PROJECT-BASED LEARNING PRINCIPLES: INSIGHTS FROM THE DEVELOPMENT OF LARGE INFRASTRUCTURE

Yan LIU
School of Management and Engineering, Nanjing Univ., Nanjing 210093, China
ly@nju.edu.cn
Erik-Jan HOUWING
Faculty of Civil Engineering and Geosciences, Delft University of Technology, Delft CN 2628, The Netherlands
E.J.Houwing@tudelft.nl
Marcel HERTOGH
Faculty of Civil Engineering and Geosciences, Delft University of Technology, Delft CN 2628, The Netherlands
M.J.C.M.Hertogh@tudelft.nl
Hans BAKKER
Faculty of Civil Engineering and Geosciences, Delft University of Technology, Delft CN 2628, The Netherlands
h.l.m.bakker@tudelft.nl

Abstract
Over the last decades of the development of organizational learning, there has been an increase in the study of project-based learning. This study addresses how learning can be promoted at the project level and develops a series of principles: Owner commitment, Social environment approach, Collaboration vision, Value orientation, and Open mindset. They are dynamic and changing and closely related to each other. These principles move to a principle-based approach that guides behavior and thinking, not only a process. It's suggested the critical role of learning in developing project capabilities should be on the future research agenda of infrastructure development projects.

Keywords: Project-based learning, principles, project capabilities, infrastructure development.

1. Introduction

Learning is a widely used term but one with comprehensive definitions. Psychologists, linguists, and educators from various disciplines have broadly studied the theme of learning. Research on organizational learning in project management has increased significantly during the last few years. A large amount of literature aims to expand the understanding of organizational learning (Chiva et al., 2007). In recent years, research on the concept of learning has dramatically evolved, and the extent reaches beyond traditional organizations to encompass projects, the temporary organization (Iftikhar et al., 2021; Wiewiora et al., 2020). Learning within and between projects, from successful and unsuccessful projects, is seen as one of the most critical enablers to improving the performance of projects (Keegan & Turner, 2001; Prencipe & Tell, 2001; Schindler & Eppler, 2003). Best practices and lessons learned bring fresh ideas and new approaches and enable project participants to make better decisions. This can help project participants address new and more complicated issues more effectively and efficiently than ever before to stay profitable and competitive.

Unfortunately, learning and reusing knowledge is still challenging (Wasko & Faraj, 2005), often hampered by professional or organizational boundaries or contractual concerns. Project

knowledge relies highly on the situational context and the adopted project processes (Bresnen et al., 2003). The client's ultimate goal is that the project should meet strategic expectations and make profits. This definite goal limits project participants' attention to accumulating and transferring knowledge, resulting in "project forgetting" that the knowledge and experience generated in a project life cycle are lost at the end (Bronte-Stewart, 2015). The organizational learning theory cannot be directly transferred to project studies as the debate on project uniqueness and temporality hinders its applicability (Koskinen, 2012). Hence, learning from experience and stopping re-inventing the wheel in the follow-up projects is missed.

The construction industry is mainly organized by a project approach. As more and more infrastructure has to be built and maintained, the need to manage projects effectively and to respond to new opportunities requires the companies to learn from their internal and external experiences in different ways, to draw effectively on lessons learned to avoid making the same mistakes, and ultimately to achieve delivery more efficiently and sustainably. However, the conservative culture leads to the belief that every construction project should be considered unique, overlooking some forms of repetition found in every project. Currently, the overarching elements are twofold: (1) project managers accept the importance of learning from projects but tend to ignore lessons learned and execute the projects at their discretion to suit their goals; (2) a deficiency of organizational controls and routines to support and facilitate an environment of project-based learning (Love et al., 2019).

There is a lack of seeking to develop theories linked to project-level learning and how we can gain an in-depth understanding of this type of learning. This research sets the following research question: "How can learning be promoted in large infrastructure development projects?" This study aims to address this question and develop a series of project-based learning principles by adopting a mixed-method approach. We address this question by reporting on the current agreement from the literature on project learning. Through case studies carried out in the Gaasperdammer tunnel project in the Netherlands and Hong Kong–Zhuhai–Macau Bridge in China, the empirical investigation uses a cross-case analysis and presents reflections in an effort to promote learning in and from projects in the context of infrastructure development. The subsequent validation by focus group discussions helps reach a repeatable and agreed understanding of project-based learning into some good practices. It arrives at how the identification of principles can improve the learning performance in the project setting. We show how learning is unfolded and bring the learnings together in five principles. Finally, we call for learning capabilities to facilitate learning in infrastructure development projects.

2. Literature Review

Projects combine multiple participants in collaborative teams and inter-organizational structures to create new knowledge (Edmondson, 2012). Project-based learning practice can be defined as a set of actions that the project participants use to share knowledge within the project (intra-project), transfer knowledge across projects (inter-project), and ultimately reuse the knowledge (Kotnour & Kurstedt, 2000).

2.1 Why Project-based Learning is Different

The organization is seen as a medium to store and reuse knowledge from the organizational learning perspective. Much research has been done into learning in organizations, mostly at the firm level. Plenty of theories deal with types of knowledge in organizations, how knowledge in organizations can develop and be recorded and shared, how conventional

organizations learn from unusual experiences and learn to respond (Garud et al., 2011; Weick, 1991). The project is theorized as a temporary organization (Sydow & Braun, 2018). The evolution of project-based learning theories may be thought of as a progression from the broad organizational learning theory to more specific theories in project studies. Project-based learning is a subset of the organizational learning theory (Keegan & Turner, 2001). Some research clearly distinguishes between organizational learning and project-based learning (Chan et al., 2005; Koskinen, 2012). There is ambiguity between project-based learning, knowledge management, and organizational learning. They are often used interchangeably with much confusion (King & Ko, 2001). Knowledge management and organizational learning are similar in some ways but have different aims (Irani et al., 2009). The classic literature on knowledge management has focused on techniques and methodologies for codifying knowledge and making it available to organizations. Organizational learning aims to manage and utilize intellectual assets by creating organizational rules and processes (Argyris & Schön, 1997; Brown & Duguid, 1991). It focuses on a firm's capability to adapt to changing knowledge pressures (Irani et al., 2009). It seems the theories of knowledge management, organizational learning, and project-based learning have been established, respectively, and there are overlaps between all three concepts. It remains unclear how they are interacting with each other in practice.

Projects are viewed as a temporary endeavor to deliver unique work. According to (Ayas & Zeniuk, 2001), a significant amount of learning may occur within a project. It is promulgated that project-based organizations and their projects can utilize organizational learning as a theoretical foundation to bolster their performance and productivity. Project-based learning has received growing attention within extant and generic organizational learning theories. However, the origin of the organizational learning theory mainly stems from routine-based organizations, not temporary projects. The organizational learning perspective has limitations in the project setting. The temporary organization is not adequately supported to accumulate knowledge in the multi-discipline practices. This is particularly critical where knowledge is "sticky" (Szulanski, 2000) and tacit in the context of non-repetitive project work (Duryan & Smyth, 2018). Unlike some manufactured products that can be made automatically, projects are characterized by time-bound interaction with different parties, non-repeatable activity, and one-off tasks (Wenger & Snyder, 2000). Project-based learning is thus influenced by temporal externalities (Eltigani et al., 2020). We are talking about learning at levels higher than the individual. It calls for the theoretical position of project-based learning at the project level instead of the team level (Senaratne & Malewana, 2011; Swan et al., 2010). A project is temporary, fluid, interrupted, and distributed. The definition of a "team" emphasizes characteristics of shared identity and continued commitment to team members. Role identities are often not clearly attributed to project members as not all of them belong to an identified team.

