to 33 project managers of ongoing and/or recently completed collaborative construction projects in Norway and Finland and a response rate of 73% was achieved.

A matrix model of competencies for the project managers was developed based on the findings from the survey (significance of project managers' different competencies in the current state, the target state and creative tension). The development process of this model was explained earlier in sub-chapter 3-2. In short, first, the competencies were structured based on their contribution to project managers' successful performance. Second, the competencies were also structured based on the degree to which project managers have difficulty to improve their competencies. Finally, the 3x3 matrix was developed based on the structuring of competencies in the previous steps.

As the main result, the matrix model presents project managers' competencies for collaborative construction projects (Figure 5). There are four sets of competencies in the model which include key competencies, supportive competencies, hybrid competencies, and threshold competencies.

Competency Model for Project Managers of Collaborative Construction Projects



Legend

Key Competencies	Those competencies to be considered by employers for selecting the project managers, as they are hidden and central to personality and considerably contribute toward the successful performance of project managers.
Supportive Competencies	Those competencies to be considered by project managers for performance improvement, as they can be improved easier by training and also contribute toward the successful performance of project managers.
Hybrid Competencies	Those competencies to be considered by both project managers and their employers. These competencies considerably contribute to successful performance, and it is neither too difficult nor too easy to improve them.
Threshold competencies	Those competencies needed for minimally accepted level of work, the lower cut off point below which a project manager of a collaborative construction project would not be considered competent.

Figure 5. Matrix Model of Competencies for Project Managers of Collaborative Construction Projects

Among the key competencies, trustworthiness, stress management, initiative, and optimism were common in the target state of the both respondent groups. This means that these competencies considerably contribute to the successful performance of the project managers. In addition, these four competencies are hard to improve, as they are more hidden and central to personality. The last competency in this group is flexibility, which is hard to improve, but its contribution to the successful performance is less than those four ones which were described earlier. The key competencies, altogether, are hard to improve while contributing to the

successful performance of the project managers. Therefore, the most cost-effective way for the employers is to select those project managers that already have these competencies.

The supportive competencies are easier to develop, as they are related to knowledge and skill-oriented competencies. In terms of contribution to the successful performance, the relevance of group capabilities competency is higher than others in this group. Training is the best way for improving the supportive competencies, which can be considered for improving the performance of the existing project managers.

The hybrid competencies are somewhat difficult to improve, but they also significantly contribute to the successful performance of project managers. Accordingly, these competencies, with dual functionality, can be considered for both selection of project managers of relevance and improving the performance of the existing ones.

Finally, the threshold competencies are those ones which seem to have less contribution to the successful performance (compared to the previously explained groups). These competencies are required for minimally accepted level of work, the lower cut off point below which a project manager of a collaborative construction project would not be considered competent.

The novelty of this model is related to its functions and features. This model not only presents the cost-effective way (easier to improve competencies) for performance improvement of the existing project managers, but also provides new insights for employers of the project managers to know which competencies are difficult to improve and cause the successful performance. This also provides the cost-effective way for the employers to select the right project manager for their collaborative construction project.

These findings provide research-based contribution for the project managers' competencies. The results can provide a frame of reference for the project managers of relevance and their employers. The generalizability of the findings of this study is rather limited as having the research basis in the Nordic countries. Therefore, further studies in various regions and business conditions is a potential area for further research.

4.5 Paper V

Paper V aimed at **identifying those competencies which contribute to project managers' individual and team performance in collaborative construction projects**. The obtained research data from Survey 2 (the significance of project managers' different competencies in the current state, target state and creative tension) were analyzed to fulfill the intended purpose of the study. This analysis was performed in two steps. First, the 10 highest significant competencies of the both respondent groups in their target state and creative tension were analyzed and the common ones were identified. Second, the meaning and behavioral indicators (the linguistic statements representing each competency) of those identified common competencies were reviewed to discover which competency contribute to the individual performance of the project managers and which one toward their team performance. **As the main result, a profile of project managers' competencies was developed for collaborative construction projects** (see Figure 6). This profile is comprised of two main parts as follows:

Competencies contributing to the individual performance. This group of project managers' competencies includes *trustworthiness, stress tolerance, initiative, optimism, self-assessment and production efficiency*. A thorough understanding of these competencies suggest that they mainly contribute to the project managers' individual performance. This means that these competencies enable project managers to be successful in those tasks which they need to handle by themselves. In terms of improvability, these competencies are mainly hard or somewhat hard to improve (except for production efficiency), and therefore it is the most cost-effective way for the employers to hire those project managers which already have these competencies.

Competencies contributing to the team performance and group dynamics. This group of project managers' competencies includes *conflict management, group capabilities, decision quality and understanding others*. Unlike the previous group, these competencies, as can be understood from their definition, seem to mainly contribute to the group dynamics and performance. This means that these competencies (group capabilities, conflict management) enable the project managers to succeed in those tasks which need to be conducted in cooperation with other team members. It also means that these competencies, (understanding others, decision quality) positively affect the project managers' leadership, as a whole, which subsequently can improve team performance and dynamics. As can be seen in Figure 6, there is a possibility for improving the competencies contributing to the team performance.

Category	Competency	Definition	Improvability	Key function(s) for employers
Competencies contributing toward individual performance	Trustworthiness	To deliver on promises, keep schedules, arrive on time on meetings and complete work as agreed and maintain trust between people.		
	Stress tolerance	To maintain performance when facing workload pressures and or organizational impediments.	Hard to improve	- Selecting those project managers that already possess these competencies
	Initiative	The ability to see new possibilities and to seize opportunities. To do more than what is expected.		
	Optimism	Pursuing goals regardless of obstacles and setbacks.		
	Self-assessment	The comprehension of one's own limits and strengths.	Somewhat hard to improve	- Improving performance of the existing project managers by training - Selecting the project managers
	Production efficiency	Performing tasks quickly and according to high standards.	Easy to improve	- Improving performance of the existing project managers by training
Competencies contributing toward team performance	Conflict management	The ability to negotiate and resolve disagreements between people. To reach out for win-win situations.	Somewhat hard to improve	- Improving performance of the existing project managers by training - Selecting the project managers
	Group Capabilities	The capability of working cooperatively with others, to be part of a team, to work together.	Easy to improve	- Improving performance of the existing project managers by training
	Decision quality	Making decisions based on principles, purposes and values.	Somewhat hard to improve	- Improving performance of the existing project managers by training - Selecting the project managers
	Understanding others	The ability to sense the feelings and perspectives of other people.		

Figure 6. Competencies Contributing to the Individual and Team performance of the Project Managers in Collaborative Construction Projects

As stated earlier, a cost-effective way for improving a competency is the training. These competencies that are improvable can be considered by the employers for selecting the project managers and for improving the performance of the existing ones.

The developed profile of project managers' competencies (Figure 6) presents those competencies which enable the project managers to build reliable relationships with all team members (through *trustworthiness, group capabilities, understanding others*), and to reach out win-win situations (through *conflict management and stress tolerance*) when there is conflict within the project team. The project managers also need to be individually productive as the project leaders, where they need *initiative, optimism, self-assessment* and *production efficiency* competencies to succeed.

These findings contribute to the existing knowledge concerning project managers' competencies in collaborative construction projects and can provide a frame of reference for the project managers of relevance and their employers. Finally, it should be acknowledged that the generalizability of the findings of this study is limited due to its scope. Therefore, relevant studies in various regions and business conditions is a potential area for further research.

5 CONCLUSIONS

This dissertation, relied on the positivism philosophy, utilizing the survey strategy with a behavioral approach, aimed to broaden the current limited research-based knowledge concerning project managers' competencies in collaborative construction projects. This chapter presents the summary of the obtained results in this process, answers the research questions, points out to the contributions of this study, and acknowledges the limitations associated with the research behind this dissertation. Finally, some suggestions are presented for the future studies.

5.1 Summary of the results

The undertaken research led to the insightful findings which are summarized in the following:

There are certain discrepancies between the research-based results and standards of practice on project managers' competencies. These discrepancies include commonly existing/missing competencies; uneven priority of some competencies in the view of researchers vs. standards of practice; uneven degree of consensus on the importance of competencies; and research results are more context-oriented than the standards of practice.

From the holistic view, there are 98 competencies for project managers (mentioned by the above sources) of which 68 ones have more than one frequency of appearance. In this list, *communication, leadership, teamwork and cooperation, flexibility, problem solving, goal orientation, developing others, impact and influence, stakeholder management, and resource management* are the top 10 ones with more than 10 appearances in the previous studies. Although construction projects have been considerably focused for understanding project managers' relevant competencies, this subject of interest in the context of collaborative construction projects has been limitedly addressed. Among the identified competencies for project managers of traditional construction projects, *teamwork and cooperation, cost management, communication, leadership, quality management, knowledge of construction, flexibility, resource management, HSE (paying attention to health, safety, and environment)* and *experience* are the top 10 ones.

Project success research led to the constitution of context-oriented studies and customization of the project success knowledge for specific targets, project contexts and project types. The main reason for the emergence of this trend is that the general perspective was rather dominant regarding studies on project success, where previous studies have insufficiently addressed different project types and/or contexts in the project success research. Moreover, the project success research has led to the identification of 65 success factors and 13 success criteria (with more than more appearance in the previous studies) in general for various types of projects. Project manager's competency is among the top five success factors which contribute to the success of projects in general, and construction projects in particular.

Successful project managers in collaborative construction projects need certain core and supportive competencies, which are different from the competencies contributing to project managers' successful performance in traditional construction projects. Their core competencies (necessary for their successful performance) comprise *group capabilities, language proficiency, leveraging diversity, stress tolerance, flexibility, relationship building, leadership, maintaining order, achievement orientation, and understanding others*. Their supportive competencies (supplementary for core competencies) were found to be *emotional awareness, communication, innovativeness, developing others, initiative, organizational savvy, and management*. Moreover, the required competencies for project managers in traditional and in collaborative construction projects are different.

The matrix model of project managers' competencies for collaborative construction projects, structured based on the contribution to the project managers' successful performance and the difficulty of improvement, presents four groups of key, supportive, hybrid and threshold competencies. The profile of the presented competencies, in the big picture, represents individual efficiency and effectiveness combined with teamwork, mutual understanding and trust, collaborative cooperation, and no-blame-related behavior. This model can be a frame of reference for hiring the project managers and improving the performance of the existing ones. It can also serve as a benchmarking tool for the project managers to evaluate and develop their competencies further. These findings also suggested that *characteristics of collaborative construction projects can affect the required competencies for the successful performance of the project managers. The common characteristics (e.g., trust-based relationships, shared risk-reward system) require certain core competencies, whereas the unique characteristics (e.g., culture, contracting parties) require certain context-oriented competencies.* However, this needs to be tested in the future studies.

The individual and team performance of the project managers in collaborative construction projects can be positively affected by certain competencies. There are six competencies contributing to the project managers' individual performance, helping them to be successful in accomplishing those tasks they need to perform alone. These competencies are *trustworthiness*, *stress tolerance*, *initiative*, *optimism*, *self-assessment*, and *production efficiency*. There are also four competencies, helping the project managers to succeed in those tasks, which they need to collaborate and cooperate with their team members. These competencies are *conflict management*, *group capabilities*, *decision quality* and *understanding others*.

The gained new understanding of competencies has obvious implications towards different project professionals of collaborative construction projects. The findings of this research also represent an evolution in terms of the concepts explaining the competencies of construction project managers. The developed concepts in papers III, IV and V (e.g., key, supportive, hybrid) for categorizing and clustering the competencies is related to the type and frequency of the functions and contributions of those competencies, whereas the similar concepts utilized in the previous studies (e.g., people, practice, personal, performance) mainly represent the specific target and/or context in which the competencies are relevant.

Moreover, it can be stated that the presented competencies in Figures 5 and 6 can be also important and value-added for the other project professionals (e.g., project coordinators, site engineers, project controllers). The reason for this argument is that those competencies, in the big picture, represent the individual efficiency and effectiveness, teamwork, mutual understanding and trust, collaborative cooperation, and no-blame related behavior, which indicate the key elements and characteristics of collaborative construction projects. The presented competency models in Figures 5 and 6 can also be considered as the bases for exploring the required competencies for the key parties and their team members in collaborative construction projects.

5.2 Answering the research questions

This research, descriptive in purpose, aimed to provide novel research-based understanding concerning project managers' competencies in collaborative construction projects through answering the following research questions:

RQ1: What are the main sources and perspectives behind the evolution of project managers' competency research in general and in the context of construction projects?

The research community and the standards of practice, with general and context-specific perspectives, have been the main sources behind the evolution of the project managers' competency research. The resultant studies by the research community represent both general and context-oriented perspectives in a hybrid manner whereas it can be stated that standards of practice have mainly relied on the general perspective for exploring the required competencies for project managers. The analysis of current research-based knowledge led to the identification of 381 competencies. Synthesizing these identified competencies resulted in a final list of 98 competencies of which 68 ones have more than one frequency of appearance. These 68 competencies, as categorized in paper I, represent four clusters of personal, performance, perspective and interpersonal.

The competence research in the context of construction projects has been benefited from the general and context-oriented perspectives originated from the research community. Therefore, as it can be understood, the research on construction project managers' competencies can be divided into two groups: construction project managers' competencies in general (for various sectors), and construction project managers' competencies for specific contexts and/or sectors (e.g., delivery models). These two groups of studies, together, account for 187 competencies mentioned in the previous studies. Synthesizing those competencies led to a final list of 65 competencies for project managers of construction projects, listed in Table 3, of which *teamwork and cooperation*, *cost management*, *communication*, *leadership*, *quality management*, *knowledge of construction*, *flexibility*, *resource management*, *HSE (paying attention to health, safety, and environment)* and *experience* are the top 10 ones.

RQ2: What are the required competencies for the successful performance of project managers in collaborative construction projects?

Project managers' competencies have two important aspects: the degree to which they contribute to the successful performance of the project managers, and the degree to which it is difficult to improve them. There are four sets of competencies, identified in this study, which form the profile of project managers' competencies for collaborative construction projects:

- *Key competencies (trustworthiness, stress tolerance, initiative, optimism, and flexibility)* considerably contribute to the successful performance of the project managers and it is difficult to improve these competencies. Therefore, the employers of the project managers need to be aware of these competencies when they want to hire them. This is a cost-effective way for the employers to hire those project managers which already have these competencies.

- *Supportive competencies* (*group capabilities, management, leadership, and production efficiency*) can be easily developed by the training and therefore can be utilized for improving the performance of the existing project managers.
- *Hybrid competencies* (*conflict management, self-assessment, decision quality, and understanding others*) also have great contribution to the successful performance of the project managers but are somewhat difficult to improve. This set of competencies can be considered for selection of the new project managers and also improving the performance of the existing ones.
- *Threshold competencies* (see Figure 5) are those ones which seem to have less contribution to the successful performance (compared to the previously explained groups). These competencies are required for the minimally accepted level of work, the lower cut off point below which a project manager of a collaborative construction project would not be considered competent.

Regardless of the difficulty of improvement, *trustworthiness, stress tolerance, initiative, optimism, and group capabilities* competencies have the greatest contribution to the successful performance of the project managers in collaborative construction projects.

RQ3: How has the evolution of construction project delivery models affected the spectrum of the required competencies for the project managers?

The findings suggest that there are differences between the required competencies for project managers in traditional and in collaborative construction projects. The differences can be explained from two aspects: (i) competency type and characteristics, (ii) impact of the different type of competencies required for collaborative and for traditional construction project managers.

Competencies of collaborative construction project managers are mainly related to motive, trait and/or self-concept (e.g., trustworthiness, stress tolerance, optimism, initiative, self-assessment) whereas traditional construction project managers' competencies are mainly knowledge and/or skill-oriented (e.g., cost management, knowledge of construction work, quality management).

These differences, consequently, affect the performance of the project managers. Those competencies identified for collaborative construction project managers help

them to maintain high level of effectiveness in those tasks they need to handle by themselves and help them also to succeed in those tasks which they need to collaborate and cooperate with their team members. Hence, it can be argued that the identified competencies for collaborative construction project managers are mainly focused on understanding relationships and value creation. Conversely, knowledge and skill-oriented competencies of traditional construction project managers are mainly focused on systems and methods.

The explained differences are also in line with the recent studies where it has been stated that a behavioral paradigm shift is needed for the projects managers and team members working in collaborative construction projects, compared to the traditional construction projects (Oakland and Marosszeky, 2017; Fischer et al., 2017). In a nutshell, the findings imply that project managers in collaborative construction projects are managers of people and relationships rather than managers of systems and technology.

5.3 Contributions of the research

The academic and industrial contributions of this research on the subject of project managers' competencies are as follows.

Compared with the existing literature and research-based knowledge this study contributes new knowledge and models on the project managers' competencies by identifying the different perspectives and consequently discrepancies between research results and the standards of practice. Moreover, the studied contexts for addressing project managers' competencies together with the key competencies were also presented. These contributions can be insightful for providers of standards and practice and the project managers as well.

The research also contributes to the project success research. The evolution process of project success research was mapped, which can be insightful for the research community to know the nature of success research so far and the leading research questions behind the previous studies and to gain ideas for potential future research. Moreover, the key success factors and critical success criteria for projects in general were identified which can be helpful for project practitioners. An interesting point in the findings was that project managers' competencies was among the critical success factors for various types of projects (including the construction ones). This finding can be a clue over the importance of project managers' competencies in project success, particularly in construction projects.

The main contribution of this research is toward project managers' competencies in the context of collaborative construction projects. This was accomplished by identifying the required competencies for the project managers. The findings not only fill the existing knowledge gap concerning the subject of interest but also provide practical and cost-effective ways for employers on how to select the right project manager for a collaborative construction project and how to improve the performance of the existing ones. Moreover, the answer to the RQ2 became it clear that majority of competency requirements in traditional construction projects seem to be no longer effective in collaborative construction projects. These findings can be of importance in industry as well where project managers' competencies can directly contribute to project success up to 44% (Toney, 2001). Since 2011, only in Finland, nearly 100 collaborative construction projects with total value of 5.5-6 billion EUR have been launched. Managers and developers of such projects can be highly benefited from the findings of this study through successful selection of the project managers and helping the existing ones to improve their performance. This can, in turn, increase the likelihood of success in collaborative construction projects.

5.4 Limitations

The quality of research, and in this dissertation as well, is usually measured based on the reliability, credibility (internal validity) and generalisability (external validity) (Saunders et al., 2019). Reliability refers to the extent to which the research procedures will yield consistent findings (Saunders et al., 2019). "Internal validity refers to the extent to which your findings can be attributed to the intervention you are researching rather than to flaws in your research design" (Saunders et al. 2019, p.215). External validity (generalisability) represent the extent to which findings of a study can be generalised to other relevant contexts (Saunders et al., 2019). In this dissertation, some factors were recognized that may affect the reliability and the validity.

The limited number of collaborative construction projects in Finland and other European countries made it difficult to find and access a large number of the relevant project managers for participating in the survey. Hence, the generalisability of the findings is still rather limited as having the research basis in the Nordic countries. Moreover, the cultural differences between the addressed contexts in this study and

other contexts could also affect the generalisability of the findings. Therefore, further studies in various regions is a potential area for the future research.

It is also worthy to mention that this study addressed the subject of the interest in alliancing and partnering construction projects, among the existing collaborative delivery models. This factor can also affect the generalisability of the findings, as some of the collaborative delivery methods (e.g., IPD), common in certain countries, were not addressed in this study. This can also be a potential area for the future research.

All in all, this study aimed to contribute to the existing limited research-based knowledge on project managers' competencies in collaborative construction projects. The conducted research, considering all the explained limitations, led to the insightful findings, which not only have academic contributions but also provide practical knowledge for the project managers and their employers in collaborative construction projects. The obtained results raised some questions, presented in the following, which can be the departure points for the future studies.

5.5 Suggestions for future research

The following research questions can form departure points for the future studies concerning project managers' competencies in collaborative construction projects:

- How to select project managers of collaborative construction projects based on the presented categories in the matrix model, developed in this study?
- How to train easy-to-improve competencies, presented in this study?
- How to develop a frame of reference for successful/superior performance of project managers in collaborative construction projects?
- What are the appropriate competencies of the project managers in construction projects with integrated project delivery (IPD)?
- What are the appropriate competencies of other key team members in collaborative construction projects?

This study aimed at contributing to the body of knowledge on construction project managers' competencies. This was accomplished through identifying those

competencies which project managers of collaborative construction projects need to possess to support their successful performance. The findings can be insightful for both the research community and practitioners of collaborative construction projects, particularly the project managers and their employers. The findings of the undertaken research also led to raising the above-mentioned questions which can be considered as the departure points for the future research and developments in the field of collaborative construction projects.

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ORIGINAL PAPERS

PAPER I

Comparison of Research and Industry Views on Project Managers' Competencies

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Comparison of research and industry views on project managers' competencies

Abstract

Purpose-The success of projects clearly relies on project management personnel and particularly on project managers. Their performance and capacities are based on the achieved competencies. This study aims at addressing possible discrepancies between the views arising from the research results and standards of practice related to project managers' competencies.

Design/methodology/approach-For reaching the aim of the study, a comprehensive literature review, covering previous studies and related standards of practice was conducted, and analyses of competencies in the studies and standards of practice containing the rank of competencies based on frequency of appearance were developed.

Findings-The findings are proposing four discrepancies between the results of previous studies and standards of practice: i) Commonly existing/missing competencies ii) Uneven priority of some competencies in the view of researchers versus standards of practice, iii) Uneven degree of consensus on the importance of competencies, and iv) Research results are more context-oriented than the standards of practice. In addition, 98 project managers' competencies were identified, from which 68 were qualified as weighty ones. Moreover, a categorization of project managers' weighty competencies was developed. Finally, a list of competencies of relevance for different project types and their targets is presented.

Originality/value-The findings of this study provide a contribution with respect of present knowledge over project managers' competencies by recognizing certain discrepancies between research results and standards of practice. Another contribution of the study is the comprehensive list of competencies together with considerations of their relevance in different project contexts and in different project types.

Key words: Project manager, Competency, Project management standards

Article type: Research paper

Introduction

Project management personnel and particularly project managers play the most important role in project success of all human resources, and the competencies of project managers are their main tool in meeting the expectations and realizing project goals (Beer et al., 1990; Brown and Eisenhardt, 1995; Crawford, 2000; Crawford, 2005; Geoghegan and Dulewicz, 2008; Karpin, 1995; Katz and Allen, 1985; Pinto et al., 1995; Smith et al., 1984). A study conducted by Toney (2001) showed that the project managers have direct influence over 35-47 per cent of project success (Toney, 2001). Additionally, an industry research by Gartner proved that insufficient project managers' competency accounts for 60% of project failures (MacInnis, 2003). Müller and Turner (2007) also proved the positive correlation between the project manager's leadership competencies and project success (Müller and Turner 2007). The importance of project managers' competencies in their effectiveness and subsequently in project success has led to a vast amount of studies which have produced new research-based understanding and also some standards of practice in this subject. Whereas the logic of research work and the preparation of standards of practices are somewhat different, it seemed possible that there may be some discrepancies between the gained research results and the content of the standards of practice. Some of these studies and standards of practice have addressed project managers' competencies in general and some other studies have focused on a specific context or project type to find competencies of relevance for project managers. Conceptually, discrepancy means one or more differences between two things that should be the same. Therefore, the probable discrepancies in the scope of this study are expected to be found in the degree of consensus on identified and important competencies. Notwithstanding studies which have been undertaken till now, there still are some gaps in this regard of which the first one is related to the mentioned discrepancies and the second one is about considering appropriate contexts of identified competencies in the literature which have been largely ignored by research community. By building on foundational research work and standards of practices on project managers' competencies, the present study aims at fulfilling the mentioned gaps by answering the following questions:

- Are there discrepancies between research results and standards of practice addressing competencies of project managers?
- What are the appropriate contexts of identified competencies in the literature?

This paper is structured in four sections. First, the summary of literature review on project managers' competencies is presented, including provided definitions and categorizations by different standards of practice, also addressing previous studies in this area. Second, research methodology is explained. Third, analysis of literature review in result section follows. Finally, a discussion is provided over the obtained results and implications of the study.

Research background

The competence of the project managers is in itself a factor in successful delivery of projects and on the other hand, the project managers need to have competency in those areas that have the most impact on successful outcomes (Crawford, 2000). Abraham et al. (2001) also defines competency as a range of different characteristics, behaviors, and traits that are required for effective job performance (Abraham et al., 2001). According to another definition, ICB.4 (2017) stated that individual competence is the application of knowledge, skills and abilities in order to achieve the desired results (ICB4, 2017). PMCD.3 (Project Manager's Competency Development framework) also mentioned that competent project managers consistently apply their project management knowledge and personal behaviors to increase the likelihood of delivering projects that meet the stakeholders' requirements

(PMCD.3, 2017). In this paper, the adopted definition is that competency means the capability to use skills, knowledge and personal characteristics that enhance the efficiency and effectiveness of project managers in their job performance and subsequently increase the likelihood of project success.

Standards of practice in the area of project managers' competencies

ICB, APM Body of Knowledge, PMBOK and Project Manager Competency Development framework (PMCD) are those standards of practice which have paid attention towards project managers' competencies. Hence, these standards of practice and frameworks present different competencies of project managers and of course categorizations of those, and address the project managers' competencies in a more general perspective. ICB.4 introduces 28 competencies of project managers in three groups of people, practice and perspective (ICB.4, 2017). In other categorization by project management competency development framework (PMCD), 16 mentioned competencies of project managers are divided into two group, performance and personal competencies. The APM standard is another reference that considers 11 competencies in two groups, interpersonal and professional. PMBOK Guide also introduced a framework titled PMI Talent Triangle which considers three types of project managers' skills. Details of the mentioned categorizations are presented in Table 1.

Table1. Categorization of project managers' competencies by different standards of practice

Project managers' competencies		
Standard/framework	Cluster/group	Competency
ICB.4	People	(1)Self-reflection and self-management (2)Personal integrity and reliability (3)Personal communication (4)Relationships and engagement (5)Leadership (6)Teamwork (7)Conflict and crisis (8)Resourcefulness (9) Negotiation (10)Result orientation
	Practice	(1)Project design (2)Requirements and objectives (3)Scope (4)Time (5)Organization and information (6)Quality (7)Finance (8)Resource (9)Procurement (10)Plan and control (11)Risk and opportunity (12)Stakeholders (13)Change and transformation
	Perspective	(1)Strategy (2)Governance, structure and processes (3)Compliance, standard and regulation (4)Power and interest (5)Culture and values
PMCD.3	Performance	(1)Project integration management (2)Project scope management (3)Project time management (4)Project cost management (5)Project quality management (6)Project human resource management (7)Project communication management (8)Project risk management (9)Project procurement management (10)Project stakeholder management
	Personal	(1)Communicating (2)Leading (3)Managing (4)Cognitive ability (5)Effectiveness (6)Professionalism
APM	Interpersonal	(1)Communication (2)Conflict management (3)Delegation (4)Influencing (5)Leadership (6)Negotiation (7)Teamwork
	professionalism	(1)Communities of practice (2)Competence (3)Ethics framework (4)Leading and development
PMI Talent Triangle(PMBOK)		(1)Technical project management skills (2)Leadership (3)Strategic and business management skills

Besides the given information by standards of practice about project managers' competencies, a substantial amount of research has been conducted by different researchers from 1959 to 2018 which is addressed in the following.

Evolution of research on project managers' competencies

Studies on the subject of project managers' competencies can be traced back to a paper by Gaddis (Gaddis, 1959) and another Harvard business review article by Lawrence and Lorsch, in 1967, titled

'The Integrator'. Since then, several studies have been conducted on the subject of project managers' competency. A study conducted by Powers (1987) identified a group of managerial competencies which were characteristics of superior performance. These competencies were grouped into 18 competencies through cluster analysis and into four larger clusters including goal and action management, directing subordinates, human resource management and leadership (Powers, 1987).

Edum-Fotwe and McCaffer, and Crawford conducted studies to explore more details of project managers' competencies in construction projects and correlation of project managers' competency with project success (Crawford, 2000; Edum-Fotwe and McCaffer, 2000). Then, Shenhar conducted a study 'one size does not fit all projects: exploring classical contingency domains' in 2001; he stated that a specific project type should affect the selection of project managers, project team members and skill development needs. In other words, Shenhar's finding on the importance of contingent thinking was the starting point of considering appropriateness of project managers' competencies and project type. Moreover, several studies were conducted by Abraham et al. (2001), El-Sabaa (2001), Ruuska and Vartiainen (2003) and Kasvi et al. (2003), addressing critical and important competencies of project managers as well as efficiency and effectiveness of project managers in their role, and competencies such as leadership, communication, goal-orientation, problem solving, decision-making, teamwork and cooperation and conceptual thinking identified in result of those studies (Abraham et al., 2001; El-Sabaa, 2001; Kasvi et al., 2003; Ruuska and Vartiainen, 2003).

