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Knowledge Management and Organizational Capabilities in Project settings: Unpacking Project-based Learning

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Abstract

Over the last 20 years, there has been an increase in the study of project-based learning to deploy knowledge management strategies and the concept of organizational capability. We address this topic in the context of infrastructure development projects. Through a review of existing literature complemented by pilot empirical research carried out in MultiWaterWork program, and Gaasperdammer tunnel project in the Netherlands, Hong Kong–Zhuhai–Macau Bridge in China and Crossrail in the UK, research propositions are presented on the relationship among knowledge management, project-based learning, and organizational capabilities. The findings reject the position of knowledge management as a best practice toolkit for immediate use and emphasize that there is no pure copy-paste knowledge learned from one project to another. Learning is proposed as the missing link between project capabilities and knowledge management. The study then focuses on the contribution of sets of project capabilities to achieve project performance. It is suggested that the critical role of learning in the development of project capabilities should be on the future research agenda of infrastructure development projects.

Keywords

Knowledge management; learning; capabilities; case study; infrastructure development

1.Introduction

Knowledge represents a strategic asset that can result in more internal effective business processes and more apparent competitive advantage in the market (Wiig, 1997). However, managing and reusing knowledge is still challenging (Wasko and Faraj, 2005). Learning is required in project settings to bridge knowledge and practice. The theory of organizational learning cannot be directly transferred to project studies as the debate on project temporality hinders its applicability. Recently, capabilities attract a great deal of attention in the project management domain. Learning fits particularly well in the project context, as learning enables the project team to develop a set of capabilities which can be applied in a dynamic environment.

This paper sets the following research question: *“What is the relationship among knowledge management, learning in projects and organizational capabilities and how does it support the management of projects?”* We address this question by focusing on the context of infrastructure development projects. We review the literature on knowledge management, project-based learning and project capabilities, and develop three research propositions. We then describe our research methodology and present research findings from four studies. Three propositions are further developed in four empirical cases with more insights and one more new proposition. Finally, we reflect on these propositions and call for learning capabilities to facilitate the learning loop in infrastructure projects.

2.Literature review

2.1Knowledge management in project studies

Knowledge management is the discipline of creating a thriving work and learning environment that fosters the continuous creation, aggregation, use, and re-use of both organizational and personal knowledge in the pursuit of new business value (Cross, 1998). Knowledge management is any process or practice of creating, acquiring, capturing, sharing and using knowledge, wherever it resides to enhance learning and performance in organizations (Scarborough et al., 1999). Knowledge management is concerned with the analysis and technical support of practices used in an organization to identify, create, represent, distribute

and enable the adoption and leveraging of good practices embedded in collaborative settings and, in particular, in organizational processes. Effective knowledge management is an increasingly important source of competitive advantage (Carneiro, 2000), and a key to the success of contemporary organizations, bolstering the collective expertise of their employees and partners.

There are several perspectives on knowledge management (Bhatt, 2001; Grover and Davenport, 2001), but all share the same core components, namely: People, Processes, and Technology. Some take a techno-centric focus, in order to enhance knowledge integration and creation; some take an organizational focus, in order to optimize organization design and workflows; some take an ecological focus, where the important aspects are related to people interaction, knowledge and environmental factors as a complex adaptive system similar to a natural ecosystem.

Numerous scholars have studied the issue of how to carry out knowledge management actions in the project environment (Havermans et al., 2014; Isabalija et al., 2010; Love et al., 2003). For project management organizations to transfer knowledge across organizational boundaries, it is vital that they address the 'boundary paradox' (Quintas et al., 1997). These organizations will have to be open to information and knowledge flows from both networks and markets on both formal and informal basis. Other lines of research have focused on the development of methodologies for the capture and reuse of the knowledge created in projects (Anumba et al., 2008; Kivrak et al., 2008; Li et al., 2013).

Different studies have tried to understand how knowledge management has been implemented in construction companies and also the perceptions of people about this topic (Carrillo and Chinowsky, 2006; Carrillo et al., 2005; Forcada et al., 2013). In the area of construction methods' selection, studies have mainly been associated with the development of expert systems (Alkass and Harris, 1988; Hanna et al., 1992; Russell and Al-Hammad, 1993).