The concept of the learning paradox of projects was introduced by (Bakker, Cambré, et al., 2011) when observing the transferability of knowledge between projects. It refers to this dilemma between the ease of knowledge creation and the difficulty of knowledge dissemination. They emphasized the fact that, on the one hand, compared with operation-centered corporation management, projects are temporary and fluid (Gann & Salter, 2000; Grabher, 2004; Hobday, 2000), thus making them suitable for stimulating and generating new and fast knowledge in the transient and inter-disciplinary context. On the other hand, projects are discontinuous and often relatively short-lived, restricting the assimilation of this generated knowledge to other projects. As soon as the project team is dissolved and participants move on, the created knowledge will likely be gone (Cacciatori, 2008; DeFillippi

& Arthur, 1998). Organizational amnesia begins if specific knowledge and experience are not directly managed in the project (Schindler & Eppler, 2003). In this case, knowledge lies with people themselves and will be assimilated through them to other projects. Corporations may be slow in creating new knowledge, but it is easier for them to sediment and transfer knowledge. Learning is now seen as something extra but is not an integral part of the whole project.

2.2 Previous Efforts on Project-based Learning

Despite the diversity of perspectives, there is no significant difference in learning mechanisms in the project and other types of organizations. Zollo and Winter developed three learning mechanisms: experience accumulation (learning by doing), knowledge articulation (learning by discussing), and knowledge codification (learning by formalizing) (Zollo & Winter, 2002). Prencipe and Tell followed the preceding research and provided a clear framework distinguishing three learning processes at various levels of the project-based firm (Prencipe & Tell, 2001). Brady & Davies combined learning at the project and organizational levels (Brady & Davies, 2004). There is mainly learning within and between the projects in the early exploratory projects. In later projects, the interaction between projects and organizations plays a role. There are differences in the focus of the process. In the early phase, exploration of new activities is the focus, and later the focus turns to knowledge sharing and transfer between organizations. This is the path for the current design and construction firms to carry out the project- and business-driven learning.

The project-based learning perspective emphasizes hybrid methodologies to integrate internal and external competencies; however, the environment is rapidly changing, making setting a particular strategic direction more challenging. The challenge is not a lack of knowledge. In fact, the point is that there is more of it than is utilized, but to structure the learning in the right way to benefit from it. It remains unclear how to systematically disseminate and absorb learning as we work with different partners from project to project.

A primary stream of research has focused on developing methodologies to capture and reuse the knowledge created and lessons learned in projects (Kivrak et al., 2008). A list of related research projects demonstrates the growing interest in knowledge capture, sharing, and transfer in construction projects (see Table 1). There have been quite a number of large research projects in the UK that sought to examine knowledge management problems. The experiments in the 1990s to develop a knowledge management model, framework, or database have largely proven to be futile.

Table 1. Quick scan of research projects on knowledge management in construction

Name	Full name	Time	Funded by	Lead
B-Hive	Building a Higher Value Construction Environment: Cross-organizational Learning Approach (COLA)	-	EPSRC and DETR	London School of Economics and Leeds Metropolitan University
KLICON	Knowledge and Learning In CONstruction (IT in knowledge management and organisational learning for construction projects)	1999-2000	EPSRC	University of Salford

CLEVER	Cross-sectoral LEarning in the Virtual entERprise	1999-2001	EPSRC	Loughborough University
KnowBiz	Knowledge Management for Improved Business Performance: Improving Management Performance through Knowledge Transformation (IMPARKT)	2000-2003	EPSRC	Loughborough University
C-SanD	Creating, Sustaining and Disseminating Knowledge for Sustainable Construction: Tools, Methods and Architecture	2001-2004	EPSRC	Loughborough University, the London School of Economics and Salford University
e-COGNOS	Methodology, tools, and architectures for electronic consistent knowledge management across projects and between enterprises in the construction domain	2001-2003	EC FP5	CSTB and University of Salford
CAPRIKON	Capture and Reuse of Project Knowledge in Construction	2003-2005	EPSRC	Loughborough University and University of Newcastle
-	A knowledge transfer approach to continuous improvement on PFI projects	2003-2004		Loughborough University
-	An Approach to Knowledge Management for SMEs	2003-2005	DTI	Glasgow Caledonian University
PROLAB-project		2003-2005		Vaasa University (Finland)
NETLIPSE	the NETwork for the dissemination of knowledge on the management and organisation of Large Infrastructure ProjectS in Europe	2006-2008	EC FP6	AT OSBORNE
the Leonardo da Vinci Programme CLOEMC I	Common Learning Outcomes for European Managers in Construction	2009-2011	the European Commission, DG Education, and Culture	Warsaw University of Technology (Poland)
MEGAPROJECT	The effective design and delivery of megaprojects in the European Union	2011-2015	COST	University of Leeds

There are earlier efforts in creating a project database. Table 2 shows several characteristics of these project case bases. They focus very much on learning from experiences in practice

on how to manage large infrastructure projects. On the one hand, they try to collect as many cases as possible for statistical analysis (benchmarking). They provide an excellent experience for most projects most of the time. On the other hand, some individual iconic projects are elaborated to open the black box of megaprojects and their impact over time. For example, the Berlin Airport BER case was described in depth by the Hertie School of Governance (Kostka, 2016).

Table 2. Characteristic of the project case base

No.	Project case base	Sponsor	Location	Leader	Existing period	Number of projects	Publicly available
1	IPA	IPA	the US	Edward Merrow	1987-now	20000+	No
2	NETLIPSE	Firstly EC FP6 and then client organizations mainly in North-West Europe	Europe	Marcel Hertogh, Eddy Westerveld & Pau Lian Staal-Ong	2006-now	17 (shown on its website)	Yes
3	OMEGA Centre	Firstly the Volvo Research & Education Foundations (VREF) and then UCL	the UK	Harry Dimitrou	2006-2011	30	Yes
4	COST Action Megaproject	EU COST Action	Europe	Naomi Brookes	2011-2015	50	Yes
5	Flyvbjerg	-	The UK	Bent Flyvbjerg	-	806	No
6	Hertie School of Governance	Hertie School of Governance	Germany	Genia Kostka	2015	170	Yes
7	MPCSC	Tongji University and National Natural Science Foundation of China	China	Zhaohan Sheng	2011-now	393	Yes

Project case bases are knowledge hubs created for projects. However, many of them are not able to avoid becoming "projects." After the funding period, COST Action became inactive, while NETLIPSE adopted a new operating model. They all face the challenge of maintaining and making use of the case base in a sustainable way.

Emerging issues of current project case bases have restricted them from achieving more value in the project-based sector. Establishing a database system will not automatically generate a learning environment or lead to greater understanding. Knowledge management considers the

interplay between knowledge as a stock category and deals with known knowns. We call for more proactive learning as a flow category. Hartmann & Doree argued that it is rather simplistic to have a more traditional sender/receiver perspective on learning (Hartmann & Dorée, 2015). The sender/receiver perspective assumes knowledge as a transferable commodity and learning to transmit knowledge between the sender and the receiver in projects. They suggested observing progress and social interactions as a tool for understanding and enhancing project learning activities. The evolution of learning perspectives exhibited a shift from hard skills toward soft skills.