Addressing the success and effectiveness of project managers in terms of their competencies followed by other researchers such as Dainty et al. (2004), Cheng et al. (2005), Gillard and Price (2005), Brill et al. (2006) and Suikki et al. (2006), and new competencies such as analytical thinking, flexibility, adaptability, and ethics were also identified in addition to those already mentioned.

Some researchers such as Serpell and Ferrada (2007), Ahadzie et al. (2008) and Isik et al. (2009) focused on the required competencies of project managers in the engineering projects particularly construction ones, and they also addressed the role of complexity in identifying important competencies of project managers (Serpell and Ferrada, 2007; Müller and Turner, 2007; Mutijwaa and Rwelamila, 2007; Patanakul and Milosevic, 2008; Chen et al., 2008; Ahadzie et al., 2008; Bosch-Rekvelde et al., 2009; Isik et al., 2009; Müller and Turner, 2010). The appropriateness of project managers' competencies with the project type was taken into account by Muller and Turner (2007, 2010), showing a positive correlation of project managers' competencies with project type, and they also identified important leadership competencies in the types of areas of engineering and construction, IT and organization and business, and showed that almost always emotional competencies contribute to project success. These studies confirmed Shenhar's (2001) finding on the necessity of matching the project type and project managers' competencies.

Crawford and Nahmias (2010) conducted a study to explore important competencies of project managers for managing change, and identified eight competencies including leadership, stakeholder management, planning, choosing/developing the team, communication, decision-making and problem-solving, cultural skills and project management skills. The findings of another study conducted by Stevenson and Starkweather (2010) revealed that preferred IT project management competencies for successful project management are leadership, the ability to communicate at multiple levels, verbal and written skills, attitude and the ability to deal with ambiguity and change. A research conducted by Ehsan et al. (2010) showed that project managers' competencies are positively correlated

with project success which confirmed the findings of Müller and Turner (2010) about positive correlation of project managers' competencies and project success.

In a more specific manner, engineering field and particularly construction projects the needed project managers' competencies have been studied in different countries. In result of these studies, some new competencies such as contract management, logical thinking, conflict management, honesty and integrity and alertness and quickness were identified (Dogbegah et al., 2011; Fisher, 2011; Lee et al., 2011; Klendauer et al., 2012; Zhang et al., 2013; Jabar et al., 2013; Hwang and Ng, 2013; Othman and Jaafar, 2013; Trivellas and Drimoussis, 2013; Ahadzie et al., 2014; Panas et al., 2014). In the same period, two different focused studies conducted by Chipulu et al. (2013) and Radu (2014) addressed the competencies that the project stakeholders and employers of project managers expect them to possess or obtain. The findings of these two studies identified new project managers' competencies and also revealed interesting differences between the competencies required by employers and those promoted by the academic community (Chipulu et al., 2013 and Radu, 2014).

The more recent studies conducted between 2015 and 2018 suggest that focus on investigating and identifying project managers' competencies in engineering projects, particularly construction type, (Omar and Fayek, 2016; Takey et al., 2015; Tabassi et al., 2016; Blixt et al., 2017; Crayon et al., 2017; Dziekoński, 2017; Abdullah et al., 2018; Kostalova et al., 2018; Shah and Prakash, 2018) and organizational context (Brière et al., 2015 and Loufrani and Saglietto, 2016) has been continued. Meanwhile, some researchers have addressed general aspects of project managers' competencies. These efforts have produced competencies having relevance for all types of projects (Liikamaa, 2015 and Ekrot et al., 2016). The results of these studies cover the findings of previous ones, which tried to address project managers' competencies, but some new competencies such as seeking information and stress management are seen among their findings. The synthesis of all mentioned competencies in the standards of practice and previous studies are presented in the results chapter.

Methodology

Theoretical framework

The first stage of the research focused on different appearances of competencies and relating analysis. Generally, this viewpoint is based on the ontology of concepts (Lundqvist et al., 2011). Ontological perspective towards competencies has been utilized by different researchers to look at the competency from its different aspects and restructuring competencies based on their nature. This restructuring generally comprises clustering competencies for generic and specific purposes. For instance, Spencer and Spencer (1993) identified, defined and clustered 20 competencies into six categories based on their nature where they were characterized by motive, trait, self-concept, knowledge and skills of the human resource. Zwell (2000) also utilized ontological perspective toward competencies where 36 competencies, based on their nature, were categorized into five clusters including task achievement, relationship, personal attribute, managerial, and leadership.

The second stage of the research focused on project managers' context-specific competencies where the contingency theory based analysis is used as a main viewpoint for studying the possible dependencies between various project contexts and project managers' competencies. The classic contingency theory view on organizations asserts that "different external conditions might require different organizational characteristics, and that the effectiveness of the organization is contingent upon the amount of congruence or goodness of fit between structural and environmental variables"

(Shenhar, 2001, p 395). Based on the ideas of classic contingency theory and its 'one size does not fit all' approach, Shenhar (2001) elaborated contingency thinking in the context of projects suggesting that "the specific project type should affect the selection of project leaders, project team member and skills development needs" (Shenhar, 2001, p 412). It can also mean that different project types need project managers with specific competencies; the contingency perspective which was employed in this study to answer the second question.

Phases of research

As a first step an extensive literature study was carried out including both project management standards of practice and previous studies on project managers' competencies. Then, the investigation of the relevant standards of practice was carried out through identifying mentioned competencies of project managers in ICB.4, PMCD.3, PMBOK and APM standards of practice. After investigating the mentioned standards of practice and findings mentioned on project managers' competencies, a list of all 58 presented competencies by standards of practice was prepared (Table 1). In this study, the identified competencies with more than one appearance qualified as weighty competencies and competencies with only one appearance qualified as notable ones. Subsequently, a synthesis of identified competencies in the content of standards of practice was prepared (Table 2) for two main purposes: first, identifying weighty competencies and ranking them based on their frequencies of appearance. Second, to reach a list of all mentioned competencies by standards of practice by excluding similarities.

Then, ScienceDirect and the Emerald databases were chosen to find relevant previous studies in the subject of project managers' competencies. The following keywords were used for searching: project managers' competency and project management competency. The search ended up in 72 relevant papers after excluding irrelevant papers based on analysis of abstracts and full texts. The analysis of those resulted in a master list (a matrix of competencies with their references). Next, the competencies in this list were studied further by grouping those having clear equivalence. Analyzing those papers led to identifying mentioned competencies of project managers in the previous studies. Following, their frequency of appearance provided the basis for their ranking (Table 3).

When targeting the first research question, possible discrepancies between research results and standards of practice were discovered (Table 4 and 5). Table 4 is based on the main viewpoints of previous studies and standards of practice on project managers' competencies. Table 5 was developed through comparing the presented competencies in the previous studies (Table 3) and standards of practice (Table 2). This comparison was made based on the similarity or sameness in title or meaning of the competencies listed in Table 2 and 3. Accordingly, three categories, representing the found discrepancies, were developed. These categories include (i) the competencies, with the same or similar meaning or title, present both in the standards of practice and previous studies, (ii) the competencies present only in the previous studies, and (iii) the competencies present only in the standards of practice. Next, the identified and ranked competencies in Tables 2 and 3 were merged to form a synthesized list of project managers' competencies (Table 7). This list presents also the ranking of competencies based on their total frequency of appearance. Additionally, a new categorization of project managers' weighty competencies (those with more than one appearance) was developed (Table 8). This was developed for structuring weighty competencies and it includes four categories (personal, performance, perspective and interpersonal). This categorization was carried out in two steps. First, a comparison was made in terms of the meaning and skill match between the project managers' weighty

competencies identified in this study and the presented competencies and their categories by standards of practice. Then, the categories (personal, interpersonal, perspective, and performance), best representing the weighty competencies, were selected based on the made comparison in the first step. These selected categories are a combination of the presented categories (Table 1) by the standards of practice for project managers' competencies.

For answering the second question, project managers' competencies of relevance for different project types or contexts were identified based on the literature study (Table 9). Figure 1 presents the process map of research.

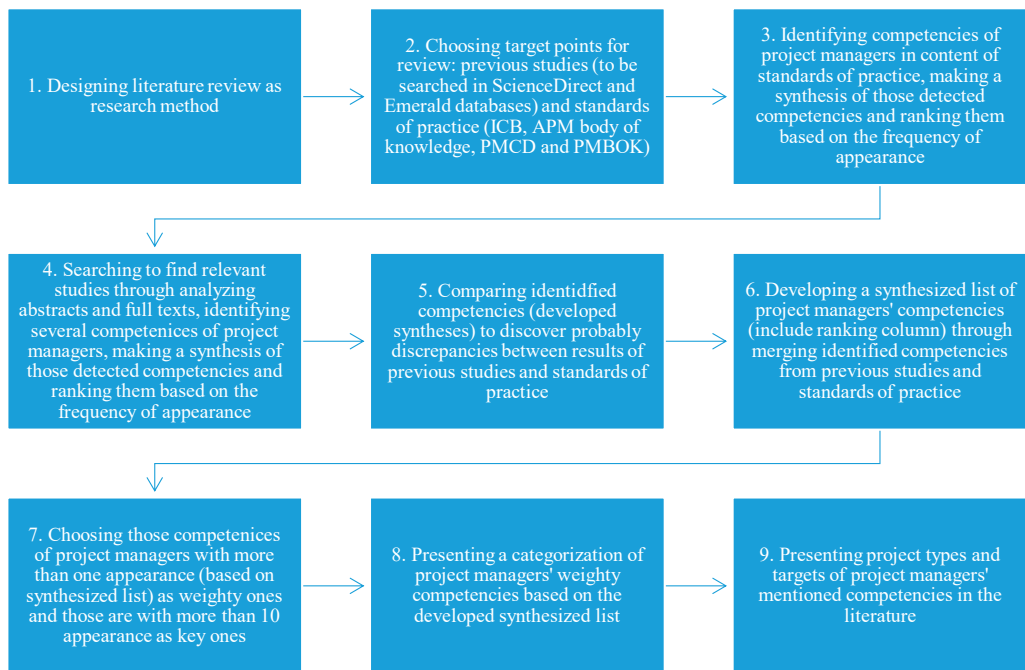


Fig.1. The research process

Results

Project managers' competencies in the standards of practice

As a result of analyzing the competencies in the standards of practice, a synthesis of 58 found competencies was developed together with their ranking (Table 2). Findings show that leadership, communication, resource management, teamwork, conflict management, negotiation, project scope management, project quality management and project cost management together with five other competencies are 14 competencies that have been mentioned in the standards of practice more than once. These competencies are considered as the weighty ones. There seems to be a degree of consensus among standards of practice about their relevance for project managers in general.

Table 2. Project managers' competencies in the standards of practice

Competency	References (frequencies)	Rank	Competency	Reference (frequencies)	Rank
Leadership	(ICB.4, APM, PMBOK, PMCD.3)	1	Result orientation	(ICB.4)	4
Communication	(ICB.4, APM, PMCD.3)	2	Project design	(ICB.4)	
Resource management	(ICB.4, APM, PMCD.3)		Requirement and objectives	(ICB.4)	
Teamwork	(ICB.4, APM)	3	Organization and information	(ICB.4)	
Conflict management	(ICB.4, APM)		Change and transformation	(ICB.4)	
Negotiation	(ICB.4, APM)		Governance, structures and processes	(ICB.4)	
Project scope management	(ICB.4, PMCD.3)		Cultures and values	(ICB.4)	
Project quality management	(ICB.4, PMCD.3)		Compliance, standard and regulation	(ICB.4)	
Project cost management	(ICB.4, PMCD.3)		Managing	(PMCD.3)	
Project procurement management	(ICB.4, PMCD.3)		Cognitive ability	(PMCD.3)	
Project integration management	(ICB.4, PMCD.3)		Effectiveness	(PMCD.3)	
Project risk management	(ICB.4, PMCD.3)		Professionalism	(PMCD.3)	
Project stakeholder management	(ICB.4, PMCD.3)		Influencing	(APM)	
Strategic and business management skills	(PMBOK, ICB.4)		Delegation	(APM)	
Self-reflection and self-management	(ICB.4)	4	Ethics framework	(APM)	
Personal integrity and reliability	(ICB.4)		Learning and development	(APM)	
Relationship and engagement	(ICB.4)		Technical project management skills	(PMBOK)	

Research -based project managers' competencies

As a main result of analyzing previous studies, 381 titles representing competencies were identified. The similarities between those provided a basis for a synthesis which includes 94 titles that are later termed as competencies (Table 3). Appendix 1 presents the references for each competence. As a result of ranking competencies based on their frequencies of appearance, it became evident that 64 competencies out of the 94 identified ones have been mentioned in the previous studies more than once (see Table 3 for details). So, it can be concluded that these are among project managers' weighty competencies in the viewpoint of the research community. Among those 64 identified weighty competencies, there are only six competencies, namely communication, leadership, teamwork and cooperation, flexibility, problem solving and goal orientation with more than 10 appearances in the previous studies. These are project managers' key competencies in the viewpoint of the research community. The following table (Table 3) presents project managers' competencies in the viewpoint of the research results.

Discrepancies between research results and standards of practice

The results show that there are four discrepancies between research results and standards of practice in terms of project managers' competencies. It was expected to see results of previous research and standards of practice addressing project managers' competencies with high similarity. This similarity was expected to be present for example about identified and weighty competencies and consensus (the same or similar viewpoints) on those identified and weighty competencies. The first discrepancy is that some competencies such as contract management, stress management and analytical thinking are missing in the standards of practice, as can be seen in Table 5. The second discrepancy is the qualitative mismatch between research results and standards of practice. This means that while there exists some consensus in the research results regarding the priority of some competencies such as goal orientation, decision-making and problem-solving, there is no corresponding consensus in the standards of practice. The third discrepancy is about the uneven degree of consensus (number of the same or similar viewpoints) in quantitative terms between research results and standards of practice. This approach produced list of weighty and key competencies. The fourth discrepancy comes back to main viewpoints of prior studies and standards of practice towards project managers' competencies. In other words, researchers not only have addressed project managers' competencies in general, but also have investigated appropriate competencies of project managers in different project types as well as the effects of those competencies on project success (see Table 9). In contrast, standards of practice have mainly taken into account project managers' competencies in a general manner and there are a few specific considered contexts in content or extensions of those standards of practice.

On the other hand, there are also some similarities between research results and standards of practice in the area of project managers' competencies. The first common point in this regard is that both standards of practice and literature have tried to address different dimensions of project managers' competencies such as personal and behavioral, and subsequently tried to discover new dimensions in that regard or update current knowledge, as can be seen in new versions of standards of practice and published papers. The second common theme deals with the competencies which have been mentioned in both of them (see Table 5). The last identified similarity is that standards of practice and previous studies have both agreed on the importance of project managers' competencies on their performance, though it seems that, as stated already, previous studies have moved further and addressed weighty competencies of project managers in different project contexts as well emphasized competencies' effect and implications on project success. These identified discrepancies (Table 4) can be useful for developers of standards of practice and research community.

Table 4. Discrepancies between research results and standards of practice over competencies of project managers

1. Some competencies are missing in the standards of practice
2. There is a mismatch between research results and standards of practice concerning priority of some project managers' competencies
3. There is uneven degree of consensus over importance of some project managers' competencies between research results and the standards of practice
4. Research results are more context-oriented than the standards of practice over project managers' competencies

The following table (Table 5) shows the discrepancies between previous studies and standards of practice in terms of present and non-present competencies.

Table 5. Discrepancies between result of research and standards of practice in terms of present and non-present competencies

The competencies present both in the standards of practice and previous studies	Communication, Leadership ,Stakeholder management, Goal orientation, Cost management , Developing others, Teamwork and cooperation, Resource management, Planning , Risk management, Conflict management, Impact and Influence, Quality management, Procurement management, Technical competencies, Scope management, Strategic direction, Ethics, Cultural skills, Negotiation, Self-control, Relationship building, Change management, Project integration management, Efficiency orientation, Delegation of authority, Cognitive capability, Professionalism, Management
The competencies present only in the previous studies	Flexibility, Problem solving, Analytical thinking, Decision making, Time management, Experience, Team management, Creativity, Conceptual thinking, Project management, Knowledge of construction work, Self-confidence, HSE(health, safety and environment), Motivation, Customer focus, Information seeking, Initiative, Proactivity, Self-assessment, Managing group process, Team selection, Conscientiousness, Behavioral competencies, Project knowledge, Interpersonal understanding, Commitment, Personal competence, Diagnostic of concepts, Sensitivity, Knowledge management, Directiveness, Continues improvement, Vision, Estimating, Emotional resilience, Assertiveness, Alertness and quickness, Trustworthiness, Stress management, Perceptual objectivity, Spontaneity, Positive regard, Mobilization, Knowledge of using tools and techniques, Skills in the use of computer, Understanding methods, process and procedures, Sharing credit for success, Self-awareness, Tendering, Operation management, General business management, Interdependency management, Multi-tasking, Being courageous, Judgment, Accountability, Social comprehension, Intuitiveness, Ability to formulate goals, Organizational awareness, Organizational awareness, Positive outlook, Learning orientation, Empathy and Aspiration, High energy level, Information technology skills
The competencies present only in the standards of practice	Requirement and Objectives; Organization and information; Governance, structures and processes; Compliance, Standard and regulation

A synthesized list of project managers' competencies

The identification and ranking of competencies present in the previous studies and related standards of practice led to development of a synthesized list of project managers' 98 competencies (Table 7). This list was developed through merging the identified competencies from previous studies and standards of practice. The following table (Table 6) presents the overall picture of the findings from the standards of practice, research results and, finally, the gained results (synthesized list).

Table 6 .Titles representing project managers' competencies

	Standards of practice	Research results	Synthesized list of project managers' competencies
Total 1	58	381	98
Total 2	34	94	
Notable	20	30	30
Weighty	14	64	68
Total 1: found competencies			
Total 2: synthesized competencies			

The synthesized list presents also competencies' ranking according to their total frequency of appearance in both previous studies and standards of practice. Appendix 1 includes also references. According to Table 7, communication, leadership, teamwork and cooperation, flexibility, problem

solving, goal orientation, developing others, impact and influence, stakeholder management, cost management and resource management are project managers' 11 key competencies (with more than 10 appearances in the previous studies and standards of practice) among the 68 identified weighty competencies (Table 7) *in viewpoint of the literature* (research community and standards of practice) which contribute to project success more than other identified competencies in this study. These key competencies of project managers have been focused by research community much more than other competencies. In addition, they have continuously been important and demanding since 2001, as their appearance trend can be seen in the following figure (Figure 2). Therefore, these competencies can be considered as project managers' core competencies in general (for all project types and targets). The following Figure shows the appearance trend of project managers' key competencies during recent decades.

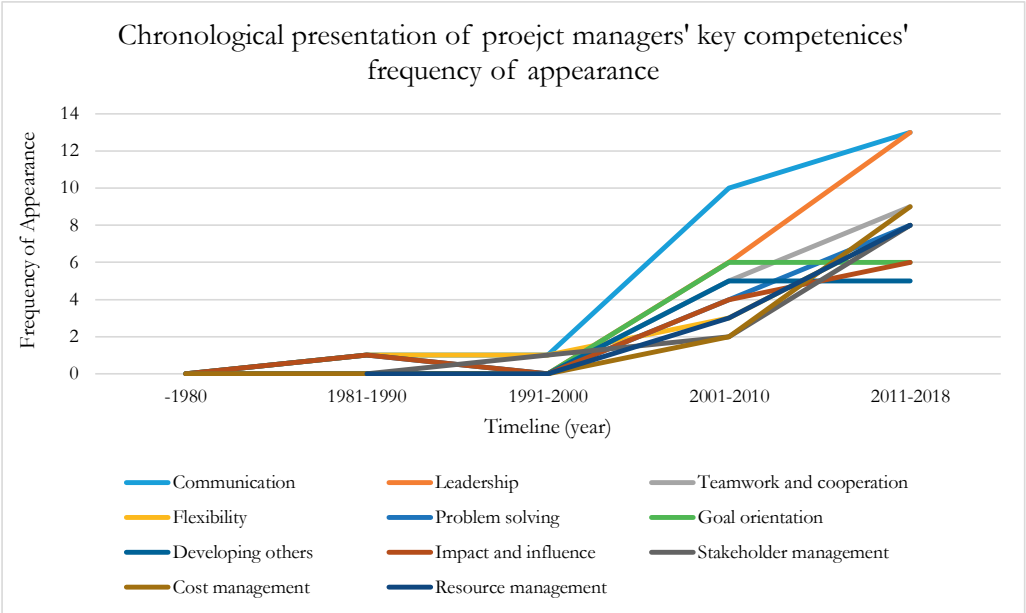


Fig. 2. Chronological presentation of project managers' key competencies' frequency of appearance

The developed list of project managers' competencies creates a new insight towards addressed project managers' competencies by standards of practice and research community from 1959 to 2018. This provided list can also be considered as a useful reference for future studies in this field. The following Table 7 shows the synthesized list of project managers' 98 competencies. In addition, definition of the listed competencies in Table 7 can be seen in Appendix 2. Moreover, Appendix 3 presents timewise distribution of these competencies. Accordingly, it looks obvious that while during recent two decades the frequency of appearance of the weighty competencies grew, the more was their demand and importance. In other words, timewise distribution of weighty competencies' frequency of appearance showed that importance and demand of them have been continuous since 2001, and therefore their appearance in literature do not belong to a specific and limited period of time.

New categorization of project managers' weighty competencies

Structuring of weighty competencies resulted in four categories that include personal (27 competencies), performance (26 competencies), perspective (8 competencies) and interpersonal (11 competencies) (Table 8). Some of the weighty competencies have been placed in more than one category. The proposed categorization has some differences in comparison with others presented by standards of practice and some of the previous studies. First, this categorization is putting attention on weighty competencies. Second, previous categorizations, particularly those presented by standards of practice, are based on a general viewpoint, and include rather limited number of competencies. The presented categorization is based on research results and standards of practice. The applicability of this categorization can be wider in comparison with previous ones.

Table 8. Categorization of project managers' weighty competencies

Category	Competencies
Personal	(1)Leadership (2)Goal-orientation (3)Creativity (4)Problem solving (5)Teamwork and cooperation (6)Initiative (7)Analytical thinking (8)Decision making (9)Flexibility (10)Self-confidence (11)Conceptual thinking (12)Information seeking (13)Ethics (14)Proactivity (15)Self-assessment (16)Self-control (17)Conscientiousness (18)Sensitivity (19)Directiveness (20)Experience (21) Assertiveness (22) Emotional resilience (23)Diagnostic of concepts (24)Perceptual objectivity (25)Trustworthiness (26)Stress management (27)Cognitive capability
Performance	(1)Cost management (2)Time management (3)Planning (4)Risk management (5)Project knowledge (6)Resource management (7)Quality management (8)Scope management (9) Procurement management (10) Project management (11)Project integration management (12)Managing group process (13)Knowledge of construction work (14)Change management (15)Diagnostics of concepts (16) Technical competencies (17)Estimating (18)Team management (19)HSE (20)Experience (21)Information seeking (22)Knowledge management (23) Professionalism (24)Management (25)Team selection (26)Delegation of authority
Perspective	(1)Strategic direction (2)Developing others (3)Customer-focus (4)Continuous improvement (5)Team selection (6)Efficiency orientation (7)Vision (8) Organizational awareness
Interpersonal	(1)Communication (2)Conflict management (3)Problem solving (4)Negotiation (5)Teamwork and cooperation (6)Impact and Influence (7)Motivation (8)Cultural skills (9)Stakeholder management (10)Team management (11) Interpersonal understanding
<i>Note: numbers do not mean ranking.</i>	

The competencies of project managers for different types of projects and targets

Shenhar (2001) and Müller and Turner (2007, 2010) state that project managers need different kind of competencies to be effective and successful in different kinds of project types. The project types and targets that have drawn the interest of researchers in competency subject are presented in Table 9. Construction, IT, and engineering projects together with other targets and project types, as can be seen, have been addressed by research community to find appropriate and important competencies of project managers. Among the pointed out project types, the largest number of identified competencies is related to construction projects, as can be seen in Table 9. Moreover, industrial employers' expectations of project managers' competencies is also a target that has also been considered by research community to detect appropriate competencies of project managers. Details of presented competencies are provided in the following table (Table 9).

Table 9. Matching different project managers' competencies to different project types/targets

Project type	Project/organization size and/or geographical location	Competencies	Reference
Organizational Change projects	Organizations with 9000-30000 employees	Leadership, Customer focus, Goal orientation, Teamwork, Stakeholder management, Planning, Developing others, Communication, Decision-making, Problem-solving, Cultural skills and Project management	Abraham et al. 2001, Crawford and Nahmias 2010, Trivellas and Drimoussis . 2013
Construction projects	All sizes (small, medium, and big): covering construction projects built around the globe include Asia, Africa, Europe, and America	Resource management, Knowledge of construction work, Teamwork and cooperation, Cost management, Flexibility, Leadership, Communication, HSE, Time management, Quality management, Stakeholder management, Experience, Project management, Ethics, Problem solving, Goal orientation, Impact and influence, Team management, Conflict management, Risk management, Creativity, Decision-making, Procurement management, Initiative, Information seeking, Analytical thinking, Developing others, Scope management, Motivation, Negotiation, Commitment, Conceptual thinking, Planning, Relationship building, Directiveness, Change management, Project integration management, Assertiveness, Self-confidence, Self-control, Tendering, Knowledge management, Operation management, Estimating, General business management, Judgment, Professionalism, Management, Alertness and quickness, Interpersonal understanding, Organizational awareness, Stress management, Ability to formulate goals, Sensitivity, Trustworthiness, Cultural competence, Positive outlook, Consciousness, Learning oriented, Empathy and Aspiration, Emotional resilience, High energy level, having information technology skills	Edum-Fortwe and McCaffer 2000, DAINITY et al. 2004, Cheng et al. 2005, Mutijwaa and Rwelamila 2007, Chen et al. 2008, Ahadzie et al. 2009, Lee et al. 2011, Dogbegah et al. 2011, Zhang et al. 2013, Hwang and Ng, 2013, Jabar et al. 2013, Panas et al., 2014, Tabassi et al. 2016, Omar and Fayek, 2016, Dziekoński, 2017, Abdullah et al. 2018, Shah and Prakash, 2018, Moradi et al. 2018
Engineering projects (all fields)	Firms ranged in size from 50 personnel to 35,000, and projects ranged \$50,000–\$500 million.	Analytical thinking, Developing others, Impact and Influence, Motivation, Conscientiousness, Leadership, Conflict management, Cultural skills, Time management, Flexibility, Continues improvement, Proactivity, Decision making, Risk management, Strategic direction	Müller and Turner 2007, Müller and Turner 2010, Fisher 2011, Takey et al. 2015
IT projects	Ranged from 1-9m\$ and 20-60 employees	Experience, Team management, Leadership, Communication, Goal orientation, Negotiation, Integration management, Cost management, Scope management and Time management	Patanakul et al. 2008, Stevenson et al. 2010, Klendauer et al. 2012, Moradi et al. 2018
Metallurgical projects	Metallurgical projects in Czech Republic	Analytical thinking, Quality management, Risk management, Resource management, Teamwork and cooperation, Project knowledge, Self-control	Kostalova et al. 2018
International NGO projects	Conducted projects by 18 Canadian NGOs in Africa and Latin America	Adaptability, Management, Communication, Ethics, Change management	Brière et al. 2015
Public service projects	Australian public service projects	Communication, Accountability, Scope management, Change management, Goal orientation	Blixt et al. 2017
Target	Competencies		
Employers' expectations	Industry-specific and generic skills over project management knowledge/expertise, Project management knowledge/expertise over, industry-specific and generic skills, Senior managerial skills, Positive personal traits, Project management methodology experience and professional qualifications, Risk management over a project life cycle, Goal orientation, Communication, Problem solving, Customer focus, Developing others, Creativity		
			Reference
			Chipulu et al. 2013, Radu 2014

Discussion

The world of project managers' competencies is presented both in the standards of practice and by the research results. Four discrepancies were discovered between these two sources. A theoretical origin behind the found discrepancies concerning project managers' competencies can be the ontological one. This is proposing that standards of practice and research efforts with the common goal (restructuring of competencies by clustering them) yields in different results because of differences in understandings the competency concept itself. Consensus on priority of project managers' competencies and the degree of consensus itself were found as two out of those four discrepancies. The main reason of these is that researchers often review the earlier studies in their field and use those results as a basis of their work. As a result of this, the maturity of findings and also consensus on some of those validated results increase gradually, but in the case of standards of practice, it seems that the main target has been the development of a unique solution in terms of content. In developing a new edition of a standard, considering a degree of difference in comparison with other standards of practice is somewhat acceptable, but trying to being totally different will lead to some differences and disagreements in understanding of concepts. After several years of publishing different standards of practice there is still no universal definition of competency. Considering a cooperation atmosphere among standards' of practice providers in developing new editions would cover these gaps.