Project knowledge is very context specific. The manager's skills for solving practical problems arising from unusual project situations and unusual needs of clients, are being formed during a

long period of practical work. It may be accounted for by the nature of practical management problems, which, unlike mathematical problems, do not have a single solution, and the solutions themselves are subjective.

Based on the above argument, we thus propose:

P1: Knowledge management contributes to achieving projects' objectives and organizational learning.

2.2 Learning in projects

The construction industry is often criticized for slow learning or not learning at all (Flyvbjerg et al., 2002; Hertogh et al., 2008), though learning has also undergone intense study in construction context (Chinowsky and Carrillo, 2007; Fu et al., 2006). The nature of infrastructure projects separates people in different departments and locations. Knowledge is often lost after the completion of a project because project team members go back to their line functions or move on to new projects (Schindler and Eppler, 2003).

Pioneering megaprojects recently delivered have shown that learning from best practices developed on other programs and innovation such as new procurement and organizational strategies can improve project performance substantially (Davies et al., 2009; Davies and Mackenzie, 2014). Project-based learning, which is mainly "ad hoc," requires commitment and continuous investment of time and resources yet is often neglected (Davies and Brady, 2000; Williams, 2008). Learning is, however, a broader concept consisting of different types (or subsets) based on the context and organizational type. Concerning its magnitude and impact, it can range from minor, incremental improvements (Hippel, 2005) to the pursuit of fundamentally different approaches leading to radical breakthroughs (Bayus, 2013).

Scarborough et al. (2004) defined project-based learning by conceptualizing both the creation and acquisition of knowledge within projects and the consequential transfer of this knowledge to the broader organization and other projects. Bartsch et al. (2013) defined learning in project-based organizations as the process of integrating project knowledge, recognizing many learning

opportunities through the projects they conduct with other partners. Duffield and Whitty (2014) proposed an adaptation of the Swiss Cheese model to help organizations conceptualize how to learn from project experiences and disseminate those learnings throughout the organization. The concept of 'learning paradox of projects' was introduced by Bakker et al. (2011) when observing the 'transferability' of knowledge between projects. They emphasized the fact that on the one hand projects are temporary and fluid, thus making them suitable for stimulating and generating knowledge. However, on the other hand, projects are discontinuous and often relatively short-lived restricts the assimilation of this generated knowledge to other projects. Knowledge, in this case, lies with people themselves and will be assimilated through them to other projects.

The literature emphasizes the importance of social relationships (Edelenbos et al., 2011; Metzger et al., 2010). Gann and Salter (2000) found that project-based firms often rely on informal activities among employees for sharing knowledge learned in projects across the firm. Access to informal networks is not sufficient for learning in projects. Pahl-Wostl et al. (2007) emphasized the importance of social learning because a particular group of experts or stakeholders can no longer learn on behalf of all stakeholders. They suggest that in order to improve the knowledge sharing within projects-based firms a central support group can be installed. This group can ensure that the knowledge is well spread. Such a knowledge group can act as a platform for knowledge, and they can share this information at all times. The knowledge distributing within the firm is maintained and that all employees are aware of the latest developments. Mostert et al. (2007) also suggested that it is essential that organizational structures are formed in which the parties can join together.

Hartmann and Dorée (2015) argued that the traditional sender/receiver perspective on learning is rather simplistic. Much learning happens through social contacts and peer-to-peer connections (Dutton et al., 2014). Social channels are more useful for distributing highly context-specific knowledge (Wiewiora et al., 2010). Internal teams and their internal networks are the current commonly used way, while networks with outside parties have been found to be significant for greater knowledge exchange. Mahr et al. (2014) highlighted the importance of

integrating different actors' knowledge sets and engaging in mutual explorative and exploitative learning. Grönroos and Voima (2013) insisted on direct face-to-face contact for co-creation. It is thus vital analytically to make a distinction between knowledge management and learning in projects, as proposed below:

P2: Learning in projects is more than knowledge management.