2.3 Towards Project-based Learning Principles

Summarizing literature around "project" and "learning," project-based learning covers both the theory and practice of the use of project setting for effective action learning on real problems to achieve tasks and performance objectives (DeFillippi, 2001). Project-based learning, mainly "ad hoc," requires commitment and continuous investment of time and resources, yet it is often neglected (Davies & Brady, 2000; Williams, 2008). Another perspective with implications for project-based learning argues that learning occurs naturally through social participation in the community of practice tradition (Brown & Duguid, 1991; DeFillippi, 2001). However, many studies of project-based learning are still simply following the organizational learning principles without adequately considering important differences between the sub and the whole.

The newly launched PMBOK 7th Edition in 2021 brought significant changes from the prior versions, one of which emphasizes the basic principles of project management. This attracted much interest as the academic literature on project management has been relatively silent on project management principles. The core principles can be defined as a framework of good project practice for those involved in a project. The underlying principles are usually not made clear enough in resources and methods. Most practitioners are so engaged in practical details that they forget about principles and do things that are not compatible with them.

Learning principles come out of nowhere. Senge developed the principles of a learning organization as five disciplines (Senge, 2006). The above discussions have shown that learning within the project does not automatically lead to organizational learning, and organizational learning theory cannot be directly used in the project setting. Therefore, we consider it necessary to tailor-make project-based principles as guides for good practice in the project environment in this paper.

3. Method

The research goals are to develop theoretical understanding holistically from the practitioners' perspective and set change in motion to solve practical problems. The methodology uses qualitative methods. It aims to describe complex phenomena situated and embedded in specific contexts (project-based learning in this research) and is suitable for studying a limited number of cases in depth (Eltigani et al., 2020). It can also yield a much more vibrant and detailed picture than a quantitative approach (Creswell & Creswell, 2017). More acceptable and well-developed theories on managing complexity and organizing multi-actor practices such as project-based learning are more likely to comprise heuristics or rules of thumb than algorithms to measure and predict.

This study adopts a three-step research design. The first step is to review fundamental organizational learning principles and their applications in the project setting. These principles are retrieved from authoritative publications, including academic papers and

reports. It is exploratory to define the focus of the research. It consists of a literature review and fieldwork performed in parallel shown in Section 2.

Table 3. Summary of two cases

Case	Description of the project	Focus on the project-based learning	Type of learning	
The Gaasperdammer tunnel (GSP)	The longest tunnel project on land in the Netherlands	To have a constant reflection going on in the project rather than just learn from the project after it has finished	Intra-project learning	Exploitative learning
The Hong Kong–Zhuhai–Macau Bridge (HZMB)	The longest sea-crossing linking Mainland China, Hong Kong, and Macau all over the world, in the form of a bridge structure, an immersed tunnel, and two artificial islands	To adopt advanced technologies and management philosophies to address the project complexity and satisfy the innovation requirements	Inter-project learning	Explorative learning

The second step is to generate a tentative set of principles from two selected cases. We selected the Gaasperdammer tunnel project in the Netherlands and Hong Kong–Zhuhai–Macau Bridge in China. These two cases are located in different places but implemented successful project-based learning initiatives. Previous studies have shown that these two cases took different perspectives or mechanisms for project-based learning (Liu et al., 2021; Liu et al., 2022). They are treated as representatives in different cultural environments. The selection of cases underpins our reasoning that management and organization studies should focus on outliers rather than averages (McKelvey, 2006) in order to generate useful and insightful research outcomes. Table 3 provides a summary description of each case. Collective learning takes place at different levels in project-oriented organizations: learning within projects (intra-project learning) and learning between projects (inter-project learning) (De Groot et al., 2020). The two cases cover all mechanisms of project-based learning. They have covered elements involved in the process of project-based learning (see Fig 1).
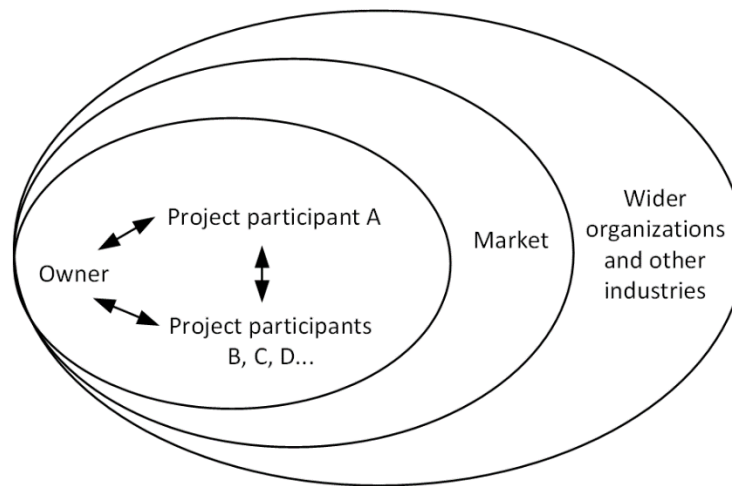
Fig 1. Levels of project-based learning

First-hand data were collected directly by the researchers, and second-hand data were taken from other sources (commercial and government agencies, marketing research firms, digital databases, etc.). Multiple cases were used as the cross-case analysis approach can augment external validity and create a more robust and testable theory than a single case (Eisenhardt & Graebner, 2007). The research chose the cross-case analysis of two cases to seek more general results and a deeper understanding of large infrastructure projects' learning processes.

The third step complements and validates the tentative principles in focus group discussions. Focus group discussion is a qualitative data collection approach where the researcher assembles a group of individuals to discuss a specific topic through a moderated interaction (Morgan, 1996). It is different from group interviews because the researcher adopts the role of a facilitator or a moderator in the group discussion between informants and is not an exchange between the researcher and the informants (Parker & Tritter, 2006). The purpose of the focus group discussion in the research is to substantiate and verify the feasibility of these principles. Principles that are too vague or not amenable to accurate and efficient implementation will be re-organized or re-presented. Three focus group discussions were arranged separately at TU Delft in the Netherlands, the 9th IPMA Research Conference and the British Academy of Management 2021 Conference. The focus group discussion allowed the informants to share their experiences and opinions on the topic of learning on a megaproject.

The researcher took advantage of evidence to explore the learning process in large infrastructure projects and programs with data sources including literature, archives, interviews, (participant) observations, and focus group discussions (Yin, 1984). Such integration could work "outside-in" and "inside-out." Studying popular concepts in the literature would be fascinating, and bringing them into the project management debate about the "outside-in." Regarding the "inside-out," it would be essential to see how knowledge within the field of project management might enhance findings from the discipline. In this way, the validity and reliability of the data were achieved.

4 Findings
Best practices might not be easily replicable, but more general principles for project-based learning can be formulated. Both cases are perceived as successful during the implementation of project-based learning. While different cultural environments and development processes delineate cases, there are commonalities. The inductive cross-case analysis was employed to

identify common conditions from the data. Many conditions must be in place to facilitate or enable learning in or between projects. Five conditions emerged across both cases regarding Leadership, Environment, Relationship, Perceptions of knowledge, and Perceptions of the way of thinking. The following sub-sections provide information on how cases could create and manage the conditions.

4.1 Leadership

We found that each project participant holds a partial and limited vision of the project and its learning objectives in both cases. A particular group of experts or stakeholders cannot learn on behalf of all stakeholders (Pahl-Wostl et al., 2007). In order to ensure that knowledge is well spread, leadership is needed. Both owners set the tone, broke the ice, and played a pivotal role in driving learning. Bakker et al. determined that it is the responsibility of the project parent organization to ensure that knowledge is valued and utilized, not the project manager (Bakker, Cambré, et al., 2011). In Case GSP, the alliance named RIXWAS, an intertwining of RWS (the government representative) and IXAS (the contractor consortium), was created to showcase the relationship between the owner and contractor. In Case HZMB, the partnership is the philosophy pursued by the HZMB Authority. The owner requires the cooperation of all parties to solve problems around the target.