The other two discrepancies were about missed and common competencies and also context-oriented attitude of the previous studies and the standards of practice toward project managers' competencies. New competencies are often discovered when addressing a specific project type, as different researchers have proved that project type should be taken into account in finding important and/or required competencies of project managers (Müller and Turner, 2007 and 2010; Shenhar, 2001). Missing some competencies and almost ignoring the correlation of project managers' competencies with project type and project success by standards of practice is due to the general attitude of standards of practice towards project managers' competencies. Although, some of the standards of practice such as ICB claim that considering different variables such as project type in presenting competency standards of practice is not possible due to the diversity of standards' of practice users in terms of geographical location and culture, several studies have shown that there is a strong and positive correlation between project managers' competencies with project success and effective competencies on project success are varied in different kind of projects (Toney, 2001; MacLinnis, 2003; Müller and Turner, 2007 and 2010; Shenhar, 2001). Therefore, it seems that considering some changes, as stated here, in providing new editions of project managers' competency standards of practice would increase usefulness and efficiency of those standards of practice.

The most important implication of the discovered discrepancies between research results and standards of practice would be the constitution of a cooperation atmosphere among providers of standards of practice in the area of project manager's competencies to develop a universal standard of practice. This kind of standard of practice not only addresses general aspects of project managers' competencies but also takes into account a context-oriented attitude to include also needed and important competencies of project managers in different project types. Moreover, developing this kind of standard of practice would cover all needed competencies of project managers and would increase consensus on the concept, definition, importance and priority of project managers' competencies. Such a universal standard of practice could also have complementary appendixes for different geographical locations and cultures to increase the generalizability of itself as much as possible.

Moreover, context-specific competencies were identified (Table 9). These findings show that different project types require project managers with the specific competencies. It can also mean that there are qualitative dependencies between different competencies of project managers and contexts which seems to be in line with the fundamental part of contingency theory for projects (Shenhar, 2001) where there are dependencies between the project type and selection of project leaders and team members and their skills. Accordingly, the project managers' identified context-specific competencies in this study and the given arguments concerning those findings can be supported by contingency theory for projects.

The identified context-specific and key competencies present another contribution of this study for practice. The senior managers as well as the HR department of project-oriented companies need to be aware of project managers' key competencies which can be considered as a necessity for their superior performance. Consequently, paying attention to these key competencies can help decision makers in companies to hire or select the right person as their project manager. Moreover, project managers' context-specific competencies (Table 9) provide more detailed information on project manager's competencies in specific project types which can also be taken into account by managers of project managers in the different types of the project. These key and context-specific competencies, together, can be considered as a competency model for companies and their decision makers which deal with hiring, selecting, or managing project managers.

Conclusions

This study aimed at studying possible discrepancies between results of previous studies and standards of practice on project managers' competencies, and identifying relevant competencies of different project types based on previous studies. According to the gained results, it can be concluded that there are certain discrepancies between the research based results and standards of practice. Those discrepancies include i) Commonly existing/missing competencies ii) Uneven priority of some competencies in the view of researchers versus standards of practice, iii) Uneven degree of consensus on the importance of competencies, and iv) Research results are more context-oriented than the standards of practice. It looks possible that partial explanation of this is relating to differences in understandings the competency concept itself.

Communication, leadership, teamwork and cooperation, flexibility, problem solving, goal orientation, developing others, impact and influence, stakeholder management, cost management, and resource management were identified as project managers' key competencies. Development of a synthesized list of project managers' 98 competencies is another main result of this study. Also it was found that 68 out of those 98 competencies can be classified as weighty competencies with respect of their appearance and likely importance for the success of project. Furthermore, a new categorization of project managers' weighty competencies was developed.

In addition, it can also be concluded that project managers need different competencies in different project types, as already stated by different researchers (for instance, Müller and Turner, 2007; Shenhar, 2001). It also seems that construction and IT industry as well as engineering projects have been in research focus more than the other sectors and project types.

The findings of this study are providing knowledge contribution by revealing certain discrepancies between research results and standards of practice which can lead to new insights for project managers, researchers and providers of standards of practice. Another contribution of this study is the presented comprehensive list of project managers' competencies and clarification about appropriate project types

of mentioned competencies by research community. As the limitation of this study, it is acknowledged that critical views and discussions over project managers' competency research have been largely dismissed, and such approaches can be potential areas for further research.

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Appendix 1. Detailed version of Tables 3 and 7

Competencies and Refereed Studies		Number of repetition
Communication (Crawford, 2000; Abraham et al., 2001; El-Sabaa, 2001; Muller and Turner, 2007; Bikkfalvi et al., 2009; Crawford and Nahmias, 2010; Dogbegah et al., 2011; de los Ríos et al., 2014; Brière et al., 2015; Liikamaa, 2015; Blixt and Kirytopoulos, 2017; Shah and Prakash, 2018; Cheng et al., 2005; Ruuska and Vartiainen, 2003; Brill et al., 2006; Chen et al., 2008; Hwang and Ng, 2013; RADU, 2014; Omar and Fayek, 2016; Dziekoński, 2017; Powers, 1987; Gillard and Price, 2005; ICB.4; APM; PMCD.3)		25
Leadership (Abraham et al., 2001; Dainty et al., 2004; Cheng et al., 2005; Bikkfalvi et al., 2009; Crawford and Nahmias, 2010; Chipulu et al., 2013; de los Ríos et al., 2014; Brière et al., 2015; Liikamaa, 2015; Tabassi et al., 2016; Omar and Fayek, 2016; Moradi et al., 2018; Bosch-Rekveltd et al., 2009; Fisher, 2011; Zhang et al., 2013; ICB.4; APM; PMBOK; PMCD.3)		19
Teamwork and cooperation (Dainty et al., 2004; Cheng et al., 2005; Abraham et al., 2001; de los Ríos et al., 2014; Omar and Fayek, 2016; Dziekoński, 2017; Kostalova et al., 2018; Lee et al., 2011; Zhang et al., 2013; Ahadzie et al., 2008, Ahadzie et al., 2009; Shah and Prakash, 2018; ICB.4; APM)		14
Flexibility (Cheng et al., 2005; Liikamaa, 2015; Takey and de Carvalho, 2015; Omar and Fayek, 2016; Dziekoński, 2017; Dainty et al., 2004; Shah and Prakash, 2018; Omar and Fayek, 2016; Brière et al., 2015; Powers, 1987; Gillard and Price, 2005; El-Sabaa, 2001)		12
Problem solving (Abraham et al., 2001; El-Sabaa, 2001; Brill et al., 2006; Crawford and Nahmias, 2010; Jabar et al., 2013; Panas et al., 2014; RADU, 2014; Omar and Fayek, 2016; Dziekoński, 2017; Shah and Prakash, 2018; Moradi et al., 2018)		
Goal orientation (El-Sabaa, 2001; Ruuska and Vartiainen, 2003; Dainty et al., 2004; Cheng et al., 2005; Abraham et al., 2001; Moradi et al., 2018; Muller and Turner, 2007; Klendauer et al., 2012; RADU, 2014; Liikamaa, 2015; Dziekoński, 2017; ICB.4)		11
Developing others (Powers, 1987; Gillard and Price, 2005; Chipulu et al., 2013; Muller and Turner, 2007; Muller and Turner, 2010; Crawford and Nahmias, 2010; RADU, 2014; Liikamaa, 2015; Cheng et al., 2005; Omar and Fayek, 2016; APM)		
Impact and Influence (Dainty et al., 2004; Cheng et al., 2005; Muller and Turner, 2007; Muller and Turner, 2010; Fisher, 2011; Zhang et al., 2013; Omar and Fayek, 2016; Powers, 1987; Gillard and Price, 2005; Lee et al., 2011; APM)		10
Stakeholder management (Crawford, 2000; Crawford and Nahmias, 2010; Zhang et al., 2013; Hwang and Ng, 2013; Omar and Fayek, 2016; Abdullah et al., 2018; Moradi et al., 2018; Brill et al., 2006; Lee et al., 2011; ICB.4; PMCD.3)		
Cost management (Lee et al., 2011; Hwang and Ng, 2013; Omar and Fayek, 2016; Dziekoński, 2017; Abdullah et al., 2018; Moradi et al., 2018; Cheng et al., 2005; Mutijwa and Rwelamila, 2007; Dogbegah et al., 2011; ICB.4; APM)		9
Resource management (Muller and Turner, 2007; Tabassi et al., 2016; Mutijwa and Rwelamila, 2007; Abdullah et al., 2018; Dogbegah et al., 2011; Omar and Fayek, 2016; El-Sabaa, 2001; Hwang and Ng, 2013; ICB.4; APM; PMCD.3)		
Analytical thinking (Dainty et al., 2004; Cheng et al., 2005; Liikamaa, 2015; Omar and Fayek, 2016; Kostalova et al., 2018; Muller and Turner, 2007; Muller and Turner, 2010; Chipulu et al., 2013; Dziekoński, 2017; Powers, 1987)		9
Quality management (Dogbegah et al., 2011; Omar and Fayek, 2016; Crayon et al., 2017; Abdullah et al., 2018; Kostalova et al., 2018; Cheng et al., 2005; Shah and Prakash, 2018; Lee et al., 2011; APM)		

Risk management (Dogbegah et al., 2011; Hwang and Ng, 2013; Omar and Fayek, 2016; Crayon et al., 2017; Kostalova et al., 2018; Crawford, 2000; Takey and de Carvalho, 2015; ICB.4; PMCD.3)	
Conflict management (Ahadzie et al., 2009; Fisher, 2011; Zhang et al., 2013; Hwang and Ng, 2013; Liikamaa, 2015; Dziekoński, 2017; ICB.4; APM)	
Ethics (Brill et al., 2006; Lee et al., 2011; Dogbegah et al., 2011; Omar and Fayek, 2016; Othman and Jaafar, 2013; Dziekoński, 2017; Shah and Prakash, 2018; ICB.4; APM)	
Decision making (Crawford and Nahmias, 2010; Othman and Jaafar, 2013; Panas et al., 2014; Liikamaa, 2015; Takey and de Carvalho, 2015; Omar and Fayek, 2016; Dziekoński, 2017; Moradi et al., 2018)	8
Time management (Ahadzie et al., 2009; Omar and Fayek, 2016; Abdullah et al., 2018; Shah and Prakash, 2018; Hwang and Ng, 2013; Takey and de Carvalho, 2015; Dziekoński, 2017)	
Planning (El-Sabaa, 2001; Chen et al., 2008; Crawford and Nahmias, 2010; Hwang and Ng, 2013; Crawford, 2000; Chipulu et al., 2013; Crawford and Nahmias, 2010; Dziekoński, 2017; ICB.4)	
Experience (Fotwe et al., 2000; Othman and Jaafar, 2013; Tabassi et al., 2016; Dziekoński, 2017; Kostalova et al., 2018; Lee et al., 2011; Patanakul and Milosevic, 2008)	7
Technical competencies (Benita et al., 2009; Silvius and Batenburg, 2009; Jabar et al., 2013; Takey and de Carvalho, 2015; Crawford, 2000; Shah and Prakash, 2018; PMBOK)	
Procurement management (Dogbegah et al. 2011; Crayon et al., 2017; Omar and Fayek, 2016; Crawford, 2000; Abdullah et al., 2018; ICB.4; PMCD.3)	
Scope management (Cheng et al., 2005; Omar and Fayek, 2016; Dziekoński, 2017; Moradi et al., 2018; Brill et al., 2006; ICB.4; APM)	6
Team management (Patanakul and Milosevic, 2008; Cheng et al., 2005; Chen et al., 2008; Abdullah et al., 2018; Omar and Fayek, 2016; Lee et al., 2011)	
Creativity (Dziekoński, 2017; Shah and Prakash, 2018; RADU, 2014; Moradi et al., 2018; Dogbegah et al., 2011; Omar and Fayek, 2016)	
Conceptual thinking (Dainty et al., 2004; Cheng et al., 2005; Powers, 1987; El-Sabaa, 2001; Klendauer et al., 2012; Ruuska and Vartiainen, 2003)	5
Project management (Mutijwaa and Rwelamila, 2007; Crawford and Nahmias, 2010; Chipulu et al., 2013; Jabar et al., 2013; Dziekoński, 2017; Dogbegah et al., 2011)	
Change management (Brière et al., 2015; Omar and Fayek, 2016; Blixt and Kirytopoulos, 2017; Zhang et al., 2013; Shah and Prakash, 2018; ICB.4)	
Strategic direction (Crawford, 2000; Muller and Turner, 2007; Takey and de Carvalho, 2015; Blixt and Kirytopoulos, 2017; PMBOK; ICB.4)	5
Negotiation (Omar and Fayek, 2016; Dziekoński, 2017; Shah and Prakash, 2018; Moradi et al., 2018; ICB.4; APM)	
Cultural skills (Crawford and Nahmias, 2010; Fisher, 2011; Omar and Fayek, 2016; Crayon et al., 2017; Moradi et al., 2018; ICB.4)	
Knowledge of construction work (Chen et al., 2008; Ahadzie et al. 2009; Jabar et al., 2013; Shah and Prakash, 2018)	5
Self-confidence (Powers, 1987; El-Sabaa, 2001; Gillard and Price, 2005; Liikamaa, 2015; Dziekoński, 2017)	
HSE (Cheng et al., 2005; Lee et al., 2011; Omar and Fayek, 2016; Abdullah et al., 2018; Shah and Prakash, 2018)	

Motivation (Muller and Turner, 2007; Muller and Turner, 2010; Omar and Fayek, 2016; Dziekoński, 2017; Shah and Prakash, 2018)	
Customer focus (Dainty et al., 2001; RADU, 2014; Dainty et al., 2004; Cheng et al., 2005)	
Information seeking (Dainty et al., 2004; Cheng et al., 2005; Likamaa, 2015; Shah and Prakash, 2018)	
Initiative (Dainty et al., 2004; Cheng et al., 2005; Likamaa, 2015; Omar and Fayek 2016)	
Self-control (Powers, 1987; Omar and Fayek, 2016; Shah and Prakash, 2018; ICB.4)	
Relationship building (Bikfalvi et al. 2009; Chen et al. 2008; Zhang et al., 2013; ICB.4)	4
Project integration management (Omar and Fayek, 2016; Moradi et al., 2018; ICB.4; PMCD.3)	
Proactivity (Powers, 1987; Gillard and Price, 2005; Takey and de Carvalho, 2015)	
Self-assessment (Powers, 1987; Likamaa, 2015; Omar and Fayek, 2016)	
Managing group process (Powers, 1987; Gillard and Price, 2005; Lee et al., 2011)	
Team selection (Crawford, 2000; Crawford and Nabmias, 2010; Omar and Fayek, 2016)	
Conscientiousness (Muller and Turner, 2007; Muller and Turner, 2010; Muller and Prakash, 2018)	
Behavioral competencies (Benita et al., 2009; Silvius and Batenburg, 2009; Fisher, 2011)	
Project knowledge (El-Sabaa, 2001; Dziekoński, 2017; Shah and Prakash, 2018)	
Interpersonal understanding (Zhang et al., 2013; Omar and Fayek 2016; Bosch-Rekveltdt et al., 2009)	
Commitment (Omar and Fayek, 2016; Moradi et al., 2018; Shah and Prakash, 2018)	
Efficiency orientation (Powers, 1987; Gillard and Price, 2005; PMCD.3)	
Personal competence (Bosch-Rekveltdt et al., 2009; Briere et al., 2015)	
Diagnostic of concepts (Powers, 1987; Gillard and Price, 2005)	
Sensitivity (El-Sabaa, 2001, Shah and Prakash, 2018)	
Knowledge management (Kasvi et al., 2003; Cheng et al., 2005)	
Directiveness (Dainty et al., 2004; Cheng et al., 2005)	
Continues improvement (Cheng et al., 2005; Takey and de Carvalho, 2015)	
Vision (Muller and Turner, 2007; Bosch-Rekveltdt et al., 2009)	
Estimating (Mutijvaa and Rwelamila, 2007; Chipulu et al., 2013)	
Emotional resilience (Muller and Turner, 2007; Shah and Prakash, 2018)	
Assertiveness (Dziekoński, 2017; Shah and Prakash, 2018)	
Trustworthiness (Shah and Prakash, 2018; Omar and Fayek, 2016)	
Stress management (Dziekoński, 2017; Likamaa, 2015)	
Delegation of authority (El-Sabaa, 2001; APM)	
Cognitive capability (Bikfalvi et al., 2009; PMCD.3)	
Professionalism (Lee et al., 2011; PMCD.3)	
Management (Lee et al., 2011; PMCD.3)	
Organizational awareness (Zhang et al. 2013; Likamaa, 2015)	
Alertness and quickness (Othman and Jaafar 2013)	
Perceptual objectivity (Powers, 1987)	1

Requirement and objectives (ICB.4)	
Organization and information (ICB.4)	
Governance, structures and processes (ICB.4)	
Compliance, standard and regulation (ICB.4)	
Spontaneity (Powers, 1987)	
Positive regard (Powers, 1987)	
Mobilization (EI-Sabaa, 2001)	
Knowledge of using tools and techniques (EI-Sabaa, 2001)	
Skills in the use of computer (EI-Sabaa, 2001)	
Understanding methods, process and procedures (EI-Sabaa, 2001)	
Sharing credit for success (Brill et al., 2006)	
Self-awareness (Muller and Turner, 2007)	
Tendering (Mutijwaa and Rwelamila, 2007)	
Operation management (Mutijwaa and Rwelamila, 2007)	
General business management (Mutijwaa and Rwelamila, 2007)	
Interdependency management (Patanakul and Milosevic, 2008)	
Multi-tasking (Patanakul and Milosevic, 2008)	
Being courageous (Bosch-Rekvelde et al., 2009)	
Judgment (Lee et al., 2011)	
Accountability (Blixt and Kirytopoulos, 2017)	
Social comprehension (Moradi et al., 2018)	
Intuitiveness (Muller and Turner, 2007)	
Ability to formulate goals (Dziekonski, 2017)	
Positive outlook (Shah and Prakash, 2018)	
Learning oriented (Shah and Prakash, 2018)	
Empathy and Aspiration (Dziekonski, 2017)	
High energy level (Shah and Prakash, 2018)	
Having information technology skills (Shah and Prakash, 2018)	

Appendix 2. Definition of the competencies listed in Table 7

Definition of the competencies listed in Table 7	
Competency	Definition
Communication	The ability of listening actively, understanding, responding to stakeholders, maintaining lines of communication, ensuring quality of information, and tailoring communication to audience.
Leadership	Providing direction and guidance to individuals and groups. It involves ability to choose and apply appropriate styles of management in different situations.
Teamwork and cooperation	The ability of bringing people together to realize a common objective.
Flexibility	Adapting and responding quickly and effectively to challenging circumstances.
Problem solving	The ability of finding a solution or a course of action for the faced problem or issue.
Goal orientation	Setting, striving to achieve and achieving challenging goals.
Developing others	The ability of perceiving the development needs of others and reinforcing their abilities.
Impact and Influence	The act of affecting the behaviors and actions of others.
Stakeholder management	Systematic identification analysis, planning and implementation of actions designed to engage with stakeholders.
Cost management	The process of estimating and justifying costs in order to secure funds, controlling expenditure and evaluating the outcomes.
Resource management	The ability of defining, acquiring, controlling and developing the resources that are necessary to realizing project outcomes.
Analytical thinking	Understanding a situation by breaking it apart into smaller pieces, or tracing the implications of a situation in a step-by-step casual way.
Quality management	Ensuring that the outputs, benefits, and the processes by which they are delivered, meet stakeholder requirements and are fit for purpose.
Risk management	The ability of identification, assessment, response planning and implementation and control of opportunities and threats around the project.
Conflict management	The ability of identifying and addressing differences that, if left unresolved, could affect objectives.
Ethics	A key requirement of a profession is that individual members should act ethically.
Decision-making	The ability of making the decisions, which will have the most efficiency for the project.
Time management	The ability of developing schedule plan for project and keeping it up-to-date to avoid delays for on time delivery of the project.
Planning	The ability of determining what is to be delivered, how much it will cost, when it will be delivered, how it will be delivered and who will carry it out.
Experience	Having the experience of working in similar project or job.
Technical competencies	The knowledge, skills, and behaviors related to specific domains of project. The technical aspects of performing one's role.
Procurement management	The process of buying or obtaining goods and/or services from external parties.
Scope management	The process whereby outputs, outcomes, and benefits are identified, defined, and controlled.
Team management	The ability of directing a group of people toward achieving common goal(s).
Creativity	The use of imagination or original ideas to create something.
Conceptual thinking	Understanding a situation or problem by putting the pieces together, seeing the large picture.

Project management	Using processes, methods, skills, knowledge and experience to achieve specific project objectives.
Change management	A systematic approach to dealing with the transition or transformation of an organization's goals, processes or technologies through implementing strategies for effecting change, controlling change and helping people to adapt to change.
Strategic direction	The knowledge of and expertise in the industry and organization that enhanced performance and better delivers business outcomes.
Negotiation	The process between two or more parties that aims to balance different interests, needs and expectations in order to reach a common agreement and commitment while maintaining a positive working relationship.
Cultural skills	The individual's approach to influence on the organization's culture and values and the wider society in which the project is situated.
Knowledge of construction	The knowledge, skills, and behaviors related to construction project.
Self-confidence	A person's belief in his or her own capability to accomplish a task.
HSE	Paying attention and having concern for health, safety, and environment of project in which people work.
Motivation	The competency through which managers enhance other's commitment to their work.
Customer focus	Focusing efforts on discovering and meeting the customer or client's needs.
Information seeking	An underlying curiosity to know more about things, people, or issues.
Initiative	A preference for taking action and doing more than is required or expected in the job, which will improve or enhance job results.
Self-control	The ability to keep emotions under control and to restrain negative actions when tempted, faced with opposition from others, or working under conditions of stress.
Relationship building	The ability of building and maintaining personal relationships to get productive collaboration and commitment of others.
Integration management	The processes and activities to identify, define, combine, unify, and coordinate the various processes and project management activities throughout the project.
Proactivity	Proactivity or proactive behavior involves acting in advance of a future situation, rather than just reacting.
Self-assessment	Knowing one's limits and strengths.
Managing group process	Ability to stimulate others to work effectively in a group setting.
Team selection	The careful choice of the best possible individuals from a group of similar people in order to accomplish a common goal.
Conscientiousness	Conscientiousness is the personality trait of being careful, or diligent.
Behavioral competencies	Any behavior attributes and personality traits a person might have, such as knowledge and skill set, which can help determine how successful he/she will be at their future job.
Project knowledge	Understanding methods, process and procedures, the technology required for project.
Interpersonal understanding	The ability of understanding and respecting other opinions, cultures, and interests.
Commitment	The state or quality of being dedicated to the project goal and success.
Efficiency orientation	Focus on delivering project on time, on budget, and based on agreed scope and quality.
Personal competencies	Personal competencies reflect the traits and characteristics that relate to what individual believe, how they think, how and what they feel and how they learn and develop.

Diagnostic of concepts	The ability of understanding concepts.
Sensitivity	An ability to understand what other people need, and be helpful and kind to them.
Knowledge management	A systematic management of information and learning which turns personal information and experience into collective knowledge that can be widely shared throughout an organization and a profession.
Directiveness	The character of being determined in direction of development or success in a project.
Continues improvement	An ongoing effort to improve project outcomes, services, or processes.
Vision	The ability to think about or plan the future with imagination or wisdom.
Estimating	The ability of estimating quantitative amounts required for planning or decision marking in a project.
Emotional resilience	The ability to adapt to stressful situations or crises.
Assertiveness	The ability of being confident and behaving forcefully.
Quickness and alertness	The ability of being alert and quick to perceive warning signals that can eventually lead to serious problems.
Trustworthiness	The ability to be relied on as honest or truthful.
Stress Management	The ability to handle adverse, tiring and stressful issues and situations.
Delegation of authority	The practice of giving a person or group the authority to perform the responsibilities of, or act on behalf of, another.
Cognitive capability	The ability to perform a certain physical or mental task.
Professionalism	The ability of demonstrating commitment to the project, operating with integrity, handling personal and team adversity in a suitable manner, manages a diverse workforce, and resolves individual and organizational issues with objectivity
Management	Management activities that are centered upon matters and things.
Organizational awareness	Understanding and utilizing organizational dynamics in order to achieve objectives.
Perceptual objectivity	Ability to be relatively objective rather than limited by excessive subjectivity or personal biases.
Requirement and Objectives	The ability of establishing the relationship between what stakeholders want to achieve and what the project is going to accomplish.
Organization and Information	The ability of creating a high-performing temporary organization, which also includes the inseparable link between organizational structure and communication processes.
Governance, structures and processes	The understanding of and the alignment with the established structures, systems, and processes if the organization that provide support for projects and influence the way they are organized, implemented and managed.
Compliance, standard and regulation	The way the individual interprets and balances the external and internal restrictions in a given area such as country, company, or industry.
Spontaneity	The ability to express oneself freely and easily.
Positive regard	The ability to express a positive belief in others.
Mobilization	Project manager is able to mobilize the mental and emotional energy of his subordinate.
Knowledge of using tools and techniques	Special knowledge in the use of tools and techniques.
Skills in the use of computer	Having required skills in the use of computer.
Understanding methods, process and procedures	Understanding methods, process and procedures of the project.

Sharing credit for success	Crediting all team or group members' efforts in the case of achieving the planned goal.
Self-awareness	The ability to step back and observe yourself objectively to know your behavior, motivations, feelings, values and desires
Tendering	The ability to handle the process of inviting bids for project and selecting a contractor for carrying out the project.
Operation management	The ability of administrating business practices to create the highest level of efficiency possible within a project organization.
General business management	The ability of understanding business including: marketing, sales, accounting, human resources, finance and logistics, coupled with a strong ability to lead teams, motivate employees, generate revenue and cut costs.
Interdependency management	Managing interdependencies and interactions among projects related to shared milestones, resources, and technology.
Multi-tasking	The ability of doing several things at once.
Being courageous	The ability to act on one's beliefs despite danger or disapproval.
Judgment	The ability to make considered decisions or come to sensible conclusions.
Accountability	The amount of freedom for staff, in a project or environment, to interpret objectives, select and choose how they deliver their work.
Social comprehension	Understanding the social features of the environment in which a project is carried out.
Intuitiveness	Perceiving directly by intuition without rational thought, as a person or the mind.
Ability to formulate goals	The ability of setting SMART (specific, measurable, achievable, realistic, and timely) goals.
Positive outlook	Having positive mental attitude for achieving something.
Learning orientation	Having strong passion for learning.
Empathy and aspiration	The ability to understand and share the feelings of another.
High energy level	Having high energy level for doing a job.
Having information technology skills	Having information technology skills.

