Defining integration capability dimensions and creating a corresponding self-assessment model for inter-organizational projects

Received 1 April 2021
Revised 8 March 2022
Accepted 25 April 2022

Laura Saukko, Kirsi Aaltonen and Harri Haapasalo
Industrial Engineering and Management, Faculty of Technology, University of Oulu, Oulu, Finland

Abstract

Purpose – The purpose of this paper is to define the integration capability dimensions and create a model for self-assessing the integration capability in inter-organizational projects.
Design/methodology/approach – A theoretical construct of, referred in this study as integration capability framework is elaborated following a systematic literature review. Thereafter, an integration capability self-assessment model, based on maturity thinking, is derived from the theoretical framework. The self-assessment model is further developed and tested for validity within five inter-organizational project networks in cooperation with industry practitioners, representing construction, industrial engineering, and mining sectors.
Findings – The results show that inter-organizational projects can use the developed model in self-assessing the maturity levels of various integration mechanisms, thus the state of integration capability at any point in time during inter-organizational projects.
Originality/value – This study is an attempt to identify how the integration capability dimensions can be self-assessed in inter-organizational projects, through the maturity levels of various integration mechanisms. The results offer insights for both academics and project management practitioners.

Keywords Integration capability, Assessment model, Inter-organizational project, Project network
Paper type Research paper

Introduction

Every project faces significant integration challenges (Aagaard *et al.*, 2014; Söderlund, 2011), with two fundamental challenges being related to cooperation and coordination issues (Söderlund, 2011). The cooperation problem originates from actors' conflicting goals and opportunistic behavior, whereas the coordination problem stems from task complexity and the need to communicate and synchronize activities (Söderlund, 2011). In the construction industry, an additional integration challenge relates to the segregation of project participants: Horizontal segregation is found between participants with similar roles, and vertical segregation between initiation, design, production, use, and maintenance participants (Atkinson and Westall, 2010), all of which need to be integrated to achieve the best possible project outcomes.

It is increasingly common for inter-organizational projects to strive for collaborative and integrative project practices. Yet, how can the degree of integration be assessed—and hence,

The Finnish Foundation for Technology Promotion has provided an encouragement grant for this work.

International Journal of Managing Projects in Business
Vol. 15 No. 8, 2022
pp. 77-110
Emerald Publishing Limited
1753-8378
DOI 10.1108/IJMPB-04-2021-0085

improved—in complex inter-organizational projects? There is a shortage of evaluation tools for different project phases, even though good practical results have been reported (Chakkol *et al.*, 2018) from the collaboration assessment exercises for bidding alliances during the procurement phase. Therefore, in this paper, we aim to, first, define the integration capability dimensions and second, evaluate how the dimensions of integration capability can be self-assessed in project network settings by the project practitioners. We assess the dimensions of integration capability through the integration mechanisms of inter-organizational projects, identified based on scientific literature.

Projects can be classified as temporary organizations (Bakker, 2010; Lundin and Soderholm, 1995), and some projects are embedded in networks consisting of inter-organizational relationships (DeFillippi and Sydow, 2016). Project networks connect legally independent but operationally interdependent organizations and individuals (Manning, 2017), and they can either sustain over individual projects or be formed only to execute a single inter-organizational project (DeFillippi and Sydow, 2016). The challenges of implementing a large inter-organizational project are related to difficulties in aligning multiple perspectives and achieving a shared understanding of project goals (Kujala *et al.*, 2021).

The integration practices of different project parties can be effectively coordinated and streamlined by arranging both the structural and operational mechanisms, including the platform, behavior, and processes of collaboration, which leads to successful integration (Ibrahim *et al.*, 2015). However, the ability to sustain and consistently drive integration practices in a complex project is an ongoing, everyday concern (Ibrahim *et al.*, 2015). The integration mechanisms of inter-organizational projects include formal governance, organizational and relational arrangements, and technological systems (Hietajärvi *et al.*, 2017a). Moreover, the integration capability of a complex project or a project alliance requires adopting a wide range of integration mechanisms and having the competency to adjust those mechanisms in everyday project situations (Hietajärvi *et al.*, 2017a).

To understand the concepts of integration capability and integration capability building in a complex inter-organizational project setting, we take project capability research as our starting point. There are three organizational capabilities in project-based organizations—functional capabilities, strategic capabilities, and project capabilities—whereby project capabilities are the capabilities needed to prepare bids and execute projects after winning bids (Davies and Brady, 2000). In inter-organizational project settings, complex project or project alliance capabilities derive from those contractual, behavioral, relational, and operational skills that are required for project initiation and management (Hietajärvi *et al.*, 2017b). The integration capability of inter-organizational projects relates to the competency to constantly use and adjust numerous integration mechanisms (Hietajärvi *et al.*, 2017a).

With regard to capability building, organizational learning is essential in developing project capabilities (Davies and Brady, 2000) in both project-based organizations and inter-organizational project settings. Complex project or project alliance capability building has been strongly linked to, first, collective learning, especially to the organization learning to manage project alliances, and second, to inter-organizational learning related to knowledge transfer across organizational boundaries (Hietajärvi *et al.*, 2017b; Wang and Rajagopalan, 2015). In other words, the project capability-building process can be analyzed and understood through project-based learning (Brady and Davies, 2004), where systematic training and continuous learning among the project parties and personnel are essential (Kujala *et al.*, 2021)—a process that can be assumed to be analogous to integration capability building.

When it comes to proactively managing project performance, continuously assessing the key dimensions of inter-organizational integration over the project life cycle is critical (Baiden *et al.*, 2006; Ibrahim *et al.*, 2016). Relevant practical examples of this are found in projects that have made significant investments in measuring the collaborative behaviors and abilities of

bidding alliances (Chakkol *et al.*, 2018), whereas actor selection during procurement, considering suppliers, and project personnel are essential elements in the governance of project capability building (Kujala *et al.*, 2021). However, more research is needed on how to assess the dimensions of inter-organizational integration in practice.

As integration capabilities in inter-organizational project networks have not been widely addressed in the previous literature, this study will assess integration capability in this context by building on the project integration literature on inter-organizational projects. Based on this reasoning, we will attempt to both identify the integration capability dimensions and to evaluate how an inter-organizational project network can self-assess its integration capabilities. Therefore, this study is guided by the following research question:

RQ. What are the integration capability dimensions and the associated integration mechanisms of inter-organizational project networks and how the integration capability can be self-assessed?

The paper is structured as follows. First, we conduct a systematic literature review to develop a theoretical framework for the integration mechanisms and dimensions to enable the identification of the integration capability dimensions. Second, in the empirical part of the study, we construct a model for self-assessing integration capability in a practical project setting and in cooperation with project practitioners. The self-assessment model is constructed during the research process as a combination of the theoretical framework, project practitioners' practical input and development of maturity level descriptions. As a result, we present a maturity model (Backlund *et al.*, 2014) for assessing the integration capability, and we validate the model in real-life projects, the results of which are also presented. The concept of maturity indicates there might be a development of one capability level to another; in addition, maturity develops over time, and it can be recognized through certain stages (Backlund *et al.*, 2014). It is also sensible to make an effort to characterize and measure maturity (Backlund *et al.*, 2014). Maturity model provides a framework that is needed to develop certain capabilities (Backlund *et al.*, 2014), and here it is used for the purposes of assessing integration capabilities.

Research process

Research strategy

To investigate the RQ the method we used can roughly be classified as design research or the design science paradigm (Ahlemann *et al.*, 2013; March and Smith, 1995; Sein *et al.*, 2011), whereby knowledge and understanding of the problem domain and its solution are achieved in building and applying the designed artifact (Hevner *et al.*, 2004). The research approach we used broadly followed the theory testing lines of reasoning, in which hypotethico-deductive thinking is central (Ketokivi and Choi, 2014). Theory testing takes place within a certain context; thus, our approach can be considered situationally grounded (Ketokivi and Choi, 2014).

We decided on the design science approach, since it enabled us to explore the RQ with experienced practitioners, develop an assessment tool in an iterative, reflective, and collaborative manner with project practitioners, and undertake interventions in actual inter-organizational projects. We do not classify our research as a pure design science experiment, however, since our research was not a genuine problem-solving research exercise that attempted to design and implement a means to an end (Holmström *et al.*, 2009). Instead, our research aimed at understanding the integration mechanisms and respective subcategories affecting integration capability and at creating a technique to assess it in inter-organizational project networks in cooperation with practitioners. Nevertheless, our study broadly aligns with design science for the project management discipline: theoretical grounding of the

artifacts, testable artifacts, design as a cyclical research process, methodological pluralism, and artifact mutability (Ahlemann *et al.*, 2013). Our research process is illustrated in Figure 1.

Systematic literature review

To identify the most essential integration mechanisms and systematically assess and classify the related capabilities, we performed a systematic literature review using a qualitative content analysis. Systematic literature review must be conducted in a systematic, explicit, and reproducible manner (Fink, 1998), and it is essential to identify keywords, publications, and databases, to identify high-quality studies by setting feasibility and methodological criteria, to read the literature and collect data in a standardized manner, to report on the review process and justify the methods to interpret the data, and to analyze and report on the findings (Fink, 1998). In qualitative content analysis, it is essential to read all the material to decide what part of the coding frame it belongs to, to use the same sequence of steps every time (Schreier, 2012), and to specify the main categories and subcategories either deductively or inductively (Schreier, 2012). In this study, the categories were developed inductively.

Our systematic literature review process began with a keyword search ("integration" and "project") of the titles, abstracts, or keywords in the Scopus and Science Direct databases. We limited the publication years to 2000–2021. The purpose of the keywords used was to identify potential papers addressing integration mechanisms—thus, dimensions of integration capability—but the final decisions were made in the qualitative content analysis phase. The journals we targeted were key leading project management journals and a leading journal covering construction management: *International Journal of Project Management* (*IJPM*), *Project Management Journal* (*PMJ*), *International Journal of Managing Projects in Business* (*IJMPiB*), and *Construction Management and Economics* (*CME*). The initial keyword search resulted in 198 hits. A comprehensive Excel database was created for the articles.

Since our focus was on integration, especially in inter-organizational project networks, we excluded papers that considered, for example, integration in intra-organizational projects, integration within project-based organizations, or integration in program or portfolio management. In addition, since high-quality literature reviews are based on evidence resulting from experimentation and systematic observation (Fink, 1998), we excluded opinions, such as conceptual papers and papers that did not include empirical work or a thorough literature analysis. The final sample consisted of 105 articles. Each paper was reviewed in terms of project integration mechanisms, as these are associated with integration capability dimensions. These identified mechanisms were coded and marked up in an Excel sheet. The codes were further analyzed and clustered into subcategories and then into the related key dimensions.

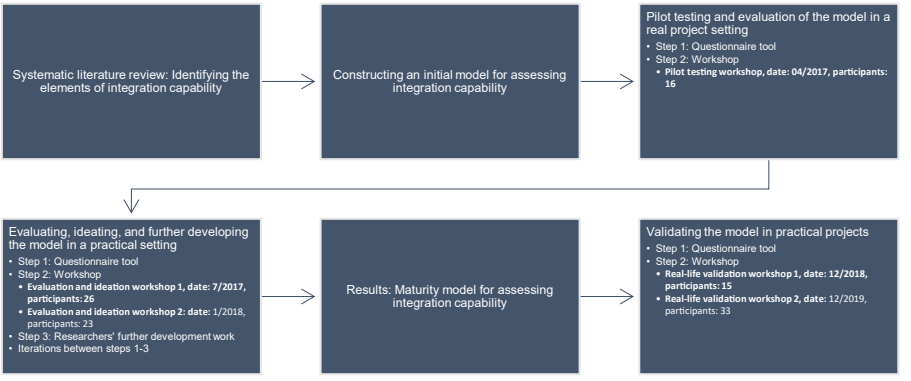

Figure 1.
Research process: Development and evolution of the integration capability assessment model during the research activities

Empirical research method and data

The aim of the empirical part of this study was to grasp how the integration capability of a project network could be self-assessed in a practical setting at a certain point in time. We then elaborated and further developed the theoretical framework derived from the literature in a practical setting with experienced project practitioners and among ongoing projects. The empirical research answers the RQ The unit of analysis in our study was an inter-organizational project network (Grabher, 2002; Manning, 2017) and inter-organizational projects (DeFillippi and Sydow, 2016), which are complex (Chakkol *et al.*, 2018), and have shadow of the past (Ligthart *et al.*, 2016).