2.3 Project capabilities

Studies have primarily focused on the permanent organizations such as firms to examine how capabilities are developed through research and development (R&D), or captured from external sources (Dodgson et al., 2014). Organizational capabilities are commonly referred to as the particular combination of skills, knowledge, competencies, resources, routines, and behaviors, which enable effective organizational performance and competitive advantages of firms (Zollo and Winter, 2002). Winter (2003) for instance describes capabilities as a high-level routine or collection of routines that enables an organization to produce an output. Wethyavivorn et al. (2009) identified six types of organizational capabilities which are essential to the performance of construction firms, including marketing, project procurement, construction, financial, business management, and learning and innovation.

Chandler et al. (2009) proposed the use of strategic capabilities and functional capabilities to explain organizational capabilities. Chandler's organizational competency framework is useful to treat the enterprise as a separate entity focusing on the internals of a single enterprise and does not contain organizational capabilities hidden outside the enterprise, so it cannot be used to explain cross-enterprise production. On the other hand, Chandler's strategic and functional capabilities are instrumental in examining the company's ability to achieve low cost through small to large volume and mass production changes. However, there are significant differences between the development of large and complex construction projects and large-scale or high-volume manufacturing products, so this framework needs adjustment.

Two capabilities of firms have been usually identified as necessary, operational capabilities and dynamic capabilities. A further issue in the capabilities literature is to be crystal clear on the

distinction between them (Helfat and Winter, 2011). A dynamic capability (Eriksson, 2014; Fainshmidt et al., 2016; Wilden et al., 2016) in a changing environment is clearly distinguished from an operational capability which supports the organization's current competitive position based on the firm's existing resources (Helfat and Winter, 2011).

Davies and Brady (2000) adopted Chandler's (2009) capabilities framework to explain how suppliers of complex product systems build the capabilities necessary to expand successfully into new lines of business. They proposed a third capability that complemented Chandler's (2009) functional and strategic capabilities: project capabilities. The framework was developed further in Söderlund's (2009) study of project competence in six firms. Söderlund initially argued that capabilities need to be contextualized. The capabilities needed in a particular project based organization are dependent upon the strategy pursued by the organization. Söderlund and Tell (2011) further developed the idea in the context of project-based organizations into four types of strategies: focusing, combining, stretching, and switching.

Project capabilities have been identified in research on firms who operate in the form of projects (Brady and Davies, 2004; Davies and Brady, 2016, 2000; Ethiraj et al., 2005; Söderlund, 2009), and the capacity to innovate through "base-moving projects" is an essential dynamic capability (Brady and Davies, 2004). Project capabilities lie in firm themselves or ecosystems of actors' participants in the delivery of projects across organizations.

Based on the above argument, we thus propose:

P3: Learning plays a vital role in the development of project capabilities.

2.4 Research gap

It seems the theories of knowledge management, project-based learning, and organizational capabilities have been established respectively and there are overlaps between all three concepts. It remains unclear how they are interacting with each other in practice. We developed three research propositions. These propositions will be used as analysis guidelines

to be tested and improved as hypotheses against the empirical data.

3. Methods

3.1 Research design

Answering the research question will be done through qualitative case study research. Given its confirmatory and exploratory nature, the use of a qualitative case study approach is considered as appropriate (Haj-Yahia, 1998). Multiple cases were used as this approach can augment external validity and hence create more robust and testable theory than a single case (Eisenhardt and Graebner, 2007; Haj-Yahia, 1998). As recommended by Eisenhardt (1989; 15), a range of 4–10 cases “usually works well” in theory-building research. We used various fieldwork methods to study the actors, the daily practices and other social situations. The combination of the fieldwork methods entails participant observation, interviews and the close reading of documents or other sources (Sierk et al., 2009).

3.2 Case sampling

A mixture of ongoing and retrospective case studies was used to obtain rich data and a complete image of infrastructure projects’ lifecycle. Among the four cases, Case A the MWW (MultiWaterWork in Dutch) ship lock program is just beginning the second, Case B the GSP project and Case C the Crossrail project have held the execution phase halfway, Case D the HZMB project is delivered recently.

3.3 Data collection

Table 3 provides a summary of sample characteristics and project descriptions. The research incorporated multiple methods of data collection, including (1) participant observation, (2) desk research, and (3) semi-structured interviews. The participant profile is provided. There is sufficient inside evidence accessible to draw a good picture of what happened.