Unlike the manufacturing setting, clients in infrastructure development projects are generally highly motivated to interact with professionals because the core task of professional services is to address their needs. The owner aiming to exert knowledge governance and act as the learning organization integrator should recognize the central and influential role in putting effective learning on the agenda and maintaining it throughout the project. As claimed by the HZMB authority director assistant, the owner expected to extend the project learning impact from the early planning to later operation stages. Still, the learning of project-based enterprises is mainly to achieve economies of scale. The cycle of experience accumulation, knowledge articulation, and knowledge codification (Prencipe & Tell, 2001) requires senior leadership intervention in making the necessary mediating policies and cultures.

In both cases, the owner is mainly responsible for establishing the culture, and all parties should maintain the culture. In the GSP case contract, the owner provided a provision for regular alignment sessions in which the client and contractor exchanged views on specific topics. There is a clear incentive to improve knowledge sharing between the different parties.

In summary, the knowledge-sharing behaviors depend on the owner to be active, committed, and engaged. This supports Winch and Leiringer's argument that the strong owner is discussed in the context where the owner is reduced to a client as a mere contract-giver (Winch & Leiringer, 2016). In this sense, the owner's attitudes and actions shape the project participants' knowledge-sharing behaviors and influence how they learn and adapt to it.

4.2. Environment

It is difficult to quantify what type of knowledge can be shared in the learning process. "Soft" knowledge manifests itself as something more relevant in our cases. Know-how and know-who are more "tacit knowledge" and are more difficult to codify and measure (Lundvall & Johnson, 1994). In the case of GSP, an exploitative learning trajectory program has been set up in collaboration between the owner and the contractor to provide a space for open dialogue, and this was generally experienced positively. One of the main aims of co-located work, in this case, is to reduce the social distance between stakeholders. Profound learning happens when people share their experiences, ask open questions, and tell honest stories. The prerequisite for learning is not processes, tools, or artifacts but establishing the cultural and

social environment: reflecting on the experience, trusting partners, and communicating openly to ensure a stringent process for decision-making and problem solving (McClory et al., 2017).

Learning is seen as a people-oriented strategy. Project knowledge produces and displays the narrative characteristics. In practice, project managers focus on project context and complexity and give a detailed narrative and analysis of the case. People with different backgrounds can provide different interpretations of objects with varying contexts. In this process, project participants and their interactions have a situational interpretation by social conditions. The HZMB authority emphasizes that projects often have short-term goals, while knowledge management aims in the long term. Projects as temporary forms of organization have particular characteristics that determine challenges for knowledge management (Lindner & Wald, 2011). The learning concern is getting and sustaining attention. The social environment can create conditions for communicating and sharing knowledge. In the social environment, project participants overcome the limitations of conventional hierarchical forms. The HZMB project does not have the ambition to build a knowledge system. There is less need to record the knowledge in systems for the rest of the standing organization. The megaproject opts for active knowledge transfer to and within the target project team. This means that knowledge remains with the people, and a limited number of documents is produced when the project ends.

4.3. Relationship
We each have a "learning horizon," a breadth of vision in time and space within which we learn effectively. When our actions have consequences beyond our learning horizon, it becomes impossible to learn from direct experience (Senge, 2006). It is clear that project participants should learn from various parties and share and transfer knowledge between organizations and projects.

The nature of the construction industry is eager to collaborate, but the industry has trouble identifying partners to collaborate with and extract value from those collaborations. In the past, in the GSP case, the owner determined the scope, and it was up to the market to deliver it. In new situations, the owner does not know how to do things right, and the market does not know how to do the right things. More bonding needs to be created between public and private. This brings "collaborate to learn" and "learn to collaborate" to the agenda (Liu et al., 2021).

Collaboration is a valuable learning strategy because it provides the project-based organization access to new human and intellectual resources, brings knowledge together, and improves performance. In both cases, many interviewed project managers explained that collaboration, particularly in the supply chain, is more important than mutual concealment. As the interviews in both two cases demonstrated, "who cannot share, cannot multiply" (GSP); "differences in perspectives can be helpful, once recognized!" (HZMB) Project participants can leverage their capabilities over time in successive projects because a learning effect translates experience into adaptability and moves faster and more effectively in new settings.

Both cases recognized collaboration as the most crucial issue during the learning process. The owner and contractor tried to implement a move away from the traditional way of thinking, which may have been seen as adversarial towards a more collaborative culture, which is clearly stated in their charters. Collaboration is about learning and creating value by working together. The partnership is a direct result of this shared project culture, as in practice, this

collaboration was experienced as very open and friendly. The culture of the owner in Case GSP and Case HZMB has been conceptualized as an alliance culture. This refers to a culture in which working together is the norm. During this collaboration, there were lessons learned from each other as well, and this line of thought fits with the learning process. Coincidently, both projects initiated writing books to share lessons learned, promote the collaborative learning culture and disseminate books among all participants. There is also a clear incentive to improve the knowledge sharing between the different parties in the GSP contract.

4.4. Perceptions of knowledge

Learning is a value-improving practice recognized by Construction Industry Institute (CII) and Independent Project Analysis (IPA). Project-based learning is not just a momentary achievement, such as the successful transfer of knowledge as a product, but a continuous performance in which learning is a daily process. Conventional knowledge management holds the management logic, aiming to keep the project within critical parameters such as schedule and cost. We noticed that the service logic of solving a specific client's specific problem instead of the management logic of keeping the project on track becomes the prime logic in our cases. The HZMB case study has found the benefits of extensive communication of value propositions before a formal contract at the front end. Central to this communication is knowledge exchange, discussions of earlier experiences with similar projects, and open discussions between stakeholders to identify adaptive solutions and supplement and strengthen the value propositions addressed in the megaproject as a program of projects. Value-oriented learning is essential because it gives people a sense of ownership. We can substantiate and even expand it by combining new information from the cases GSP and HZMB.

Conventionally, knowledge was seen as an object. In our two cases, the experience the interviewees gained was not only practical but somewhat more bound to "soft" knowledge. In this sense, the temporality of expertise generated in projects does not significantly affect its assimilation possibilities. Instead of reducing the cost and shortening the projects' schedule, it may be more important to think about the value delivered by learning to improve the whole performance and organizational capabilities. Project participants were interested in value creation mechanisms. People believed in a broader interest and did not put their own short-time business interests first. Everyone has a new understanding of the challenges they are facing. Differences of opinion are valued and sublimated, and a new consensus began to shape.

Learning gives meaning to what is happening in the project. In that sense, it is also the carrier of the culture in an organization. All project participants have situational considerations and the sub-cultural context in the project environment. The owner and contractor in Case GSP stand closer to each other than they do to their parent organizations. The collaboration was predominantly positive and personal; this only exemplifies the shared project culture and the mindset that would be brought to the next project. This project culture was experienced strongly, even more so than separate organizational cultures. 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."

4.5. Perceptions of the way of thinking

It is difficult to quantify what type of knowledge can be shared in the learning process. Soft knowledge is somewhat more relevant in our cases. In Case GSP, the most significant change

the learning trajectory has led to is the mindset shift. The learning trajectory can be conceptualized as thinking and discussing more things and new things.