Data collection and analysis

During the solution design and evaluation phases (Ahlemann *et al.*, 2013), the research data were collected through a questionnaire tool assessing different integration capability dimensions and through five evaluation workshops (one pilot tool testing and initial results evaluation workshop, two further evaluation and development workshops for the integration capability assessment model, and two integration capability assessment workshops in a practical project environment). Details of the workshops are presented in Figure 1. The initial role of the workshops was to test and develop the assessment model and respective tool with project practitioners, and later to gain data from using the model in a practical setting. The elements of the questionnaire tool that we developed, the respective maturity model, in addition to the outcomes of integration capability assessments in practical project environments are presented in the results section. The questionnaire tools were filled in by project practitioners, who were also the workshop participants, and the respective workshops took place between 2017 and 2020.

The development of the model for assessing integration capability and the related questionnaire tool for project practitioners was an iterative process. First, the researchers developed an initial assessment model based on the literature review. This pilot model was tested in a real construction project environment, and the results were evaluated in a workshop. Based on the initial results, the researchers further developed the model, which was again tested in a practical construction project setting and evaluated in a workshop; these iterations took place twice. In the last stage, the final integration capability assessment maturity model was used and evaluated in a practical project setting in an industrial engineering project and a mining project. The model does not include field-specific things, which allowed it to be tested, evaluated, and validated in different industries.

During the workshops, experienced project managers and project participants involved in complex projects ideated, tested, evaluated, and used the integration capability assessment model in real project settings. Group discussions took place after practitioners had filled in the integration capability assessment tools, generating both practice-oriented propositions for further development of the assessment model and initiatives to develop the actual project practices taking place in real project settings. The researchers continued the development work on the assessment model and respective questionnaire tool between the workshops in an iterative manner.

Examples of the quotes from the project practitioners in the workshops:

> The four main dimensions of integration capability resonate well with the experiences from the practical setting.

> The classification into four dimensions of integration capability makes the self-assessment model easier to communicate.

> Right and important themes have been chosen to be included in the assessment model.

Academic terminology is sometimes confusing.

The self-assessment model is suitable for developing the project activities.

It is very valuable to know where we as a project are at the moment. It enables us to develop the actions to achieve the next level.

One important realization that came from the development workshops was that maturity model scaling within each subcategory of the integration capability assessment model was introduced to reduce the subjectivity of the assessment; this stemmed from a query made by research participants, as they found it difficult to assess the actual level of project performance without an illustrative scale highlighting the levels and respective requirements of ideal and non-ideal performance.

Empirical context

Our empirical project sample consisted of three inter-organizational projects and one somewhat looser inter-organizational project network. All sample projects and project networks had a so-called shadow of the past, meaning that the project participants had some previous experience of working together (Ligthart *et al.*, 2016) either in collaborative projects or in more traditional project settings. The sample consisted of complex projects, which have three characteristics: temporary project-based partnerships, highly complicated and unique, and ambiguous organizational structures and hierarchies involving multiple organizations and teams (Chakkol *et al.*, 2018). The sample was collected from complex construction projects, industrial engineering projects, and mining sector projects, all of which include multiple operators from different sectors, such as builders and construction organizations, designers, industrial equipment suppliers, assemblers, and government officials. One sample project was a project alliance, two sample projects used traditional contracting, and the sample project network used some forms of integrated project delivery (IPD).

Systematic literature review to develop a framework for the integration capability dimensions and the associated integration mechanisms

Integration capability dimensions: integration mechanisms

Based on the systematic literature review, the following theoretical framework for the integration mechanisms and dimensions (i.e. integration capabilities) was identified. The framework developed in the systematic literature review is presented in Figure 2 and discussed in further detail below, in addition to tables demonstrating the identified literature sources related to each framework category and subcategory. Altogether, the integration mechanisms in inter-organizational project networks were divided into four main categories representing the integration capability dimensions: administrative, organizational, and contractual; behavioral and relationship-based; technological and process; and the capability for continuous management and the adaptation of integration and collaboration. The theoretical framework presented forms the basis for creation a practical integration capability self-assessment model, presented in the results section.

Administrative, organizational, and contractual integration capability

Administrative, organizational, and contractual integration capability building forms the basis of the integration capability of an inter-organizational project network and mostly addresses the coordination integration challenge. The literature tackling the topic is elaborated in the text, and for a comprehensive listing of all the literature sources and respective classification into subcategories, see Table 1. Building collaborative behavior, encouraging and supporting the building of a collaborative culture, is one approach toward

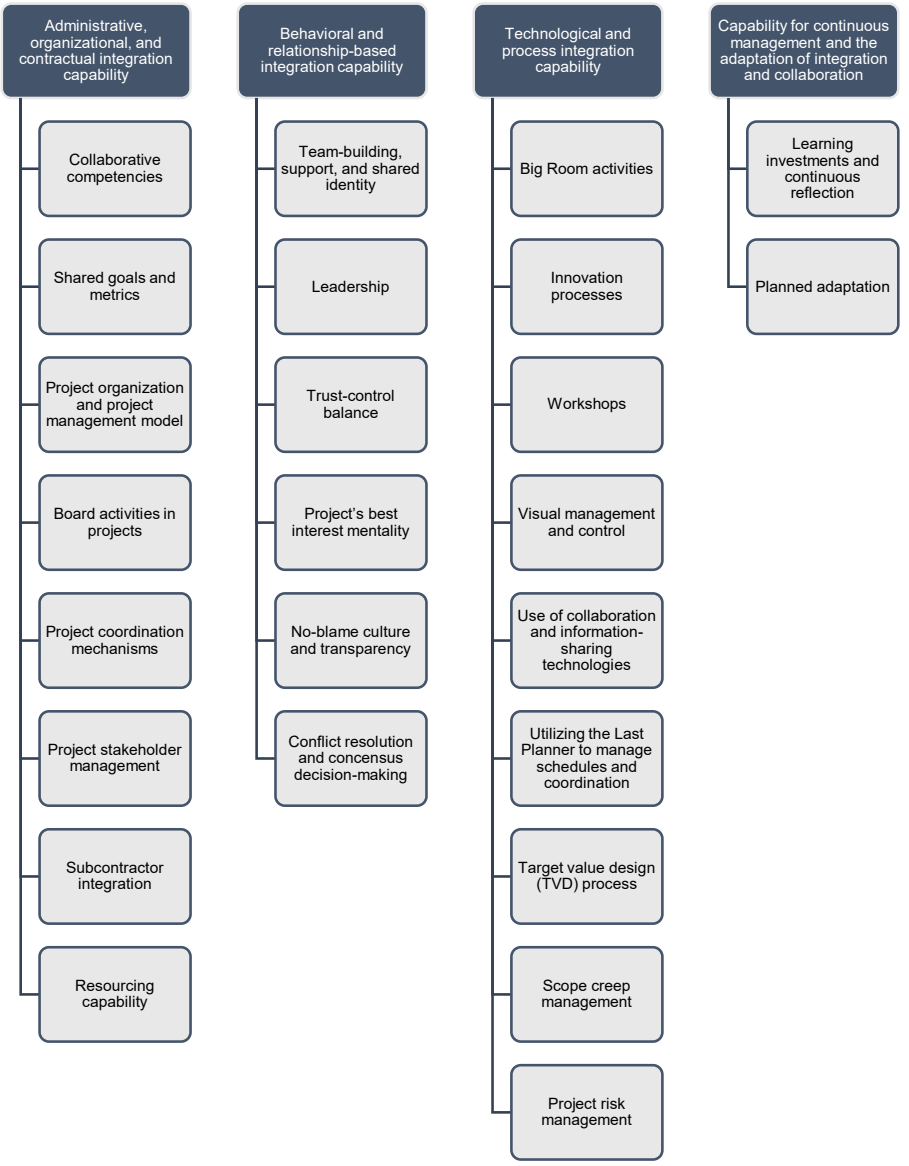

Figure 2.
Integration capability dimensions: Integration mechanisms identified in the literature

improving project outcomes in complex projects (Brady and Davies, 2014) and supporting integration through collaborative competencies. Building shared goals and respective metrics to guide project network integration is also essential, as the alignment of interests and objectives is one of the most influential drivers of project performance (Mesa *et al.*, 2016).

To achieve inter-organizational project network integration through a common project organization and management model, written policies on integration mechanisms, decision-making plans, organization charts, job descriptions (Hietajärvi *et al.*, 2017a), and the early

Table 1.
Administrative, organizational, and contractual integration capability

Main dimension	Subcategory	Integration mechanisms identified in the literature
Administrative, organizational, and contractual integration capability	Collaborative competencies	Cultural barriers can impact both the adoption and implementation of partnering (Mollaoglu *et al.*, 2015) Collaborative practices as an antecedent for project performance through team-working quality (Suprapto *et al.*, 2015b) Well-known IPD process as a cornerstone for creating integrated teams (Aapaoja *et al.*, 2013) A collaborative relationship is a crucial factor in contractual arrangements (Ndoni and Elhag, 2010) Collaborative behaviors (Brady and Davies, 2014) Collaborative working leads to knowledge integration in an informal relationship not based on contractual commitment (Ruan *et al.*, 2012)
	Shared goals and metrics	Goal setting as a planned integration mechanism related to formal governance (Hietajärvi *et al.*, 2017a, b) Defining objectives for relationship management as a critical success factor (Zou *et al.*, 2014) Alignment of interests and objectives as the most influential drivers of project performance (Mesa *et al.*, 2016) Contractual model influencing key risk indicators (KRIs) of team integration (Khairil *et al.*, 2015) Operational monitoring influences the KRIs of team integration (Khairil *et al.*, 2015) Standardized forms for reporting results supporting knowledge integration (Enberg, 2012) Monitoring as a control-oriented practice in supplier integration (Martinsuo and Ahola, 2010) A causation model for guiding project governance actions (Cardenas *et al.*, 2017) Integrating project baseline scheduling, schedule risk analysis, and project control to control project time performance (Vanhoucke, 2012) Technical dimension of systems integration, integration of technical and contractual elements (Liinamaa and Gustafsson, 2010) Flexible contractual arrangements as a part of system integration (Davies and Mackenzie, 2014) Integrating sustainability into the operational level through a common framework (Matar *et al.*, 2008) Client's proactive role in choosing procurement approach and contractual conditions, creating incentives and balance between control and flexibility (Rahman and Kumaraswamy, 2005) Coherent, explicit standards and organizing mechanisms as collaborative practices (London and Pablo, 2017) Design of profit-sharing mechanisms have an ability to manage uncertainty to a great extent (Guo *et al.*, 2021) Social sustainability integration (Goel *et al.*, 2020)

(*continued*)

Table 1.

Main dimension	Subcategory	Integration mechanisms identified in the literature
	Project organization and project management model	Written policies and decision-making plans as a planned integration mechanism related to formal governance, in addition to organization charts and job descriptions (Hietajärvi *et al.*, 2017a, b) Early establishment of integrative work practices (Buvik and Rolfsen, 2015) Planning and process specifications supporting knowledge integration (Enberg, 2012) Boundary objects as a control-oriented practice in supplier integration (Martinsuo and Ahola, 2010) Defining the partnering scope between transactional and relational as a strategy for initiating building information modeling (BIM)-related supply chain management (SCM) (Papadonikolaki *et al.*, 2017) Benefits of combining project management and change management early in the project life cycle (Gordon and Pollack, 2018)
	Board activities in projects	Coordinating bodies as a planned integration mechanism related to organizational and relational arrangements (Hietajärvi *et al.*, 2017a, b) Coordinating body as an integration mechanism (Artto *et al.*, 2016) Top management control of both process and knowledge content integration (Enberg, 2012) Commitment from the project alliance board is a key indicator (KI) for team-integration performance (Ibrahim *et al.*, 2013)
	Project coordination mechanisms	Knowledge integration refers to the exchange of knowledge to all stakeholders and project parties and the sharing of previous and current knowledge (Demirkesen and Ozorhon, 2017) Integration of the divisions as a critical success factor of relationship management (Zou *et al.*, 2014) Professional boundary action as a renewal initiative (Gustavsson and Gohary, 2012) Communication as the most influential driver of project performance (Mesa *et al.*, 2016) Project action boundary, project knowledge boundary, and project social boundary allow for successful knowledge integration (Ratcheva, 2009) By appropriately managing social capital coordination and knowledge, integration can be increased (Di Vincenzo and Mascia, 2012) Integrative persons as a cooperation-oriented practice in supplier integration (Martinsuo and Ahola, 2010) A process for processing client requirements simultaneously with setting up the project organization (Kamara *et al.*, 2001)

(*continued*)

Table 1.