Appendix 3. Timewise distribution of project managers' competencies (listed in Table 7)

Competency	Frequency of appearance over time				
	Total frequency of appearance	-1990	1991-2000	2001-2010	2010-2018
Communication	25	1	1	10	13
Leadership	19	0	0	6	13
Teamwork and cooperation	14	1	0	5	9
Flexibility	12	1	0	4	7
Problem solving		0	0	4	8
Goal orientation		0	0	6	6
Developing others	11	1	0	5	5
Impact and Influence		1	0	5	5
Stakeholder management		0	1	2	8
Cost management		0	0	2	9
Resource management	10	0	0	3	8
Analytical thinking		1	0	4	5
Quality management	9	0	0	1	8
Risk management		0	1	0	8
Conflict management		0	0	2	7
Ethics		0	0	1	8
Decision-making	8	0	0	1	7
Time management		0	0	2	6
Planning		0	1	3	4
Experience	7	0	1	1	5
Technical competencies		0	1	2	4
Procurement management		0	1	0	6
Scope management		0	0	2	5
Team management	6	0	0	3	3
Creativity		0	0	0	6
Conceptual thinking		1	0	3	2
Project management		0	0	2	4
Change management		0	0	0	6
Strategic direction		0	1	1	4
Negotiation		0	0	0	6
Cultural skills		0	0	0	6
Knowledge of construction	5	0	0	3	2
Self-confidence		1	0	2	2
HSE		0	0	1	4
Motivation		0	0	2	3
Customer focus	4	0	0	3	1
Information seeking		0	0	2	2
Initiative		0	0	2	2
Self-control		1	0	0	3
Relationship building		0	0	2	2
Project integration management		0	0	0	4

Proactivity	3	1	0	1	1
Self-assessment		1	0	0	2
Managing group process		1	0	1	1
Team selection		0	1	1	1
Conscientiousness		0	0	2	1
Behavioral competencies		0	0	2	1
Project knowledge		0	0	1	2
Interpersonal understanding		0	0	0	3
Commitment		0	0	0	3
Efficiency orientation		1	0	1	1
Personal competence	2	0	0	1	1
Diagnostic of concepts		1	0	1	0
Sensitivity		0	1	0	1
Knowledge management		0	0	2	0
Directiveness		0	0	2	0
Continues improvement		0	0	1	1
Vision		0	0	2	0
Estimating		0	0	1	1
Emotional resilience		0	0	1	1
Assertiveness		0	0	0	2
Trustworthiness		0	0	0	2
Stress Management		0	0	0	2
Delegation of authority		0	0	1	1
Cognitive capability		0	0	1	1
Professionalism		0	0	0	2
Management		0	0	0	2
Organizational awareness		0	0	0	2
Quickness and alertness	1	0	0	0	1
Perceptual objectivity		1	0	0	
Requirement and Objectives		0	0	0	1
Organization and Information		0	0	0	1
Governance, structures and processes		0	0	0	1
Compliance, standard and regulation		0	0	0	1
Spontaneity		1	0	0	0
Positive regard		1	0	0	0
Mobilization		0	0	1	0
Knowledge of using tools and techniques		0	0	1	0
Skills in the use of computer		0	0	1	0
Understanding methods, process and procedures		0	0	1	0
Sharing credit for success		0	0	1	0
Self-awareness		0	0	1	0
Tendering		0	0	1	0

Operation management		0	0	1	0
General business management		0	0	1	0
Interdependency management		0	0	1	0
Multi-tasking		0	0	1	0
Being courageous		0	0	1	0
Judgment		0	0	0	1
Accountability		0	0	0	1
Social comprehension		0	0	0	1
Intuitiveness		0	0	1	0
Ability to formulate goals		0	0	0	1
Positive outlook		0	0	0	1
Learning orientation		0	0	0	1
Empathy and aspiration		0	0	0	1
High energy level		0	0	0	1
Having information technology skills		0	0	0	1

PAPER II

From Past to Present- the Development of Project Success Research

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From Past to Present – the Development of Project Success Research

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Abstract- Project success research has been a field of importance for more than three decades. The research field has been developing along the passed time; however, our understanding of this development is very limited. This study aims at understanding the longitudinal developments in the project success research field and discussing and elaborating further results based on previous studies. For this purpose, a literature study was conducted where the emergent research interests were identified. After that, two separate syntheses of success factors and criteria were developed for identifying the most often present ones (later termed weighty). The findings of this study present the evolution process of project success research. This directs one's attention to the nature of project success research, leading research questions, main targets, outcomes, and chronological presentation of the obtained results. In addition, this study led to interesting results concerning project success factors and criteria. The findings suggest that there are 65 factors contributing to project success, among which communication, top management support, project manager's competency, clear objectives and realistic obligation, monitoring and feedback, and risk management are the critical ones. Moreover, 13 frequently mentioned project success criteria in the literature were identified where meeting cost, meeting time, customer satisfaction, meeting quality, and business success are the top five ones. The findings of this study can be insightful for the research community and project practitioners to be aware of the development process of project success research.

Keywords: Project success criteria; project success factors; project management.

1. INTRODUCTION

Project success has been a popular research field during the last three decades. A large amount of research has been conducted to address different aspects of project success. For example, several studies have tried to define project success as clearly as possible (for instance, Baccarini, 1999; Jugdev and Müller, 2005; Shenhar et al., 2001). Some scholars have pursued to identify factors and criteria for project success (for instance, Andersen et al., 2006; Cooke-Davies, 2002; Chua et al., 1997; Pinto and Slevin, 1987; Pinto and Prescott, 1988). The efforts concerning identification of success factors and criteria can be divided into two main parts: success factors and criteria of general significance (for various types of projects) (for instance Aga, 2016; Cooper and Kleinschmidt, 1987; Chipulu et al., 2014; Davis, 2014; de Carvalho et al., 2015; Hussein et al., 2015; Ika et al., 2011; Lim and Mohamed, 1999; Malach-Pines et al., 2009; Müller and Jugdev, 2012; Mirza et al., 2013; Martens et al., 2018; Nanthagopan et al., 2019; Scott-Young and Samson, 2008; Serrador and Turner, 2014; Turner, 2004; Taherdoost and Keshavarzsaleh, 2016; ul Musawir et al., 2017), and success factors and criteria for specific project types or contexts, e.g., construction and IT projects (for instance Cozijnsen et al., 2000; Chua et al., 1999; Chang et al., 2013; Daniel et al., 2018; Espinosa et al., 2006; Engelbrecht et al., 2017; Fortune and White, 2006; Handzic et al., 2016; Müller and Turner, 2007; Rodriguez-Repiso et al., 2007; Standing et al., 2006; Sudhakar, 2012).

The nature of these studies on project success research, their motivations, and the gained outcomes can be seen as the main cornerstones of project success research development. Analyses such as mapping of the development of project success research have been addressed in a very limited manner. Moreover, this research effort, which is as comprehensive as possible, can provide new knowledge contributions by its overall analyses of the research results gained so far.

Such analyses can provide further understanding of the critical success factors on the resultant flourishing projects of various business contexts. This study aims at contributing towards the mentioned knowledge gaps through: (1) Mapping the development of project success research through describing its changing trends and obtained outcomes, and (2) Exploring the results of previous studies in a manner that is as comprehensive as possible.

This paper is structured into five sections. The first one is presenting the point of departure, which describes the conceptual background. The second section is about the research methodology and relating the research process. The third one presents the results of this study. The fourth one presents the discussions about the obtained results. Finally, the last one includes the main conclusions.

2. THEORETICAL BACKGROUND

2.1 DEFINITIONS

The project is considered an overall success if the project meets the technical performance specifications and/or mission to be performed, and if there is a high level of satisfaction concerning the project outcome among key people in the parent organization, key people in the project team, and key users or clientele of the project effort (de Wit, 1986). Success on a project

means that certain expectations for a given participant were met, whether owner, planner, engineer, contractor or operator. These expectations may be different for each participant (Sanvido et al., 1992). Project success as a concept can cover different aspects from achieving the project time and cost targets to the stakeholder satisfaction and business success (Baccarini, 1999; Martens et al., 2018; Müller and Turner, 2010). Baccarini (1999) defined project management success and product success as two distinct components of project success. According to another definition by Shenhar et al. (2001), the project success means different things for different people; an architect may consider success in terms of aesthetic appearance, an engineer in terms of technical competence, an accountant in terms of dollars spent under budget, a human resources manager in terms of employee satisfaction. Chief executive officers rate their success in the stock market.

Jugdev and Müller (2005) stated that success is an interesting word; the word connotes different things to different people and is very context-dependent. Trying to pin down what success means in the project context is akin to gaining consensus from a group of people on the definition of “good art.” Müller and Turner (2007a) defined project success factors and project success criteria as two components of project success. Mertens et al. (2018) stated that project success is related to the goals and benefits that are provided in a project for its organization as a whole, dealing with the effectiveness, objectives, and benefits that are provided by the project, and success in project management is related to the direct actions from a project manager, applying tools as determined by the scope, deadline, and cost of each project.

As can be understood, several researchers have defined project success. There are some common points, e.g., meeting time and cost, and customer satisfaction, among those definitions which can provide a basis for a more comprehensive definition. This study defines project success as a concept comprised of four components as follows:

- Project management success: meeting time, cost, scope, and quality
- Project execution success: meeting technical requirements and safety goals
- Business success: reoccurring business and meeting expected commercial success
- Stakeholder satisfaction: meeting various expectations of different project stakeholders

2.2 PROJECT SUCCESS FACTORS (PSFs)

In addition to the efforts for defining the project success itself conceptually, several studies have addressed the identification of the project success factors (PSFs). Success factors are the set of circumstances, facts, or influences that contribute to the result (Lim and Mohamed, 1999). Two studies carried out by Pinto and Slevin (1987), and Pinto and Prescott (1988) can be considered as pioneering efforts over project success factors. The first one showed which success factors have relevance in different phases of the project life cycle (Pinto and Slevin, 1987). The second one explained the critical project success factors resulting in nine factors such as clarity of goals and general direction, top management support, and client consultation (Pinto and Prescott, 1988). Then, other studies conducted by Chua et al. (1997 and 1999) tried to address success factors for specific performance targets in a project. As a result of these studies, different success factors for budget, schedule, and quality performances and also for general purposes (all objectives) were identified and presented. Project failure studies have also provided valuable results for explaining possibilities for successful projects (for instance, Cooke-Davies, 2002; Cozijsen, 2000; LIM and LING, 2002).

In 2004 and 2005, a context-oriented approach, addressing specific project types and environments in which projects operate within, was formed toward identifying success factors of construction projects. Different studies were carried out to detect success factors of construction projects (for instance, Chan et al., 2004; Carù et al., 2004; Chileshe and Haupt, 2005; Nguyen et al., 2004; Phua and Rowlinson, 2004). Addressing success factors and causes of failures of specific contexts or project types were continued in the next years. For instance, Fortune and White (2006) conducted a study, which identified success factors of different attributes in the project such as goals and objectives, decision making, and environment. Moreover, other studies have paid attention toward identifying project success factors for other aims such as delivering results in time and cost and also success factors and barriers in construction and in information system projects (Agarwal and Rathod, 2006; Espinosa et al., 2006; Frödel et al., 2008; Koutsikouri et al., 2008; Rodriguez-Repiso et al., 2007).

From 2011 to 2018, research attention has increasingly been broader in terms of studying both general and specific success factors of projects. Accordingly, a few studies have provided evidence for generic success factors such as monitoring, coordination, training, clear definition of the project goal, communication, competent project manager and teamwork (for instance Berssaneti and Carvalho, 2015; Ika et al., 2011; Joslin and Müller, 2016; Jugdev et al., 2013; Müller and Jugdev, 2012; Mirza et al., 2013; Montequin et al., 2016; Rolstadås et al., 2014). At the same time, other studies have tried to discover specific success factors. For example, software development projects, construction projects, post-disaster housing reconstruction projects, BOT projects, time success, IT projects, petroleum industry and PPP (public partnership projects) success have been addressed by different researchers, and several success factors such as risk management, good coordination and communication, transparency, accountability and planning efforts have been identified (Alzahrani and Emsley, 2013; Ahmadabadi and Heravi, 2019; Almarri and Boussabaine., 2017; Doulabi and Asnaashari, 2016; Daniel et al., 2018; Engelbrecht et al., 2017; Gupta et al., 2013; Handzic et al., 2016; Heravi and Ilbeigi, 2012; Mišić and Radujković, 2015; Maqbool and Sudong, 2018; Mavi and Standing, 2018; Nguyen and Hadikusumo, 2018; Ophiyandri et al., 2013; Peetawan and Suthiwartnarueput, 2018; Rodriguez-Segura et al., 2016; Rezvani et al., 2016; Sudhakar, 2012; Sanchez and Terlizzi, 2017; Tsiga et al., 2017; Ullah et al., 2017; Wu et al., 2017 and 2018; Yamin and Sim, 2016; Zheng et al., 2014; Zuo et al., 2018). More details of the mentioned success factors in the literature are presented in the results section.

2.3 PROJECT SUCCESS CRITERIA (PSC)

In addition to conducting studies to address project success factors, several studies have also been undertaken to discover appropriate project success criteria for measuring project success. Criteria are the set of principles or standards by which judgment is made (Lim and Mohamed, 1999). The presented success criteria by Freeman and Bale (1992) can be considered as a starting effort in this subject. These PSC include seven components of which five of them have been more frequently mentioned than others: technical performance, efficiency orientation (meeting time, cost and quality), managerial and organizational implications (mainly customer satisfaction), personal growth and manufacturability and business performance. Shenhar et al. (1997) presented another PSC for measuring project success, which includes four components: project efficiency, impact on the customer, business success, and preparing for the future. After that, Lim and Mohammad (1999) introduced other PSC based on macro and micro viewpoints.

Macro viewpoint addresses the timely completion and satisfaction components, and micro viewpoints deal with completion of time, cost, quality, performance, and safety. Moreover, Agarwal and Rathod (2006) stated that meeting scope, time, cost, and customer satisfaction are the project success criteria. Another study conducted by Müller and Turner (2007b) presented a new set of project success criteria. This includes 10 components: end-user satisfaction, supplier satisfaction, team satisfaction, other stakeholder's satisfaction, performance in terms of time, cost and quality, meeting user requirements, project achieves its purpose, customer satisfaction, and reoccurring business. In two other undertaken studies by Lam et al., (2007 and 2010), meeting time, cost, quality, safety goals, and environmental friendliness were presented as project success criteria. After that, several studies were conducted by different researchers which mainly emphasized on time, scope, cost, quality, safety, satisfaction and meeting technical requirements as project success criteria (Al-Tmeemy et al., 2011; Albert et al., 2017; Davis, 2016 and 2017; Gomes and Romão, 2016; Koops et al., 2016 and 2017; Osei-Kyei and Chan, 2018; Rohman et al., 2017; Sebestyen. 2017; Pankratz and Basten, 2018). Findings of analyzing the mentioned success criteria in the literature are presented in the results section.

3. METHODOLOGY

The literature study behind this paper addressed as comprehensively as possible the previous research on project success. For this purpose, ScienceDirect and the Emerald databases were chosen to locate the relevant studies. The selection of the forgoing databases was carried out based on the data access possibilities. The following keywords were utilized for searching: project success, project success factor, and project success criteria. As a result of searches through the mentioned keywords and checking for their presence in the title, 114 papers were found. Next, abstract and content of all found papers were fully reviewed, and 19 papers were excluded in the results of this effort; because the purpose and result of those papers had no match to project success, and its supplementary concepts include project success factor and criteria. Therefore, 95 remaining relevant papers were analyzed for three main purposes, (i) describing the nature of project success research, (ii) discovering and depicting leading research questions, main targets, and outcomes over the conducted studies and subsequently mapping the evolution process of project success research, and (iii) addressing the mentioned success factors and success criteria in the literature.

As one of the main results, the evolution process of project success research was mapped through analyzing the nature of project success research, the leading research questions, the main targets, and the main outcomes. In addition, several success factors and success criteria were extracted from the previous studies. According to obtained project success factors and project success criteria, two matrixes of mentioned PSFs and PSC in the previous studies and their references were provided. Due to a few similarities among identified PSFs and PSC, two syntheses of them were developed with a ranking column based on the frequency of appearance (Appendices A and B). The development of those syntheses was conducted by identifying those project success factors or criteria which had very close or similar meaning or title. In this study, the identified success factors and criteria with more than one frequency of appearance were qualified as weighty ones, and those with only one frequency of appearance qualified as notable ones.

4. RESULTS

4.1 EVOLUTION MAP of PROJECT SUCCESS RESEARCH

The Figure 1 shows the evolution map of project success research. This map comprises five main components: the nature of project success research, the leading research questions, the main research targets, the main outcomes, and the chronological presentation of the outcomes. The following paragraph provides a detailed explanation of the mentioned components.

The first part of Figure 1 presents the nature of project success research. Basically, it seems that project success research has been interested in increasing the success chance of the project through an improved understanding of the project success concept and its different components. Hence, three groups of leading research questions have been adopted. These questions are related to the concept of project success, viewpoints on that, measurement of project success, and finally, success factors that would be useful and helpful for realizing project goals and benefits. In other words, those three groups of leading research questions account for understanding the definition of project success, project success criteria, and project success factors.

The nature of project success research besides leading research questions over conducted studies have created different research targets and also led to a growing trend towards the context-oriented studies, as pointed out in Figure 1. The main reason for this growing trend could be the fact that the specific contexts or project types have had to be addressed separately in terms of success, as it has been mentioned by different researchers such as Shenhar (2001). Due to the undertaken research in the area of project success, three main outcomes have been achieved, which are mentioned in the following:

- The increasing maturity of adapted definitions for project success and its components;
- Development of understandings towards expected common (general) and unique (context-oriented) goals and benefits of projects as a measurement way to judge project success;
- Identification of project success factors generally (for all types of projects) and particularly (for specific project type, context or target)

Additionally, the mentioned growing trend towards the context-oriented studies has consequently led to gradual customization of project success knowledge for specific targets and contexts, as can be understood from the chronological presentation of the outcomes. For instance, considerable improvements have been obtained in our understandings of the different aspects of success in the construction and information technology projects. The Figure 1 presents the evolution process of project success research.

Nature of project success research: To increase success chance of projects through improving understandings of project success concept, its different components and enablers									
Leading research questions									
What would be the appropriate definition of project success?			What a project should deliver and how it can be considered as a successful maneuver?			What can be helpful for a project to reach its goals and benefits? What are the enablers of project success?			
What are the different aspects of project success?			How can we judge the project success?			A growing trend towards context-oriented research from past to the present			
Main research targets									
Identifying success enablers over the stages of project life cycle (Pinto and Slevin, 1987; Pinto and Prescott, 1988) Starting point	Developing a universal framework to measure project success (Freeman and Bale, 1992; Shenhar et al., 1997) Significant step towards success measurement	Identifying success factor of construction project based on objectives of budget, time, and quality (Chua et al., 1997 and 1999) Starting point of context-oriented studies	Defining project success. (Baccarini, 1999) The only focused study to define project success	Addressing success enablers, way of judging success and causes of failure in general (Lim and Mohamed, 1999; Cozjensen et al., 2000; and Cooke-Davies, 2002) Paying attention to failure causes	Identifying success factor in construction projects (Duy Nguyen et al., 2004; Chan et al., 2004) Growing interest	Assessing our evolving understanding of success factors and frameworks in the past 40 years (Jugdev and Muller, 2005) A Review	Identifying success criteria and as well as causes of failure in specific project types such as construction and IT projects (Standing et al., 2006; Lam et al., 2007; Al-Tameemy et al., 2011) Increasing interest toward context-oriented studies	Addressing different aspects of project success in general and in specific contexts such as construction and IT projects (Alzahrani, 2013; Serardor, 2014; Alnagari, 2017) Taking deeper in success aspects of construction and IT industry	
Other researchers such as Shenhar et al. (2001), Muller and Turner (2007) and Mertren et al. (2018) have also adapted other definitions of project success in their studies.									
Main outcomes									
Increasing maturity of adapted definitions for project success and its components			Development of understandings towards expected common (general) and unique (context-oriented) goals and benefits of projects as a measurement way to judge project success			Identification of project success factors generally (for all types of projects) and particularly (for specific project, context or target)			
Chronological presentation of outcomes									
Gradual customization of project success knowledge for specific targets and contexts									
Discovery of success factors in different stages of project life cycle	Adaption of several definitions of project success and identifying new success factors	Picture of different aspects of project success and showing the importance of post-project outcomes on its success	Identification of effects of leadership, competency and teamwork shortages in project failure	Highlight importance of satisfaction and business success in project success	Discovery of weighty factors of construction project's success such as enough funding and resources,	Clarification of contribution of some cultural differences and competent project manager on project success	Identification of specific success criteria in different project types such as, construction and IT	Identification of general and specific success factors for BOT, PPP, Petroleum and IT projects	Adaption of success criteria for specific project types and contexts such as PPP, information system and toll road projects
1985-1990	1991-2000	2000-2003	2004-2005	2006-2010	2011-2018				

Fig.1. The evolution map of project success research

4.2 WEIGHTY and NOTABLE PROJECT SUCCESS FACTORS

The weighty and notable project success factors were identified through analyzing the outcomes of the conducted studies, making a synthesis of 338 identified success factors, excluding similarities, and finally reaching to a final list of 132 success factors (Appendix A). Based on this list, there are 65 weighty success factors that contribute to project success more than the 67 notable ones. Among those weighty factors, there are six ones with equal to or more than 10 appearances in the previous studies, which were found to be the critical success factors for projects. These critical success factors include communication, top management support, project manager's competency, clear objectives and realistic obligations, monitoring and feedback, and risk management. Look at table 1 for their frequency of appearance and relating ranking. Appendix A presents the resultant success factors with their literature sources.

Table1. Top 10 weighty project success factors

Project success factors	Appearance	Rank	Project success factors	Appearance	Rank
Communication	17	1	Stakeholder involvement	6	8
Top management support	12	2	Project size	5	9
Project manager's competency	11	3	Quality control		
Clear objectives & realistic obligations			Teamwork		
Monitoring & feedback	10	4	Design efforts	6	10
Risk management			Strong business case		
Team competency	9	5	Economic risks		
Adequacy of funding	8	6	Contractual aspects		
Coordination	7	7	Commitment to the project		
Planning efforts			Project complexity		
Organization structure			Effective safety program		
Political environment			Leadership		

4.3 WEIGHTY PROJECT SUCCESS CRITERIA

Analyzing the previous studies also resulted in identifying 257 success criteria. Due to a few similarities among found success criteria, a synthesis of them was created, and they were ranked according to their frequencies of appearance. Then, success criteria with more than one frequency of appearance were qualified as weighty ones. Findings show that there are 13 weighty project success criteria where meeting cost, meeting time, customer satisfaction, meeting quality, business success, and technical performance are the top 5 ones in the ranking (Figure 2, look at Appendix B for references).

Success criteria/reference	Shenhar et al., 1997	Freeman and Bale, 1992	Lam and Mohamed, 1999	Cooper and Kleinschmidt, 1987	Shenhar et al., 2001	Agarwal and Rathod, 2006	Müller and Turner, 2007	Lam et al., 2007	Lam et al., 2010	Ika et al., 2011	Al-Tmeemy et al., 2011	Chupulu et al., 2014	Koops et al., 2016 and 2017	Davis, 2016 and 2017	Gomes and Romão, 2016	Rohman et al., 2017	Osei-Kyei and Chan, 2018	Pankratz and Basten, 2018	Rank (based on appearance)
Meeting cost	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	1
Meeting time	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	2
Customer satisfaction	✓	✓	✓		✓	✓	✓				✓		✓	✓	✓			✓	3
Meeting quality			✓				✓	✓	✓		✓	✓	✓	✓			✓		4
Business success	✓	✓			✓		✓				✓						✓		5
Technical performance		✓	✓											✓	✓		✓		
Safety			✓						✓			✓	✓						6
Meeting scope						✓	✓			✓		✓			✓				
Preparing for the future	✓			✓	✓														7
Project specific political or social factors													✓						
Effect on the professional image of client organization													✓						8
Benefit to stakeholder group														✓					
Meeting expectations														✓					

Fig. 2. The identified weighty project success criteria

5. DISCUSSION

The evolution map of project success research points out the nature of activities in this research field, leading research questions and main outcomes. It also shows the emerging interest for conducting target and context-oriented studies. The main reason behind the constitution of this interest is the widely distributed contingency thinking among the research community advocating that “one size does not fit all”; the contingency theory which was developed by Shenhar (2001) and stated that project type should affect the selection of project leaders, team members, and skill development needs. This mapped evolution process of project success research shows that general findings of project success have had limited explanatory power, mainly because of the uniqueness of the project that imposes many challenges and issues to project performance and subsequently its success, and general knowledge of project success is insufficient to overcome those challenges. Hence, customization of project success knowledge has been emerged as a requirement for each specific project type or context to overcome barriers and increase the success potential of projects. Accordingly, the contingency theory for projects developed by Shenhar (2001) can be developed; Project type not only affects the selection of

the project human resources and their required competencies but also requires defining specific criteria, for measuring project success, and identifying certain factors, for facilitating the realization of project success criteria. This is one of the most important implications of the mapped evolution process of project success research in this study. This contingency perspective could be extremely insightful for industry practitioners to spend enough time defining success measurement way as well as the factors facilitating the meeting of those success criteria specified for every single project at the beginning of the project. It can also be a valuable starting point for future relevant studies. The mapped process of project success research itself can also be insightful for the research community to know the past and recent research streams in the project success domain and to get idea for the future possible studies.

The mapped evolution process of project success research also reflects the evolution of the project management field in general. During recent decades, project management has been represented by a set of efforts to use proper knowledge, techniques, and tools for meeting project goals. These goals, generally, have been defined as completing projects on time, within budget, and in a satisfying level of quality. Meanwhile, considerable efforts have been made to figure out what can facilitate the meeting of the mentioned goals, and consequently, industry practitioners, together with the research community, have tried to find out what factors can contribute to project success and what kind of success criteria could be appropriate for projects. This explained evolution can be understood from the map. It can be stated that the identified nature of project success research, its leading research questions, and subsequent main targets, have supported the development of the project management profession in specific aspects. These aspects are increasing the maturity of understandings in project success by clearly defining project success, then finding reasonable measurement criteria for judging it, and finally looking for factors which can facilitate meeting the success criteria.

Furthermore, the analysis of project success literature led to another interesting outcome i.e., weighty project success factors. Consequently, it became clear that communication, top management support, project manager's competency, clear objectives and realistic obligation, monitoring and feedback, and risk management are the critical success factors for projects. These findings are in line with previous studies (For instance, Pinto and Slevin, 1987; Pinto and Prescott, 1988; Fortune and White, 2006; Sudhakar, 2012; Nguyen et al., 2004; Rolstad et al., 2014) and also standards of practice (for instance, PMBOK) which have emphasized the importance of factors such as communication, top management support and project manager's competency in project success.

6. CONCLUSIONS

This study aimed at understanding the longitudinal developments in the project success research field, and discussing and elaborating further results based on previous studies. It was carried out through mapping the evolution of project success research and identifying weighty project success factors and success criteria. The obtained results provide a basis for the following conclusions:

- Project success research has led to the constitution of interest to conduct context-oriented studies and customization of project success knowledge for specific targets, contexts, or project types.

- There are 65 weighty factors that contribute to project success, among which communication, top management support, project manager's competency, clear objectives and realistic obligation, monitoring and feedback, and risk management are the critical ones.
- There are 13 weighty project success criteria where meeting cost, meeting time, customer satisfaction, meeting quality, business success, and technical performance are the top 5 ones.

The gained findings are capable of explaining the nature and certain outputs of project success research in a novel manner. This includes the evolution map of project success research, weighty project success factors, and project success criteria. These findings can provide new insights for project managers, project team members, project owners, and other stakeholders of the project to increase the success chance of the project by explaining the weighty success factors and criteria. As the limitation of this study, it should be acknowledged that certain keywords were used in a couple of databases (ScienceDirect and Emerald) for literature review, which subsequently narrowed the scope of the study.