Projects undertaken by temporary inter-organizational teams may hinder knowledge sharing and transfer (Bakker, Knoben, et al., 2011; Papadonikolaki et al., 2019). So, we must go beyond the current needs to include the future usage context, prepare the execution, and keep looking outside. The position of knowledge management and learning is more than a best practice toolkit for immediate use. Case HZMB offers new procurement and delivery models to emulate but not a one-size-fits-all approach. As a pioneering megaproject, HZMB has also shown that learning from best practices developed in other industries and innovations such as large precast and prefabricated elements, remote control, and information technology can improve project performance and productivity substantially (Davies & Mackenzie, 2014). 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 are needed on projects, how they can be developed, and developing the capability skill set.

Learning within projects is a cognitive and experiential undertaking. Edmondson observed that the better performing teams admit to errors and discuss their occurrence - a climate of openness (Edmondson, 1999). In Case HZMB, even though the first 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 unsuccessful towing and immersion attempts, tunnel element E15 finally achieved a precise connection through trial-and-error learning on March 26, 2015. This played an exemplary role in the following tunnel immersion project. For learning to be productive, people must focus on how the project can proceed rather than blaming someone for a mistake or complaining about a process. People have to be able to speak openly but with an intention to improve, not to blame and complain.

5. Perceptions of the way of thinking

Literature has shown that different learning approaches are complementary rather than exclusive, giving rise to an integrative socio-technical perspective. The theoretical and empirical evidence provide interesting guidelines for future infrastructure development project-based learning practices. By examining the underlying conditions enabling project-based learning, we provide principles for effective project-based learning. Principles are smart ways of handling things that repeatedly happen in similar situations. Both cases provided interesting narrative data and confirmed the importance of five principles for project-based learning. The five principles for project-based learning are developed as a short, accessible guide. They are:

1) Owner commitment. It calls for the owner's motivation, engagement, and participation in project-based learning. This principle recognizes the indispensable role of a committed owner as a project champion.

2) Social environment approach. It calls for motivating and engaging teams and facilitating dialogues in social interactions.

3) Collaboration vision. It calls for team members' coordination, quality, and ability to work together to achieve the learning objective.

4) Value orientation. It calls for assigning a more strategic role to learning in the project setting.

5) Open mindset. It highlights the ability of project participants to think outside the box in both project design and implementation.
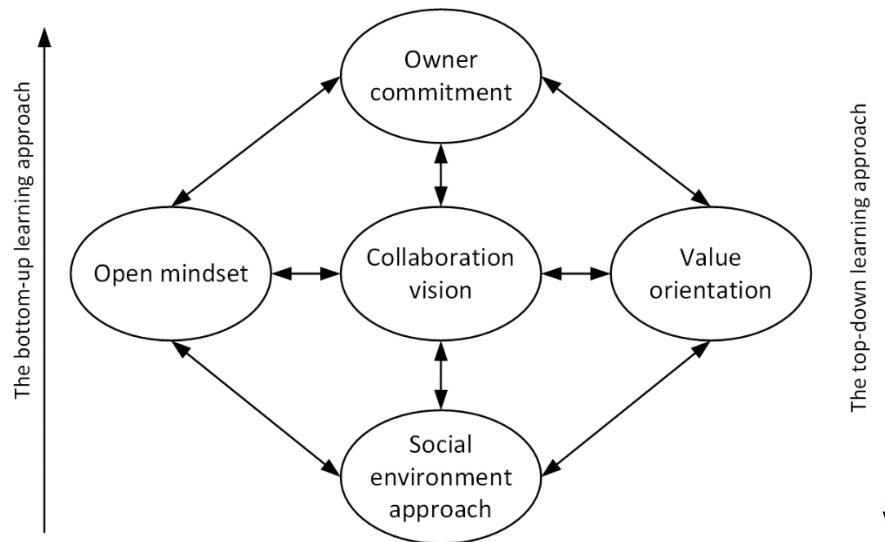
Fig 2. Five project-based learning principles

The principles define necessary conditions that have to be met for project participants to learn. They are dynamic and changing and closely related to each other. Due to their synergy and systemic nature, they strengthen each other's effects and are implemented together, not in isolation. The outputs of one principle will provide critical input into another principle and vice versa. Fig 2 illustrates how projects can use the principles to learn. The arrows between the five principles refer to the necessity of the interrelations. By enhancing each other, principles continually remind us that the whole can exceed the sum of its parts.

Summarizing the above theoretical and empirical research shows that there are two structures for learning within the AEC industry: the top-down and the bottom-up learning approaches. The top-down (formal and institutional) approach via organizational procedures is mainly used for business-led learning. The top management often has a better strategic overview of what is happening in the market and the need to develop specific capabilities in order to stay ahead. They can ensure that this necessary knowledge is distributed in the project by, for instance, creating a particular learning program and database. This can bring benefits because new knowledge enters the project that is not necessarily related to the central business, yet it can increase its strategic advantages. There is a positive attitude towards the creation of knowledge communities. Therefore, knowledge exchange can best be organized by bringing together "knowledge providers" and "knowledge seekers." This can ensure that different realities come together and get meaning. In this way, learning becomes a value-improving practice.

The bottom-up learning approach (informal and behavioral) without thematic priority and via experience-based initiatives mostly happens in the social environment. Informal procedures emerging from day-to-day management can better contribute to the collaboration between

project participants. This approach often happens through different access to knowledge sources and experiments with good and best practices when the project starts using new technologies or developing new capabilities. Our case studies indicate many bottom-up learning initiatives and emphasize that learning from each other and with each other is considered necessary in different situations.

The owner often has a better strategic overview of what is needed in the project and can motivate the project team to learn in order to stay ahead. They can ensure that this required knowledge is distributed in the project by, for instance, creating a particular learning program and database. Most respondents and interviewees strongly believed that learning is best achieved through direct interactions with colleagues, other project team members within the focal project or cross-projects, and even outside the organization. The bottom-up learning approach in the social environment helps participants build a narrative that helps tell their story. Project-based learning should be established through social learning processes. The owner commitment principle and social environment approach principle can both facilitate the other three principles. The strong collaborative spirit obtains and maintains the condition by building trust and providing access to information, people, and networks (Ika & Donnelly, 2017). The value orientation principle reminds project participants of the importance of learning instead of only seeking short-term problem solving and performance improvements. The final principle requires us to embrace new ideas even outside our industry, allow mistakes, encourage staff to give bad news and experiment with trial and error. Unlike the value orientation principle, which addresses more strategic positioning, this principle addresses learning flexibility, allowing it to evolve to a broader scope. The overview can be found in Table 4.
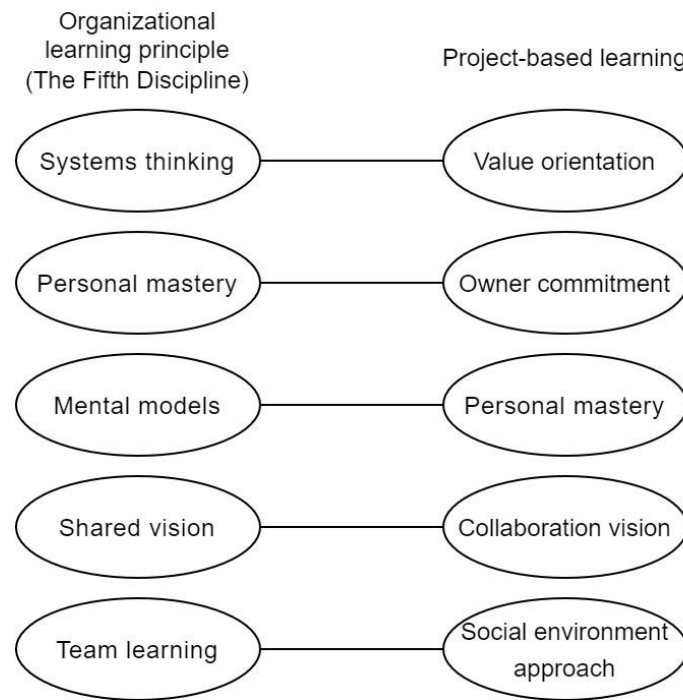
Table 4. Use of five project-based learning principles