Main dimension	Subcategory	Integration mechanisms identified in the literature
		Reducing life-cycle costs by integrating planning, construction, and operations (Kleiss and Imura, 2006) Standardized processes as a part of system integration and meta-system integration (Davies and Mackenzie, 2014) Systems integration focusing on the systems that projects deliver, and on the contexts of use (Whyte and Davies, 2021) Improved safety by integrating design and construction through communication and cooperation, and a positive relationship (Atkinson and Westall, 2010) Knowledge integration and activity coordination simultaneously influence the project execution (Klessova *et al.*, 2020) A choice of project control modes improves knowledge integration (Lin *et al.*, 2019)
	Project stakeholder management	Stakeholder boundary action as a renewal initiative (Gustavsson and Gohary, 2012) Early involvement and assessment of stakeholders as a cornerstone for creating integrated teams (Aapaoja *et al.*, 2013) A network perspective strategy and consideration given to project relationships (Ndoni and Elhag, 2010) Early involvement of participants and coordination are key to integrating design and construction (Austin *et al.*, 2002) Improved risk management through understanding stakeholders' socio-cultural context (Dyer, 2017) Continuous adjustment of legislative framework (Kleiss and Imura, 2006) Stakeholder management as a part of meta-system integration (Davies and Mackenzie, 2014) Early involvement of suppliers and architect participation as a strategy for initiating BIM-related SCM (Papadonikolaki *et al.*, 2017) Aligning the stakeholders around a vision of the meta-project and active meta-project management (Alderman and Ivory, 2010) Evaluating and managing a social license among stakeholders (Boutilier and Zdziarski, 2017) Multi-stakeholder engagement in all project phases (Miković *et al.*, 2020) Sustainability considerations in relation to stakeholder management (Sabini *et al.*, 2019)

(*continued*)

Main dimension	Subcategory	Integration mechanisms identified in the literature
	Subcontractor integration	Integration of suppliers into the processes and knowledge-sharing mechanisms (Demirkesen and Ozorhon, 2017) Subcontractor smallness as a driver for informal collaboration (Aagaard *et al.*, 2014) Supplier selection as a control-oriented practice in supplier integration (Martinsuo and Ahola, 2010) Communication and information sharing in addition to sustainable procurement plans (Zuo *et al.*, 2009) Strong client leadership to drive subcontractor integration and transparent and mutually beneficial processes for all parties in the supply chain (Dainty *et al.*, 2001) A strategic plan and consideration of critical success factors are essential for successful implementation of a commercial information exchange system (Pala *et al.*, 2016) BIM-competence partner selection as a strategy for initiating BIM-related SCM (Papadonikolaki *et al.*, 2017) Technology cluster management as an approach to integrating the supply chain (Al-Bizri and Gray, 2010) Early involvement of specialists as a best practice (Glass, 2005) Decision-making model for supply chain optimization and supply-chain management strategies (Le *et al.*, 2021)
	Resourcing capability	Integration of project staff into the current processes (Demirkesen and Ozorhon, 2017) Clear role expectations (Buvik and Rolfsen, 2015) Alternative resource-allocation strategy (Zerjav, 2015)

Table 1.

establishment of the respective integrative work practices (Buvik and Rolfsen, 2015) are essential. The importance of coordinating bodies as integration mechanisms (Artto *et al.*, 2016; Hietajärvi *et al.*, 2017a) is a finding that stresses the overall importance of board activities in projects. Project coordination mechanisms building the administrative, organizational, and contractual integration capability were also identified in the literature, and many were related to knowledge integration (Atkinson and Westall, 2010; Demirkesen and Ozorhon, 2017; Di Vincenzo and Mascia, 2012; Ratcheva, 2009; Zou *et al.*, 2014). Professional boundary action, as a renewal initiative (Gustavsson and Gohary, 2012), was recognized in relation to project coordination.

Project stakeholder management was extensively discussed in the project integration literature. In addition, stakeholder boundary action was identified as a renewal initiative (Gustavsson and Gohary, 2012). Finally, alternative resource-allocation strategies (Zerjav, 2015), thus a resourcing capability as a part of the overall administrative, organizational, and contractual integration capability, were distinguished based on the literature.

Behavioral and relationship-based integration capability

The characteristics we classified as the behavioral and relationship-based integration capability can be viewed as the softer side of inter-organizational integration, as it relates to the cooperation integration challenge. A comprehensive listing of the literature sources covering the topic and the related subcategories are found in Table 2 and elaborated here.

One key subcategory in the literature was team-building, support, and shared identity, whereas external image and internal identity (Artto *et al.*, 2016), and fostering a cooperative culture and relational practices (Hietajärvi *et al.*, 2017a) were identified as integration mechanisms, in addition to joint capability and structure (Suprapto *et al.*, 2015b), and shared understanding (McCarthy *et al.*, 2021). Integration capabilities can be assessed through the lens of team-building integration mechanisms, especially through a single team focus and objectives (Baiden and Price, 2011), in addition to pinpointing team-working as the most influential driver of project performance (Mesa *et al.*, 2016) and innovation (Gambatese and Hallowell, 2011). In addition, the importance of the client's proactive role in choosing team members and the early involvement of the selected members (Rahman and Kumaraswamy, 2005) were stressed.

Another important subcategory affecting the behavioral and relationship-based integration capability was leadership. The commitment and participation of senior executives is a critical success factor in relationship management (Zou *et al.*, 2014) and team integration (Ibrahim *et al.*, 2015). In turn, the different origins of leadership promoting integration existed in the literature, such as strong client leadership and capabilities (Brady and Davies, 2014; Rahman and Kumaraswamy, 2005), owner influence (Gambatese and Hallowell, 2011), and team leadership (Ibrahim *et al.*, 2013). Furthermore, a trust–control balance was stressed, especially regarding the importance of developing trust and respect (Baiden *et al.*, 2006; Buvik and Rolfsen, 2015; Glass, 2005; Martinsuo and Ahola, 2010) as integrative practices. Notably, trust and good chemistry within the inter-organizational project network were linked to previously successful collaboration histories (Aagaard *et al.*, 2014).

One of the positively connotated subcategories—the project's best interest mentality—arises from the cultural change within integrated teams (Aapaoja *et al.*, 2013), involving the development of a common philosophy (Buvik and Rolfsen, 2015), and creating practical team integration through a project culture of working toward a common goal (Baiden *et al.*, 2006). A no-blame culture (Baiden *et al.*, 2006; Baiden and Price, 2011; Ibrahim *et al.*, 2015) and transparency, in the form of free-flowing information (Aapaoja *et al.*, 2013; Buvik and Rolfsen, 2015; Gambatese and Hallowell, 2011), were also widely discussed.

Table 2. Behavioral and relationship-based integration capability

Main dimension	Subcategory	Integration mechanisms identified in the literature
Behavioral and relationship-based integration capability	Team-building, support, and shared identity	Fostering a cooperative culture and relational practices is a planned integration mechanism related to organizational and relational arrangements (Hietajärvi *et al.*, 2017a, b) External image and an internal identity as integration mechanisms (Artto *et al.*, 2016) Integrated team approach creating value for money in purchasing power parity (PPP) (Clifton and Duffield, 2006) Joint capability and structure perspective to improve relationships (Suprapto *et al.*, 2015b) Project team-related barriers can impact successful implementation of partnering (Mollaoglu *et al.*, 2015) Team-working as the most influential driver of project performance (Mesa *et al.*, 2016) Team's joint capability as an antecedent for project performance through team-working quality (Suprapto *et al.*, 2015a) Team formation influencing the KRIs of team integration (Khairil *et al.*, 2015) Single team focus and objectives, and seamless operation without organizational boundaries (Baiden and Price, 2011) Team-building improves mechanical productivity (Shan *et al.*, 2011) Project team collaboration and integration as innovation-leading indicators (Gambatese and Hallowell, 2011) Client's proactive role in choosing team members and early involvement of selected members (Rahman and Kumaraswamy, 2005) Shared understanding in integrating the divergent knowledge of individual team members and support collaborative knowledge building (McCarthy *et al.*, 2021) Behavioral integration and engagement to collaborative interactions of the top management team as a critical success factor (Wang *et al.*, 2021) Task, team and individual needs affect the development of an integrated team (Jones *et al.*, 2021)
	Leadership	Commitment and participation of senior executives as a critical success factor for relationship management (Zou *et al.*, 2014) Senior leadership pair perspective to improve relationships (Suprapto *et al.*, 2015a) Relational attitudes of senior management as an antecedent for project performance through team-working quality (Suprapto *et al.*, 2015a) Commitment from top management is a KI for successful team integration (Khairil *et al.*, 2015) Strong client leadership and capabilities (Brady and Davies, 2014)

(*continued*)

Table 2.

Main dimension	Subcategory	Integration mechanisms identified in the literature
		Owner influence and upper management support as innovation-leading indicators (Gambatese and Hallowell, 2011)
		Team leadership is a KI for team-integration performance (Ibrahim *et al.*, 2013)
		Client's proactive role in creating basis for the emergence of relational integration (Rahman and Kumaraswamy, 2005)
	Trust–control balance	Execution-focused team perspective, build on trust and contractual targets, to improve relationships (Suprapto *et al.*, 2015a)
		Trust as the most influential driver of project performance (Mesa *et al.*, 2016)
		Trust and good chemistry, and a previously successful collaboration history as drivers for informal collaboration (Aagaard *et al.*, 2014)
		Promoting ethical and trustworthy behavior increases trust and thus integration in the supply chain (Manu *et al.*, 2015)
		Shared climate of trust (Buvik and Rolfsen, 2015)
		Trust and respect are KIs for successful team integration (Khairil *et al.*, 2015)
		Good relationships and trust as a team-integration practice (Baiden *et al.*, 2006)
		Impact of national culture (Bony, 2010)
		Trust as a cooperation-oriented practice in supplier integration (Martinsuo and Ahola, 2010)
		Trust and respect are KIs for team-integration performance (Ibrahim *et al.*, 2013)
		Developing an ethos of trust as a best practice (Glass, 2005)
		Procurement-specific and dyad-specific factors mediate in turning project trust into project performance (Jagtap and Kamble, 2020)
		Level of trust between team members effects the degree of collaboration and project management success (Bond-Barnard *et al.*, 2018)
	"Project's best interest" mentality	Development of a common philosophy (Buvik and Rolfsen, 2015)
		A single team focus on goals and objectives is a KI for successful team integration (Khairil *et al.*, 2015)
		Cultural change as a cornerstone for creating integrated teams (Aapaoja *et al.*, 2013)
		Project culture of working toward a common goal as a team-integration practice (Baiden *et al.*, 2006)
		Committed relationships in collaborative working connect all organizations tightly in a knowledge-supporting network (Ruan *et al.*, 2012)

(*continued*)

Table 2.

Main dimension	Subcategory	Integration mechanisms identified in the literature
	No-blame culture and transparency	Open communication (Buvik and Rolfsen, 2015)
		No-blame culture is a KI for successful team integration (Khairil *et al.*, 2015)
		Free-flowing communication is a KI for successful team integration (Khairil *et al.*, 2015)
		Continuous communication and interaction as a cornerstone for creating integrated teams (Aapaoja *et al.*, 2013)
		No-blame culture as a team-integration practice (Baiden *et al.*, 2006; Baiden and Price, 2011)
		Unrestricted sharing of information (Baiden and Price, 2011)
		Communication as an innovation-leading indicator (Gambatese and Hallowell, 2011)
		Free-flowing communication as a KI for team-integration performance (Ibrahim *et al.*, 2013)
		Dynamic project environments, high project team integration, and high interdependence between project tasks lead to high individual psychological empowerment (Tuuli, 2018)
	Mutual support and responsibility sharing	Shared team responsibility perspective to improve relationship (Suprapto *et al.*, 2015a)
		Gain–pain sharing as the most influential driver of project performance (Mesa *et al.*, 2016)
		The teamwork principle influences the KRIs of team integration (Khairil *et al.*, 2015)
		Collective understanding is a KI for team-integration performance (Ibrahim *et al.*, 2013)
		Championing, shared goals, a comprehensive pool of skills, and openness to change as collaborative practices (London and Pablo, 2017)
		A shared sense of purposefulness (Çıdık and Boyd, 2020)
		Positive association between shared project mission, mutual trust, mutual influence and knowledge integration (Rauniar *et al.*, 2019)
	Conflict resolution and consensus decision-making	Equitable team relationships and respect for all as a team-integration practice (Baiden *et al.*, 2006; Baiden and Price, 2011)
		Collaborative problem-solving strategy (Zerjav, 2015)
		Unanimous decision-making as a strategy for initiating BIM-related SCM (Papadonikolaki *et al.*, 2017)
		Single team focus on project objectives and key result areas are KIs for team-integration performance (Ibrahim *et al.*, 2013)

Mutual support and responsibility sharing as an integration mechanism, culminating in behavioral and relationship-based integration capabilities, may take the form of gain–pain sharing (Mesa *et al.*, 2016), for example, and may be practically enhanced through championing, shared goals, a comprehensive pool of skills, and openness toward change (London and Pablo, 2017). Conflict resolution and consensus decision-making have the capacity to enhance integration capabilities through collaborative problem-solving strategies (Zerjav, 2015), unanimous decision-making (Papadonikolaki *et al.*, 2017), and equitable relationships (Baiden *et al.*, 2006).