Table 3. Profile of participants and projects

Project ID	Project name	Brief Project Description	Data sources	Participant Profile
A	MWW	A large program for the replacement and renovation of 52 ship locks in the Netherlands until 2050.	(1) Participant observation, (2) desk research, (3) exploratory interviews with informants, (4) a questionnaire and (5) semi-structured interviews.	Fourteen phone semi-structured interviews with five from the client, six from the market and three from the universities. Each interview lasted approximately half an hour.
B	GSP (Gaasperdammer in Dutch) tunnel project	A land tunnel between the Amsterdam-Utrecht railway line and the Gaasp River in one crowded area Amsterdam Zuidoost, belonging to the most significant infrastructure program in the Netherlands, Schiphol-Amsterdam-Almere (the SAA program) from 2015 to 2020	(1) archival documents (book published by COB (the Center for Building Undergrounds)), (2) interviews and (3) site observations (weekly meetings)	Eleven face-to-face semi-structured interviews with five from the client and six from the contractor. Each interview lasted approximately one hour.
C	Crossrail	Upgrading existing and constructing new lines running through Greater London over a 118 km route and	Academic articles and reports about Crossrail Innovation Program; online	Interviews were not conducted.*

		the total cost would be 14.8 billion pounds.	media report.	
D	Hong Kong-Zhuhai-Macao Bridge (HZMB) project	A 55-kilometer cross-sea link situated at the Pearl River Estuary of the Lingdingyang Sea, which consists of 29.6 km of dual three-lane carriageway in the form of a bridge structure, a tunnel of about 6.7 km, and two artificial islands from 2009 to 2018	(1) the archival project logs, (2) participant observation and (3) interviews with senior project managers.	Two participants from the HZMB authority, two from the contractor, one from consultancy firms and two from the advisory team were interviewed face-to-face, lasting for more than an hour.

3.4 Case description

Case A

The MWW program seeks standardization opportunities to increase reliability and availability (RA), decrease life-cycle cost (LCC), and decrease the uncertainty of construction cost and time while maintaining market-driven innovation. The strategy is that every new lock must be better. That means that Rijkswaterstaat (RWS), the Dutch Ministry of Infrastructure and Environment, wants to learn from the design, realization, maintenance, and operation of previous locks. That is why apart from the technical products to be delivered. A learning project has been started. It is essential that learning is a permanent priority within the program. To search for these more concrete notions, RWS organized four co-creation sessions and brought the client, market partners, and knowledge partners together, which took place for eleven months between April

2016 and March 2017.

Case B

In 2015, just before the opening, the project Sluiskil tunnel was completed and evaluated in collaboration with COB. The results appeared in a publication and were shared via a conference with the sector. This evaluation inspired the GSP project managers also to consider their own project critically. They went a step further than the Sluiskil Tunnel: to start a knowledge project, together with RWS, IXAS (a consortium of contractors), and COB (Center for Building Undergrounds), from the beginning so that experiences are “fresh” immediately collected and shared, which is later called the learning trajectory. There was an ambition to give even more added value if this will not only be done at the end but from the start. In the contract, there was a provision for it: alignment sessions. There is a clear incentive to improve the knowledge sharing between the different parties. The setup and experiences of the first phase were published in the publication. One of the recommendations was to evaluate the learning: to learn from learning.

Case C

To set innovations as a strategic priority for megaproject management, Crossrail introduced the Crossrail Innovation Program which is the first formal megaproject innovation strategy in the UK's construction industry. This strategy reinforced dedicated support and resources for a program-wide project-based learning process (Abedifar and Abdideh, 2017). Crossrail holds innovation competitions to stimulate the generation of new ideas within projects and evaluate the innovative ideas generated across the program. Worthy ideas will be funded for further development and implementation. At the same time, the online database “Innovate18” is established to submit and capture innovative ideas and solutions generated in each of the projects along the supply chain, and then track and report their adoption and implementation progress across the program (Worsnop et al., 2016). Crossrail collects data into a database with a particularly rich source of learning data. The database is being used all along the project and will be further transferred to next practices. By adopting “Innovate18”, Crossrail

attracted more than 800 ideas by mid-2015. Many innovations were supported to be implemented by other projects.