Principles	How principles can be achieved	Relation to other principles	Application
Owner commitment	Demonstrating learning value; Helping mediate tensions	strengthen	Creating a particular learning program and database; Reward instead of punishment; Proactive engagement
Social environment approach	Creating safe spaces for feedback	enable	Knowledge sharing workshops; An external knowledge party
Collaboration vision	Generating feelings of partnership	contribute to	Partnership; supply chain management
Value orientation	Attaining consensus and sustainability	set goals to	Management tool; Shaping the project culture
Open mindset	Thinking out of the box; Allowing mistakes	influence	Innovations from other industries; Experiment

We admit that from the top-down, project-based reflecting and analyzing remain on the agenda when this is considered necessary by the owner and concerned project participants. From the bottom up, collecting lessons learned from each other and fitting the line of thought with the learning process is better done in the social environment. Collaboration provides the project-based organization with access to new human and intellectual resources. We encourage a service logic (of solving the client's business problem) rather than the management logic (of keeping the project on track) (Grabher, 2004).

These principles move to a principle-based approach that guides behavior and thinking and describes a meta-capability, not only a process (Eltigani et al., 2020). Typically, a process-based approach, by its nature, focuses too much on predictive work. It is prescriptive by detailing specific actions to be performed and exerting extrinsic motivation. We argue that this type of approach is more suitable for a hierarchical management organization. A principle-based approach should be followed in the context of projects, a flat organizational structure with semi-autonomous operating units. The principles provide boundaries within which to work. The acknowledgment is that there are many ways to remain aligned with the intent of the principles. This aligns with the newly published seventh Edition of the PMBOK Guide, moving from a process-oriented approach to a principles-oriented one. These project-based learning principles can be seen as a customization of organizational learning principles in the project setting. Fig 3 shows the connections between organizational learning principles and project-based learning principles. Good learning should maximize the potential for value throughout the project work. The Value Delivery System introduced by the PMBOK Guide 7th edition follows Systems Thinking to look at the patterns and events as interrelated parts. The discipline of Personal Mastery is tailor-made in the project setting to emphasize the owner's commitment. The owner is the orchestrator to create a network where the project participants interact and share knowledge. Project participants will passively and actively join the learning activities. Finally, they will recognize the purpose of learning and keep a continual learning mode with the owner. The innovation and problem-solving-oriented project-based learning welcome a more open and adaptable atmosphere. An open mindset is a mental model in project-based learning. Shared Vision and Collaboration can be considered similar. Genuine commitment and enrollment are always necessary for all types of organizational learning. The project-based learning focus on collaboration as project participants may have different goals in a project. Project participants form a team. Literature and practices have shown the limited value of codification and call for more social learning. Team learning and the social environment approach are aligned to enter into genuine thinking together.

Fig 3. linking organizational learning principles to project-based learning principles

6. Link Project-based Learning with Project Capabilities

The accumulated knowledge in projects might be lost when the project team(s) is(are) disbanded (Bakker, Cambré, et al., 2011). Project-based organizations lack the natural mechanisms for the knowledge captured in one project to be transferred and reused in subsequent phases and other projects. There is no copying and pasting knowledge learned in this project to the next project. Both cases agree that the most important lessons learned were, for the most part, bound to the experiences people had during the project and are therefore bound to those who experienced them. Brady and Davies have an interesting point of view on project-based learning (Brady & Davies, 2004). They believed that project-based learning could be analyzed and understood to build project capability over time. In this sense, project capability refers to the specific knowledge and experience required to engage with customers, set up, and implement projects.

Learning enables the project team to develop a set of capabilities applied in a dynamic environment. This construct refers to the specific skills and experience required by the project-based organizations to prepare, design and execute projects (Eriksson et al., 2017), the high-level management skills and experiences that enable organizations to design and deploy projects for strategic purposes.

Construction does innovate in many ways, but much of it is hidden as it happens in practice when problems arise, are solved, and subsequently forgotten. Introducing ideas from outside the project team and learning by doing not only increases the possible sources of innovation but also emphasizes a new range of capabilities required to establish and develop weak-tie collaborations (Chesbrough, 2004), manage external proponents of unsolicited changes, allow intellectual property and ideas to flow freely, strengthen problem-solving capabilities, and maintain an overall nimble and proactive organization. Project-based organizations that implement large-scale infrastructure development projects need to build capability by understanding their cultural environment and employees' perspectives regarding enablers and

inhibitors to knowledge transfer (Davies & Brady, 2000). Project capabilities identify the unique knowledge required to undertake projects tailored to individual customer requirements (Davies & Brady, 2016). Capabilities are developed through the integration and transfer of knowledge (Grant, 1996). The firm's ability to move base is dependent on and shaped by previously acquired managerial expertise and experience and its ability to absorb new learning and build new capabilities.

To acquire project capabilities, project participants must develop and maintain in-house skills, competencies, and abilities to engage with the supply chain. Some capabilities can be seen as learning outcomes through repeated interactions and follow different learning trajectories, such as the learning program in Case GSP and the partnership promoted between international participants in Case HZMB.

Researchers argue that dynamic capabilities can be developed through the process of deliberate learning activities (Winter, 2003; Zollo & Winter, 2002). Similarly, Eisenhardt and Martin identified the experiential learning mechanisms of repeated practice, mistakes, and pacing of experience (Eisenhardt & Martin, 2000). Dodgson, for example, defined learning as a dynamic capability, placing emphasis on the continually changing nature of organizations (Dodgson, 1993). Newell and Edelman held a similar view of project-based learning as a dynamic capability since it is concerned with changing routines (Newell & Edelman, 2008). Easterby-Smith and Prieto independently argued a similar position and developed their theory by adding the mediating effect of learning capabilities (Easterby-Smith & Prieto, 2008). We further developed the model from Easterby-Smith and Prieto in the project context. The model also echoes insights from the general trend and several vital studies on project-based learning in the literature (framed in Fig 4).
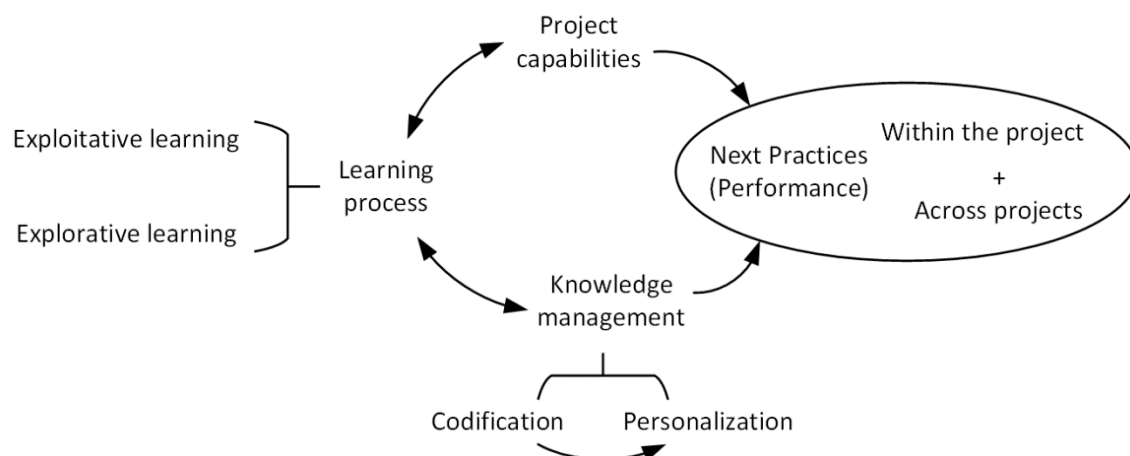
Fig 4. An integrative framework linking learning, capabilities, and performance (adapted from Easterby-Smith and Prieto, 2008)