Technological and process integration capability

The technological and process integration capability refers to the tools, processes, and practices operating as integration mechanisms within an inter-organizational project network, thus enhancing the integration capability in the respective area. For details of the literature sources referred to, see Table 3, with a summary below.

Collaborative co-locational space (i.e. Big Room activities as a key integrative practice) was an area where the project and construction management literature was in strong agreement (Baiden and Price, 2011; Davies and Mackenzie, 2014; Gustavsson and Gohary, 2012; Hietajärvi *et al.*, 2017a; Ibrahim *et al.*, 2013; London and Pablo, 2017; Papadonikolaki *et al.*, 2017). Conversely, when it comes to the subcategory of workshops, the practitioner's underestimation of the potential of early value-management workshops was highlighted (Ellis *et al.*, 2005), even though inter-organizational meetings and working sessions are noted as a planned integration mechanism (Hietajärvi *et al.*, 2017a). Innovation processes as an activity to improve integration capabilities was identified in the literature through, for example, incentives fostering ongoing innovations (Clifton and Duffield, 2006), innovation champions (Gambatese and Hallowell, 2011), or the diffusion of innovation through external lateral and vertical communication and external integration (Widén and Hansson, 2007).

Visual management and control can be used as a technology-enhancing inter-organizational integration capability (Isidore *et al.*, 2001; Perera and Imriyas, 2004) in the form of Last Planner technology to manage schedules and coordination (Hietajärvi *et al.*, 2017a). In addition, using collaboration and information-sharing technologies (Brady and Davies, 2014), such as building information modelling (BIM) (Korpela *et al.*, 2015; Lu *et al.*, 2016; Oraee *et al.*, 2017), were mentioned in the literature.

Scope creep management—using integrative practices reflecting the priorities between cost, time, and scope (Ahola *et al.*, 2017)—can be enhanced through integrating project control and forecasting mechanisms (Batselier and Vanhoucke, 2017), for example. The literature also identified an area, which we classified as inter-organizational project network risk management, as a key integration mechanism (Aagaard *et al.*, 2014; Arashpour *et al.*, 2016, 2017; Mollaoglu *et al.*, 2015).

Capability for continuous management and the adaptation of integration and collaboration

We subcategorized the capability for continuous management and the adaptation of integration and collaboration into two: planned adaptation, and learning investments and continuous reflection. A comprehensive listing of the literature sources is found in Table 4.

Learning investments and continuous reflection is an integrative practice through, for example, codifying lessons learned and promoting the measurement of benefits (Fuller *et al.*, 2011). Also, the prospect for future collaboration (Aagaard *et al.*, 2014; Ahola *et al.*, 2017) was noted as an integration mechanism within an inter-organizational project network and as a component of the respective learning capability building. Planned adaptation may take the form of, for example, change integration (Demirkesen and Ozorhon, 2017), or flexibility and responsiveness (Baiden *et al.*, 2006), and the ability to be adaptive and responsive (Brady and Davies, 2014).

Table 3. Technological and process integration capability

Main dimension	Subcategory	Integration mechanisms identified in the literature
Technological and process integration capability	Big room activities	Co-location in the Big Room as a planned integration mechanism related to organizational and relational arrangements (Hietajärvi *et al.*, 2017a, b) Geographical boundary action in the form of joint offices as a renewal initiative (Gustavsson and Gohary, 2012) Creation of a single, co-located team (Baiden and Price, 2011) Team processes as a cooperation-oriented practice in supplier integration (Martinsuo and Ahola, 2010) Co-located teams as a part of system integration (Davies and Mackenzie, 2014) Strategic co-locations as a strategy for initiating BIM-related SCM (Papadonikolaki *et al.*, 2017) Creation of a single co-located team is a KI for team-integration performance (Ibrahim *et al.*, 2013) Investment in relationships, shared spaces, and mutual problem-solving as collaborative practices (London and Pablo, 2017)
	Innovation processes	Integrating forward in the value stream from the customer to the project (Kirsila *et al.*, 2007) Defined processes for collaborative working, such as innovation management as a planned integration mechanism related to formal governance (Hietajärvi *et al.*, 2017a, b) Incentives to foster ongoing innovations in PPP (Clifton and Duffield, 2006) Innovative approaches (Brady and Davies, 2014) Successful implementation of renewable energy technologies through the social construction of the technology approach between relevant social groups (Boyd *et al.*, 2015) Innovation champion as an innovation-leading indicator (Gambatese and Hallowell, 2011) Diffusion of innovation through external lateral and vertical communication and external integration (Widén and Hansson, 2007) Managing the innovation paradox through temporal separation and contextual ambidexterity (Liu *et al.*, 2012) Integration of environmental principles (Li *et al.*, 2020) Workflow analysis and governance tools enhancing the value creation through innovation and systems integration capabilities (Eriksson *et al.*, 2019)
	Workshops	Inter-organizational meetings and working sessions as a planned integration mechanism related to organizational and relational arrangements (Hietajärvi *et al.*, 2017a, b) Practitioner's underestimation of the potential of early value-management workshops (Ellis *et al.*, 2005)

(*continued*)

Table 3.

Main dimension	Subcategory	Integration mechanisms identified in the literature
	Visual management and control	Visual tools as planned integration mechanisms related to technological systems, such as the use of Last Planner and visual process maps in the Big Room (Hietajärvi *et al.*, 2017a, b) Decision support systems should be model-driven and function as early warning systems, utilizing visual tools (Hazir, 2015) Graphical technique for integrating cost range estimating and probabilistic scheduling (Isidore *et al.*, 2001) Integrating time and cost management in an IT system accessible for SMEs (Perera and Imriyas, 2004)
	The use of collaboration and information-sharing technologies	Knowledge integration includes the input of all data into the current knowledge-transfer system (Demirkesen and Ozorhon, 2017) Project bank, visual, and virtual tools as planned integration mechanisms related to technological systems (Hietajärvi *et al.*, 2017a, b) BIM as an integrative technology (Oraee *et al.*, 2017) Small and medium-sized projects gain more project success from technology usage than large projects do (Yang *et al.*, 2006) Evaluation of risks related to application outsourcing (Currie, 2003) Sufficient estimation of the efforts related to electronic-application integration projects (Wagner *et al.*, 2017) Integration of electronic commerce and information (Wang *et al.*, 2007) A tool for evaluating the state of system integration (Magnaye *et al.*, 2014) A 5D BIM-based framework for cash flow analysis and project financing (Lu *et al.*, 2016) Use of digital technologies (Brady and Davies, 2014) Automation and integration of information systems improving mechanical productivity (Shan *et al.*, 2011) Integrating health and safety issues into management tools for all members of the project team (Cameron and Hare, 2008) Effective management of explicit and tacit knowledge as a best practice (Glass, 2005) Partial, stepwise integration of BIM systems for facility maintenance (Korpela *et al.*, 2015) BIM-based collaboration includes both structural collaboration and agential aspects of knowledge sharing and innovation (Papadonikolaki *et al.*, 2019)

(*continued*)

Table 3.

Main dimension	Subcategory	Integration mechanisms identified in the literature
	Utilizing the last planner to manage schedules and coordination	Last Planner as a visual tool enabling technological systems-related planned integration mechanisms (Hietajärvi *et al.*, 2017a, b)
	The target value design (TVD) process	Open-book delivery in a PPP project (Clifton and Duffield, 2006)
		Client satisfaction during the course of a project as a driver for informal collaboration (Aagaard *et al.*, 2014)
		Service innovations through integrating a service-providing organization and the users of the service (Bygstad and Lanestedt, 2009)
		Pre-project planning improving mechanical productivity (Shan *et al.*, 2011)
		Client's requirements' value specificity leads to project goal specificity, which improves project outcomes when integrated with conflict resolution (Leung and Liu, 2003)
	Scope creep management	Use of integrative activities reflects the priorities between cost, time, and scope (Ahola *et al.*, 2017)
		Integration of project control and forecasting mechanisms (Batselier and Vanhoucke, 2017)
		Integration of project completion estimates and knowledge sources (Caron *et al.*, 2013, 2016)
		Predicting implementation cost contingencies (Van *et al.*, 2019)
	Project risk management	In the bundled PPP model, all risks are retained by the concessionaire (Carpintero and Petersen, 2015)
		Efficient risk allocation among project partners in PPP projects creates value for money (Clifton and Duffield, 2006)
		Organizational barriers related to unfair risk sharing can impact the adoption of partnering (Mollaoglu *et al.*, 2015)
		Risks and the related costs of not minimizing the risks as a driver for informal collaboration (Aagaard *et al.*, 2014)
		Risks associated with coordination of on-site and off-site project dimensions cause the most significant deviations from project objectives (Arashpour *et al.*, 2017)
		Integrated risk management of on-site and off-site uncertainties (Arashpour *et al.*, 2016)
		Quantifying project risks in financial terms and treating risks as costs for the project (Espinoza, 2014)
		Integrating safety risk data into project schedules (Esmaeili and Hallowell, 2013)
		Project financial risk evaluation and management using decoupled net present value (DNPV) (Espinoza and Morris, 2013)
		Plotting safety risk over time by integrating safety risk data with the schedule (Hallowell *et al.*, 2011)
		Integration of risk management into logical framework approach into project management (Rodríguez-Rivero *et al.*, 2021)
		Integration of capabilities at transitions to balance the risks (Abd Razak *et al.*, 2020)

Main dimension	Subcategory	Integration mechanisms identified in the literature
Capability for continuous management and the adaptation of integration and collaboration	Learning investments and continuous reflection	Prospects for future collaboration as a driver for informal collaboration (Aagaard *et al.*, 2014) Cooperative benchmarking (Li *et al.*, 2001) Improving project learning through an event-based approach, which codifies lessons learned and promotes the measurement of benefits (Fuller *et al.*, 2011) Suppliers actively participate in integration when motivated by future collaboration (Ahola *et al.*, 2017) An outcome-driven approach (Brady and Davies, 2014) Safety improves mechanical productivity (Shan *et al.*, 2011) Education of BIM and SCM, diffusion of SCM philosophy, and learning sessions as strategies for initiating BIM-related SCM (Papadonikolaki *et al.*, 2017) Lessons learned as an innovation-leading indicator (Gambatese and Hallowell, 2011) Systematic collection and use of defect data through a plan–do–check–act (PDCA) cycle enabling quality improvements (Lundkvist *et al.*, 2014)
	Planned adaptation	Integration of changes through evaluation of change requests and making respective modifications (Demirkesen and Ozorhon, 2017) Flexibility and responsiveness to change as a team-integration practice (Baiden *et al.*, 2006) All integrative activities used by suppliers are emergent (Ahola *et al.*, 2017) Social dimension of system integration and customer integration (Liinamaa and Gustafsson, 2010) The ability to be adaptive and responsive (Brady and Davies, 2014)

Table 4.
Capability for continuous management and the adaptation of integration and collaboration

Results

In this section, we describe the results gained during the empirical research process. Overall, the empirical data supported the existence and practical importance of the integration capability dimensions identified in the literature review, which were also presented in the form of a theoretical framework. Below we summarize a practical integration capability self-assessment maturity model created during the research process. A summary of the findings is presented below.

Model for assessing the integration capability in an inter-organizational project network

The model for assessing integration capabilities in inter-organizational project networks is divided into four main categories, as identified in the literature review: administrative, organizational, and contractual integration capability; behavioral and relationship-based

integration capability; technological and process integration capability; and the capability for continuous management and the adaptation of integration and collaboration. All these categories are divided into subcategories and are presented in Figure 2, with the key elements describing the maturity levels being covered in each section.

Administrative, organizational, and contractual integration capability

Collaborative competencies lay the basis for integration capability through collaborative working, practices, and collaborative behaviors that together enable collaboration between project participants. When assessed based on a maturity scale, optimizing mature level project network organizations understand the significance of interdisciplinary collaboration, respecting different opinions and aspiring to understand the views of other parties. In addition, unnecessary barriers and hierarchies are removed between project participants. Conversely, at an initial maturity level, projects are characterized by a culture of individual competition. Each organization's own goals are focal even in collaborative projects, which is why collaboration between companies may even end in finger-pointing.