Case D

Considering its technical challenges and significance, In HZMB, the project-based learning initiative is mainly led by the general contractor of design and construction, China Communications Construction Co., Ltd and national essential technology research program. China Communications Construction organized the project-based learning in the way of consultancy with leading global firms such as AECOM, COWI, Holland Tunnel Engineering Consultant and Chodai Co., Ltd. Given the scale, complexity and sensitivity of the project, advanced technologies, and management philosophies were adopted to come up with innovative systems and mechanisms, and excellent design, construction, and consultancy companies were invited to build this remarkable project. HZMB was delivered successfully and the project we observed exhibited learning.

3.5 Data analysis

In this research, the interview transcripts were coded and analyzed through an iterative within the case and cross-case analysis process as suggested by Eisenhardt (1989). We started with the within-case analysis to identify new constructs and their relationships within a single case in corresponding to the research propositions. In this process, we further clustered critical interview quotes under emergent themes to ensure the consistency between data and theory. We repeated this process until all data were classified and we were confident with our interpretations of the data. Next, we performed a cross-case analysis to compare and contrast the patterns emerged from individual cases (Eisenhardt, 1989; Haj-Yahia, 1998).

4. Data presentation and findings

Integrated research findings from four studies are discussed according to our three research propositions developed from the literature review.

4.1P1 knowledge management

Knowledge is fundamental and put in the strategic level in all cases. In the Case A, both the client and the market partners argued that the exchange of knowledge should be outside of the contract. There is a clear incentive to improve the knowledge sharing between the different parties in the contract of the Case B. Case C launched the learning legacy framework to contribute to an overall body of knowledge on major construction projects.

Our data further suggested that knowledge may contribute to the project management. In the project environment, knowledge enables project teams to make decisions, apply these decisions to actions and solve problems. Integration of knowledge from successful and unsuccessful projects into the present project management processes has become a necessity for staying profitable and competitive in the infrastructure industry. Project knowledge will bring fresh ideas and new approaches to problem-solving for project management. Best practices and lessons learned to enable project participants to solve new and more difficult problems more effectively and efficiently than ever before.

However, knowledge sharing is often hampered by professional or organizational boundaries or contractual concerns. The ultimate goal of the project is to meet or exceed customer expectations. This strong goal limits the attention of project teams to accumulate and transfer knowledge. Project resource constraints also make project managers more concerned about the project, while ignoring the accumulation of the experience. This leads directly to the barriers to the transfer of knowledge between different projects, resulting in "project forgetting" that the knowledge and experience generated in a project life cycle are lost at the end of the project, failing to use project experience in the follow-up projects effectively. It can be seen that the contextual dependency makes the knowledge of the project difficult to share fully, and it is necessary to think about learning between the projects.

Second, the project management knowledge produces and displays the narrative characteristics. In practice, project management researchers hold a "case-centered" perspective. They focus on project context and complexity and give detailed narrative and analysis of the case. People with

different background can give different interpretations on objects with different contexts. In this process, the elements of the project management theory and their interaction also have a situational, causal interpretation, but also by social conditions. Thus, the meaning, status, and influence of each theoretical element in different cases are concerned, and the boundaries of the project management knowledge and the conditions of their application are defined and clarified. In Case A, that market partners and the client require valuable but different knowledge: client experience, market experience, and scientific research. Complementary knowledge can develop program themes that satisfy evolving local demands and lead to new work practices in the program.

Thirdly, the knowledge of project management is based on analytical rather than statistical induction, so it cannot explain the number of cases under certain types of phenomena and the frequency of their occurrence. The project management knowledge does not pursue the overall truth, but the content and the richness of the information carried by each case. The project management knowledge does not account for the frequency, probability, or scale of certain phenomena or of a causal mechanism. Besides, the theory does not undergo a large sample of measurement and testing, so it cannot rule out the "probability" for the impact of the single project, neither respond to interactive effects such as large-scale sample support research. The complexity of the project is easy to guide the researcher to focus on specific case studies rather than theoretical construction. In Case D, even though the first a few tunnel elements were installed. In 2015, the E15 tunnel element encountered the severe challenge of exceptional siltation. The contractor pooled technical resources to solve the problem. After two times unsuccessful towing and immersion and with the support of the Guangzhou government, tunnel element E15 finally achieved a precise connection on March 26, 2015. This played an exemplary role for the following tunnel immersion project.