Critical project-based learning processes use existing knowledge (exploitative learning) and create new knowledge (explorative learning). Even though exploitation and exploration are handled separately, ambidexterity was observed in both cases. The blending of exploitation and exploration is recommended to promote project-based learning. Knowledge management lies in the potential to conduct both codification (technical process) and personalization (social process). Knowledge management can be enhanced by learning from both exploitation and exploration, while technical and social elements can provide complementary resources to the learning processes. Project-based learning is a central mechanism that links knowledge

management and project capabilities together. In line with the original integral framework from Easterby-Smith and Prieto, the bidirectional arrows to and from learning processes indicate that there is mutual interaction between learning processes, project capabilities, and knowledge management. By learning capabilities, a project-based organization can build new project capabilities and transform itself into the next practices within the project and across projects to have an impact on the project performance.

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, as we argued in the five project-based learning principles. This form of learning is learning by communicating and exchanging with others, asking for reflection, or, more easily, learning from learning (McClory et al., 2017).

Based on the close relationship between learning and capability, we argue the research on project capabilities needs to pay attention to learning capabilities. Project-based learning with multiple parties can leverage existing capabilities and create new knowledge (Edmondson, 2012).

7. Conclusion
Project-based learning has been challenging due to projects' temporary and unique nature. It is less likely to simply copy and paste the organizational learning theory developed from other routine-based industries to the project context (Bresnen & Marshall, 2001). The evolution of project-based learning theories in infrastructure projects may be thought of as a progression from the broad organizational learning theory to more specific theories in project studies.

This research provides new insights into learning in the project setting. The project is temporary, but the partners' long-term stable business relationships characterize the project's context. The research aims to gain a deeper understanding of how project participants can learn from their involvement in one-off complex projects and build capabilities to deliver them better.

A cross-case analysis of the Gaasperdammer tunnel project in the Netherlands, and the Hong Kong–Zhuhai–Macau Bridge in China, was performed. The empirical evidence gathered in this research forms five project-based learning principles: 1) Owner commitment, 2) Social environment approach, 3) Collaboration vision, 4) Value orientation, and 5) Open mindset. We admit that project-based reflecting and analyzing remains on the agenda when considered necessary by the owner and concerned project participants. Collaboration provides the project-based organization with access to new human and intellectual resources. Collecting lessons learned from each other and fitting the line of thought with the learning process is better done in the social environment.

We argued that learning is related to project capabilities, which case studies have proved. This aligns with the model Easterby-Smith and Prieto developed (Easterby-Smith & Prieto, 2008), stating that learning is considered the central mechanism that links dynamic capabilities and knowledge management. Brady and Davies have an interesting point of view on project-based learning (Brady & Davies, 2004). They believe that project-based learning can be analyzed and understood to build project capability over time. In this sense, project

capability refers to the specific knowledge and experience required to engage with customers and set up and implement projects. Overall, this research contributes to 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. We recognize that project-based learning and project capabilities lead to better business and project performance. This research underlines an essential capability for project management to develop, i.e., learning capabilities. It prepares for tomorrow in infrastructure development projects.

References

Argyris, C., & Schön, D. A. (1997). Organizational learning: A theory of action perspective. Reis(77/78), 345-348.

Ayas, K., & Zeniuk, N. (2001). Project-based learning: Building communities of reflective practitioners. Management Learning, 32(1), 61-76.

Bakker, R. M., Cambré, B., Korlaar, L., & Raab, J. (2011). Managing the project learning paradox: A set-theoretic approach toward project knowledge transfer. International Journal of Project Management, 29(5), 494-503.

Bakker, R. M., Knoben, J., De Vries, N., & Oerlemans, L. A. (2011). The nature and prevalence of inter-organizational project ventures: Evidence from a large scale field study in the Netherlands 2006–2009. International Journal of Project Management, 29(6), 781-794.

Brady, T., & Davies, A. (2004). Building project capabilities: from exploratory to exploitative learning. Organization studies, 25(9), 1601-1621.

Bresnen, M., Edelman, L., Newell, S., Scarbrough, H., & Swan, J. (2003). Social practices and the management of knowledge in project environments. International Journal of Project Management, 21(3), 157-166.

Bresnen, M., & Marshall, N. (2001). Understanding the diffusion and application of new management ideas in construction. Engineering, Construction and Architectural Management.

Bronte-Stewart, M. (2015). Beyond the iron triangle: Evaluating aspects of success and failure using a project status model. Computing & Information Systems, 19(2), 19-36.

Brown, J. S., & Duguid, P. (1991). Organizational learning and communities-of-practice: Toward a unified view of working, learning, and innovation. Organization science, 2(1), 40-57.

Cacciatori, E. (2008). Memory objects in project environments: Storing, retrieving and adapting learning in project-based firms. Research policy, 37(9), 1591-1601.

Chan, P., Cooper, R., & Tzortzopoulos, P. (2005). Organizational learning: conceptual challenges from a project perspective. Construction management and economics, 23(7), 747-756.

Chesbrough, H. (2004). Managing open innovation. Research-technology management, 47(1), 23-26.

Chiva, R., Alegre, J., & Lapiedra, R. (2007). Measuring organisational learning capability among the workforce. International Journal of Manpower.

Creswell, J. W., & Creswell, J. D. (2017). Research design: Qualitative, quantitative, and mixed methods approaches. Sage publications.

Davies, A., & Brady, T. (2000). Organisational capabilities and learning in complex product systems: towards repeatable solutions. Research policy, 29(7-8), 931-953.

Davies, A., & Brady, T. (2016). Explicating the dynamics of project capabilities. International Journal of Project Management, 34(2), 314-327.

Davies, A., & Mackenzie, I. (2014). Project complexity and systems integration: Constructing the London 2012 Olympics and Paralympics Games. International Journal of Project Management, 32(5), 773-790.

De Groot, B., Leendertse, W., & Arts, J. (2020). Building adaptive capacity through learning in project-oriented organisations in infrastructure planning. Urban Planning, 5(1), 33-45.

DeFillippi, R. J. (2001). Introduction: Project-based learning, reflective practices and learning. In (Vol. 32, pp. 5-10): Sage Publications Sage CA: Thousand Oaks, CA.

DeFillippi, R. J., & Arthur, M. B. (1998). Paradox in project-based enterprise: The case of film making. California management review, 40(2), 125-139.

Dodgson, M. (1993). Organizational learning: a review of some literatures. Organization studies, 14(3), 375-394.

Duryan, M., & Smyth, H. (2018). Cultivating sustainable communities of practice within hierarchical bureaucracies: the crucial role of an executive sponsorship. International Journal of Managing Projects in Business.

Easterby-Smith, M., & Prieto, I. M. (2008). Dynamic capabilities and knowledge management: an integrative role for learning? British journal of management, 19(3), 235-249.

Edmondson, A. (1999). Psychological safety and learning behavior in work teams. Administrative science quarterly, 44(2), 350-383.

Edmondson, A. C. (2012). Teaming: How organizations learn, innovate, and compete in the knowledge economy. John Wiley & Sons.