Shared goals and the metrics of inter-organizational project networks operate as an integrative mechanism, and are thus an essential building block in creating integration capability. Optimizing mature level organizations have well-defined processes for goal setting and metric formulation, and the metrics guide the development of project activities. Conversely, if the maturity level is initial, there is no commitment to shared goals within the organization, and project activities are solely guided by optimizing each participant's efforts.

Defining the project's organization and project management model creates an integration capability through integrative work practices and supplier integration, for example. At an optimizing maturity level, the project's actors have a clear understanding of their roles, responsibilities, and task descriptions. At an initial maturity level, organizations rush the project execution without properly planning the project's organization.

Board activities in projects build the integration capability, and a key to integrating the project parties is top management commitment. An indicator of optimizing maturity in board activities is a relatively small coordinating body, which has been allocated sufficient time, expertise, and resources to focus on the management work. Initial maturity project network organizations, in turn, have large boards operating unsystematically and inefficiently.

Project coordination mechanisms, as a part of the integration capability, refer to the activities related to enhancing communication and knowledge integration and the use of integrative persons between project participants. At an optimizing maturity level, project coordination is considered from the perspective of interdependency management and knowledge integration, whereas an insufficient information flow between technical problem fields and problems in accessing the information indicate an initial maturity level.

Project stakeholder management, from the perspective of the early involvement of key stakeholders, is one essential integration capability. In an optimizing mature level project network, there are defined processes and clear responsibilities for stakeholder management, identified stakeholder needs, and empowered key stakeholders involved in project activities. Initial maturity is demonstrated by randomness and reactive actions toward stakeholder needs that arise.

Subcontractor integration in the processes and knowledge-sharing mechanisms of an inter-organizational network is also an integration capability. Optimizing maturity level networks encourage and ensure suppliers work toward collaborative goals. At an initial maturity level, traditional contracts are used with no collaborative goal incentives.

Resourcing capability relates to resourcing processes and practices. An optimizing maturity level is manifested by sufficient, competent, and timely allocated resources. At an initial maturity level, resourcing activities are random and driven by unnecessary competition and rivalries.

Behavioral and relationship-based integration capability

Team-building, support, and a shared identity as a part of the integration capability are tied to the level of team integration and collaboration—the more integrated the project team is, the better the project outcomes are. At an optimizing maturity level, the project team shares an identity, works toward common goals, and every member is equally appreciated. Instead, with initial maturity, team members advance their personal goals, which differ from the project goals.

Leadership, in the form of relational attitudes, commitment, and management participation, creates an integration capability. If maturity is optimizing in an inter-organizational project network, managers are competent, motivating, and show leadership in tackling challenging situations. In addition, the project team is supported by the top management and the necessary resources are allocated. Initial maturity is indicated by confusion, bottlenecks, and unethical and individual behavior in decision-making.

The trust–control balance is also a critical aspect of the integration capability. At an optimizing maturity level, project actors trust each other and parties working toward common goals, without control. When maturity is initial, mistrust and power struggles prevail.

The project's best interest mentality is a cultural matter, and when maturity is high, actions and decisions are made only with the project's best interests in mind, even though all actions do not directly benefit some project parties. At an initial maturity level, project parties work toward their home organization's goals, which differ from project goals.

A no-blame culture and transparency are important for an integrative capability and are related to interpersonal relationships and information sharing. At an optimizing maturity level, problems are collectively identified and solved without finding someone to blame. Errors are allowed. If maturity is initial, a single party is solely responsible for problem solving, and individuals are blamed for errors. Information is not freely available.

Mutual support and responsibility sharing at an optimizing maturity level is manifested by project actors having the knowledge, opportunities, and competencies to make decisions in the project's best interests. Gains and pains are shared between project participants, whereas at an initial maturity level, project actors only feel responsible for their own actions and do have the mentality to share information and teach each other.

Conflict resolution and consensus decision-making as an integration capability are only possible when the project participants share the same understanding of the state of the project and its operating environment. Where maturity is optimizing, a clear process for conflict resolution exists and project parties are able to resolve conflicts in a collaborative manner. In contrast, when maturity is initial, the threat of litigation is always present and conflicts often remain unsolved.

Technological and process integration capability

Big Room activities are an essential subcategory in integration capability creation through geographical boundary action. If maturity is optimizing, Big Room activities are planned, managed, and developed in a systematized manner, for example, through careful optimization of the co-located spaces, predefined Big Room schedules, and work facilitation. At an initial maturity level, experts work in silos, and Big Rooms are not perceived as constructive environments.

Innovation processes, at an optimizing maturity level, originate from encouraging a culture of innovation. In mature project network organizations, systematic processes for innovation activities exist, and ideas that arise are collected in a systematized way. A suitable incentive system is in place, in addition to the innovation coordinator role. Where maturity is initial, innovation activities are unsystematic and random, and seen as trivial. Innovation processes are not managed, and even if incentives are set, they fail to motivate.

Workshops, in contrast to ineffective meetings, are an integration mechanism in collaborative projects, thus forming a part of integration capability. At an optimizing

maturity level, several workshop models and methods are available and used effectively, and project actors receive workshop training. When a workshop takes place, it is well-planned, facilitated, documented, and the results are communicated. In turn, when maturity is initial, project participants are unable to differentiate between workshops and regular meetings.

Visual management and control is a core element of collaborative projects. If maturity is optimizing, visual elements are systematically employed in strategic and operational project management. Project members feel that visual management facilitates the flow of information, whereas when maturity is initial, members are still learning to use visual management systems, which are not systematically in use, either.

Use of collaboration and information-sharing technologies is one aspect in which the creation of integration capabilities can be supported. The technologies used can be of various types, but a common feature at an optimizing maturity level is that technologies automate and facilitate effective project activities and support decision-making and knowledge sharing. At an initial maturity level, the use of technologies is situational, and the systems themselves are difficult and unintuitive to use. Information may be stored in a system, but it is difficult to find when needed.

Utilizing Last Planner to manage schedules and coordination is a separate component of integration capability based on the project practitioners' views in our research. An indicator of optimizing maturity is a clear and systematic process for using Last Planner, sufficient experience and offering training to use it, in addition to constant development of the Last Planner activities. When maturity is initial, the method is only used on individual occasions.

The target value design (TVD) process, as a collaborative design process involving clients, users, designers, builders, and key subcontractors, was another integration capability component identified by project practitioners and also by the literature. An optimizing maturity level is manifested by TVD workshops, organized in Big Room environments as integral to project activities. Work between parties is effortless. In turn, at an initial maturity level, a significant part of the project network organization does not understand the core benefits of the process nor is it fully familiar with it.

At an optimizing maturity level, scope creep management involves dedicating a person to examine project-related change processes in relation to scope creep. When maturity is optimizing, changes to the scope are also approved by the project board. If the maturity level is initial, the management process pays no attention to scope creep.

Project risk management has an evident part to play in integration capability building. When maturity is optimizing, the risk management process has a process owner who is supported by risk management coordinators. Risk management is an integral part of daily project activities, and risk owners are allocated whenever issues arise. The process also includes opportunity management. Initial maturity is manifested by randomness, and risks are not systematically monitored or prioritized.

Capability for continuous management and the adaptation of integration and collaboration

Learning investments and continuous reflection are essential for integration capability creation, whereas continuous reflection and a philosophy of continuous improvement are integral to collaborative projects. At an optimizing maturity level, project actors, also managers, actively reflect on their roles and contributions in relation to project goals. Tools are used to support the reflection process. If maturity is initial, reflection is not seen as valuable during other project activities.

Planned adaptation is the last element in our model for assessing integration capability. It refers to the ability to adapt both known and unknown factors in the project environment. When maturity is optimizing, actions and processes are adjusted flexibly and quickly whenever needed. In turn, at an initial maturity level, project activities are not actively nor sufficiently monitored and adjusted.

Practical validation: self-assessing integration capability in an inter-organizational project network

In this section, we only present the results from two projects used for validation purposes, since the integration capability assessment model itself was not further changed during the validation phase. In practice, self-assessing the integration capability of an inter-organizational project or project network took place in two phases. The first phase was a questionnaire assessing the maturity level of the elements related to integration capability, which was filled in individually by each selected key project practitioner. The second phase was an evaluation workshop, in which the collective results were summarized, analyzed, and further actions decided.

As Figures 3 and 4 show, the integration capability maturity level varied from one project to another, but the highest scores were found in a project network engaged in IPD. In contrast, lower maturity levels were found in a project using traditional contracting. The visual presentation of the results also helps to evaluate the state of the integration within projects in an easily approachable manner.

The practical experience of using collaborative project management practices varied significantly in the researched inter-organizational projects, project networks, and project management professionals. During the empirical work, there were indicators regarding the value of the integration capability self-assessment model not necessarily being in the outcomes of the assessment *per se*, but rather in the questions and insights it provoked among the project management professionals. Furthermore, it was noted that the whole process of assessing the integration capability operated as an integrative activity in itself. This included both the integrative effects of the workshops where the results from the self-assessment model were analyzed and the effects of individual project actors filling in the questionnaire prior to the evaluation workshop. For example, one identified integrative effect originated from the increased knowledge level, first, related to the elements of integration capability, and second, related to identifying optimizing mature level project activities. Overall, using the model provoked various insights among the participants related to enhancing project practices in action, thus operating as an integrative activity.

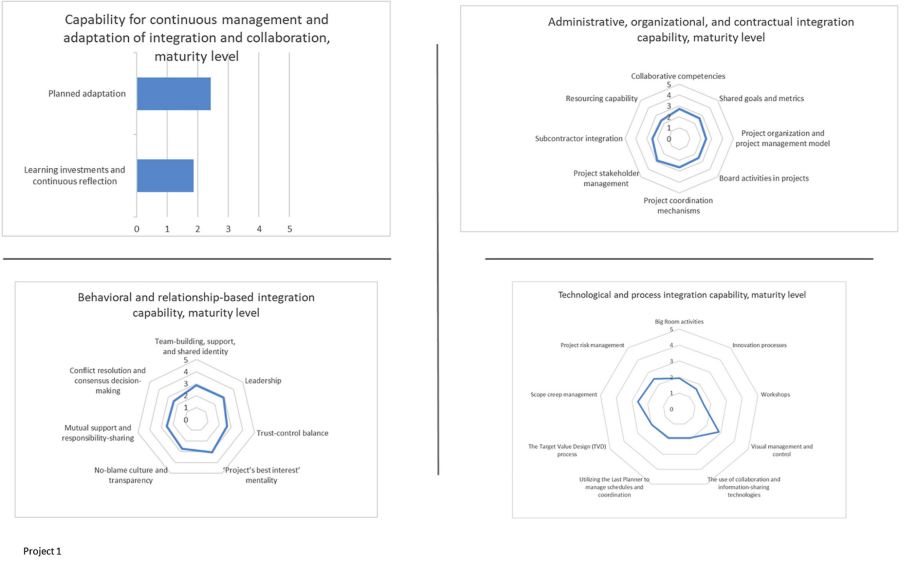

Figure 3.
Elements of the integration capability and levels of maturity for the first evaluated project

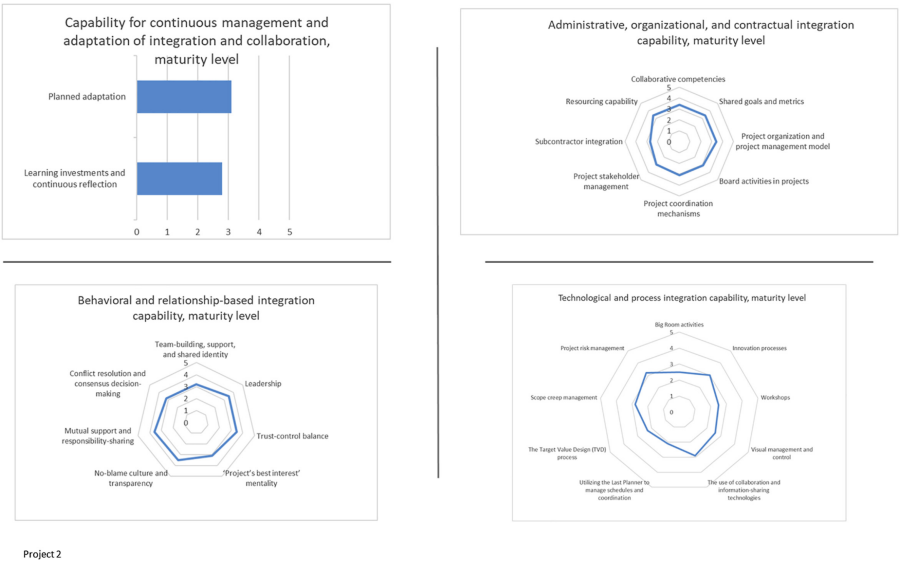

Figure 4.
Elements of the integration capability and levels of maturity for the second evaluated project

What we found during the model's practical application was that self-assessing the integration capability level could take place one or more times during a project. The knowledge gained from the analysis can be used to design integrative activities and interventions in strategically important or other selected areas, or simply to identify components that need focused on during projects. As the integration capability level is not static, as it fluctuates during different project phases, to get the most out of the assessment exercise, it should be conducted several times during a project, with results from previous rounds being compared and contrasted, and actions designed accordingly. If the integration capability level is assessed only once during a project, the most fruitful phase, according to our experiments, would be right at the beginning of the design or execution phase, whereby the results may initiate activities enhancing the integration between project participants, which eventually has the potential to improve project outcomes.