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Appendix A. Details of identified project success factors from literature

Success factors and references	Appearance	rank
Communication (Pinto and Slevin, 1987; Chua et al., 1999, Chan et al., 2004, Phua and Rowlinson, 2004; Fortune and White, 2006; Espinosa et al., 2006, Andersen et al., 2006; Young and Samon, 2008; Sudhakar, 2012; Ophiyandri et al., 2013; Chang et al., 2013; Rolstades et al., 2014; Davis, 2014; Montequin et al., 2016; Wu et al., 2017; Zuo et al., 2018; Maqbool and Sudong, 2018)	17	1
Top management support (Pinto and Slevin, 1987; Pinto and Prescott, 1987; Andersen et al., 2006; Fortune and White 2006; Sudhakar, 2012; Rolstades et al., 2014; Davis, 2014; Berssaneti and Carvalho, 2015; Gomesa and Romaoa, 2016; Tsiga et al., 2017; Mavi and Standing, 2018; Maqbool and Sudong, 2018)	12	2

Project manager's competency (Chua et al. 1999; Nguyen et al., 2004; Chan et al., 2004; Tuner, 2004; Fortune and White, 2006; Rolstades et al., 2014; Davis, 2014; Taherdoost and Keshvarzsaleh, 2016; Misisic and Radujkovic 2017; Tsiga et al., 2017; Mavi and Standing, 2018)	11	3
Clear objectives and realistic obligations (Chua et al., 1999; LIM and LING 2002; Fortune and White, 2006; Scott-Young and Samon, 2008; Sudhakar, 2012; Mirzaa et al., 2013; Rolstades et al., 2014; Davis, 2014; Aga, 2016; Montequin et al., 2016; Maqbool and Sudong, 2018)		
Monitoring & feedback (Pinto and Slevin, 1987; Chua et al., 1997; Chan et al., 2004; Phua and Rowlinson, 2004; Chileshe and Haupt, 2005; Fortune and White, 2006; Ika et al., 2011; Rolstades et al., 2014; Yamin and Sim, 2016; Tsiga et al., 2017)	10	4
Risk management (Chua et al., 1999; Cooki-Davis, 2002; Tuner, 2004; Fortune and White, 2006; Gomesa and Romaoa, 2016; Wu et al., 2018; Almarri and Boussabanie, 2017; Tsiga et al., 2017; Ahmadabdi and Heravi, 2019; Mertens et al., 2018)		
Team competency (Andersen et al., 2006; Nguyen et al., 2004; Fortune and White, 2006; Espinosa et al., 2006; Young and Samon, 2008; Rolstades et al., 2014; Tsiga et al., 2017; Nguyen and Hasikusumo, 2018; Maqbool and Sudong, 2018)	9	5
Adequacy of funding (Chua et al., 1999; Nguyen et al., 2004; Phua and Rowlinson, 2004; Fortune and White, 2006; Ophiyandri et al., 2013; Gupta et al., 2013; Gomes and Romaoa, 2016; Maqbool and Sudong, 2018)	8	6
Coordination (Espinosa et al., 2006; Ika et al., 2011; Sudhakar, 2012; Ophiyandri et al., 2013; Davis, 2014; Yamin and Sim, 2016; Maqbool and Sudong 2018)		
Planning efforts (Pinto and Slevin, 1987; Pinto and Prescott, 1987; Chan et al., 2004; Sudhakar, 2012; Doulabi and Asnaashari, 2016; Tsiga et al., 2017; Peetawan and Suthiwartnarueput, 2018)		
Organization structure (Andersen et al., 2006; Chua et al., 1997; Chileshe and Haupt, 2005; Fortune and White, 2006; Young and Samon, 2008; Misisic and Radujkovic, 2017; Tsiga et al., 2017)	7	7
Political environment (Andersen et al., 2006; Chan et al., 2004; Phua and Rowlinson, 2004; Fortune and White, 2006; Doulabi and Asnaashari, 2016; Tsiga et al., 2017; Maqbool and Sudong, 2018)		
Stakeholder involvement (Andersen et al., 2006; Frodell et al., 2008; Sudhakar, 2012; Ophiyandri et al., 2013; Rolstades et al., 2014; Zheng et al., 2018)	6	8
Project size (Andersen et al. 2006; Chan et al., 2004, Fortune and White 2006; Alzahrani and Emsley, 2013; Tsiga et al., 2017)		
Quality control (Sudhakar, 2012; Alzahrani and Emsley, 2013; Doulabi and Asnaashari, 2016; Tsiga et al., 2017; Maqbool and Sudong, 2018)		
Teamwork (Frodell et al., 2008; Sudhakar, 2012; Doulabi and Asnaashari, 2016; Zuo et al., 2018; Maqbool and Sudong 2018)	5	9
Design efforts (Chua et al. 1997 and 1999; Phua and Rowlinson, 2004; Ika et al., 2011; Yamin and Sim, 2016)		
Strong business case (Shenhar et al., 1997; Chileshe and Haupt, 2005; Fortune and White, 2006; Rolstades et al., 2014)		
Economic risks (Chua et al., 1999; Phua and Rowlinson, 2004; Doulabi and Asnaashari, 2016; Almarri and Boussabanie, 2017)		
Contractual aspects (Chua et al., 1999; Phua and Rowlinson, 2004; Tsiga et al., 2017; Wu et al., 2018)		
Commitment to project (Nguyen et al., 2004; Andersen et al., 2006; Frodell et al., 2008; Taherdoost and Keshvarzsaleh, 2016)	4	10
Project complexity (Chan et al., 2004; Fortune and White, 2006; Carvalho et al., 2015; Tsiga et al., 2017)		
Effective safety program (Chan et al., 2004; Phua and Rowlinson, 2004; Tsiga et al., 2017; Peetawan and Suthiwartnarueput, 2018)		
Leadership (Fortune and White, 2006; Young and Samon, 2008; Zuo et al., 2018; Maqbool and Sudong, 2018)		
Procurement method (Chan et al., 2004; Gupta et al., 2013; Ahmadabdi and Heravi, 2019)		
Troubleshooting (ability to handle unexpected crises and deviations from plan) (Pinto and Slevin, 1987; Pinto and Prescott, 1987; Maqbool and Sudong, 2018)		
Client acceptance (Pinto and Slevin, 1987; Pinto and Prescott, 1987; Sudhakar, 2012)	3	11
Technical tasks (availability of required technology and expertise) (Pinto and Slevin, 1987; Pinto and Prescott, 1987; Chileshe and Haupt, 2005)		

Government support (Ophiyandri et al., 2013; Gupta et al., 2013; Ahmadabdi and Heravi, 2019)		
Meeting budget goals (Shenhar et al., 1997; Frodell et al., 2008; Davis, 2014)		
Meeting scope (Serrador and Turner, 2014; Gomes and Romaoa, 2016; Doulabi and Asnaashari, 2016)		
Meeting time goals (Shenhar et al., 1997; Serrador and Turner, 2014; Davis, 2014)		
Customer satisfaction (Shenhar et al., 1997; Davis, 2014; Berssaneti and Carvalho, 2015)		
Trust (LIM and LING, 2002; Ophiyandri et al., 2013; Rezvani et al., 2016)		
Project manager's commitment (Chua et al., 1999; Young and Samon 2008; Montequin et al., 2016)		
Availability of resources (Nguyen et al., 2004; Alzahrani and Emsley, 2013; Gomes and Romaoa, 2016)		
Keeping project plans up to date (Cooki-Davis, 2002; Fortune and White, 2006; Rolstades et al., 2014)		
Cooperation (Phua and Rowlinson, 2004; Tuner, 2004; Davis, 2014)		
Client's experience (Chan et al., 2004; Phua and Rowlinson, 2004; Tsiga et al., 2017)		
Institutional environment (standards and permits) (Ika et al., 2011; Yamin and Sim, 2016; Tsiga et al., 2017)		
Training (Fortune and White, 2006; Yamin and Sim, 2016; Nguyen and Hasikusumo, 2018)		
Development of project management (Misic and Radujovic, 2015; Berssaneti and Carvalho, 2015; Rodriguez-Segura et al., 2016)		
Project environment (Rodriguez-Segura et al., 2016; Taherdoost and Keshvarzsaleh, 2016; Doulabi and Asnaashari, 2016)		
Market impact and business opportunity (Shenhar et al., 1997; Gomes and Romaoa, 2016)	2	12
Reliability of output and accuracy of output (Sudhakar, 2012; Peetawan and Suthiwartnarueput, 2018)		
Project mission (Pinto and Slevin, 1987; Pinto and Prescott, 1987)		
Client consultation (Pinto and Slevin, 1987; Pinto and Prescott, 1987)		
Cognitive ability (Espinosa et al., 2006; Zuo et al., 2018)		
Cost management (Doulabi and Asnaashari, 2016; Tsiga et al., 2017)		
Actually used by customer (Shenhar et al., 1997; Davis, 2014)		
Project team background (Andersen et al., 2006; Taherdoost and Keshvarzsaleh, 2016)		
Technological or industrial environment (Andersen et al., 2006; Chan et al., 2004)		
Social environment (Chan et al., 2004 ; Tsiga et al., 2017)		
Control meetings (Chua et al., 1997 and 1999)		
Constructability (Chua et al. 1997 and 1999)		
Project manager's experience (Chua et al., 1997 ; Chan et al., 2004)		
Reduce ambiguity (Sudhakar, 2012; Maqbool and Sudong, 2018)		
Project type (Chan et al., 2004 ; Tsiga et al., 2017)		
Project nature (Chan et al., 2004 ; Tsiga et al., 2017)		
Short construction period (Cooki-Davis, 2002; Gupta et al., 2013)		
Learning from experience (Cooki-Davis, 2002; Fortune and White, 2006)		
Maximize stability (Sudhakar, 2012; Maqbool and Sudong, 2018)		
High public enthusiasm for project (Phua and Rowlinson, 2004; Koutsikouri et al., 2008)		
Stakeholder management (Misic and Radujovic, 2015; Gomes and Romaoa, 2016)		
Innovativeness (Koutsikouri et al., 2008; Mertens et al., 2018)		
Project urgency (Pinto and Slevin, 1987)	1	13
Project uniqueness (Andersen et al., 2006)		
Project manager's emotional intelligence (Rezvani et al., 2016)		
To have a governing structure (Chang et al., 2013)		
Job satisfaction (Rezvani et al., 2016)		
Personnel(recruitment, selection, training) (Pinto and Slevin, 1987)		
Meeting operational specifications (Shenhar et al., 1997)		
Meeting technical specifications (Shenhar et al., 1997)		
Fulfilling customer needs (Shenhar et al., 1997)		
Solving a major operational problem (Shenhar et al., 1997)		
Effective change management (Rolstades et al., 2014)		
Project attributes (Taherdoost and Keshvarzsaleh, 2016)		
Physical environment (Tsiga et al., 2017)		

Team turnover (Chua et al., 1997)		
Expended money for controlling (Chua et al., 1997)		
Company image (Alzahrani and Emsley, 2013)		
Respecting cultural differences (Misic and Radujovic, 2015)		
Opened a new line of product (Shenhar et al., 1997)		
Developed a new technology (Shenhar et al., 1997)		
Transparency and accountability (Ophiyandri et al., 2013)		
Client and user (Rodriguez-Segura et al., 2016)		
Site inspection (Chua et al., 1999)		
Stakeholder expectations (Mavi and Standing, 2018)		
Capability of contractor's key person (Chua et al., 1999)		
End user's imposed restrictions (Mavi and Standing, 2018)		
Client is credit worthy (LIM and LING, 2002)		
Client does not contribute to project complexity (LIM and LING, 2002)		
Client is not litigious (LIM and LING, 2002)		
Facilitator capacity (Ophiyandri et al., 2013)		
Appropriate reconstruction policy (Ophiyandri et al., 2013)		
Waste disposal (Alzahrani and Emsley, 2013)		
Private sector capability (Ahmadabdi and Heravi, 2019)		
Project popularity (Zheng et al., 2018)		
Pro-activeness (Mertens et al., 2018)		
National environment (Carvalho et al., 2015)		
Ethics (Doulabi and Asnaashari, 2016)		
A mature scope change control process (Cooki-Davis, 2002)		
Good partnering (Ahmadabdi and Heravi, 2019)		
Suitable project metrics (Cooki-Davis, 2002)		
Reducing cost (Maqbool and Sudong, 2018)		
Availability of relevant and realistic information to make decision about business case (Wu et al., 2017)		
Personal friendship between project firms (Phua and Rowlinson, 2004)		
Good weather condition (Phua and Rowlinson, 2004)		
Minimal government red tape (Phua and Rowlinson, 2004)		
Agreed success criteria among stake holders (Tuner, 2004)		
Owner interest in project performance (Tuner, 2004)		
Contingent reward of transactional leadership (Aga, 2016)		
Nature of client(public or private)(Chan et al., 2004)		
Size of client organization (Chan et al., 2004)		
Increasing efficiency (Maqbool and Sudong, 2018)		
Client emphasis on time, cost and quality (Chan et al., 2004)		
Client's ability to brief (Chan et al., 2004)		
Decision making ability(client)(Chan et al., 2004)		
Successful beneficiary identification (Ophiyandri et al., 2013)		
Project management methodologies and tools (Misic and Radujkovic, 2017)		
Cross functional project team (Scott-Young and Samon, 2008)		
Achievement motivation skill (Zuo et al., 2018)		
Virtual office usage (Scott-Young and Samon, 2008)		
Conflict management skill (Zuo et al., 2018)		
Shared values (Koutsikouri et al., 2008)		
Research & development (Peetawan and Suthiwartnarueput, 2018)		
Delivering strategic benefits (Davis, 2014)		
Social support (Almarri and Boussabanie, 2017)		
Turnover history (Alzahrani and Emsley, 2013)		
Stakeholder endorsement of project plans (Andersen et al., 2006)		
Well-structured and formal project approach (Andersen et al., 2006)		
Understood and accepted project purpose (Andersen et al., 2006)		

Appendix B. Details of identified project success criteria from literature

Project success criteria in the literature		
Presented success criteria	Frequency	Rank
Meeting Cost (Al-Tmeemy et al., 2011; Agarwal and Rathod, 2006; Cooper and Kleinschmidt, 1987; Davis, 2016, 2017; Freeman and Bale, 1992; Lim and Mohamed, 1999; Shenhar et al., 2001; Müller and Turner, 2007; Lam et al. 2007 and 2010; ka et al., 2011; Koops et al, 2016,2017; Gomes and Romãoa, 2016; Osei-Kyei and Chan, 2018; Pankratz and Basten, 2018; Shenhar et al., 1997)	18	1
Meeting Time (Al-Tmeemy et al., 2011; Agarwal and Rathod, 2006; Chipulu et al., 2014; Davis, 2016 and 2017; Freeman and Bale, 1992; Gomes and Romãoa, 2016; Ika et al., 2011; Koops et al., 2016 and 2017; Lim and Mohamed, 1999; Lam et al. 2007 and 2010; Müller and Turner, 2007; Pankratz and Basten, 2018; Shenhar et al., 1997; Shenhar et al., 2001)	15	2
Customer satisfaction (Al-Tmeemy et al., 2011; Agarwal and Rathod, 2006; Davis 2016 and 2017; Freeman and Bale, 1992; Gomes and Romãoa, 2016; Koops et al., 2016,2017; Lim and Mohamed, 1999; Müller and Turner, 2007; Shenhar et al., 2001; Shenhar et al., 1997; Pankratz and Basten, 2018;)	13	3
Meeting Quality (Al-Tmeemy et al., 2011; Chipulu et al., 2014; Davis, 2016 and 2017; Koops et al., 2016 and 2017; Lim and Mohamed, 1999; Lam et al., 2007 and 2010; Müller and Turner, 2007; Osei-Kyei and Chan, 2018;)	11	4
Business success (Al-Tmeemy et al., 2011; Freeman and Bale, 1992; Shenhar et al., 1997; Shenhar et al., 2001; Müller and Turner, 2007; Osei-Kyei and Chan, 2018)	6	5
Technical performance (Freeman and Bale, 1992; Davis, 2016 and 2017; Gomes and Romãoa, 2016; Lim and Mohamed, 1999; Osei-Kyei and Chan, 2018)		
Safety (Chipulu et al., 2014; Koops et al., 2016,2017 ; Lim and Mohamed, 1999; Lam et al., 2010)	5	6
Meeting Scope (Agarwal and Rathod, 2006; Chipulu et al., 2014; Gomes and Romãoa, 2016; Ika et al., 2011; Müller and Turner, 2007)		
Preparing for the future (Cooper and Kleinschmidt, 1987; Shenhar et al., 1997; Shenhar et al., 2001)	3	7
Project specific political or social factors (Koops et al., 2016 and 2017)		
Effect on the professional image of client organization (Koops et al., 2016 and 2017)		
Benefit to stakeholder group (Davis, 2016 and 2017)	2	8
Meeting expectations (Davis, 2016, 2017)		
Personal growth (Freeman and Bale, 1992)		
Manufacturability (Freeman and Bale, 1992)		
Sustainability (Ika et al., 2011)		
The project team (Chipulu et al., 2014)		
Functionality (Lam et al., 2007)		
Environmental friendliness (Lam et al., 2010)		
Contractor satisfaction (Pankratz and Basten, 2018)		
Relevance/country (Ika et al., 2011)		
Relevance/beneficiaries (Ika et al., 2011)		
Impact (Ika et al., 2011)		
Sustainability (Ika et al., 2011)		
Organizational goals (Chipulu et al., 2014)		
Leadership and decision making (Chipulu et al., 2014)		
Improve the quality of life and community engagement (Rohman et al., 2017)		
Provide peace of mind (Psychological needs, Present smooth traffic and regulation compliance environment) (Rohman et al., 2017)		
Meeting functional requirements and Meeting non-functional requirements (Pankratz and Basten, 2018)	1	9
System is used by the end users (Pankratz and Basten, 2018),		

PAPER III

Project Managers' Competencies in Collaborative Construction Projects

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Article

Project Managers' Competencies in Collaborative Construction Projects

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Abstract: Collaborative delivery methods in construction projects provide a new operational environment, which can foster effective interaction and cooperation between different project stakeholders. Project managers are one of the most important players in this environment, who therefore need to possess appropriate competencies. Collaborative construction projects and their managerial solutions are still a relatively new field and, thus, special aspects such as competencies of project managers in such projects have been limitedly studied. The present research aimed to evaluate project managers' competencies in collaborative construction projects in Finland through a human behavioral approach, where project managers' everyday work was the main source for understanding the competencies of relevance. Accordingly, a web-based questionnaire and semi-structured interviews were used for data collection from the case projects. Based on the gained data, project managers' behaviors were analyzed, and consequently, their specific competencies were identified. Findings of this study propose 10 core competencies for project managers in collaborative construction projects, e.g., group capabilities, language proficiency, and leveraging diversity. Additionally, a set of supportive competencies were identified which, together with the core competencies, form the profile of project managers' competencies for collaborative construction projects. Finally, the differences between competencies needed in traditional and in collaborative construction projects are discussed.

Keywords: project manager; competency; collaborative construction projects; project delivery method

1. Introduction

The selected delivery method for any construction project has a significant role in its success or failure. Changing business conditions, new requirements, and development of technologies are challenging traditional delivery methods and have resulted in several changes and the emergence of new ones, where collaboration between project stakeholders is of prime importance (such as project partnering, integrated project delivery, and project alliance) [1,2]. These new collaborative delivery methods in construction projects provide a different operational project environment, which can foster collaboration (working together) and cooperation (information exchange) among different project stakeholders for the good of the project.

In such an operational environment, appropriate stakeholder management is crucial to facilitate collaborative behaviors and project managers, as project leaders, are responsible for managing the project stakeholders and its atmosphere. Thus, project managers' competencies are one of the main predictors of their performance, and they need to have certain kinds of competencies to have superior performance in their job [3]. Accordingly, the role of competent project managers in successful delivery

of projects, in general, and for construction projects, in particular, has been one of the most investigated topics among the research community.

In this regard, several studies have pursued to identify project managers' competencies in general [4–8] and for specific types of project [9–13]. Those context-oriented studies have focused on different types of projects, such as construction and IT. Construction projects as one of the focused contexts, have received considerable attention for addressing project managers' competencies. Consequently, several conducted studies, mainly focused on traditional construction projects, have resulted in identification of a few competencies [14–19]. Meanwhile, as stated earlier, there have been significant changes in delivery methods of construction projects over the recent years. Particularly, the use of collaborative project delivery methods has spread gradually to facilitate new management approaches, especially for complex infrastructure projects.

Due to the changes in construction project delivery methods and the focus of construction-oriented competency studies on traditional delivery methods, collaborative construction projects and their managerial solutions are still a relatively new field, and thus, special aspects such as competencies of project managers in such projects have been studied in a very limited manner. This study aimed to identify project managers' appropriate competencies for collaborative construction projects. To that end, first, the theoretical background is presented followed by the description of the research methodology and relating research process. After that, the research results are presented together with relating discussion and their positioning with the prior research. The final chapter highlights the gained novel contributions.

2. Theoretical Background

2.1. Definition of Competency

Competency is an underlying characteristic of an individual that is causally related to criterion-referenced effective and/or superior performance in a job or situation [3]. There are also other definitions of competency in prior research. Project managers' competencies are the capabilities to use skills, knowledge, and personal characteristics that enhance the efficiency and effectiveness of project managers in their job performance and subsequently increase the likelihood of project success [20]. Abraham et al. [4] also defined competency as a range of different characteristics, behaviors, and traits that are required for effective job performance. ICB.4 (Individual Competence Baseline for project, program, and portfolio management (ICB) by IPMA) [21] states that individual competency is the application of knowledge, skills, and abilities in order to achieve the desired results. In addition to ICB, there are also other standards of practice (APM Body of Knowledge [22], PMBOK [23], and the Project Manager Competency Development framework (PMCD) [24]) that have provided definitions and categorizations of project managers' competencies.

2.2. Project Managers' Competencies in the View of Standards of Practice

ICB.4, APM Body of Knowledge, PMBOK, and Project Manager Competency Development framework (PMCD) are those standards of practice that have addressed project managers' competencies. ICB.4 [21] introduces 28 competencies of project managers in the three groups of people, practice, and perspective. In another categorization by the Project Management Competency Development framework (PMCD) [24], 16 mentioned competencies of project managers are divided into two group, performance and personal competencies. The APM standard [22] is another reference that considers 11 competencies in two groups, interpersonal and professional. PMBOK Guide [23] also introduced a framework titled PMI Talent Triangle which considers three types of project managers' skills.

2.3. Project Managers' Competencies in the View of Research Community

The research community has been active in studying project managers' competencies in terms of both competencies of general significance (for various types of projects) and competencies of specific

significance for certain types of projects. Here, the focus is more on the studies addressing project managers' competencies in construction projects. Crawford [25], and Edum-Fotwe and McCaffer [26] conducted studies to explore details of project managers' competencies in construction projects and the correlation of project managers' competency with project success. This was followed by a study carried out by Shenhar [27] "One Size Does Not Fit All Projects: Exploring Classical Contingency Domains" in 2001; he stated that a specific project type should affect the selection of project managers, project team members, and skill development needs.

Then, other studies were conducted by Abraham et al. [4], El-Sabaa [28], Ruuska and Vartiainen [29], and Kasvi et al. [30], addressing project managers' important competencies, and competencies such as leadership, communication, and goal-orientation were identified in the results of those studies. These efforts concerning the contribution of project managers' competencies on their success and efficiency were followed by other researchers such as Dainty et al. [9], Cheng et al. [31], Gillard and Price [5], Brill et al. [32], and Suikki et al. [33], and new competencies such as analytical thinking, flexibility, and adaptability were also identified in addition to the previous ones.

Some studies focused on the required competencies of project managers in engineering projects particularly, construction ones [14,15,34–40]. The appropriateness of project managers' competencies with the project type was taken into account by Muller and Turner [37,40], and they also identified important leadership competencies in the areas of engineering and construction, IT, and organization and business. These studies were in line with Shenhar's [27] finding on the necessity of matching the project type and project managers' competencies.

Specifically, the project managers' competencies needed in construction projects have been studied in different countries. In the results of these studies, some new competencies, such as contract management and conflict management, were identified [17,41–50]. The more recent studies conducted between 2015 and 2019 suggest that the focus on investigating and identifying project managers' competencies in construction projects has been continued [13,18,51–57]. A recent study [20] concerning project managers' competencies has also shown that construction projects have been considerably focused on by the research community among the other specific project types for addressing project managers' competencies. Reviewing relevant studies resulted in a synthesis of 184 competencies of project managers for construction projects. The following Table 1 presents the top 10 competencies based on that synthesis. Ranking (R) of the listed competencies have been calculated based on their frequency of appearance.

Table 1. Project managers' key competencies in construction projects.

Competency	R	Competency	R	Competency	R
Teamwork and cooperation	1	Resource management	4	Team management	4
Cost management		Knowledge of construction		Project management	
Communication	2	HSE (Health, Safety, and Environment)		Conflict management	
Leadership	3	Experience		Achievement orientation	5
Time management		Ethics		Innovation	
Quality management		Problem solving		Decision-making	
Flexibility and adaptability	4	Impact and influence		Analytical thinking	

R: Rank based on the frequency of appearance in literature.

2.4. What Is Missing in Project Managers' Competency Research?

Literature analysis revealed that project managers' competencies in construction projects have formed a rather popular research topic. However, the focus of conducted studies has been mainly on

traditional construction projects, and there is no clear evidence whether identified competencies of project managers in traditional construction projects are relevant in collaborative construction projects as well. This study aimed at filling this knowledge gap by identifying project managers' appropriate competencies for collaborative construction projects. The result of comparing identified competencies in this study and the found ones from literature is presented in the discussion section.

3. Methodology

The study employed two different data collection techniques, including a web-based questionnaire and semi-structured interviews. The web-based questionnaire was utilized to identify project managers' competencies by evaluating the frequency and type of their behaviors related to their everyday work. Then, semi-structured interviews were used to validate the obtained findings from completed questionnaires. The process of collecting data through the mentioned techniques is described in the following.

3.1. Web-Based Questionnaire

Self-evaluation of behavioral events is the most effective way for identifying project managers' competencies in a certain context, as competency is a concept based on behavior, and a project manager is the best evaluator of his/her own everyday behavior related to his/her job [3,58,59]. Accordingly, a web-based questionnaire, in a self-evaluation manner, was employed to identify the most appropriate competencies of project managers in collaborative construction projects. This questionnaire was sent to 24 project managers in construction projects of interest. These project managers were selected among the ongoing or recently completed alliance construction projects in Finland. In terms of the role, 10 (42%) out of the 24 approached project managers in this study are/were working as the client's project manager and 14 (58%) of them as the contractor's project manager. The categories of the studied construction projects in this study comprised residential building (housing construction), institutional construction (hospital and school), and infrastructure (road and railway construction). In total, five questionnaires were completed (June–September 2019) with a response rate of 21%. Among respondents, 20% of them are/were working as the client's project manager and 80% of them as the contractor's project manager. The following Figure 1 presents the demographic information of the survey respondents.

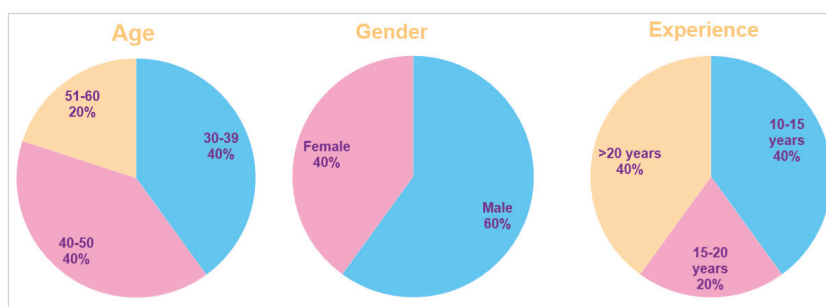


Figure 1. Demographic information of the survey respondents.

The utilized web-based questionnaire "Cycloid", by Evolute Technology, focuses on the evaluation of key behavioral competencies of project managers based on their current state (reality), target state (vision), and creative tension (the probable gap between the current and target state: improvement-needed competencies). For this purpose, 30 behavioral competencies of project managers were evaluated through 120 linguistic statements. Respondents were asked to choose and determine the frequency of their behaviors in the situations presented by each linguistic statement on the following scale: never/seldom/often/always in their current and target state. How often these behaviors occurred

in the statements were evaluated both in current and target states through analyzing the numeric values of the current and target states of the self-evaluation results.

These 30 competencies and 120 linguistic statements were developed by Kirsi Liikamaa [6]. Liikamaa [59] has also categorized these 30 competencies into two main groups and five subgroups, including personal competencies and social competencies (see Table 2). Liikamaa's [59] categorization is based on the Goleman's [60] ontology of the five components of emotional intelligence at work, which include personal competencies (including self-awareness, self-management, and motivation) and social competencies (including social awareness and relationship management). Since its first development, Cycloid has been utilized in several studies for evaluating project managers' competencies in different contexts [6,61–65].

Table 2. Categorization of project managers' competencies in Cycloid.

Group	Subgroup	Competency
Personal Competencies	Self-awareness	Emotional awareness, Self-assessment, Self-confidence
	Self-control	Trustworthiness, Maintaining order, Flexibility, Innovation, Responsibility, Seeking information, Production efficiency, Decision quality, Stress management
	Cognitive ability	Analytical thinking, Conceptual thinking, Language proficiency
	Motivation	Achievement drive, Commitment, initiative, Optimism
Social Competencies	Empathy	Understanding others, Developing other people, Leveraging diversity, Organizational savvy
	Social skills	Communication, Conflict management, Management, Leadership, Relationship building, Collaboration, Teamwork

3.2. Semi-Structured Interviews

In addition, transcripts of 17 interviews were analyzed to evaluate and strengthen the reliability of the obtained results. The mentioned interviews were undertaken with practitioners of two alliance construction projects (Liekki and Rantatunneli) in Finland in 2014 and 2015. These semi-structured interviews addressed management of collaborative construction projects, overall, and the perceived required competencies of project managers in alliance construction projects, in particular. Transcripts of these interviews were analyzed to identify competencies of project managers in the context of interest and compare them with the identified competencies from the Cycloid survey. These results yielded in similar findings (Group 4), and this outcome is seen as evidence that has strengthened the reliability of the research results. Tables 3 and 4 present background information on the interviewees, survey respondents, and projects where they were/are working.

Table 3. Case projects of interviewees and survey respondents.

Data Collection Technique	Project	Owner	Contract Type	Construction Category	Budget	Duration
Questionnaire	Kanta-Häme	KHSHP	Alliance	Institutional (hospital)	-	2018–2024
	Rajatorpan koulu	City of Vantaa	Alliance	Institutional (school)	-	2018–2020
	Botnia High5	VHSHP	Alliance	Institutional (hospital)	-	2018–2022
	Asemataso	Finavia	Alliance	Infrastructure (airport terminal)	100 M€	2014–2017
	T2	Finavia	Alliance	Infrastructure (airport terminal)	200 M€	2015–2017
Interviews	Liekki	Finnish Transport Agency	Alliance	Infrastructure (railway)	100 M€	2011–2015
	Rantatunneli	Finnish Transport Agency	Alliance	Infrastructure (road tunnel)	180 M€	2011–2017

Note: Duration of projects include both their development and construction phases.

Table 4. The job profiles of interviewees and survey respondents.

Data Collection Method	Studied Projects	Participants' Job Title and Parent Organization
Questionnaire	Kanta-Häme	Project manager (contractor)
	Rajatorpan koulu	Project manager (contractor)
	Botnia High5	Project manager (contractor)
	Asemataso	Project manager (contractor)
	T2	Project manager (client)
Interviews	Liekki	Assistant Project Manager (National Transport Agency)
		Manager (National Transport Agency)
		Alliance Project Manager (Track Contractor)
		Project Engineer (Track Contractor)
		Design Manager (Track Contractor)
	Rantatunneli	External consultant, expert and evaluator (Track Consultant)
		Project Manager (Infra Contractor)
		Health, Safety and Environment Coordinator (Infra Contractor)
		Assistant Project Manager (National Transport Agency)
		Procurement Manager (Tunnel City)
		Chairman of the Alliance Executive Team (National Transport Agency)
		Planning Manager (Infra Contractor)
		Public Relations Manager (Infra Designer)
		Technical Project Director (Tunnel Subcontractor)
		Chief Structural Designer (Tunnel Subcontractor)
		Project Cost Engineer (Infra Contractor)
		Procurement Manager (Infra Contractor)

4. Results

The results are presented in four groups (1–4) based on the significance of different competencies in the current and target state of project managers as well as their creative tension and the gap between their current and target state. Finally, as a synthesis of the results the profile of project managers' competencies in collaborative construction projects is presented.