Fourth, project management knowledge is open, trying to avoid easily denying the other factors which may have an impact. Project management knowledge can identify commonalities, differences, and influencing factors, but, limited by the constraints of research conditions and research objectives, researchers cannot explain all the causal relationships in one project, but

instead need a series of simplified studies.

This finding on the different levels of project knowledge has suggested a revision to our first proposition, as below:

RP1: Knowledge management contributes to achieving the project's objectives and organizational learning. However, this process is still plagued with difficulty.

4.2P2 knowledge management and learning

It is difficult to quantify what type of knowledge can be shared in the learning process. "Soft" knowledge as something that is more of relevance in our cases. In Case B, the most significant change that the learning trajectory has led to, according to the experiences of the interviewees, is the change in mindset. A change in the typical mindset, practices, and self-centered behaviors from partners is observed. The learning trajectory can be conceptualized as a 'mindset change' that people have started to think and discuss more things. The trajectory leads to having this "open" and "inclusive" mindset. This mindset is also partially a requisite for the trajectory to succeed in the first place. This mindset that fits with these lessons learned aligns more with the thought that the "right" culture is almost a requisite in the first place for the trajectory to be put into place. Mindset change was the biggest effect learning had on them and thus the biggest 'piece of knowledge' the interviewees would take with them to a next project. This becomes evident when one interviewee stated that:

"The good thing about this is that acts are performed more explicitly, because of the realization that acts are noted or are passed onto other projects. Because this leads to unconsciously thinking about the fact of why and how are you doing things. The second important effect is that you create a mindset in which you search after sharing the knowledge."

One of the findings is that learning stimulates openness and that this has a positive impact on collaboration, which echoes the theory about collaboration from Hertogh and Westerveld (2010). This insight has been that a collaborative partnership and understanding of each other's

roles in Case D. The mindset of creating a stable and trusting relationship with the client/contractor will lead to a 'better' project. In Case A, a social learning form called the co-creation sessions brought in collaborative values in which participants increased mutual trust and partners were reassembling in innovative networks.

Our study demonstrates that there is a reciprocal relationship. In all four cases, the client is mainly responsible for establishing the culture, and all parties should maintain the culture. Edmondson (1999) observed that the better performing teams admit to errors and discuss their occurrence - a climate of openness. A collaborative partnership leads to a successful project. An interviewee from the client in Case B experienced learning as a reassurance of the way they are already working:

“It is a reassurance of the way we were already working. The openness and transparency were already present at RWS, but for IXAS it probably took a bit more effort. It is very brave by IXAS.”

Learning gives meaning to what is happening in an organization. In that sense, it is also the carrier of the culture in an organization. Both the client and contractor in Case B stand closer to each other than they do to their parent organizations. The collaboration was experienced as predominantly positive and personal; this only exemplifies the project culture that was shared and the mindset which would be brought to the next project. This project culture was strongly experienced, even more so than separate organizational cultures. Therefore, this might make it difficult to share this knowledge with other projects. The concluding remarks seek to establish a relationship between organizational culture and learning environment to motivate employees to communicate and share knowledge and expertise with their colleagues and across the supply chain instead of working in “silos.”

Most interviewees focused more on the possibility of creating the right organizational culture in Case B. Organizational culture can be referred to as existing out of practices, symbols, values, and assumptions that members of an organization share with regards to appropriate behavior (Willmott, 2011). The organizational culture can be shaped, and at the same time, they also

experienced this organizational culture to affect the knowledge sharing behaviors. The knowledge sharing behaviors are, in this sense, embedded in the standard organizational culture present in both the client and contractor. In this sense, this thought process goes in line with the thought that organizational cultures shape the members' knowledge sharing behaviors and influence how they learn and adapt this knowledge (Lekkakos and Robertson, 2009). The culture of client in Case B and Case C has been conceptualized as an alliance culture. This culture refers to a cultural type in which working together is the norm.

It is important to recognize that there are various parties involved in knowledge sharing. What the client and contractor tried to implement here was a move away from this traditional way of thinking towards a more collaborative culture. The collaboration is a direct result of this 'shared' project culture, as in practice this collaboration was experienced as very open and friendly. The collaboration was experienced as unanimously positive by all the interviewees. During this collaboration, there were lessons learned from each other as well, and this line of thought fits with the learning trajectory.