As a result, the practical application of the model proved that it actually worked in real project settings. The project practitioners felt both the self-assessment process and the respective results were insightful and provided essential information to further develop actual project practices. It also resulted in the notion that the model could be used as an integrative practice and as a tool for guiding improvements in project practices.

Conclusion and discussion

To conclude, the purpose of this study was, first, to identify the integration capability dimensions within inter-organizational project networks, and second, to explore how the integration capability in such networks can be self-assessed. The integration capability dimensions were elaborated through an extensive systematic literature review of project management- and construction management-related journals. Furthermore, a maturity model for self-assessing integration capability was developed in cooperation with project management professionals; the model was iteratively developed, tested, and validated in five practical project settings.

This study advances our understanding of the components of inter-organizational integration and the respective integration capabilities in temporary project network

organizations, whereas the traditional integration literature (Galbraith, 1974; Lawrence and Lorsch, 1967) has mainly focused on the intra-organizational integration of manufacturing organizations (Bechky, 2006; Hietajärvi *et al.*, 2017a).

As a practical and managerial implication, this study has created a model that can be used in assessing the integration capability of inter-organizational projects in various project phases. The project practitioners who participated the empirical research thought the main value of the self-assessment model was in its suitability for developing the project activities. As one of the participants put it: "It is very valuable to know where we as a project are at the moment. It enables us to develop the actions to achieve the next level." Indeed, the assessment points out, in a quantitative and visualizable form, the subcategories in which the project parties perform well. Respectively, the focal areas for improvement activities can be determined from the assessment results. Furthermore, the assessment model was found to operate as an integrative activity in itself within an inter-organizational project. The results are in line with the notion that the benefits of maturity assessment in the field of project management lie in setting directions, prioritizing actions, and beginning cultural change, rather than in primarily identifying the current level at which the project organization is performing (Backlund *et al.*, 2014).

Naturally, there are several limitations to this study. The literature that was systematically analyzed only covered project management-related journals in addition to one construction management journal. The research data were gathered through assessment tool questionnaires and workshops, but the research efforts included no systematic longitudinal analysis of the inter-organizational projects and the project network in question, which represented different industries. A definite aim for future analysis would be to evaluate how the use of the integration capability assessment model actually affects real-life project practices. Moreover, the relations between the integration mechanisms and dimensions of integration capability are a source for further research.

References

Aagaard, A., Eskerod, P. and Madsen, E.S. (2014), "Key drivers for informal project coordination among sub-contractors a case study of the offshore wind energy sector", *International Journal of Managing Projects in Business*, Vol. 8 No. 2, pp. 222-240.

Aapaoja, A., Herrala, M., Pekuri, A. and Haapasalo, H. (2013), "The characteristics of and cornerstones for creating integrated teams", *International Journal of Managing Projects in Business*, Vol. 6 No. 4, pp. 695-713.

Abd Razak, D.S., Mills, G. and Roberts, A. (2020), "A strategic approach to mitigating operational failure across transitions", *Project Management Journal*, Vol. 51 No. 5, pp. 474-488, doi: 10.1177/8756972820928703.

Ahlemann, F., El Arbi, F., Kaiser, M.G. and Heck, A. (2013), "A process framework for theoretically grounded prescriptive research in the project management field", *International Journal of Project Management*, Vol. 31 No. 1, pp. 43-56, doi: 10.1016/j.ijproman.2012.03.008.

Ahola, T., Vuori, M. and Viitamo, E. (2017), "Sharing the burden of integration : an activity-based view to integrated solutions provisioning", *International Journal of Project Management*, Vol. 35 No. 6, pp. 1006-1021, doi: 10.1016/j.ijproman.2017.05.002.

Al-Bizri, S. and Gray, C. (2010), "Management framework for technology clusters implementation", *Construction Management and Economics*, Vol. 28 No. 7, pp. 771-782, doi: 10.1080/01446191003725170.

Alderman, N. and Ivory, C. (2010), "Service-led projects: understanding the meta-project context", *Construction Management and Economics*, Vol. 28 No. 11, pp. 1131-1143, doi: 10.1080/01446193.2010.506644.

Arashpour, M., Wakefield, R., Lee, E.W.M., Chan, R. and Hosseini, M.R. (2016), "Analysis of interacting uncertainties in on-site and off-site activities: implications for hybrid construction",

International Journal of Project Management, Vol. 34, pp. 1393-1402, doi: 10.1016/j.ijproman.2016.02.004.

Arashpour, M., Abbasi, B., Arashpour, M., Hosseini, M.R. and Yang, R. (2017), "Integrated management of on-site, coordination and off-site uncertainty: theorizing risk analysis within a hybrid project setting", *International Journal of Project Management*, Vol. 35 No. 4, pp. 647-655, doi: 10.1016/j.ijproman.2017.02.016.

Artto, K., Ahola, T. and Vartiainen, V. (2016), "From the front end of projects to the back end of operations: managing projects for value creation throughout the system lifecycle", *International Journal of Project Management*, Vol. 34 No. 2, pp. 258-270, doi: 10.1016/j.ijproman.2015.05.003.

Atkinson, A.R. and Westall, R. (2010), "The relationship between integrated design and construction and safety on construction projects", *Construction Management and Economics*, Vol. 28 No. 9, pp. 1007-1017, doi: 10.1080/01446193.2010.504214.

Austin, S., Newton, A., Steele, J. and Waskett, P. (2002), "Modelling and managing project complexity", *International Journal of Project Management*, Vol. 20, pp. 191-198.

Backlund, F., Chronéer, D. and Sundqvist, E. (2014), "Project management maturity models – a critical review", *Procedia - Social and Behavioral Sciences*, Vol. 119, pp. 837-846, doi: 10.1016/j.sbspro.2014.03.094.

Baiden, B.K. and Price, A.D.F. (2011), "The effect of integration on project delivery team effectiveness", *International Journal of Project Management*, Vol. 29 No. 2, pp. 129-136, doi: 10.1016/j.ijproman.2010.01.016.

Baiden, B.K., Price, A.D.F. and Dainty, A.R.J. (2006), "The extent of team integration within construction projects", *International Journal of Project Management*, Vol. 24, pp. 13-23, doi: 10.1016/j.ijproman.2005.05.001.

Bakker, R.M. (2010), "Taking stock of temporary organizational forms: a systematic review and research agenda", *International Journal of Management Reviews*, Vol. 12 No. 4, pp. 466-486, doi: 10.1111/j.1468-2370.2010.00281.x.

Batselier, J. and Vanhoucke, M. (2017), "Improving project forecast accuracy by integrating earned value management with exponential smoothing and reference class forecasting", *International Journal of Project Management*, Vol. 35 No. 1, pp. 28-43, doi: 10.1016/j.ijproman.2016.10.003.

Bechky, B.A. (2006), "Gaffers, gofers, and grips: role-based coordination in temporary organizations", *Organization Science*, Vol. 17 No. 1, pp. 3-21, doi: 10.1287/orsc.1050.0149.

Bond-Barnard, T.J., Fletcher, L. and Steyn, H. (2018), "Linking trust and collaboration in project teams to project management success", *International Journal of Managing Projects in Business*, Vol. 11 No. 2, pp. 432-457, doi: 10.1108/IJMPB-06-2017-0068.

Bony, J.D. (2010), "Project management and national culture: a Dutch – French case study", *International Journal of Project Management*, Vol. 28 No. 2, pp. 173-182, doi: 10.1016/j.ijproman.2009.09.002.

Boutilier, R.G. and Zdziarski, M. (2017), "Managing stakeholder networks for a social license to build", *Construction Management and Economics*, Vol. 35 Nos 8-9, pp. 498-513, doi: 10.1080/01446193.2017.1289229.

Boyd, P., Larsen, G.D. and Schweber, L. (2015), "The co-development of technology and new buildings: incorporating building integrated photovoltaics", *Construction Management and Economics*, Vol. 33 Nos 5-6, pp. 349-360, doi: 10.1080/01446193.2015.1074262.

Brady, T. and Davies, A. (2004), "Building project capabilities: from exploratory to exploitative learning", *Organization Studies*, Vol. 25 No. 9, pp. 1601-1621, doi: 10.1177/0170840604048002.

Brady, T. and Davies, A. (2014), "Managing structural and dynamic complexity: a tale of two projects", *Project Management Journal*, Vol. 45 No. 4, pp. 21-38, doi: 10.1002/pmj.

Buvik, M.P. and Rolfsen, M. (2015), "Prior ties and trust development in project teams – a case study from the construction industry", *International Journal of Project Management*, Vol. 33 No. 7, pp. 1484-1494, doi: 10.1016/j.ijproman.2015.06.002.

Bygstad, B. and Lanestedt, G. (2009), "ICT based service innovation – a challenge for project management", *International Journal of Project Management*, Vol. 27 No. 3, pp. 234-242, doi: 10.1016/j.ijproman.2007.12.002.

Cameron, I. and Hare, B. (2008), "Planning tools for integrating health and safety in construction", *Construction Management and Economics*, Vol. 26 No. 9, pp. 899-909, doi: 10.1080/01446190802175660.

Cardenas, I.C., Voordijk, H. and Dewulf, G. (2017), "Beyond theory: towards a probabilistic causation model to support project governance in infrastructure projects", *International Journal of Project Management*, Vol. 35 No. 3, pp. 432-450, doi: 10.1016/j.ijproman.2017.01.002.

Caron, F., Ruggeri, F. and Merli, A. (2013), "A Bayesian approach to improve estimate at completion in earned value management", *Project Management Journal*, Vol. 44 No. 1, pp. 3-16, doi: 10.1002/pmj.

Caron, F., Ruggeri, F. and Pierini, B. (2016), "A Bayesian approach to improving estimate to complete", *International Journal of Project Management*, Vol. 34 No. 8, pp. 1687-1702, doi: 10.1016/j.ijproman.2016.09.007.

Carpintero, S. and Petersen, O.H. (2015), "Bundling and unbundling in public – private partnerships: implications for risk sharing in urban transport projects", *Project Management Journal*, Vol. 46 No. 4, pp. 35-46, doi: 10.1002/pmj.

Chakkol, M., Selviaridis, K. and Finne, M. (2018), "The governance of collaboration in complex projects", *International Journal of Operations and Production Management*, Vol. 38 No. 4, pp. 997-1019, doi: 10.1108/IJOPM-11-2017-0717.

Çıdık, M.S. and Boyd, D. (2020), "Shared sense of purposefulness": a new concept to understand the practice of coordinating design in construction", *Construction Management and Economics*, Vol. 38 No. 1, pp. 18-31, doi: 10.1080/01446193.2019.1593471.

Clifton, C. and Duffield, C.F. (2006), "Improved PFI/PPP service outcomes through the integration of Alliance principles", *International Journal of Project Management*, Vol. 24, pp. 573-586, doi: 10.1016/j.ijproman.2006.07.005.

Currie, W.L. (2003), "A knowledge-based risk assessment framework for evaluating web-enabled application outsourcing projects", *International Journal of Project Management*, Vol. 21, pp. 207-217.

Dainty, A.R.J., Briscoe, G.H. and Millett, S.J. (2001), "Subcontractor perspectives on supply chain alliances", *Construction Management and Economics*, Vol. 19 No. 8, pp. 841-848, doi: 10.1080/01446190110089727.

Davies, A. and Brady, T. (2000), "Organisational capabilities and learning in complex product systems: towards repeatable solutions", *Research Policy*, Vol. 29 Nos 7-8, pp. 931-953, doi: 10.1016/s0048-7333(00)00113-x.

Davies, A. and Mackenzie, I. (2014), "Project complexity and systems integration: constructing the London 2012 Olympics and paralympics games", *International Journal of Project Management*, Vol. 32 No. 5, pp. 773-790, doi: 10.1016/j.ijproman.2013.10.004.