Eisenhardt, K. M., & Graebner, M. E. (2007). Theory building from cases: Opportunities and challenges. Academy of Management journal, 50(1), 25-32.

Eisenhardt, K. M., & Martin, J. A. (2000). Dynamic capabilities: what are they? Strategic management journal, 21(10-11), 1105-1121.

Eltigani, A., Gardiner, P., Kirkham, R., Williams, T., Ou, L., & Calabrese, A. (2020). Learning in and from projects: the learning modes and a learning capability model. Production Planning & Control, 31(10), 786-798.

Eriksson, P. E., Leiringer, R., & Szentes, H. (2017). The role of co-creation in enhancing explorative and exploitative learning in project-based settings. Project management journal, 48(4), 22-38.

Gann, D. M., & Salter, A. J. (2000). Innovation in project-based, service-enhanced firms: the construction of complex products and systems. Research policy, 29(7-8), 955-972.

Garud, R., Dunbar, R. L., & Bartel, C. A. (2011). Dealing with unusual experiences: A narrative perspective on organizational learning. Organization science, 22(3), 587-601.

Grabher, G. (2004). Temporary architectures of learning: Knowledge governance in project ecologies. Organization studies, 25(9), 1491-1514.

Grant, R. M. (1996). Prospering in dynamically-competitive environments: Organizational capability as knowledge integration. Organization science, 7(4), 375-387.

Hartmann, A., & Dorée, A. (2015). Learning between projects: More than sending messages in bottles. International Journal of Project Management, 33(2), 341-351.

Hobday, M. (2000). The project-based organisation: an ideal form for managing complex products and systems? Research policy, 29(7-8), 871-893.

Iftikhar, R., Ahola, T., & Butt, A. (2021). Learning from interorganizational projects. International Journal of Managing Projects in Business.

Ika, L. A., & Donnelly, J. (2017). Success conditions for international development capacity building projects. International Journal of Project Management, 35(1), 44-63.

Irani, Z., Sharif, A. M., & Love, P. E. (2009). Mapping knowledge management and organizational learning in support of organizational memory. International Journal of Production Economics, 122(1), 200-215.

Keegan, A., & Turner, J. R. (2001). Quantity versus quality in project-based learning practices. Management Learning, 32(1), 77-98.

King, W. R., & Ko, D.-G. (2001). Evaluating knowledge management and the learning organization: An information/knowledge value chain approach. Communications of the Association for Information Systems, 5(1), 14.

Kivrak, S., Arslan, G., Dikmen, I., & Birgonul, M. T. (2008). Capturing knowledge in construction projects: Knowledge platform for contractors. Journal of Management in Engineering, 24(2), 87-95.

Koskinen, K. U. (2012). Organizational learning in project-based companies: A process thinking approach. Project management journal, 43(3), 40-49.

Kostka, G. (2016). Large infrastructure projects in Germany. Springer.

Kotnour, T. G., & Kurstedt, H. A. (2000). Understanding the lessons-learned process. International Journal of Cognitive Ergonomics, 4(4), 311-330.

Lindner, F., & Wald, A. (2011). Success factors of knowledge management in temporary organizations. International Journal of Project Management, 29(7), 877-888.

Liu, Y., Amini-Abyaneh, A., Hertogh, M., Houwing, E.-J., & Bakker, H. (2021). Collaborate to learn and learn to collaborate: a case of exploitative learning in the inter-organizational project. Engineering, Construction and Architectural Management.

Liu, Y., Houwing, E.-J., Hertogh, M., Yuan, Z., & Liu, H. (2022). Explorative Learning in Infrastructure Development Megaprojects: The Case of the Hong Kong-Zhuhai-Macao Bridge. Project management journal, 87569728211065574.

Love, P. E., Smith, J., Ackermann, F., & Irani, Z. (2019). Making sense of rework and its unintended consequence in projects: The emergence of uncomfortable knowledge. International Journal of Project Management, 37(3), 501-516.

Lundvall, B.-ä., & Johnson, B. (1994). The learning economy. Journal of industry studies, 1(2), 23-42.

McClory, S., Read, M., & Labib, A. (2017). Conceptualising the lessons-learned process in project management: Towards a triple-loop learning framework. International Journal of Project Management, 35(7), 1322-1335.

McKelvey, B. (2006). Van De Ven and Johnson's "engaged scholarship": Nice try, but…. Academy of management review, 31(4), 822-829.

Morgan, D. L. (1996). Focus groups. Annual review of sociology, 22(1), 129-152.

Newell, S., & Edelman, L. F. (2008). Developing a dynamic project learning and cross-project learning capability: synthesizing two perspectives. Information Systems Journal, 18(6), 567-591.

Pahl-Wostl, C., Sendzimir, J., Jeffrey, P., Aerts, J., Berkamp, G., & Cross, K. (2007). Managing change toward adaptive water management through social learning. Ecology and society, 12(2).

Papadonikolaki, E., van Oel, C., & Kagioglou, M. (2019). Organising and Managing boundaries: A structurational view of collaboration with Building Information Modelling (BIM). International Journal of Project Management, 37(3), 378-394.

Parker, A., & Tritter, J. (2006). Focus group method and methodology: current practice and recent debate. International Journal of Research & Method in Education, 29(1), 23-37.

Prencipe, A., & Tell, F. (2001). Inter-project learning: processes and outcomes of knowledge codification in project-based firms. Research policy, 30(9), 1373-1394.

Schindler, M., & Eppler, M. J. (2003). Harvesting project knowledge: a review of project learning methods and success factors. International Journal of Project Management, 21(3), 219-228.

Senaratne, S., & Malewana, C. (2011). Linking individual, team and organizational learning in construction project team settings. Architectural Engineering and Design Management, 7(1), 50-63.

Senge, P. M. (2006). The fifth discipline: The art and practice of the learning organization. Currency.

Swan, J., Scarbrough, H., & Newell, S. (2010). Why don't (or do) organizations learn from projects? Management Learning, 41(3), 325-344.

Sydow, J., & Braun, T. (2018). Projects as temporary organizations: An agenda for further theorizing the interorganizational dimension. International Journal of Project Management, 36(1), 4-11.

Szulanski, G. (2000). The process of knowledge transfer: A diachronic analysis of stickiness. Organizational Behavior and Human Decision Processes, 82(1), 9-27.

Wasko, M. M., & Faraj, S. (2005). Why should I share? Examining social capital and knowledge contribution in electronic networks of practice. MIS quarterly, 35-57.

Weick, K. E. (1991). The nontraditional quality of organizational learning. Organization science, 2(1), 116-124.

Wenger, E. C., & Snyder, W. M. (2000). Communities of practice: The organizational frontier. Harvard business review, 78(1), 139-146.

Wiewiora, A., Chang, A., & Smidt, M. (2020). Individual, project and organizational learning flows within a global project-based organization: exploring what, how and who. International Journal of Project Management, 38(4), 201-214.

Williams, T. (2008). How do organizations learn lessons from projects—And do they? IEEE Transactions on Engineering Management, 55(2), 248-266.

Winch, G., & Leiringer, R. (2016). Owner project capabilities for infrastructure development: A review and development of the "strong owner" concept. International Journal of Project Management, 34(2), 271-281.

Winter, S. G. (2003). Understanding dynamic capabilities. Strategic management journal, 24(10), 991-995.

Yin, R. (1984). case study research. Beverly Hills. In: ca: Sage.

Zollo, M., & Winter, S. G. (2002). Deliberate learning and the evolution of dynamic capabilities. Organization science, 13(3), 339-351.