4.1. Group 1: The Significance of Different Competencies in the Current State

Group 1 presents the competencies, which the respondents have identified as the most significant in their current state based on the statements. Group capabilities competency was identified as the most significant, with the statements concerning the competency concentrating on working with others toward common goals. The second highest identified competency was trustworthiness, which is the quality of one behaving honestly and ethically. The third highest identified competency was leveraging diversity, which points to the ability of the project manager in creating opportunities for cooperation with different kinds of people. The fourth highest identified competency was leadership, the competency concentrating on the capability to engage group members as well as the project managers' ability to motivate others and to act fair toward them. The fifth highest competency was responsibility, which is being conscientious and responsible for one's own personal performance. The following Table 5 presents the complete list of the competencies identified as the highest in the current state of project managers.

Group 1 also presents the competencies that the respondents have identified as the least significant in their current state, based on the statements. The least significant identified competency was innovativeness, of which statements concentrated on the natural and open attitude towards new ideas, attitudes, and information. The second least identified competency was conceptual thinking, in which the use of concepts and abstractions to find similarities are examined. The third one was emotional awareness, which rates the ability to recognize, realize, and specify one's feelings. The fourth least identified one in the current state was initiative, of which statements evaluate the ability to assess and initiate things independently and voluntarily before obligation. The fifth least identified competency

in the current state was management, in which the ability to concentrate on management activities that are centered upon matters and things are evaluated. The following Table 6 presents the identified 10 least significant competencies of project managers in collaborative construction projects.

Table 5. The 10 highest significant competencies based on the project managers' behaviors in their current state.

Rank	Competency	Rank	Competency
1	Group capabilities	6	Relationship building
2	Trustworthiness	7	Stress tolerance (management)
3	Leveraging diversity	8	Language proficiency
4	Leadership	9	Achievement orientation
5	Responsibility	10	Flexibility

Table 6. The ten least significant competencies based on the project managers' behavior in their current state.

Rank	Competency	Rank	Competency
1	Innovativeness	6	Management
2	Conceptual thinking	7	Developing others
3	Emotional awareness	8	Decision quality
4	Analytical thinking	9	Optimism
5	Initiative	10	Production efficiency

In terms of subgroup competencies (see Table 2 for categorization), as can be seen in the following Figure 2, the competencies of social skills and self-control subgroups have been identified as the highest in the current state of project managers in collaborative construction projects.

4.2. Group 2: The Significance of Different Competencies in the Target State

Group 2 presents the 10 most significant competencies according to the project managers' behavior in their target state (Table 7). These 10 competencies are the core competencies that every project manager in collaborative construction projects is expected to possess. These competencies are those ones that, in the respondent group, were identified as the most important and desirable competencies of project managers in collaborative construction projects. The most significant competency in the target state was identified for the group capabilities, which also was the highest in the current state (group 1). The second highest identified competency was language proficiency, which also rose from its current state (group 1) as the eighth highest identified competency. Language proficiency competency points out to the ability and courage of the project manager to use foreign languages. The third highest significant competency was leveraging diversity, which in fact, is the ability of a collaborative construction project manager in creating opportunities for cooperation with different kinds of people. This competency was identified as the third highest in its current state (group 1) as well. The fourth most significant competency was stress tolerance (stress management), which evaluates project managers' ability to handle adverse, tiring, and stressful issues and situations. The fifth highest identified competency was flexibility, which is the ability of project manager to adapt to changes.

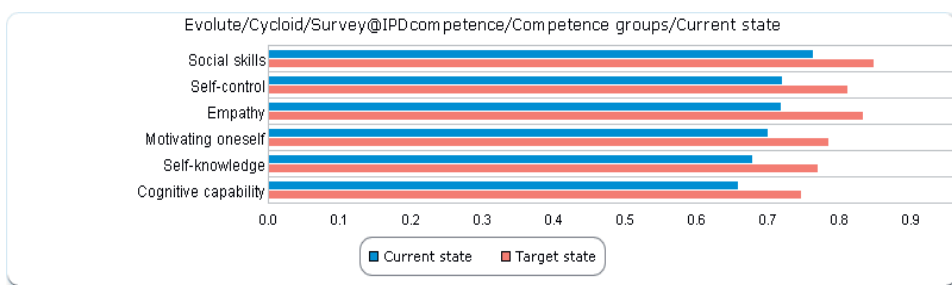


Figure 2. Project managers' subgroup competencies sorted according to their importance (current state).

Table 7. The ranking of core competencies of project managers in collaborative construction projects in the target state.

Rank	Competency	Rank	Competency
1	Group capabilities	6	Relationship building
2	Language proficiency	7	Leadership
3	Leveraging diversity	8	Maintaining order
4	Stress tolerance (management)	9	Achievement orientation
5	Flexibility	10	Understanding others

In terms of subgroup competencies, the competencies of social skills and empathy groups have been identified as the most significant in the target state (Figure 3). In terms of group competencies, it is worthy to point out that the social skills competence group has been identified as the most significant in the both current and target state (Figure 4).

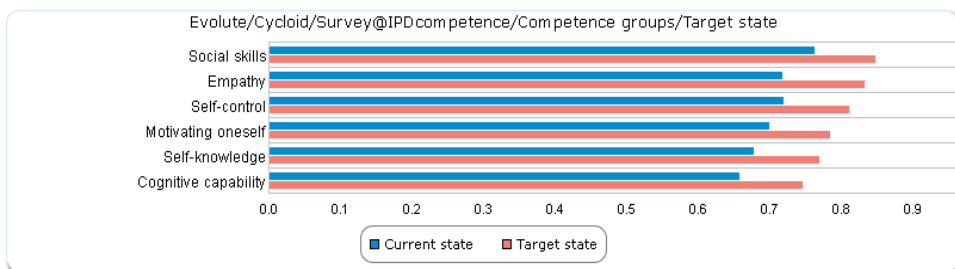


Figure 3. Project managers' subgroup competencies sorted according to their significance (target state).

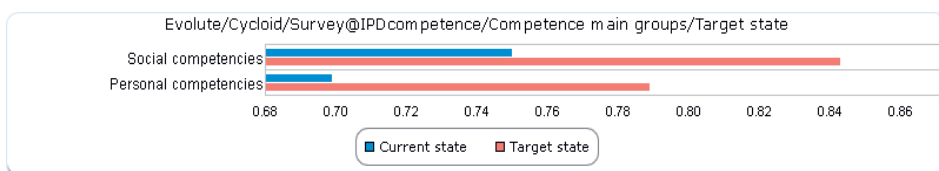


Figure 4. Project managers' group competencies sorted according to their significance (current and target state).

In a holistic view, the following Figure 5 shows the complete list of the competencies sorted based on their significance in the target state.

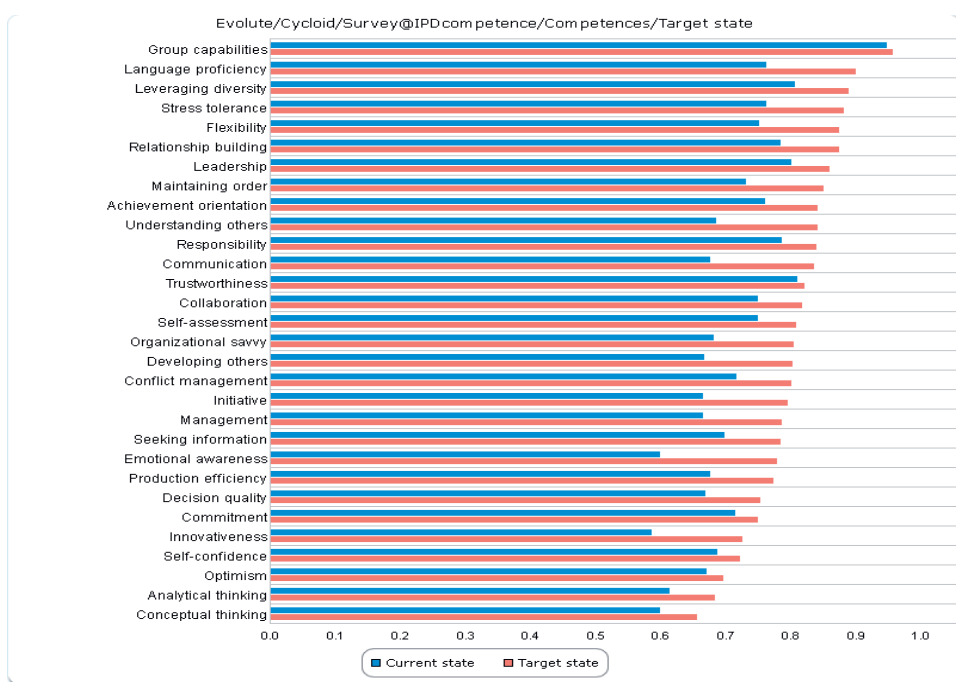


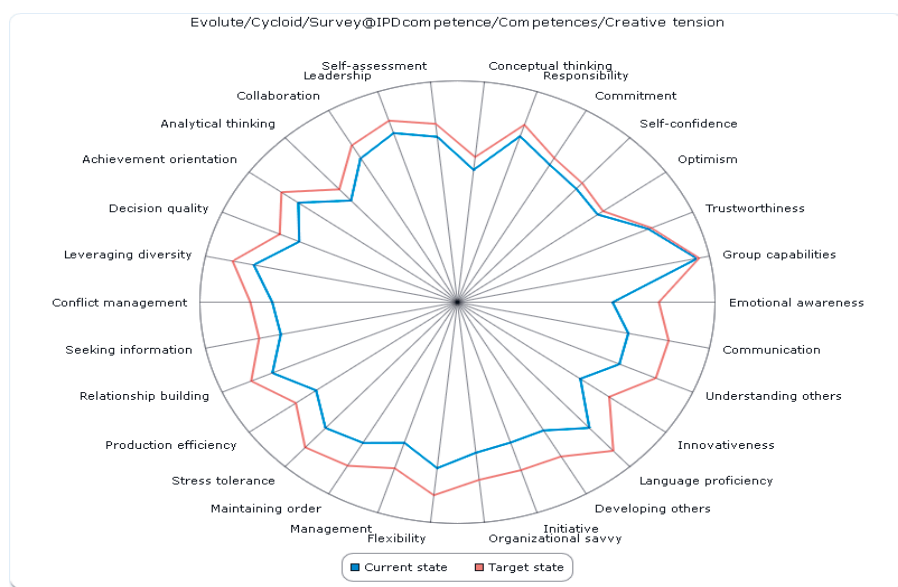
Figure 5. Project managers' competencies sorted according to their significance in the target state.

4.3. Group 3: Competencies That Project Managers Have the Most Willingness to Develop and Improve Them (Creative Tension)

Group 3 presents the competencies for which the greatest creative tension was identified, the gap between the current and target state. Here, the respondents have shown their interest to improve these competencies the most. Accordingly, such competencies are labeled here as creative tension competencies. Participants are most interested in improving their emotional awareness, which also was identified in the current state (group 1) as the third least significant competency. Emotional awareness is related to the ability of a project manager to recognize, realize, and specify others' feelings. The second competency of interest was the communication competency, of which statements concentrated on the ability of listening openly and conveying clearly. The highest creative tension was identified for the competency of understanding others, in which perceiving, considering, and understanding the feelings and viewpoints of others is evaluated. The fourth highest creative tension was for the innovativeness competency, which also was identified as the least significant competency in group 1. Innovativeness points out to the capability of project managers in being comfortable and open with new ideas, approaches, and data. The following Table 8 and Figure 6 present the highest 10 creative tension competencies of project managers in collaborative construction projects. Figure 6 shows the amount of project managers' willingness for improving different competencies, which emanates from the gap between their current (group 1) and target state (group 2) in each competency. The bigger this gap is, the more creative tension will be formed toward improving a competency.

Table 8. The ranking of 10 creative tension competencies.

Rank	Competency	Rank	Competency
1	Emotional awareness	6	Developing others
2	Communication	7	Initiative
3	Understanding others	8	Organizational savvy
4	Innovativeness	9	Flexibility
5	Language proficiency	10	Management

**Figure 6.** Project managers' willingness to improve their competencies (creative tension).

4.4. Group 4: Profile of Project Managers' Competencies in Collaborative Construction Projects

The profile of project managers' competencies can be reasoned from their core (target state) (Table 7) and supportive (creative tension) competencies (Table 8). Core competencies are those ones that are required and necessary for everybody who is going to manage a collaborative construction project. Creative tension competencies, in fact, are those supportive ones that their presence can be supplementary for the core competencies, as can be understood from the respondents' opinions on the necessity of developing these competencies. Consequently, these supportive competencies (listed in Table 8) are expected to have three effective roles in collaborative construction projects. First, they can positively affect project managers' performance as supplementary competencies. Second, they can be considered as a competitive advantage for those project managers that possess these competencies in addition to the core ones. Third, they can be helpful for decision makers in hiring or selecting project managers for their collaborative construction projects in the sense that those project managers possessing these competencies in addition to the core ones can be outweigh others.

Figure 7 presents the resultant profile of project managers' competencies in collaborative construction projects. Among the listed competencies in Table 8, three of them—understanding others, language proficiency, and flexibility—were eliminated from the list of supportive competencies since the category of core competencies already includes those. Figure 7 comprises four sections that are competence category, a brief description of each category, the competencies belonging to each category, and their definitions.

The profile of project managers' competencies in collaborative construction projects			
Competence Category	Description	Competency (ranked based on importance)	Competency definition
Core Competencies	Necessary and required for superior performance	Group capabilities	The ability of working with others toward common goals.
		Language proficiency	Ability and courage to use foreign languages.
		Leveraging diversity	Appreciative attitude towards others. Respecting people from different backgrounds.
		Stress tolerance (management)	To maintain performance when facing workload pressures and/or organizational impediments.
		Flexibility	To be open to new experiences and viewpoints.
		Relationship building	Building or maintaining friendly relationships or networks of contacts with people who are or might be useful in achieving work-related goals.
		Leadership	Management activities that are centered upon human beings.
		Maintaining order	Concern for order, quality, and accuracy.
		Achievement orientation	The drive towards a high standard of excellence. Setting challenging goals and working hard to achieve them.
		Understanding others	The ability to sense the feelings and perspectives of other people.
Supportive Competencies	Competitive advantage and supplementary for superior performance	Emotional awareness	The ability to recognize, understand, and analyze one's own feelings.
		Communication	The ability to listen to others. The ability to openly express one's feelings, ideas, and opinions. The ability to read non-verbal cues.
		Innovativeness	Natural and open attitude towards new ideas, attitudes, and information.
		Developing others	Noticing other people's needs for development and promotion of their abilities.
		Initiative	The ability to see new possibilities and to seize opportunities. To do more than what is expected.
		Organizational savvy	Understanding and utilizing organizational dynamics in order to achieve objectives.
		Management	Management activities that are centered upon matters and things.

Figure 7. The profile of project managers' competencies in collaborative construction projects.

4.5. Data Validation

The interview data were used as another research basis. Transcripts of these interviews were analyzed through content analysis to identify competencies of project managers in collaborative construction projects and compare them with the identified competencies from the web-based survey (Cycloid). The following Table 9 shows the detected competencies from interviews.

Table 9. Project managers' competencies in collaborative construction projects, identified from interviews.

Organizational Savvy	Project Knowledge
Collaboration/cooperation/teamwork	Understanding others
Leadership	Analytical thinking
Flexibility and Adaptability	Delegation of authority
Management	Experience
Communication	Alliance construction management knowledge

As can be understood by comparing the identified competencies from a web-based survey (Figure 7) and interviews (Table 9), it becomes clear that more than 70% of identified competencies through interviews were also among the found ones from the survey. This match between two types of results is seen as an indication of conformance between findings. Moreover, results of analyzing interviews transcripts lead to identification of three competencies, which were not among the list of competencies identified through Cycloid. These competencies include alliance construction management knowledge, experience, and delegation of authority.

5. Discussion

The first group of results showed the most and least significant competencies in the current state of project managers in collaborative construction projects. Group capabilities, trustworthiness, leveraging diversity, and leadership were the four highest valued competencies in the current state of collaborative construction project managers. This seems to be in line with the expectations from the project managers

in collaborative construction projects, as part of their responsibility is to manage the projects, and in which one of their principles is cooperation and trust-based relationships among all participants for the good of the project [1,2]. In such a collaborative environment, leadership ability is also crucial in order to take full advantage of the mentioned principal. Concerning the four least significant competencies, including innovativeness, conceptual thinking, emotional awareness, analytical thinking, and initiative, it is quite surprising because these competencies (except emotional awareness), in general, are referred to as the necessary competencies for managerial level jobs [3,58]. Therefore, project managers in collaborative construction projects are expected to possess these competencies, as the areas requiring improvement. Subsequently, findings on the creative tension (supportive) competencies (Group 3) make it clear that among the ten least significant competencies in the current state of collaborative construction project managers, they have willingness for improving five (50%) of them, including innovativeness, emotional awareness, initiative, management, and developing others.

Group 2 included the most significant competencies of project managers in their target state, which later were termed as their core competencies. Here, group capabilities, leveraging diversity, relationship building, and maintaining order are among the ten most significant competencies in the target state (Table 7). This is not surprising as we have already stated that these competencies are highly required for project managers in the collaborative construction projects. In addition, there are six other competencies among the ten most significant ones in the target state, which were not high in the current state. The first one was language proficiency, which surprisingly has been identified as the second core competency of project managers. This can be mainly emanated from the fact that utilizing foreign languages (particularly English) in Finnish construction projects has been considerably increasing during recent two decades. Accordingly, project managers in Finnish collaborative construction projects see language proficiency as a core competency for their success. The importance of language proficiency also emphasizes the need to be able to communicate more in a collaborative environment and this then also makes the language more critical. The second one was flexibility. The nature of collaborative construction projects considerably increases the amount of interactions between project participants. Project manager needs to be open to several various opinions and be able to manage multiple demands, resulted from those interactions, without losing focus, as the leader of the project. Thus, the flexibility competency seems to be completely necessary for project managers in collaborative construction projects.

Maintaining order and achievement orientation are the next competencies identified as the highest in the target state. A very important goal of collaborative construction projects is the concern for quality, which is most often is sacrificed in traditional construction projects for meeting time or cost targets [1]. One other important goal in collaborative construction projects is the orientation toward excellent results through setting and meeting the challenging goals [2]. The two mentioned competencies, maintaining order and achievement orientation, precisely account for these goals, and therefore are of prime importance for project managers in collaborative construction projects. The last one is relationship building. As already stated, collaborative and trust-based relationships are principally required to set and meet the common goals for the good of the collaborative construction projects. Conceptually, relationship building is the ability of establishing or maintaining friendly relationships or networks of contacts with people who are or might be useful in achieving work-related goals. Accordingly, the relationship-building competency is completely needed for establishing effective and trust-based relationships in the collaborative construction projects.

Moreover, project managers' core and supportive competencies, together, characterized the profile of their competencies in collaborative construction projects. This finding is originated from project managers' self-evaluations concerning their competencies. Self-evaluation in a behavioral manner is one of the most valid and effective methods in conducting competency studies [3]. This competency profile of project managers contributes to the existing knowledge and brings new insights on project managers' competencies in collaborative construction projects, particularly in the Finnish context.

Finally, based on the obtained results, it looks obvious that there are differences between the required competencies for project managers in traditional and collaborative construction projects. Whereas the managerial competencies for traditional construction projects highlight the significance of systems and methods, the recognized competencies of relevance for collaborative construction projects draw attention to human issues and management. This argument can be supported from two aspects. First, looking at top 10 competencies identified from literature (Table 1) and those competencies from survey and interviews (Figure 7 and Table 9), competencies such as time management, quality management, and human resource management, which have been important in traditional construction projects, are no longer focused in collaborative construction projects. Second, looking at the competencies detected in this study, it seems that the importance of competencies (such as understanding others and stress management) related to human issues and in particular, behavior of project managers in collaborative construction projects, have increased.

Moreover, the body of needed competencies in traditional and in collaborative construction projects may well emanate from the differences between the working culture, management style, and business model of traditional and collaborative construction projects. The working culture in collaborative construction projects is based on trust, cooperation, effective communication, and teamwork whereas traditional construction projects suffer often from mistrust, adversarial relationships, and ineffective communication [1,2]. The type of culture in collaborative construction projects needs a project manager whose management style helps him/her to trust project team members and foster teamwork and effective communication [66]. To that end, competencies such as group capabilities, language proficiency, leveraging diversity, flexibility, relationship building, and understanding others are here characterizing the needed culture as mentioned by this study (Figure 7). Then, a business model comprising elements such as fixed profit and profit based on project outcome (shared risk/reward system) needs a project manager who can lead all project practitioners toward a common goal by aligning their commercial interests toward project efficiency as a whole. Such a project manager needs competencies such as leadership, management, and developing others (see Figure 7). In other words, project managers in collaborative construction projects are managers of people rather than managers of systems and technology. Therefore, in collaborative construction projects the behavioral competencies related to human issues are of prime importance, whereas in traditional construction projects the key competences are around systems and methods.

6. Conclusions

This study aimed at evaluating project managers' competencies in collaborative construction projects, especially in a Finnish context, to identify the most appropriate ones suiting the context of interest. It was carried out through undertaking qualitative research to analyze project managers' behaviors related to their everyday work. The obtained results provide the basis for the following conclusions concerning the collaborative construction projects:

- Project managers' 10 core competencies (necessary for their superior performance) comprise group capabilities, language proficiency, leveraging diversity, stress tolerance (management), flexibility, relationship building, leadership, maintaining order, achievement orientation, and understanding others.
- The seven supportive competencies (supplementary for core competencies) of project managers were found to be emotional awareness, communication, innovativeness, developing others, initiative, organizational savvy, and management.
- There are four competencies that were found to be very important in both current and target state of project managers. These are group capabilities, leveraging diversity, relationship building, and maintaining order.
- Project managers have a strong willingness to improve the emotional awareness, communication, innovativeness, developing others, initiative, organizational savvy, and management competencies that are not high in their current state.

- The profile of project managers' competencies can assist them to cover their competency deficiencies and help decision makers in companies to hire or select the right person as a project manager.
- The recognized competencies of relevance draw attention to human issues and management, whereas the managerial competencies for traditional construction projects are highlighting the significance of systems and methods.

These findings provide new insights for project managers of collaborative construction projects in terms of possessing the competencies necessary for their superior performance, and their managers to be aware of project managers' core and supportive competencies in collaborative construction projects. Since 2011, the total value of launched alliance-type construction projects in Finland is more than EUR 3 billion. This highlights the importance of this study's findings for contributing to the existing knowledge on project managers' competencies in collaborative construction projects. Finally, it should be acknowledged that the generalizability of the findings of this study is rather limited due to its scope, which includes project managers of collaborative construction projects in Finland. Therefore, studies on project managers' competencies in collaborative construction projects in various regions and business conditions is a potential area for further research.

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PAPER IV

A Competency Model for the Selection and Performance Improvement of Project Managers in Collaborative Construction Projects: Behavioral Studies in Norway and Finland

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Article

A Competency Model for the Selection and Performance Improvement of Project Managers in Collaborative Construction Projects: Behavioral Studies in Norway and Finland

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Abstract: Collaborative work practices are getting more common in construction projects. Consequently, new project delivery models have emerged and new practices have also entered the world of traditional delivery models. The resultant collaborative construction projects provide a different working environment compared to the traditional construction delivery models. This different environment seems to require project managers with certain types of competencies, but there is currently very limited research-based knowledge concerning this subject. This study aims at identifying such competencies, which project managers of collaborative construction projects need to possess to succeed. For this purpose, a human behavioral approach was employed where project managers' behavior in their everyday work was the main source for understanding their competencies. Accordingly, the survey strategy was utilized, where a self-evaluation questionnaire was sent to 33 project managers of collaborative construction projects, and a response rate of 73% was achieved. The findings present four groups of competencies within a matrix model, structured based on their contribution to project managers' successful performance in collaborative construction projects and the degree to which they can develop those competencies. The developed model can provide a baseline for selecting project managers and for enhancing the performance of the current ones.

Keywords: competency model; project manager; collaborative construction project; project delivery model



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1. Introduction

Delivery models of construction projects are subjects of continuous development and changes. Some of them reflect past practices and traditions, but it is possible to recognize developments that can present valuable drivers for improving the performance of construction projects. An example of such developments is shifting from traditional delivery models of construction projects (e.g., design-bid-build, design-build) toward relational contracting/lean project deliveries (also called collaborative project delivery models) [1,2].

In a holistic view, collaborative delivery models of construction projects comprise alliancing, partnering, integrated project delivery (IPD), relational contracting and relationship-based procurement [3,4]. These collaborative delivery models of construction projects are usually characterized by fixed profit, guaranteed variable cost without a cap, profit based on project outcome and limited change orders [5,6]. Moreover, these collaborative delivery models have some key elements such as early involvement of the

key participants of the project, shared risk-reward based on project outcome, joint project control, and trust-based relationships for collaboration and cooperation [5–7]. The mentioned characteristics and elements direct collaboration and cooperation of the key parties, integrated within a single team, toward the good of the project.

The emergence of collaborative delivery models (with the explained characteristics and elements) for construction projects has led to the creation of a new working environment, compared to the traditional delivery models. This different working environment fosters trust-based collaboration and cooperation toward value maximization and waste reduction for the efficiency of the project, as a whole [5,6]. Consequently, amongst the implications of this different working environment are the striking changes in the performance results of the construction projects. For instance, Forbes and Ahmed [1] stated that collaborative delivery models have decreased office construction costs by 25% within 18 months and schematic design time from 11 to 2 weeks. Moreover, a recent study [8] compared the performance of 109 projects in USA, Canada, Colombia and Ireland in terms of project delivery models. The comparison was carried out based on 11 performance metrics (e.g., construction cost growth, schedule growth, deficiency issues, rework). The findings of this study showed that the construction projects undertaken with collaborative delivery models (in this case IPD) outperformed those ones carried out with traditional delivery models (design-bid-build, construction management and design-build).

Additionally, it is acknowledged that some collaborative working practices are gradually finding their ways also into the traditional delivery models of construction projects. For instance, one of the authors of this study, involved in project management consultancy services, has observed that currently there are a few ongoing partnering construction projects in Norway wherein traditional EPC (Engineering-Procurement-Construction) or design-build contracts are combined with collaborative and/or integrated teams. Construction projects applying collaborative delivery models are also called collaborative construction projects [2,9]. In this study, “traditional construction projects” and “collaborative construction projects”, as the clear, concise and meaningful replacements represent the terms “construction projects with traditional delivery models”, and “construction projects with collaborative delivery models/working practices”, respectively.

The emergent collaborative delivery models (e.g., alliance, IPD) and collaborative ways of working seem also to have effects on the competencies needed for the project managers of collaborative construction projects. In any kind of construction project, a competent project manager significantly contributes to the successful delivery of the project [10–13]. Such competencies are seen as the main predictors and causes of project managers’ successful performance, which in turn has a considerable effect on project success [14–16]. Project managers’ competencies can directly account for 35–44% of project success [17]. Another study has shown that lack of project managers’ relevant competencies can account for 60% of project failures [18]. Thus, different scholars have studied project managers’ competencies, mainly in traditional construction projects [19–23]. However, the required competencies for project managers of collaborative construction projects seem to be different due to the focus on no-blame-related behavior, supporting others and collaborative leadership (i.e., bringing up some of the behavioral principles in these projects based on which we can assume that the competency requirements may be different). Therefore, this study aims to contribute toward this subject, limitedly addressed by the research community, by answering the following research question:

RQ. What are the appropriate and important competencies of project managers in collaborative construction projects?

The resultant paper is structured as follows. The review of the previous research in the following section is followed by the explanation of the methodology. Then, the findings are presented and discussed. Finally, the conclusions are presented based on the obtained results.

2. Theoretical Background

2.1. Definition of Competency

Competencies were explained by Abraham et al. [24] as traits, behaviors, and characteristics which cause successful performance. McClelland [25,26] and Boyatzis [27,28] stated that competency is a capability comprised of related but different sets of behavior emanating from and demonstrating an underlying construct called the intent, which is context-oriented [29].