DeFillippi, R. and Sydow, J. (2016), "Project networks: governance choices and paradoxical tensions", *Project Management Journal*, Vol. 47 No. 5, pp. 6-17.

Demirkesen, S. and Ozorhon, B. (2017), "Impact of integration management on construction project management performance", *International Journal of Project Management*, Vol. 35 No. 8, pp. 1639-1654, doi: 10.1016/j.ijproman.2017.09.008.

Di Vincenzo, F. and Mascia, D. (2012), "Social capital in project-based organizations: its role, structure, and impact on project performance", *International Journal of Project Management*, Vol. 30 No. 1, pp. 5-14, doi: 10.1016/j.ijproman.2011.03.006.

Dyer, R. (2017), "Cultural sense-making integration into risk mitigation strategies towards megaproject success", *International Journal of Project Management*, Vol. 35 No. 7, pp. 1338-1349, doi: 10.1016/j.ijproman.2016.11.005.

Ellis, R.C.T., Wood, G.D. and Keel, D.A. (2005), "Value management practices of leading UK cost consultants", *Construction Management and Economics*, Vol. 23 No. 5, pp. 483-493, doi: 10.1080/01446190500040711.

Enberg, C. (2012), "Enabling knowledge integration in coopetitive R&D projects - the management of conflicting logics", *International Journal of Project Management*, Vol. 30 No. 7, pp. 771-780, doi: 10.1016/j.ijproman.2012.01.003.

Eriksson, K., Wikström, K., Hellström, M. and Levitt, R.E. (2019), "Projects in the business ecosystem: the case of short sea shipping and logistics", *Project Management Journal*, Vol. 50 No. 2, pp. 195-209, doi: 10.1177/8756972818820191.

Esmaeili, B. and Hallowell, M. (2013), "Integration of safety risk data with highway construction schedules", *Construction Management and Economics*, Vol. 31 No. 6, pp. 528-541, doi: 10.1080/01446193.2012.739288.

Espinoza, R.D. (2014), "Separating project risk from the time value of money: a step toward integration of risk management and valuation of infrastructure investments", *International Journal of Project Management*, Vol. 32 No. 6, pp. 1056-1072, doi: 10.1016/j.ijproman.2013.12.006.

Espinoza, D. and Morris, J.W.F. (2013), "Decoupled NPV: a simple, improved method to value infrastructure investments", *Construction Management and Economics*, Vol. 31 No. 5, pp. 471-496, doi: 10.1080/01446193.2013.800946.

Fink, A. (1998), *Conducting Research Literature Reviews - from Paper to the Internet*, Sage Publications, London.

Fuller, P.A., Dainty, A.R.J. and Thorpe, T. (2011), "Improving project learning: a new approach to lessons learnt", *International Journal of Managing Projects in Business*, Vol. 4 No. 1, pp. 118-136.

Galbraith, J.R. (1974), "Organization design: an information processing view", *Interfaces*, Vol. 4, pp. 28-36.

Gambatese, J.A. and Hallowell, M. (2011), "Enabling and measuring innovation in the construction industry", *Construction Management and Economics*, Vol. 29 No. 6, pp. 553-567, doi: 10.1080/01446193.2011.570357.

Glass, J. (2005), "A best practice process model for hybrid concrete construction", *Construction Management and Economics*, Vol. 23 No. 2, pp. 169-184, doi: 10.1080/0144619042000326756.

Goel, A., Ganesh, L.S. and Kaur, A. (2020), "Project management for social good: a conceptual framework and research agenda for socially sustainable construction project management", *International Journal of Managing Projects in Business*, Vol. 13 No. 4, pp. 695-726, doi: 10.1108/IJMPB-06-2019-0155.

Gordon, A. and Pollack, J. (2018), "Managing healthcare integration: adapting project management to the needs of organizational change", *Project Management Journal*, Vol. 49 No. 5, pp. 5-21, doi: 10.1177/8756972818785321.

Grabher, G. (2002), "Cool projects, boring institutions: temporary collaboration in social context", *Regional Studies*, Vol. 36 No. 3, pp. 205-214, doi: 10.1080/00343400220122025.

Guo, K., Zhang, L. and Wang, T. (2021), "Concession period optimisation in complex projects under uncertainty: a public–private partnership perspective", *Construction Management and Economics*, Vol. 39 No. 2, pp. 156-172, doi: 10.1080/01446193.2020.1849752.

Gustavsson, T.K. and Gohary, H. (2012), "Boundary action in construction projects: new collaborative project practices", *International Journal of Managing Projects in Business*, Vol. 5 No. 3, pp. 364-376.

Hallowell, M., Esmaeili, B. and Chinowsky, P. (2011), "Safety risk interactions among highway construction work tasks", *Construction Management and Economics*, Vol. 29 No. 4, pp. 417-429, doi: 10.1080/01446193.2011.552512.

Hazir, Ö. (2015), "A review of analytical models, approaches and decision support tools in project monitoring and control", *International Journal of Project Management*, Vol. 33 No. 4, pp. 808-815, doi: 10.1016/j.ijproman.2014.09.005.

Hevner, A.R., March, S.T., Park, J. and Ram, S. (2004), "Design science in information systems research", *MIS Quarterly: Management Information Systems*, Vol. 28 No. 1, pp. 75-105, doi: 10.2307/25148625.

Hietajärvi, A.-M., Aaltonen, K. and Haapasalo, H. (2017a), "Managing integration in infrastructure alliance projects Dynamics of integration mechanisms", *International Journal of Managing Projects in Business*, Vol. 10 No. 1, pp. 5-31.

Hietajärvi, A.-M., Aaltonen, K. and Haapasalo, H. (2017b), "What is project alliance capability?", *International Journal of Managing Projects in Business*, Vol. 10 No. 2, pp. 404-422, doi: 10.1108/IJMPB-07-2016-0056.

Holmström, J., Ketokivi, M. and Hameri, A.-P. (2009), "Bridging practice and theory: a design science approach", *Decision Sciences*, Vol. 40 No. 1, pp. 65-87, doi: 10.1111/j.1540-5915.2008.00221.x.

Ibrahim, C., khairil, I.C., Costello, S.B. and Wilkinson, S. (2013), "Development of a conceptual team integration performance index for alliance projects", *Construction Management and Economics*, Vol. 31 No. 11, pp. 1128-1143, doi: 10.1080/01446193.2013.854399.

Ibrahim, C.K.I., Costello, S.B. and Wilkinson, S. (2015), "Development of an assessment tool for team integration in alliance projects", *International Journal of Managing Projects in Business*, Vol. 8 No. 4, pp. 813-827.

Ibrahim, C.K.I., Costello, S.B. and Wilkinson, S. (2016), "Application of a team integration performance index in road infrastructure alliance projects", *Benchmarking: An International Journal*, Vol. 23 No. 5, pp. 1341-1362, doi: 10.1108/BIJ-06-2015-0058.

Isidore, L.J., Back, W.E. and Fry, G.T. (2001), "Integrated probabilistic schedules and estimates from project simulated data", *Construction Management and Economics*, Vol. 19 No. 4, pp. 417-426, doi: 10.1080/01446190010022677.

Jagtap, M. and Kamble, S. (2020), "An empirical assessment of relational contracting model for supply chain of construction projects", *International Journal of Managing Projects in Business*, Vol. 13 No. 7, pp. 1537-1560, doi: 10.1108/IJMPB-05-2018-0097.

Jones, K., Mosca, L., Whyte, J., Davies, A. and Glass, J. (2021), "Addressing specialization and fragmentation: product platform development in construction consultancy firms", *Construction Management and Economics*. doi: 10.1080/01446193.2021.1983187.

Kamara, J.M., Anumba, C.J. and Evbuomwan, N.F.O. (2001), "Assessing the suitability of current briefing practices in construction within a concurrent engineering framework", *International Journal of Project Management*, Vol. 19, pp. 337-351.

Ketokivi, M. and Choi, T. (2014), "Renaissance of case research as a scientific method", *Journal of Operations Management*, Vol. 32 No. 5, pp. 232-240, doi: 10.1016/j.jom.2014.03.004.

Khairil, C.K., Ibrahim, C., Costello, S.B. and Wilkinson, S. (2015), "Key indicators influencing the management of team integration in construction projects", *International Journal of Managing Projects in Business*, Vol. 8 No. 2, pp. 300-323.

Kirsila, J., Hellström, M. and Wikström, K. (2007), "Integration as a project management concept: a study of the commissioning process in industrial deliveries", *International Journal of Project Management*, Vol. 25, pp. 714-721, doi: 10.1016/j.ijproman.2007.02.005.

Kleiss, T. and Imura, H. (2006), "The Japanese private finance initiative and its application in the municipal solid waste management sector", *International Journal of Project Management*, Vol. 24 No. 7, pp. 614-621, doi: 10.1016/j.ijproman.2006.07.007.

Klessova, S., Thomas, C. and Engell, S. (2020), "Structuring inter-organizational R&D projects: towards a better understanding of the project architecture as an interplay between activity coordination and knowledge integration", *International Journal of Project Management*, Vol. 38 No. 5, pp. 291-306, doi: 10.1016/j.ijproman.2020.06.008.

Korpela, J., Miettinen, R., Salmikivi, T. and Ihalainen, J. (2015), "The challenges and potentials of utilizing building information modelling in facility management: the case of the center for

Properties and Facilities of the University of Helsinki", *Construction Management and Economics*, Vol. 33 No. 1, pp. 3-17, doi: 10.1080/01446193.2015.1016540.

Kujala, J., Aaltonen, K., Gotcheva, N. and Lahdenperä, P. (2021), "Dimensions of governance in interorganizational project networks", *International Journal of Managing Projects in Business*, Vol. 14 No. 3, pp. 625-651, doi: 10.1108/IJMPB-12-2019-0312.

Lawrence, P.R. and Lorsch, J.W. (1967), "Differentiation and integration in complex organizations", *Adminstrative Science Quarterly*, Vol. 12 No. 1, pp. 1-47, doi: 10.2307/2391211.

Le, P.L., Jarroudi, I., Dao, T.M. and Chaabane, A. (2021), "Integrated construction supply chain: an optimal decision-making model with third-party logistics partnership", *Construction Management and Economics*, Vol. 39 No. 2, pp. 133-155, doi: 10.1080/01446193.2020.1831037.

Leung, M.Y. and Liu, A.M.M. (2003), "Analysis of value and project goal specificity in value management", *Construction Management and Economics*, Vol. 21 No. 1, pp. 11-19, doi: 10.1080/0144619032000065081.

Li, H., Cheng, E.W.L., Love, P.E.D. and Irani, Z. (2001), "Co-operative benchmarking: a tool for partnering excellence in construction", *International Journal of Project Management*, Vol. 19 No. 3, pp. 171-179, doi: 10.1016/S0263-7863(99)00033-2.

Li, Y., Xu, L., Sun, T. and Ding, R. (2020), "The impact of project environmental practices on environmental and organizational performance in the construction industry", *International Journal of Managing Projects in Business*, Vol. 13 No. 2, pp. 367-387, doi: 10.1108/IJMPB-07-2018-0137.

Ligthart, R., Oerlemans, L. and Noorderhaven, N. (2016), "In the shadows of time: a case study of flexibility behaviors in an interorganizational project", *Organization Studies*, Vol. 37 No. 12, pp. 1721-1743, doi: 10.1177/0170840616655487.

Liinamaa, J. and Gustafsson, M. (2010), "Integrating the customer as part of systems integration", *International Journal of Managing Projects in Business*, Vol. 3 No. 2, pp. 197-215.

Lin, L., Müller, R., Zhu, F. and Liu, H. (2019), "Choosing suitable project control modes to improve the knowledge integration under different uncertainties", *International Journal of Project Management*, Vol. 37 No. 7, pp. 896-911, doi: 10.1016/j.ijproman.2019.07.002.

Liu, L., Wang, X. and Sheng, Z. (2012), "Achieving ambidexterity in large, complex engineering projects: a case study of the Sutong Bridge project", *Construction Management and Economics*, Vol. 30 No. 5, pp. 399-409, doi: 10.1080/01446193.2012.679948.

London, K. and Pablo, Z. (2017), "An actor–network theory approach to developing an expanded conceptualization of collaboration in industrialized building housing construction", *Construction Management and Economics*, Vol. 35 Nos 8-9, pp. 553-577, doi: 10.1080/01446193.2017.1339361.

Lu, Q., Won, J. and Cheng, J.C.P. (2016), "A financial decision making framework for construction projects based on 5D Building Information Modeling (BIM)", *International Journal of Project Management*, Vol. 34 No. 1, pp. 3-21, doi: 10.1016/j.ijproman.2015.09.004.