The experience of Crossrail shows that managers can effectively create the conditions for communicating and sharing ideas, and use information systems to foster innovation (Winch, 2015, 2010) and enhance "network connectivity" (Björk and Magnusson, 2009) within and across the organizations of the megaproject.

This research responds to the debate over the learning in projects. On a theoretical level, the research fits in with various debates on learning in and between projects (Bakker et al., 2011; Hartmann and Dorée, 2015). The knowledge that was learned by the interviewees was also not practical, but somewhat more bound to 'soft' knowledge. In this sense, the temporality of knowledge generated in projects does not play a significant factor in the possibilities of its assimilation. This finding proves that the learning paradox of projects does not play a factor in the learning trajectory present in Case B.

Based on the above findings, we further divided P2 into three sub-propositions as below:

RP2.1: learning can help facilitate a change of mindset.

RP2.2: learning can create conditions for communicating and sharing knowledge.

RP2.3: Organizational culture plays a vital role in motivating and facilitating learning from projects.

4.3P3 learning and project capabilities

There is no copy and paste knowledge learned in this project to the next. All four cases agree that the most significant lessons learned were for the most part bound to the very experiences people had during the project and are therefore bound to the people that experienced them. "Capability" is then introduced and defined as potential to do something and not the work did itself. This construct refers to the specific skills, knowledge, and experience required by the project-based firms to develop bids and implement or execute projects, including pre-bid, bid, project, and post-project activities (Eriksson et al., 2017).

To acquire project capabilities, construction participants need to develop and maintain in-house skills, competencies, and abilities to engage with the supply chain. Some capabilities can be seen as the outcome of learning through repeated interactions and will follow different learning trajectories, such as co-creation sessions in Case A and Innovate18 in Case C.

Capacity building is, therefore, broader than training employees alone.

Construction does innovate in many ways, but much of it is 'hidden' as it happens in practice when problems arise, solved and forgotten. Introducing ideas from outside the firm not only increases the possible sources of innovation, it also places emphasis on a new range of capabilities required to establish and develop weak-tie collaborations (Chesbrough, 2004), manage external proponents of unsolicited innovations, allow intellectual property and ideas to flow freely, strengthen problem-solving capabilities, and maintain an overall nimble and proactive organization (Resources, 2011).

Organizations that implement large-scale infrastructure projects need to build capability by understanding their cultural environment and perspectives of employees regarding enablers and inhibitors to knowledge transfer (Davies and Brady, 2000). In Case A, the client proactively

advocates value co-creation with all potential market partners and knowledge partners. In Case B, the word RIXWAS, an intertwining of IXAS and RWS was created showcased the relationship between the client and contractor. In Case D, the partnership is the philosophy pursued by the HZMB authority. It requires the cooperation of all parties to solve problems around the target. Project capabilities identify the unique knowledge required to undertake projects that are tailed to individual customer requirements (Davies and Brady, 2016). Capabilities are developed through integration and transfer of knowledge (Grant, 1996). Firm's ability to move base is dependent on and shaped by previously acquired managerial knowledge and experience and its ability to absorb new learning and build new capabilities.

Case C and D offer new delivery models to emulate, but not a one-size-fits-all approach. Each project has unique challenges and structures. New ideas, practices, knowledge, and tools circulate between projects. It needs not become a one-stop shop that has all the capabilities in-house. Instead, it is more a case of knowing what type or scope of capabilities they may need on projects, knowing how it can be developed, and developing the capability skill set.

Experience can be precipitated into information through reflection and questioning. After analysis and organization, information can be sublimated into knowledge. Knowledge is transformed into capability through reuse and practices. Practices bring about the new experience. Experience brings new information, and reflection brings new knowledge. So continually circling in the experience and reflection, it has reached the unity of knowing and doing and has produced the way of learning.

The above findings have led to the revision of P3 and new P4 as below:

RP3: On the one hand, the learning process accumulates knowledge, and on the other hand, it builds capability, including knowledge crossover, and rapid knowledge transfer.

P4: Learning connects knowledge management and capability building.

5. Discussion

5.1 Reflections on propositions

This paper sheds light on how learning in projects departs beyond the traditional view of knowledge management and goes towards capability building.