Spencer and Spencer [15] stated that “a competency is an underlying characteristic of an individual that is causally related to criterion-referenced effective and/or successful performance in a job or situation”. Accordingly, underlying characteristics, here, include motives (the things that a person consistently thinks about or wants that cause action), traits (physical characteristics and consistent responses to situations or information), self-concept (a person’s attitudes, values or self-image), knowledge (the information a person has in a specific content area) and skills (the ability to perform a certain physical or mental task). According to the Iceberg Model [15], knowledge and skill competencies tend to be visible, and relatively surface, and subsequently easy to develop through training which is the most cost-effective way to secure these employee abilities. Conversely, self-concept, trait and motive competencies are more hidden and central to personality, and consequently are more difficult to assess and develop; it is the most cost-effective way to use those as project managers’ recruitment criteria.

Zwell [30] defined competencies as enduring traits or characteristics that are behind certain job performances. The mentioned source also presented a categorization of competencies based on their difficulty of improvement, which seems to be line with the theory of the Iceberg Model. This categorization included three clusters: easy to improve, somewhat hard to improve, and hard to improve competencies. Moradi et al. [31] defined project managers’ competencies as “the capabilities of utilizing skills, knowledge and personal characteristics, which improve project managers’ effectiveness and efficiency in their job performance and subsequently increase the likelihood of project success”. The capabilities present both hidden and visible competencies, building on the principles presented by Spencer and Spencer [15]. The exemplified definitions, in a nutshell, imply that competencies have two important aspects: (i) contribution to successful performance, and (ii) difficulty of improvement.

This study, based on the previous research (particularly [15,25–28,30,31]), defines competencies as underlying characteristics (motives, traits, self-image, skills and knowledge) which cause different kinds of actions while being combined with an intent, which is situation-oriented. The resultant action in a given situation is called competency. Competency, due to its behavioral nature, can predict and cause successful performance in a consistent manner. The mentioned underlying characteristics can be categorized in three groups of highly personality-oriented (motives and traits), knowledge and skill-oriented, and somewhat personality-oriented (self-image). This means that some of the competencies (those related to motive and traits) are central to the personality (e.g., trustworthiness, initiative, optimism). This is the reason for which the previous studies (for instance, [15,30]) have stated that competencies related to motives and/or traits are hard to develop. In contrary, knowledge and skill-oriented competencies (e.g., management, leadership) are easy to assess and improve because they are detached from the personality and therefore individuals can be easily trained for the knowledge and skills which they lack. Finally, the third group of competencies, called self-image (e.g., self-confidence and self-control), is related to individuals’ understanding about their strengths and weaknesses, which lies between the above-mentioned categories.

2.2. Evolution of Research on Construction Project Managers’ Competencies

According to a recent study [31], the pioneers of research efforts regarding the subject of competency can be attributed to Gaddis [32] for his paper entitled “The Project Manager”, Lawrence and Lorsch [33] for their Harvard business review article titled “The Integrator”,

and McClelland [25] for his paper entitled “Testing for Competence Rather Than for Intelligence”. These research efforts on the competency subject have been actively followed by different scholars. For instance, the study undertaken by Powers [34] resulted in discovering a set of managerial competencies, characterizing successful performance. These competencies were then grouped within four clusters, including human resource management, goal and action management, directing subordinates and leadership [34]. It can be argued that the ideas of these competency research pioneers, particularly those behavioristics ones (e.g., McClelland, [25]), were followed with a study carried out by Spencer and Spencer [15] which stressed the importance of the behavioral approach for studying the competency and which presented the Iceberg Model. The book entitled *Creating a Culture of Competency* by Zwell [30] is also another prominent work concerning the competency subject, whereby its categorization of competencies, in terms of improvability, seems to be in line with the theory of the Iceberg Model.

Since 2000, several scholars have actively studied project managers’ competencies from general and context-specific perspectives. Two studies carried out by Crawford [35] and Edum-Fotwe and McCaffer [36] aimed to explore the significance of project managers’ competencies in construction projects and the correlation of those competencies with project success. These efforts were followed by a study undertaken by Shenhar [37], entitled “one size does not fit all projects: exploring classical contingency domains”. He stated that a specific project type affects the selection of project managers, project team members and skill development needs. In other words, Shenhar’s finding in terms of the importance of contingency thinking can be seen as the departure point for the succeeding context-specific studies concerning the competency subject. As a result, several studies were undertaken in the following years to identify project managers’ competencies in different contexts, such as construction, IT, organizational change, and metallurgical projects (for instance, Refs. [21,38–41]).

Competency studies addressing construction project managers were continued by different researchers (for instance, Refs. [24,42–44]). Consequently, different competencies, such as flexibility, conceptual thinking and knowledge management, were found to be of importance for the project managers in the results of the mentioned research efforts. These efforts were then followed by other scholars and new competencies of importance were discovered, such as adaptability and analytical thinking [45–49].

Regional and cultural differences have also provided sources for competency studies in the context of construction projects, and competencies such as alertness and quickness, experience and ethics have been identified [50–57]. The recently undertaken research on construction project managers’ competencies (mainly with traditional delivery models) suggest that this research topic has remained popular during the recent decade [58–64]. Reviewing the relevant studies resulted in the identification of several literature-based competencies for project managers of traditional construction projects (see Appendix A). The following Figure 1 presents the top five competencies (in terms of ranking) listed in Appendix A.

Competency/Reference	Edum-Forve and McCaffer, 2000	Dainty et al., 2004	Cheng et al., 2005	Mutiwaa and Rvelamila, 2007	Ahadzie et al., 2008	Chen et al., 2008	Ahadzie et al., 2009	Lee et al., 2011	Dogbegeh et al., 2011	Hwang and Ng, 2013	Zhang et al., 2013	Iali Jabar et al., 2013	Liyana Othman and Jaafar, 2013	Panas et al., 2014	Omar and Fayek, 2016	Tabassi et al., 2016	Dziekoński, 2017	Abdullah et al., 2018	Shah and Prakash, 2018	Moradi et al., 2018	Appearance	Rank
Teamwork and cooperation		✓	✓		✓		✓	✓			✓				✓		✓		✓		9	1
Cost management			✓	✓				✓	✓						✓		✓		✓		7	2
Communication			✓			✓			✓	✓					✓		✓		✓			
Leadership		✓	✓								✓				✓	✓				✓	6	3
Time management					✓		✓			✓					✓		✓		✓			
Quality management			✓					✓	✓						✓			✓	✓			
Flexibility and adaptability		✓	✓												✓		✓	✓				
Resource management				✓					✓	✓					✓			✓				
Knowledge of construction					✓	✓	✓					✓							✓			
HSE			✓					✓							✓			✓	✓			
Experience	✓							✓					✓			✓	✓				5	4
Ethics									✓				✓		✓		✓	✓				
Problem solving											✓			✓	✓	✓	✓	✓				
Impact and influence		✓	✓					✓			✓				✓							
Team management			✓			✓		✓							✓			✓				
Project management				✓					✓		✓						✓					
Conflict management					✓		✓				✓						✓					
Achievement orientation		✓	✓														✓			✓	4	5
Stakeholder management								✓		✓					✓					✓		
Decision-making													✓	✓	✓		✓					

Figure 1. Project managers' competencies in traditional construction projects.

It looks obvious that project managers' behavior in their everyday work has been one of the important sources for understanding their competencies [2,15,30,65]. This viewpoint is selected in this study as well to address the subject of interest.

2.3. The View of Standards of Practice on Project Managers' Competencies

Four standards of practice have been identified as the sources addressing project managers' competencies. ICB.4(Individual Competence Baseline) explains the competency as the utilization of abilities, skills and knowledge for achieving the desired results, and presents project managers' 28 competencies in three groups of people, practice and perspective [66]. The PMCD (Project Manager Competency Development) framework introduces 16 competencies that are categorized in two groups, performance and personal competencies [67]. The APM (Association for Project Management) Body of Knowledge classifies project managers' 11 competencies in interpersonal and professional groups [68]. A framework, entitled PMI Talent Triangle, was introduced in the PMBOK (Project Management Body of Knowledge) Guide, in which three types of project managers' skills are presented [69] (see Table 1 for details).

Table 1. Categorization of project managers' competencies by standards of practice.

Standard	Group	Competency
ICB.4	People	(1) Self-reflection and self-management (2) Personal integrity and reliability (3) Personal communication (4) Relationships and engagement (5) Leadership (6) Teamwork (7) Conflict and crisis (8) Resourcefulness (9) Negotiation (10) Result orientation
	Practice	(1) Project design (2) Requirements and objectives (3) Scope (4) Time (5) Organization and information (6) Quality (7) Finance (8) Resource (9) Procurement (10) Plan and control (11) Risk and opportunity (12) Stakeholders (13) Change and transformation
	Perspective	(1) Strategy (2) Governance, structure and processes (3) Compliance, standard and regulation (4) Power and interest (5) Culture and values
PMCD.3	Performance	(1) Project integration management (2) Project scope management (3) Project time management (4) Project cost management (5) Project quality management (6) Project human resource management (7) Project communication management (8) Project risk management (9) Project procurement management (10) Project stakeholder management
	Personal	(1) Communicating (2) Leading (3) Managing (4) Cognitive ability (5) Effectiveness (6) Professionalism
APM	Interpersonal	(1) Communication (2) Conflict management (3) Delegation (4) Influencing (5) Leadership (6) Negotiation (7) Teamwork
	Professionalism	(1) Communities of practice (2) Competence (3) Ethics framework (4) Leading and development
PMI Talent Triangle (PMBOK)		(1) Technical project management skills (2) Leadership (3) Strategic and business management skills

3. Methodology

3.1. Research Design

The research is undertaken to identify the competencies of project managers in the context of collaborative construction projects. Consequently, the research purpose here is descriptive, as it aims to portray the relevant competency profile. An important principle for the competency evaluation is the fit of competencies to the required characteristics and the job [15,30]. As explained earlier, the behavioral approach has been common for the competency studies, where frequency and type of individuals' (here the project managers') behavior in their everyday work is the main source for understanding their competencies. Thus, the self-evaluation of project managers' behavior is an efficient method of a competency study, because it is seen that a competency is a behavioral capability, and thus the project manager is the best evaluator of his/her behavior in the everyday work [65,70]. Accordingly, the survey strategy was employed to fulfill the intended purpose of this study, the approach of which is deductive, as there is a wealth of literature on project managers' competencies. According to Saunders et al. [71], "the survey strategy is popular and common in business and management research and is mainly utilized to answer who, what, where, how much and how many questions". Therefore, it is usually employed for conducting exploratory and descriptive studies. The popularity of surveys is mainly due to the possibility which they provide for collecting data in shorter periods of time and in a cost-effective manner [71].

3.2. The Utilized Survey Technique

The behavioral approach in competence research has acted as a starting point for the development of research techniques. Reviewing the literature on project managers' competencies in this study also led to the identification of a self-evaluation questionnaire. In this survey tool "Cycloid", by Evolute Technology (www.evolute.fi), the focus is on evaluating project managers' key behavioral competencies based on their current state (reality), target state (vision), and creative tension, which is the gap between personal vision and current reality [65,72,73]. If the reality and the vision are the same and there is no gap between them, there will be no motivation because of the lack of perceived need to move toward the vision. Accordingly, project managers' 30 behavioral competencies are evaluated through 60 linguistic statements (Appendix B), two statement per competency. This was performed by asking the respondents to select and determine the frequency of their behaviors in the situations presented by each linguistic statement on a scale of always/often/seldom/never in their current and target state. Evaluation of the frequency of these behaviors occurring in the representative statements of each competency was carried out both in the current and target states through analyzing the numeric values of the current and target states of the self-evaluation results.

3.3. Theoretical Origin of the Competencies and Their Representing Statements in Cycloid

These competencies and their representing linguistic statements originate from the research by Kirsi Liikamaa [74]. Later, these competencies have been categorized into two main groups and five subgroups [65] (Table 2).

Table 2. Project managers' behavioral competencies in Cycloid.

Group	Subgroup	Competency
Personal Competencies	Self-awareness	Emotional awareness, Self-assessment, Self-confidence
	Self-control	Trustworthiness, Maintaining order, Flexibility, Innovation, Responsibility, Seeking information, Production efficiency, Decision quality, Stress tolerance
	Cognitive ability	Analytical thinking, Conceptual thinking, Language proficiency
	Motivation	Achievement orientation, Commitment, Initiative, Optimism
Social Competencies	Empathy	Understanding others, Developing others, Leveraging diversity, Organizational savvy
	Social skills	Communication, Conflict management, Management, Leadership, Relationship building, Collaboration, Group capabilities

Liikamaa [65] undertook this categorization according to Goleman's [75] ontology of the five components of emotional intelligence at work, containing social competencies (social awareness and relationship management) and personal competencies (self-awareness, self-management and motivation). Several studies have employed Cycloid for evaluating project manager's competencies in various contexts [2,65,72,76,77]. Moreover, the competencies in Cycloid (listed in Table 2) were compared with identified competencies from the literature study (Figure 1 and Appendix A), and it became clear that the competencies in the Cycloid questionnaire are in line with the previous research on construction project managers' competencies.

3.4. Motivations for Choosing Cycloid

Cycloid was selected for data collection in this study for six reasons. First, it has considerable theoretical support, and its content (30 behavioral competencies) is in line with the previous research on the competency subject in the context of construction projects. Second, it has a record for being utilized in numerous competency studies since 2006. Third, it provides the possibility of using the behavioral approach for the competency study in a reliable and highly economical way. Fourth, it was available in several languages (e.g., English, Finnish, Norwegian), thus making possible the collection of data from the respondents in their mother tongue. Fifth, its structure makes it possible to carefully evaluate the significance and frequency of project managers' different behaviors in their everyday job, representing their competencies, in the current state (reality) and target state (vision). Sixth, it can reveal the gap between the current and target state of the project managers' different behaviors, which in turn can be a useful source of information for the performance improvement.

3.5. Data Collection

The collection of data was undertaken through non-probability volunteer sampling. The sampling choice was based on three reasons: (i) there was no sampling frame available concerning the targeted population, (ii) there was no need for statistical inference from the sample, and (iii) data could be collected from the entire target population [71]. Accordingly, the questionnaire was sent to 33 project managers of recently completed or ongoing alliance and/or partnering construction projects in Finland and Norway. Finland and Norway were chosen for data collection because of their representativeness in terms of collaborative construction projects [2,78].

The categories of the studied construction projects comprise infrastructure (road and railway), institutional (hospital and school) and residential building (housing construction). In total, 24 questionnaires were completed (February–April 2020) and a response rate of 73% was achieved. Among respondents, 35% of them are/were working as the client's project manager and 65% of them as the contractor's project manager. Figure 2 presents the survey respondents' demographic information.

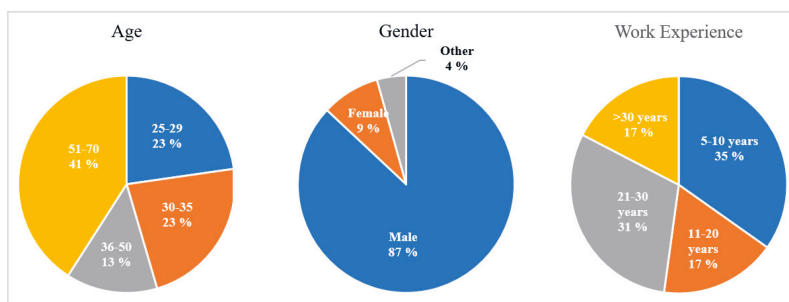


Figure 2. Demographic information of the survey respondents.

3.6. Development of the Matrix Model of Competencies for Project Managers of Collaborative Construction Projects

The research data portray the current state, the target state, and the creative tension of project managers' competencies in the context of collaborative construction projects. The analysis of these data formed a basis for the matrix model of competencies which answers the research question in this paper. The development of the matrix model was undertaken in three steps, and was based on two important aspects of competencies which were mentioned earlier: (i) contribution to successful performance, and (ii) difficulty of improvement. The following Figure 3 shows the process of developing the matrix model which is followed by an explanation of the process.

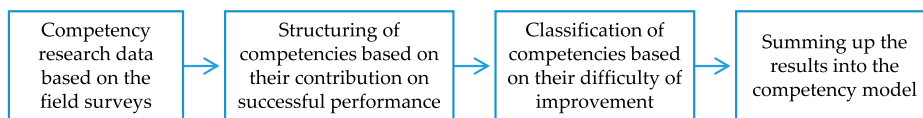


Figure 3. The research and development process behind the matrix model of competencies.

The first step was obtaining the competency research data (the significance of project managers' different competencies in the current state, target state and creative tension) through the conducted surveys in Norway and Finland, which were explained earlier. In the second step, the competencies were structured based on their contribution to project managers' successful performance. These structured competencies were those top 10 ones (in terms of the significance) in the target state, current state and creative tension of the respondent groups. The top 10 competencies in the target state and creative tension as well as current state are seen as the most important ones among the total 30 competencies for contributing toward the successful performance of the project managers. This structuring was performed through developing a three points scale (1–3), where:

- those competencies “common” in the “target state” of the “both respondent groups” were qualified as the highest (3);
- those competencies “common” in the “current state and creative tension” of the “both respondent groups” were qualified as the medium (2);
- those competencies “specific” in the “target state and/or creative tension” of “each respondent group” were qualified as the lowest (1). (See Table 3)

Table 3. Numeric values of the competencies based on their contribution to successful performance and difficulty of improvement.

Competency	CSP	DAI	CSP × DAI	Competency	CSP	DAI	CSP × DAI
Trustworthiness	3	3	9	Flexibility	2	3	6
Stress tolerance	3	3	9	Relationship building	1	1	1
Conflict management	3	2	6	Leveraging diversity	1	1	1
Self-assessment	3	2	6	Maintaining order	1	2	2
Initiative	3	3	9	Collaboration	1	1	1
Optimism	3	3	9	Communication	1	1	1
Group capabilities	3	1	3	Achievement orientation	1	3	3
Decision quality	2	2	4	Emotional awareness	1	3	3
Understanding others	2	2	4	Language proficiency	1	1	1
Production efficiency	2	1	2	Analytical thinking	1	2	2
Management	2	1	2	Organizational savvy	1	2	2
Leadership	2	1	2	Responsibility	1	3	3

Legend: CSP: Contribution on successful performance; DAI: Difficulty of improvement.

This developed scale represents the extent to which competencies contribute to the successful performance of the project managers. Therefore, it was entitled as CSP (contribution on successful performance). Table 3 presents the CSP values assigned to each competency.

The reason why common target state competencies were outweighed was that these competencies, as can be understood from the title, are the visionary and the most appropriate ones for project managers of collaborative construction projects. Moreover, the high overlap between the target state competencies of both the respondent groups was the second reason for the prioritization.

In the third step, the competencies were structured based on the degree to which project managers have difficulty in improving them. It was carried out by determining the difficulty of improvement of those competencies (structured in the first step) with high, medium and low contribution to successful performance of the project managers. A three-point scale (1–3) was then developed, where:

- the “most difficult to improve” competencies were qualified as “the highest point (3)”;
- “somewhat difficult to improve” competencies were qualified as “the medium point (2)”;
- “easy to improve” competencies were qualified as “the lowest point (1)”.

This developed scale represents the extent to which project managers can improve their competencies. Therefore, it was entitled DAI (difficulty of improvement). Table 3 presents the DAI values assigned to each competency. This structuring of competencies was undertaken based on the relevant classifications made by Zwell [15] and Spencer and Spencer [30], whereby competencies related to skill and knowledge are relatively easy to develop, competencies related to motive and trait are hard to develop, and finally the competencies related to self-concept lie somewhere between and are somewhat hard to develop.

In the fourth step, the 3×3 matrix was developed based on the structuring of competencies in the previous steps. This was conducted by creating a table (see Table 3) and multiplying the CSP and DAI values of each competency and placing the competencies within the matrix accordingly. The definitions and behavioral indicators of the listed competencies in the model can be found in Appendix B.

3.7. Limitations and Reliability of the Utilized Survey Technique

Generally, “self-evaluation can be seen as an efficient and effective way for managing personal growth, developing oneself, clarifying roles, and committing to project-related tasks”, [70,72]. However, there is a concern regarding this type of evaluation. It is less reliable for evaluating work performance [79], as people prefer to evaluate their own performance as the better one compared to others [80]. According to Refs. [72,81], “the effectiveness of self-evaluation can be better in evaluating the relationship between different items, such as competencies, than in comparing individuals’ performance with each other”.

Torrington and Hall [81] stated that “the effectiveness of this method depends on the content of the evaluation, the application method, and the organizational culture”. In the selected approach for this study, the significance of different competencies in the current state and the target state were evaluated through statements related to the individual’s everyday work. Individuals thus directly evaluated their own behavior instead of their own performance. Additionally, the futuristic viewpoint includes the concept of creative tension [73]. For this purpose, the self-evaluation presents an efficient way to reveal individuals’ intentions and aspirations [72].

4. Results

The findings are presented in four groups. The first group presents the significance of project managers’ various competencies in their current state. This is followed by presenting the 10 highest significant target state and creative tension competencies. Finally, Group 4 presents the matrix model of competencies for project managers of collaborative construction projects.

4.1. Group 1: The Current State of Project Managers' Different Competencies

Table 4 presents Finnish and Norwegian project managers' highest significant competencies (top 10) in their current state.

Table 4. Highest significant competencies of project managers in the current state.

Finnish Project Managers		Norwegian Project Managers	
Rank	Competency	Rank	Competency
1	Trustworthiness	1	Trustworthiness
2	Responsibility	2	Group capabilities
3	Achievement orientation	3	Collaboration
4	Stress tolerance	4	Initiative
5	Leveraging diversity	5	Flexibility
6	Optimism	6	Self-assessment
7	Leadership	7	Optimism
8	Group capabilities	8	Analytical thinking
9	Initiative	9	Stress tolerance
10	Flexibility	10	Leadership

Here, with Finnish project managers', trustworthiness was discovered as the highest significant competency, with the statements focusing on acting honestly and in an ethical manner, and admitting mistakes. The second highest ranked competency was responsibility, with the statements evaluating the ability of being responsible for the progress of one's own work and responsibility for common goals. The third highest one was achievement orientation, representing the ability of driving toward a high standard of excellence, and setting challenging goals and working hard to achieve them. The fourth highest one was stress tolerance, with the statements evaluating the capability to maintain performance when facing workload pressures and/or organizational impediments. The fifth highest one was leveraging diversity, with the statements focusing on the appreciative attitude towards others and respecting people from different backgrounds. Figure 4 presents different current state competencies of Finnish project managers in terms of the significance.

Regarding Norwegian project managers, it looks obvious that 70% of their highest significant competencies in the current state are the same as their Finnish colleagues (Table 4). This can be also a clue to the reliability and validity of this study. Another interesting point here is that trustworthiness competency has been discovered as the most significant in the current state of the both respondent groups, as trust-based relationships and cooperation in collaborative construction projects are crucial.

There are also some differences between the current state competencies of the two respondent groups. Collaboration, self-assessment and analytical thinking are three competencies in the current state of Norwegian project managers which are not present among the most significant competencies of Finnish project managers (Table 4). Concerning Finnish project managers, responsibility, achievement orientation and leveraging diversity are those highest-significant competencies which are not common with the current state competencies of Norwegian project managers. Figure 5 presents different current state competencies of Norwegian project managers in terms of their significance.

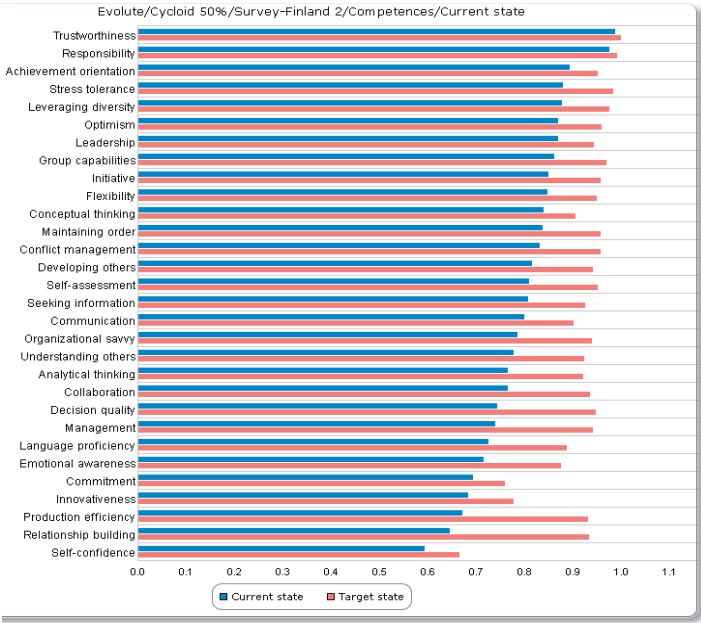


Figure 4. Competencies of Finnish project managers sorted according to their significance in the current state (blue bars).

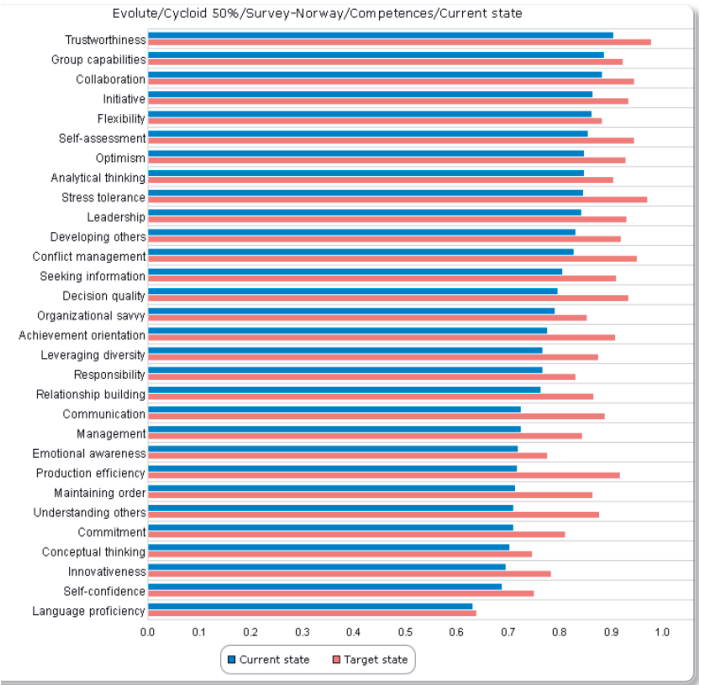


Figure 5. Competencies of Norwegian project managers sorted according to their significance in the current state (blue bars).

4.2. Group 2: The Target State of Project Managers' Different Competencies

The following Table 5 presents the top 10 target state competencies (in terms of significance) of Finnish project managers for collaborative construction projects.

Table 5. Competencies of project managers in the target state.

Finnish Project Managers		Norwegian Project Managers	
Rank	Competency	Rank	Competency
1	Trustworthiness	1	Trustworthiness
2	Responsibility	2	Stress tolerance
3	Stress tolerance	3	Conflict management
4	Leveraging diversity	4	Collaboration
5	Group capabilities	5	Self-assessment
6	Optimism	6	Initiative
7	Maintaining order	7	Decision quality
8	Conflict management	8	Leadership
9	Initiative	9	Optimism
10	Self-assessment	10	Group capabilities

There is 90% overlap for the five most significant competencies in the current and target states of Finnish project managers (see Tables 4 and 5). Group capabilities competency is the one which is not present among their top five current state competencies. This overlap suggests that the current competency profile of Finnish project managers in the addressed context is close to the ideal one in their target state. Figure 6 presents different target state competencies of Finnish project managers in terms of their significance.

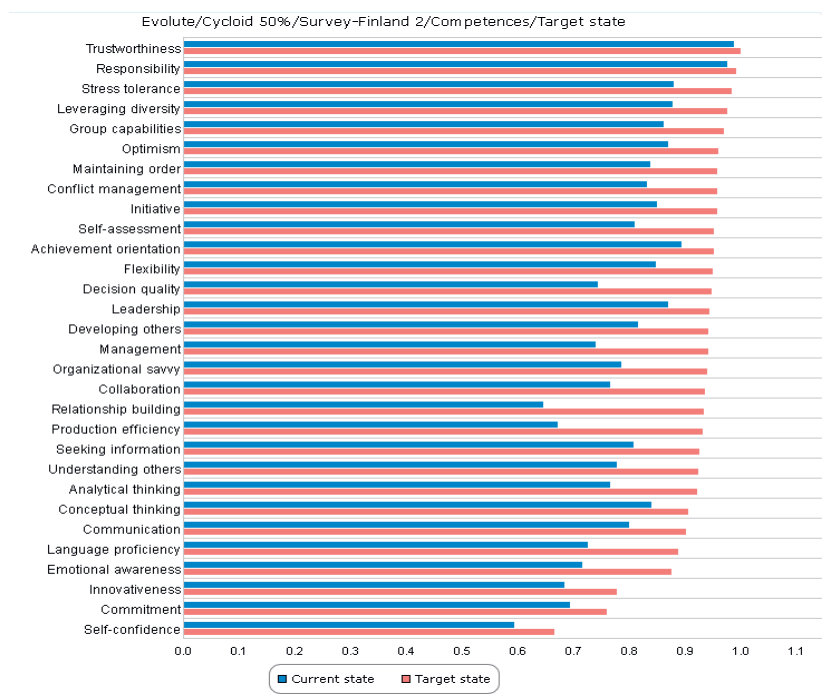


Figure 6. Competencies of Finnish project managers sorted according to their significance in the target state (red bars).