Lundin, R.A. and Soderholm, A. (1995), "A theory of the temporary organization", *Scandinavian Journal of Management*, Vol. 11 No. 4, pp. 437-455.

Lundkvist, R., Meiling, J.H. and Sandberg, M. (2014), "A proactive plan-do-check-act approach to defect management based on a Swedish construction project", *Construction Management and Economics*, Vol. 32 No. 11, pp. 1051-1065, doi: 10.1080/01446193.2014.966733.

Magnaye, R., Sauser, B., Patanakul, P., Nowicki, D. and Randall, W. (2014), "Earned readiness management for scheduling, monitoring and evaluating the development of complex product systems", *International Journal of Project Management*, Vol. 32 No. 7, pp. 1246-1259, doi: 10.1016/j.ijproman.2014.01.009.

Manning, S. (2017), "The rise of project network organizations: building core teams and flexible partner pools for interorganizational projects", *Research Policy*, Vol. 46 No. 8, pp. 1399-1415, doi: 10.1016/j.respol.2017.06.005.

Manu, E., Ankrah, N., Chinyio, E. and Proverbs, D. (2015), "Trust influencing factors in main contractor and subcontractor relationships during projects", *International Journal of Project Management*, Vol. 33 No. 7, pp. 1495-1508, doi: 10.1016/j.ijproman.2015.06.006.

March, S.T. and Smith, G.F. (1995), "Design and natural science research on information technology", *Decision Support Systems*, Vol. 15 No. 4, pp. 251-266, doi: 10.1016/0167-9236(94)00041-2.

Martinsuo, M. and Ahola, T. (2010), "Supplier integration in complex delivery projects: comparison between different buyer – supplier relationships", *International Journal of Project Management*, Vol. 28 No. 2, pp. 107-116, doi: 10.1016/j.ijproman.2009.09.004.

Matar, M.M., Georgy, M.E. and Ibrahim, M.E. (2008), "Sustainable construction management: introduction of the operational context space (OCS)", *Construction Management and Economics*, Vol. 26 No. 3, pp. 261-275, doi: 10.1080/01446190701842972.

McCarthy, S., O'Raghallaigh, P., Fitzgerald, C. and Adam, F. (2021), "Shared and fragmented understandings in interorganizational IT project teams: an interpretive case study", *International Journal of Project Management*, Vol. 39 No. 7, pp. 762-773, doi: 10.1016/j.ijproman.2021.07.003.

Mesa, H.A., Molenaar, K.R. and Alarcón, L.F. (2016), "Exploring performance of the integrated project delivery process on complex building projects", *International Journal of Project Management*, Vol. 34 No. 7, pp. 1089-1101, doi: 10.1016/j.ijproman.2016.05.007.

Miković, R., Petrović, D., Mihić, M., Obradović, V. and Todorović, M. (2020), "The integration of social capital and knowledge management – the key challenge for international development and cooperation projects of nonprofit organizations", *International Journal of Project Management*, Vol. 38 No. 8, pp. 515-533, doi: 10.1016/j.ijproman.2020.07.006.

Mollaoglu, S., Sparkling, A. and Thomas, S. (2015), "An inquiry to move an underutilized best practice forward: barriers to partnering in the architecture, engineering, and construction industry", *Project Management Journal*, Vol. 46 No. 1, pp. 69-83, doi: 10.1002/pmj.

Ndoni, D.H. and Elhag, T.M.S. (2010), "The integration of human relationships in capital development projects a case study of BSF scheme", *International Journal of Managing Projects in Business*, Vol. 3 No. 3, pp. 479-494.

Oraee, M., Hosseini, M.R., Papadonikolaki, E., Palliyaguru, R. and Arashpour, M. (2017), "Collaboration in BIM-based construction networks: a bibliometric-qualitative literature review", *International Journal of Project Management*, Vol. 35 No. 7, pp. 1288-1301, doi: 10.1016/j.ijproman.2017.07.001.

Pala, M., Edum-Fotwe, F., Ruikar, K., Peters, C. and Doughty, N. (2016), "Implementing commercial information exchange: a construction supply chain case study", *Construction Management and Economics*, Vol. 34 No. 12, pp. 898-918, doi: 10.1080/01446193.2016.1211718.

Papadonikolaki, E., Verbraeck, A. and Wamelink, H. (2017), "Formal and informal relations within BIM-enabled supply chain partnerships", *Construction Management and Economics*, Vol. 35 Nos 8-9, pp. 531-552, doi: 10.1080/01446193.2017.1311020.

Papadonikolaki, E., van Oel, C. and Kagioglou, M. (2019), "Organising and managing boundaries: a structurational view of collaboration with building information modelling (BIM)", *International Journal of Project Management*, Vol. 37 No. 3, pp. 378-394, doi: 10.1016/j.ijproman.2019.01.010.

Perera, A.A.D.A.J. and Imriyas, K. (2004), "An integrated construction project cost information system using MS AccessTM and MS ProjectTM", *Construction Management and Economics*, Vol. 22 No. 2, pp. 203-211, doi: 10.1080/0144619042000201402.

Rahman, M.M. and Kumaraswamy, M.M. (2005), "Assembling integrated project teams for joint risk management", *Construction Management and Economics*, Vol. 23 No. 4, pp. 365-375, doi: 10.1080/01446190500040083.

Ratcheva, V. (2009), "Integrating diverse knowledge through boundary spanning processes – the case of multidisciplinary project teams", *International Journal of Project Management*, Vol. 27 No. 3, pp. 206-215, doi: 10.1016/j.ijproman.2008.02.008.

Rauniar, R., Rawski, G., Morgan, S. and Mishra, S. (2019), "Knowledge integration in IPPD project: role of shared project mission, mutual trust, and mutual influence", *International Journal of Project Management*, Vol. 37 No. 2, pp. 239-258, doi: 10.1016/j.ijproman.2019.01.002.

Rodríguez-Rivero, R., Ortiz-Marcos, I., Ballesteros-Sánchez, L. and Sánchez, M.J. (2021), "Improving the management of international development projects", *International Journal of Managing Projects in Business*, Vol. 14 No. 2, pp. 253-269, doi: 10.1108/IJMPB-03-2019-0057.

Ruan, X., Ochieng, E.G., Price, A.D.F. and Egbu, C.O. (2012), "Knowledge integration process in construction projects: a social network analysis approach to compare competitive and collaborative working", *Construction Management and Economics*, Vol. 30 No. 1, pp. 5-19, doi: 10.1080/01446193.2011.654127.

Sabini, L., Muzio, D. and Alderman, N. (2019), "25 years of 'sustainable projects'. What we know and what the literature says", *International Journal of Project Management*, Vol. 37 No. 6, pp. 820-838, doi: 10.1016/j.ijproman.2019.05.002.

Schreier, M. (2012), *Qualitative Content Analysis in Practice*, Sage Publications, London.

Sein, M.K., Henfridsson, O., Purao, S., Rossi, M. and Lindgren, R. (2011), "Action design research", *MIS Quarterly*, Vol. 35 No. 1, pp. 37-56.

Shan, Y., Goodrum, P.M., Zhai, D., Haas, C. and Caldas, C.H. (2011), "The impact of management practices on mechanical construction productivity", *Construction Management and Economics*, Vol. 29 No. 3, pp. 305-316, doi: 10.1080/01446193.2010.538070.

Söderlund, J. (2011), "Theoretical foundations of project management: suggestions for a pluralistic understanding", *The Oxford Handbook of Project Management*, (January 2011), doi: 10.1093/oxfordhb/9780199563142.003.0003.

Suprapto, M., Bakker, H.L.M. and Mooi, H.G. (2015a), "Relational factors in owner – contractor collaboration: the mediating role of teamworking", *International Journal of Project Management*, Vol. 33 No. 6, pp. 1347-1363, doi: 10.1016/j.ijproman.2015.03.015.

Suprapto, M., Bakker, H.L.M., Mooi, H.G. and Moree, W. (2015b), "Sorting out the essence of owner – contractor collaboration in capital project delivery", *International Journal of Project Management*, Vol. 33 No. 3, pp. 664-683, doi: 10.1016/j.ijproman.2014.05.001.

Tuuli, M.M. (2018), "What has project characteristics got to do with the empowerment of individuals, teams and organisations?", *International Journal of Managing Projects in Business*, Vol. 11 No. 3, pp. 708-733, doi: 10.1108/IJMPB-08-2017-0097.

Van, S.Q., Le-Hoai, L. and Dang, C.N. (2019), "Predicting implementation cost contingencies for residential construction projects in flood-prone areas", *International Journal of Managing Projects in Business*, Vol. 12 No. 4, pp. 1097-1119, doi: 10.1108/IJMPB-04-2018-0071.

Vanhoucke, M. (2012), "Measuring the efficiency of project control using fictitious and empirical project data", *International Journal of Project Management*, Vol. 30 No. 2, pp. 252-263, doi: 10.1016/j.ijproman.2011.05.006.

Wagner, H., Pankratz, O., Mellis, W. and Basten, D. (2017), "Effort of EAI projects: a repertory grid investigation of influencing factors", *Project Management Journal*, Vol. 46 No. 5, pp. 62-80, doi: 10.1002/pmj.21523.

Wang, Y. and Rajagopalan, N. (2015), "Alliance capabilities: review and research agenda", *Journal of Management*, Vol. 41 No. 1, pp. 236-260, doi: 10.1177/0149206314557157.

Wang, Y., Yang, J. and Shen, Q. (2007), "The application of electronic commerce and information integration in the construction industry", *International Journal of Project Management*, Vol. 25, pp. 158-163, doi: 10.1016/j.ijproman.2006.09.008.

Wang, G., Locatelli, G., Wan, J., Li, Y. and Le, Y. (2021), "Governing behavioral integration of top management team in megaprojects: a social capital perspective", *International Journal of Project Management*, Vol. 39 No. 4, pp. 365-376, doi: 10.1016/j.ijproman.2020.11.005.

Whyte, J. and Davies, A. (2021), "Reframing systems integration: a process perspective on projects", *Project Management Journal*, Vol. 52 No. 3, pp. 237-249, doi: 10.1177/8756972821992246.

Widén, K. and Hansson, B. (2007), "Diffusion characteristics of private sector financed innovation in Sweden", *Construction Management and Economics*, Vol. 25 No. 5, pp. 467-475, doi: 10.1080/01446190601089104.

Yang, L., O'Connor, J.T. and Wang, C. (2006), "Technology utilization on different sizes of projects and associated impacts on composite project success", *International Journal of Project Management*, Vol. 24, pp. 96-105, doi: 10.1016/j.ijproman.2005.06.008.

Zerjav, V. (2015), "Design boundary dynamics in infrastructure projects: issues of resource allocation, path dependency and problem-solving", *International Journal of Project Management*, Vol. 33 No. 8, pp. 1768-1779, doi: 10.1016/j.ijproman.2015.09.009.

Zou, W., Kumaraswamy, M., Chung, J. and Wong, J. (2014), "Identifying the critical success factors for relationship management in PPP projects", *International Journal of Project Management*, Vol. 32 No. 2, pp. 265-274, doi: 10.1016/j.ijproman.2013.05.004.

Zuo, K., Potangaroa, R., Wilkinson, S. and Rotimi, J.O.B. (2009), "A project management prospective in achieving a sustainable supply chain for timber procurement in Banda Aceh, Indonesia", *International Journal of Managing Projects in Business*, Vol. 2 No. 3, pp. 386-400.

Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1108/IJMPB-04-2021-0085.

About the authors

Laura Saukko is a Doctoral student in Industrial Engineering and Management at University of Oulu. She has more than a decade of professional experience of creating, purchasing and implementing new digital and other public services. Her research interests relate to inter-organizational integration and collaboration, and she has published in International Journal of Managing Projects in Business.

Kirsi Aaltonen (Dr. Tech) is Associate Professor of Project Management at University of Oulu, Finland, where she heads Project Business Research Team in the Industrial Engineering and Management Research Unit. She has published widely on project stakeholder management and engagement in *Scandinavian Journal of Management, International Journal of Project Management, International Journal of Production and Operations Management, Industrial Marketing Management, Project Management Journal* and *International Journal of Managing Projects in Business*. Her current research interests are in the areas of stakeholder management in complex projects, integrated project deliveries and institutional change in project-based industries. Kirsi Aaltonen is the corresponding author and can be contacted at: kirsi.aaltonen@oulu.fi

Harri Haapasalo has been a Professor in Industrial Engineering and Management for over 20 years at the University of Oulu, Finland. He has research interests in business management, product management and also in management of production processes. His list of publications covers more than 300 international scientific publications. He has been a chair and committee member organizing numerous international conferences, and has been a reviewer and belongs to the editorial board for several international scientific journals.