Our initial P1, which drew upon a literature review, suggested that knowledge management is necessary for the project environment. However, our empirical data painted a more detailed picture of the multi-dimensional nature of project knowledge. It is truly important, but challenging with complicated context and calling for more social interactions.

The P2 showed that besides accumulating project knowledge, learning from projects also includes a mindset change and proactive communication. There is a reciprocal relationship between learning and collaboration. Collaboration can enhance learning, while learning can facilitate collaboration. Our findings confirmed this theoretical relationship and future suggested cultivating project culture in promoting learning.

Lastly, our first P3 argued that learning is related to project capabilities, which is proved by cases. This is in line with Easterby-Smith and Prieto (2008). In the model they developed, learning is considered the central mechanism that links dynamic capabilities and knowledge management. Brady and Davies (2004) have an interesting point of view on project-based learning in which they believe that project-based learning can be analyzed and understood as a process of building ‘project capability’ over time. Project capability in this sense refers to the specific knowledge and experience required to engage with customers and set up and implement projects.

Overall, this research contributes to the understanding of rejecting the notion of project management as a best practice toolkit, which is always applicable and useful, to instead direct attention to which sets of capabilities should be deployed.

5.2 Learning capabilities to facilitate learning loops

Zollo and Winter (2002) suggest that dynamic capabilities evolve via three learning mechanisms: behavioral learning mechanisms of experience accumulation; and more deliberate cognitive processes of knowledge accumulation and knowledge codification derived from reflection on experience. Similarly, Eisenhardt and Martin (2000) identified the experiential learning mechanisms of repeated practice, mistakes, and pacing of experience. Knowledge management is a type of learning centered on accumulating and sorting out project knowledge. Project-based learning focuses on solving problems and establish project capabilities. Based on the close relationship between learning and capability, we argue the research on project capabilities needed to pay attention to learning capabilities. (Dodgson, 1993), for example, defined learning as a dynamic organizational capability, placing emphasis on the continually changing nature of organizations. Easterby-Smith and Prieto (2008) independently argued a similar position and develop their theory by adding the mediating effect of learning capabilities. By learning capabilities, an organization can build new dynamic capabilities and transform itself into a learning organization.

Literature suggested three general steps of learning: single, double and triple loop learning. With single loop learning errors in a system are restored, without looking at the underlying cause. This does happen with double loop learning. Double loop learning is applied in cases where routine solutions no longer work. This requires reflection and dialogue. Triple loop learning goes one step further. At this level it is not so much about finding a solution to a problem, but about optimizing the learning capability: learning from learning. People reflect on their actions, thinking, learning, assumptions and convictions. Interaction with others is of crucial importance here. At an aggregate level, our cases support these generic steps.

Learning is changing in a dynamic environment in which issues are ambiguous. Innovation processes are triggered by interaction. It is about optimizing the learning capability, recognizing and thinking through assumptions and patterns of action. This requires reflecting on one's thinking, acting, and learning, on underlying assumptions that determine how project managers observe, interpret, define problems, analyze, conceptualize, act and interact. This form of

learning is learning by interacting and exchanging with others and asks for reflection-on-reflection-in-action, or more easily learning from learning.

With a standard approach, the four cases could not be realized. Elements of double loop learning have been applied to the design process. This created a new concept that has worked out well in practice. In order to eventually achieve four successful cases, single, double and triple loop learning is required. Our data suggested that the project capabilities is still in its infancy. It is important for employees that they learn from learning that they reflect with others on their knowledge development. In this way, they gain insight into their talents and their limitations.

5.3 Research limitation and future research

Two critical limitations still need to be noted. The number of cases is small. Findings from only four cases cannot be over-generalized. The next step in this research stream would be to test and validate the propositions through a quantitative survey empirically. Future research would benefit from more theoretical sampling approaches and the inclusion of more cases to contrast our findings.

6. Conclusion

This research provides new insights into learning in the project setting, adding its perspectives to knowledge management and organizational capabilities. We argue the tacit side of knowledge management and the concept of learning in projects rather than the more common focus in project management research of explicit knowledge. Our results show that learning plays a central role in facilitating knowledge and capabilities building. This paper underlines an essential capability for project management to develop, i.e., learning capabilities. It prepares for the tomorrow in infrastructure projects.

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