Regarding Norwegian project managers, there is a high match (80%) between their 10 most significant competencies in the current and target states (see Tables 4 and 5). Conflict management and decision quality are two competencies in their target state which are not present in the current state. Conflict management competency is related to project managers' capability to negotiate and resolve disagreements between people and to reach out for win-win situations. The statements representing decision quality competency evaluate project managers' ability to make decisions according to principles, purposes, and values. The mentioned overlap between Norwegian project managers' current and target state competencies indicates a considerable match between their current and the ideal (target) competency profile.

There is also a considerable match (70%) between the 10 most significant competencies of Finnish and Norwegian project managers in their target state (Table 5). This identified overlap can be seen as an indication of the match between the obtained results from two different contexts, addressed in this study. This match, in turn, can provide a basis for developing a synthesis of the findings. Figure 7 presents different target state competencies of Norwegian project managers in terms of their significance.

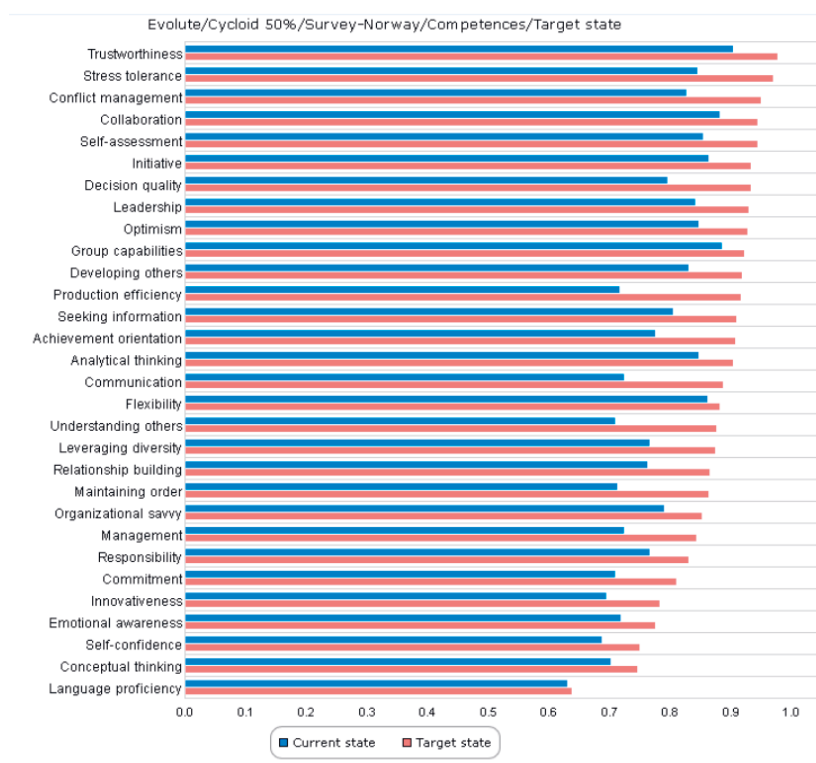


Figure 7. Competencies of Norwegian project managers sorted according to their significance in the target state (red bars).

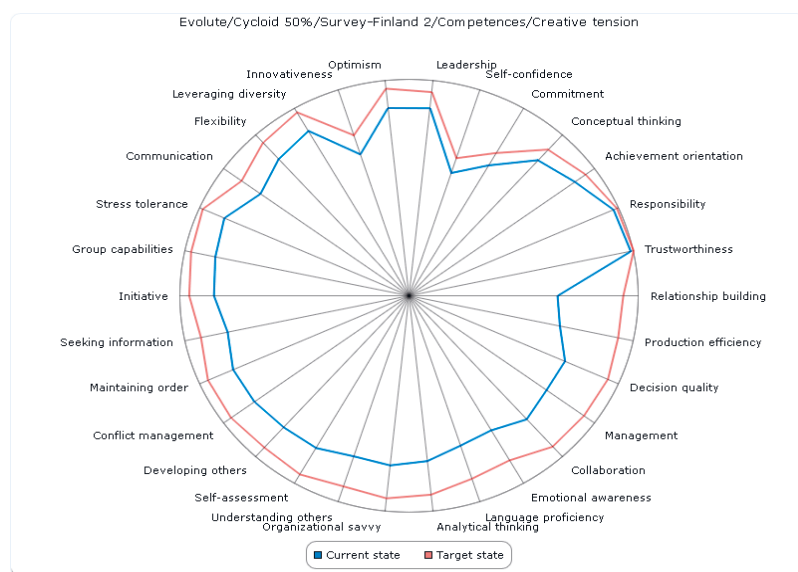
4.3. Group 3: The Creative Tension regarding Project Managers' Competencies

Group 3 presents the competencies in which the greatest gap between the current state and the target state (creative tension) was identified (see Table 6). The mentioned gap shows the respondents' interest in improving their competencies.

Table 6. Creative tension competencies of project managers.

Finnish Project Managers		Norwegian Project Managers	
Rank	Competency	Rank	Competency
1	Relationship building	1	Production efficiency
2	Production efficiency	2	Communication
3	Decision quality	3	Understanding others
4	Management	4	Stress tolerance
5	Collaboration	5	Conflict management
6	Emotional awareness	6	Maintaining order
7	Language proficiency	7	Decision quality
8	Analytical thinking	8	Commitment
9	Organizational savvy	9	Seeking information
10	Understanding others	10	Achievement orientation

Finnish project managers are most interested in developing their *relationship building* (see Table 6). This competency was the second least significant in their current state and is related to project managers' ability to build and maintain friendly relationships with those contacts which are or might be useful for realizing work-related goals. This amount of creative tension toward this competency is understandable, as trust-based relationships are one of the main success factors for collaborative construction projects. The second competency of interest here is production efficiency, wherein the statements concentrated on the ability of performing tasks quickly and according to high standards. This competency was evaluated as the third least significant in the current state (see Figure 4). The third highest creative tension was identified for the competency of decision quality. This is followed by the management competency (see Figure 8), which also was among the 10 least significant competencies in the current state.

**Figure 8.** Creative tension competencies of Finnish project managers.

It is worth mentioning that the common competencies in the current state and in the target state of Finnish project managers are not present among their top 10 creative tension competencies. This can be a message that they need complementary competencies (those

highly significant ones in their creative tension), in addition to the target state ones, to support their successful performance.

Norwegian project managers, like their Finnish colleagues, have the most willingness to improve and develop further their production efficiency competency (see Table 6). Communication competency was evaluated as the second highest here, which points to the ability to listen to others, to openly express one's feelings, ideas and opinions, and to read non-verbal cues. Understanding others' competency was the third highest in this category, with the statements focusing on project managers' capability to notice other individuals' feelings and perspectives. Stress tolerance is the next competency, which was also among the 10 highest ones in their current state. This can be a clue that Norwegian project managers of collaborative construction projects deal with considerable amounts of stress in their everyday work. The fifth competency which Norwegian project managers have high amounts of willingness to improve was conflict management (see Table 6 and Figure 9).

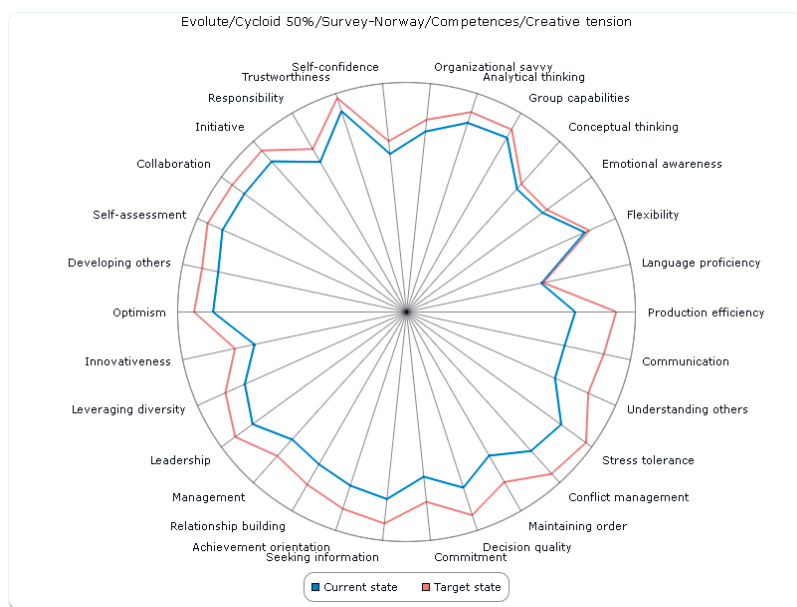


Figure 9. Creative tension competencies of Norwegian project managers.

Table 7 presents the differences, labeled “unique”, and similarities, labeled “same for all”, between the creative tension competencies of the two respondent groups (see Table 6) for improving their competencies.

Unlike the current state and target state, there are several differences between the viewpoints of the two respondent groups. The ranking of the competencies listed in Table 7 was developed based on the median of the ranking in the creative tension of the two respondent groups (Table 6). Those competencies with the same rank in both respondent groups have been listed alphabetically.

Table 7. Similarities and differences between creative tension competencies of Finnish and Norwegian project managers.

Rank	Competency	Same for All or Unique
1	Production efficiency	Same for all
2	Decision quality	
3	Understanding others	
1	Relationship building	Unique
2	Communication	
3	Management Stress tolerance	
4	Collaboration Conflict management	
5	Emotional awareness Maintaining order	
6	Language proficiency	
7	Analytical thinking Commitment	
8	Organizational savvy Seeking information	
9	Achievement orientation	

4.4. Group 4: Matrix Model of Competencies

This matrix model presents project managers' competencies for collaborative construction projects. The model was developed for classifying and grouping competencies according to their nature, i.e., characteristics of importance.

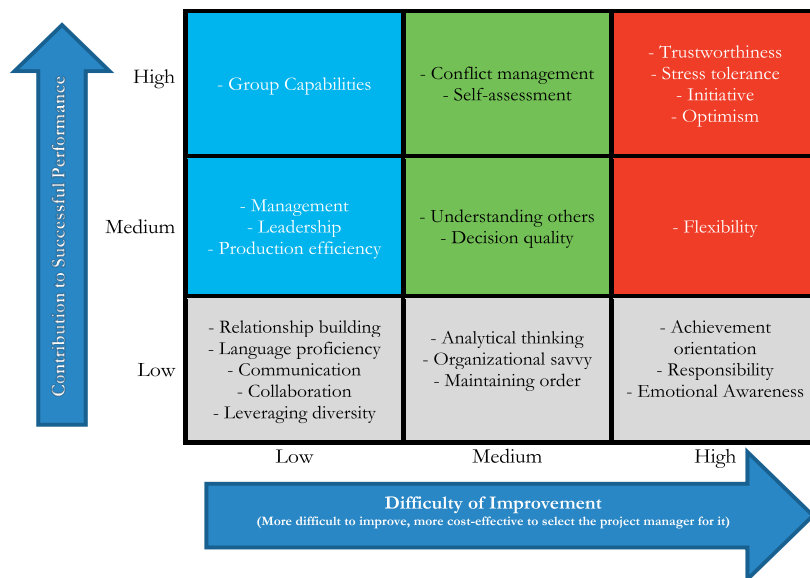
For this purpose, competencies were structured based on the following: Contribution to project managers' successful performance (vertical axis), and the Degree of difficulty to improve those competencies (horizontal axis) (see Table 3 for details). This structuring, as can be seen in Figure 10, resulted in discovering key competencies, supportive competencies, hybrid competencies and threshold competencies based on which the matrix was divided into four sets.

Among the key competencies, trustworthiness, stress management, initiative and optimism were common in the target state of both the respondent groups. This means that these competencies considerably contribute toward the successful performance of the project managers. In addition, these four competencies are hard to improve, as they are more hidden and central to personality. The last competency in this group is flexibility, which was common in the current state competencies of Finnish and Norwegian respondents. This competency is also hard to improve, but its contribution to successful performance is lesser than the four ones described earlier.

The key competencies, altogether, are hard to improve while contributing to the successful performance of the project managers. Therefore, the most cost-effective way for the employers is to select those project managers for collaborative construction projects that already have these competencies. The definition and behavioral indicators of the presented competencies within the model in Figure 10 can be found in Appendix B.

The supportive competencies are easier to develop, as they are knowledge and skill-oriented. In terms of contribution to successful performance, the relevance of group capabilities competency is higher than others in this group. Training is the best means of improving the supportive competencies, which can be considered for improving the performance of the existing project managers.

Competency Model for Project Managers of Collaborative Construction Projects



Legend

Key Competencies	Those competencies to be considered by employers for selecting the project managers, as they are hidden and central to personality and considerably contribute toward the successful performance of project managers.
Supportive Competencies	Those competencies to be considered by project managers for performance improvement, as they can be improved easier by training and also contribute toward the successful performance of project managers.
Hybrid Competencies	Those competencies to be considered by both project managers and their employers. These competencies considerably contribute to successful performance, and it is neither too difficult nor too easy to improve them.
Threshold competencies	Those competencies needed for minimally accepted level of work, the lower cut off point below which a project manager of a collaborative construction project would not be considered competent.

Figure 10. Matrix model of competencies for project managers of collaborative construction projects.

The hybrid competencies are somewhat difficult to improve, but they also significantly contribute toward the successful performance of project managers. Accordingly, these competencies, with dual functionality, can be considered for both the selection of project managers of relevance and for improving the performance of the existing ones.

Finally, the threshold competencies are those ones which seem to make less contribution to successful performance (compared to the previously explained groups). These competencies are required for the minimally accepted level of work, the lower cut off point below which a project manager of a collaborative construction project would not be considered competent.

5. Discussion

The first and second groups of results showed considerable matches between the current state competencies of both the respondent groups as well as their target state competencies (Tables 4 and 5). Project managers of collaborative construction projects, as the leaders, need to establish cooperation between project team members based on trust-based relationships for the good of the project [2,5]. Such an achievement by the project manager requires competencies such as trustworthiness, stress management, conflict

management, and groups capabilities, as have been identified in this study. Moreover, the manager of a project with a single co-located team, jointly developing and validating goals and controlling the project, needs to know his or her strengths and weaknesses (self-assessment competency) to effectively contribute toward project development and control. Additionally, such a project manager should be able to see the different opportunities and seize them (initiative competency) for the good of the project. Finally, the project manager needs to be determined to achieve the goals of the project regardless of the setbacks and/or organizational impediments (optimism competency).

The third group of results presented the creative tension competencies of the project managers, wherein there were some similarities between the viewpoints of the two respondent groups. Both Finnish and Norwegian project managers prefer to improve their production efficiency, understanding of others, and decision quality competencies. Throughout every collaborative construction project, in the design and construction processes, there are a series of internal suppliers and customers [6]. “These relationships are often implicit rather than explicit, and there is a very long chain of events starting with planning and design, where information is built on information, while in construction, material is built upon material”, [6]. The project manager of such a collaborative environment needs to perform his or her tasks quickly and according to high standards (production efficiency competency) and make reliable decisions based on principles, purpose and values (decision quality competency) in order to be a successful supplier for his/her customers (team members). Such a project manager also needs to sense the feelings and perspectives of other people (understanding others’ competency) to be able to build and maintain effective relationships with his/her team members.

Unlike the target state competencies, there are several differences between the creative tension competencies of the two respondent groups, which are understandable, as some features of collaborative construction projects are unique and context-oriented, e.g., culture, contracting parties. For instance, leveraging diversity and language proficiency are two competencies, which Finnish project managers have high willingness to improve, but there is no such desire in Norwegian project managers. One reason for these interests in Finland can be the fact that the usage of English language and the presence of foreign experts in the Finnish construction industry have been considerably increased in the last two decades [2]. Therefore, these uncommon and specific creative tension competencies of each respondent group can be considered for the performance improvement of project managers in the relevant context.

The differences and overlaps mentioned earlier can be seen as a basis to argue that the elements of collaborative construction projects affect the required competencies for the successful performance of project managers. This means that the common elements, e.g., trust-based relationships and shared risk/reward systems, require certain core competencies, whereas the unique elements, e.g., culture and contracting parties, require context-oriented competencies. The developed hypothesis needs to be tested in future studies. However, it seems to be somewhat in line with the prior project contingency research [14,37,82], where it has been shown that different types of projects need project managers with certain types of competencies.

Finally, the last group of results presented a novel matrix model of competencies for project managers of collaborative construction projects. The novelty of this model is related to its functions and features. This model not only presents the cost-effective method (easier to improve competencies) for performance improvement of the existing project managers, but also provides new insights for employers of the project managers to know which competencies are difficult to improve and contribute to the successful performance. This also provides the cost-effective way for employers to select the right project manager for their collaborative construction project. These functions of the model are based on its two important features: addressing the contribution of competency to the successful performance, and difficulty of the improvement. This model provides new insights into the importance of the human side of project management in collaborative construction projects.

The findings can also intensify the interest in potential future research on the competencies of all the project team members in collaborative construction projects.

The findings of this study, in the big picture, present a novel conceptual perspective (the matrix model) toward project managers' competencies. The focus of this different perspective is on two important aspects of competencies (contribution to successful performance and difficulty of improvement) which have been very limitedly addressed in the previous competency studies in an integrated manner. Moreover, addressing the subject of interest in the context of collaborative construction projects contributes toward the body of knowledge on project managers' competencies. This contribution was accomplished through identifying those competencies which project managers of collaborative construction projects need to possess to succeed. As the implications of this research, it can be stated that project managers and their employers in collaborative construction projects need to be aware of those easy to improve and hard to improve competencies which make the greatest contribution to the successful performance. Those employers can use key, supportive and hybrid competencies (presented in this research) to recruit the right person for their projects and improve the performance of their current project managers.

6. Conclusions

The purpose of this study was to identify project managers' most important competencies for collaborative construction projects, which finally led to the development of a matrix-form competency model. This model has an explanatory capacity for structuring various competencies in a novel manner that can be useful for individual project managers together with organizations in charge of collaborative construction projects. The following conclusions concerning project managers of collaborative construction projects (particularly in Finland and Norway) are based on the obtained results:

- Elements of collaborative construction projects can affect the required competencies for the successful performance of project managers. The common elements, e.g., trust-based collaboration and cooperation, shared risk-reward system, require certain core competencies, whereas the unique elements, e.g., culture and contracting parties, require certain context-oriented competencies;
- The profile of the project managers' competencies, in the big picture, represents individual efficiency and effectiveness, combined with teamwork, mutual understanding and trust, collaborative cooperation, and no-blame-related behavior;
- Trustworthiness, stress tolerance, initiative, optimism and flexibility competencies are cost-effective criteria for recruiting the project managers;
- Group capabilities, management, leadership and production efficiency competencies represent sources for the performance improvement of the existing project managers;
- Conflict management, self-assessment, decision quality and understanding others competencies are sources for both the selection of the project managers and improving the performances of the existing ones;
- The 11 threshold competencies (presented in Figure 10), required for the minimally accepted level of work, represent the lower cut off point below which the project manager would not be considered competent.

These findings contribute to the body of knowledge on project managers' competencies through providing academic and practical insights for competence-based selection and performance improvement of the project managers in the context of collaborative construction projects. The generalizability of the findings of this study is still rather limited. The research is based on input from professionals in Norway and Finland, but the challenges and issues discussed in the paper are of a general nature, relevant well beyond the Nordic countries. As with all new concepts, the matrix model of competencies needs validation in other contexts before consideration as a generally accepted model. Therefore, further studies in various regions and business conditions are a potential area for further research. The obtained results provide a basis for the following research areas, which can form starting points for the future studies:

- How to select project managers of collaborative construction projects based on the presented categories in the matrix model, developed in this study;
- How to train competencies in those different categories;
- How to develop a frame of reference for successful/superior performance of project managers in collaborative construction projects;
- How to adapt the developed competency model in this study to other sectors of construction projects;
- Although this study found no fundamental differences in the viewpoints of different age groups among the survey respondents, more detailed analysis on the potential impact of project managers' experience/age can be considered as an area for further relevant research.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Project managers' competencies in construction projects, identified from the literature.

Competency	Reference	Appearance
Teamwork and cooperation	[16,19,20,23,46,47,52,61,63]	9
Cost management	[10,12,22,47,52,54,61–63]	
Communication	[21–23,47,54,61,63]	7
Leadership	[16,46,47,62–64]	6
Time management	[19,20,23,54,61,63]	
Quality management	[10,22,23,47,52,63]	
Knowledge of construction	[19–21,23,55]	5
Flexibility and adaptability	[23,46,47,61,63]	
Resource management	[10,12,22,54,63]	
HSE (health, safety and environment)	[10,23,47,52,63]	
Experience	[36,52,56,61,65]	
Ethics	[22,23,56,61,63]	
Problem solving	[13,23,55,61,63]	
Impact and influence	[16,46,47,52,63]	
Team management	[10,21,47,52,63]	
Project management	[12,22,55,61]	4
Achievement orientation	[46,47,61,62]	
Conflict management	[16,19,20,61]	
Stakeholder management	[52,54,62,63]	
Innovation	[22,23,61,63]	
Decision-making	[13,56,61,63]	
Analytical thinking	[46,47,61,63]	

Risk management	[22,54,63]	3
Procurement management	[10,61,63]	
Initiative	[46,47,63]	
Information seeking	[23,46,47]	
Scope management	[47,61,63]	
Motivation	[23,61,63]	
Negotiation	[23,61,63]	
Commitment	[23,62,63]	
Developing others	[47,63]	2
Conceptual thinking	[46,47]	
Planning	[21,54]	
Directiveness	[46,47]	
Change management	[16,23]	
Project integration management	[62,63]	
Assertiveness	[23,61]	
Self-control	[23,63]	
Reliability	[23,63]	
Relationship building	[16,21]	
Interpersonal understanding	[16,63]	
Customer focused	[46,47]	
Self-confidence	[61]	1
Tendering	[12]	
Knowledge management	[47]	
Operation management	[12]	
Estimating	[12]	
General business management	[12]	
Judgment	[52]	
Professionalism	[52]	
Management	[52]	
Alertness and quickness	[56]	
Organizational awareness	[16]	
Ability to deal with stress	[61]	
Ability to formulate goals	[61]	
Sensitivity	[23]	
Cultural competence	[63]	
Mental agility	[23]	
Positive outlook	[23]	
Consciousness	[23]	
Learning oriented	[23]	
Empathy and Aspiration	[61]	
Emotional resilience	[23]	
High energy level	[23]	
Information technology skills	[23]	

Appendix B

Competencies with their definitions and representing linguistic statements in Cycloid.

Competency	Definition	Statement
Emotional awareness	The ability to recognize, understand and analyze one's own feelings.	<p>I recognize the factors that have caused a certain emotional reaction.</p> <p>I realize how my feelings affect my thoughts, and what I say and do.</p>
Self-confidence	A sense of one's self-worth and capabilities. The ability to present and defend one's opinion.	<p>I prefer to behave in accordance with external influences rather than in accordance with my own point of view.</p> <p>It is difficult for me to defend my own opinion when other people disagree.</p>
Trustworthiness	To deliver on promises. Keep schedules, arrive on time on meetings and complete work as agreed. Maintain trust between people.	<p>I act honestly and in an ethical manner</p> <p>Instead of covering up my mistakes I admit them.</p>
Maintaining order	Concern for order, quality and accuracy	<p>I check my work once more before handing it in.</p> <p>I work systematically and effectively.</p>
Innovativeness	Natural and open attitude towards new ideas, attitudes and information	<p>I would rather adhere to established ways of action than to try something new.</p> <p>I like to solve the encountered problems in new and unique ways.</p>
Responsibility	Be responsible for the progress of one's own work. Take responsibility of own mistakes. The feeling of responsibility over common goals.	<p>I complete my tasks conscientiously even if nobody is supervising me.</p> <p>It is difficult for me to keep my promises.</p>
Seeking information	The curiosity to know more about things, people or issues.	<p>If I am not satisfied with the facts presented to me, I get in touch with outsiders to obtain some background information.</p> <p>I am curious and I collect information from my environment that could be of use in the future.</p>

Analytical thinking	The use of logical, systematic reasoning to understand, analyze, and resolve problems. The ability to break problems into smaller pieces and the ability to discern causal relationships.	In problem situations I break down the problem into smaller sub-problems.
		I prepare in advance for foreseeable problems by thinking about different solutions to them.
Conceptual thinking	The ability to use models, theories or frameworks to interpret or to explain events. The ability to identify patterns and to the see the “big picture”.	I use ‘rules of thumb’ or common sense to solve problems.
		I aim to simplify complex situations by combining issues.
Language proficiency	Ability and courage to use foreign languages	I avoid using my language skills in my work tasks if at all possible.
		I do not hesitate to use my language skills in my work tasks.
Achievement orientation	The drive towards a high standard of excellence. Setting challenging goals and working hard to achieve them.	I develop my working methods to improve my performance.
		When performing a task I always do my best to guarantee as good a result as possible.
Initiative	The ability to see new possibilities and to seize opportunities. To do more than what is expected.	I consciously behave in a way that creates new opportunities and minimizes possible problems.
		I act quickly and determinedly whenever opportunities and crises appear. (arise)
Optimism	Pursuing goals regardless of obstacles and setbacks.	I believe that people do the right things if they are given the possibility.
		I believe in achieving my goals despite obstacles and setbacks.
Understanding others	The ability to sense the feelings and perspectives of other people.	I notice hints of other people’s feelings and I am able to read between the lines.
		I actively listen and seek hints of other people’s feelings and intentions to understand their earlier behavior.
Developing others	Noticing other people’s needs for development and promotion of their abilities.	I pursue the development of others by delegating suitable and challenging tasks to them, and by giving them the authority needed to perform the tasks.
		I give constructive feedback which is not directed at the person himself/herself but at his/her doings.

Communication	The ability to listen to others. The ability to openly express one's feelings, ideas and opinions. The ability to read non-verbal cues.	I find it difficult to express myself or to say my opinion.
		When listening I avoid interrupting the speaker and I try to make apposite questions to understand him/her better.
Conflict management	The ability to negotiate and resolve disagreements between people. To reach out for win-win situations.	I encourage others to discuss matters constructively and openly in order to find a solution to a problem.
		I aim to arrive at solutions by which everybody wins.
Management	The ability of controlling things and people.	When assigning a task, I give adequate directions and make clear both the objectives and requirements.
		I evaluate other people's performance and achievements and compare them with the targets.
Leadership	Management activities that are centered upon human beings.	I treat group members impartially and fairly.
		I act in a way as to (inspire and commit others) make other people enthusiastic and committed to the group's tasks.
Relationship building	Building or maintaining friendly relationships or networks of contacts with people who are or might be useful in achieving work-related goals.	I maintain contacts that I can make use of when the situation requires.
		I experience establishing new relationships difficult and displeasing.
Collaboration	Working together with others towards common goals.	I act in a way that creates a climate encouraging cooperation.
		I recognize possibilities to cooperate and I try to maintain them through my own activities.
Self-assessment	The comprehension of one's own limits and strengths.	I am familiar with my strengths and weaknesses.
		I analyze my actions and learn from my experiences.
Flexibility	The ability to manage multiple demands without losing focus. The ability to handle the ambiguities of organizational life. To be open to new experiences and viewpoints.	I am open to new ideas, approaches and data (information).
		It is difficult for me to adapt to the changes in my working environment.

Stress tolerance	To maintain performance when facing workload pressures and or organizational impediments.	The level of my performance weakens when I work under pressure or when stressed.
		I can handle tasks and situations that are unpleasant and stressful.
Commitment	Adopting the goals of the group or organization.	I act according to the way determined by my environment and I respect the organizational norms.
		My own objectives differ from the objectives of the group.
Production efficiency	Performing tasks quickly and according to high standards.	I organize my tasks in a way that speeds up their accomplishment.
		I delegate tasks and utilize resources efficiently even if they would be (are) scarce.
Decision quality	Making decisions based on principles, purposes and values.	In my decisions I take into account problems which may arise.
		I foresee the implications of different options.
Leveraging diversity	Appreciative attitude towards others. Respecting people from different backgrounds.	I see diversity as an opportunity, and I try to create an environment where diverse people can thrive.
		I am biased against people because of their backgrounds.
Organizational savvy	Understanding and utilizing organizational dynamics in order to achieve objectives.	I recognize the current culture and atmosphere of the organization.
		I use formal and informal communication channels efficiently.
Group capabilities	the capability of working cooperatively with others, to be part of a team, to work together, as opposed to working separately or competitively.	It is difficult or unpleasant for me to encourage and motivate other people.
		In a team, I act in a way that creates friendship and team spirit between the group members.

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PAPER V

Profile of Project Managers' Competencies for Collaborative Construction Projects

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