Achieving inter-project learning in multi-contractor infrastructure programmes

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Abstract

Achieving learning within programmes is key for programme management success. Dutch infrastructure clients adopting a programme-based approach have to consider traditional project-based structures of the industry that limit learning. Transferring project knowledge between organizations results in extra complexity. Therefore, this study aims to provide insight into the mechanisms behind achieving inter-project learning in a programme with multiple contractors. Two cases were selected at Dutch infrastructure clients that manage a programme in which they collaborate with multiple market parties. Data was gathered from participants through surveys and interviews. Theory on inter-organizational transfer of knowledge and management of programmes was combined in a framework on the barriers and drivers for learning in programmes. The case study provides insights into the conditions for achieving inter-project learning. Inter-project learning can be achieved by converting opportunities to transfer relevant experience and knowledge to allow teams of subsequent projects to apply this knowledge. Four conditional factors were identified critical to achieving inter-project learning. Relationship, interaction, organizational and programme factors stimulate the presence of the conditional factors. In order to achieve inter-project learning in their programmes, infrastructure clients should aim to realize the four conditional factors among the project employees of all participating organizations within their programme. Achieving inter-project learning allows to optimize the use of knowledge and resources across projects.

Keywords: Programmes; inter-organizational; inter-project learning; interactions; collaboration; infrastructure projects

1. Introduction

Dutch infrastructure clients are facing a challenge to renovate their aging infrastructure, calling for an increase in production of the Dutch infrastructure sector (Bleijenberg, 2021; Rijkswaterstaat, 2023). Organizing work in single projects limits the ability to learn between projects and build upon experience from one project to the other, making it unlikely to accomplish efficiency improvements or develop innovations (Arnoldussen, Groot, Halman, & van Zwet, 2016; Hällström, Bosch-Sijtsema, Poblete, Rempling, & Karlsson, 2021). Infrastructure clients are instead more likely to adopt programmes as a strategy for maintaining their assets (Rijkswaterstaat, 2022). In programmes multiple related deliveries or projects are bundled together to meet extra-project objectives (Lycett, Rassau, & Danson, 2004; Pellegrinelli, 1997). By bundling projects in programmes strategic goals, such as realizing innovations related to societal challenges, can be achieved that would not have been achieved had the work been conducted independently (Arnoldussen et al., 2016; Lycett et al., 2004; Martinsuo & Hoverfält, 2018; Pellegrinelli, 1997; Shehu & Akintoye, 2009). Adopting a programme-based approach can be challenging for infrastructure clients due to the traditional project-oriented structures in the construction industry that can cause tensions when a programmatic approach is adopted (De Groot, Leendertse, & Arts,

2020; Vosman, Volker, & Deken, 2022). Therefore, client organizations should have sufficient knowledge of programme management when adopting a programme-based approach (Lycett et al., 2004) To realize the strategic goals of a programme learning must be achieved (Lycett et al., 2004). Learning in infrastructure programmes with similar repeating projects is defined as: *"optimizing the use of resources across projects, particularly knowledge and skills"* (De Groot, Leendertse, & Arts, 2022, p. 8).

In the construction industry learning is often limited to individuals in project teams and not towards other projects or organizations (Berg, et al., 2012). Team learning is naturally focused on optimizing project performance towards achieving the project goals (De Groot et al., 2022). To realize learning between projects in a project-oriented industry, knowledge and experience from projects must be retained at project closure (Gann & Salter, 2000; Brady & Davies, 2004). Due to its importance to programme management, Martinsuo and Hoverfält (2018) suggest more research on learning in programmes, while Dutton, Turner and Lee-Kelley (2014) suggest research into learning in programmes within different industrial contexts. Different business objectives of organizations provide an extra layer of complexity when trying to achieve inter-project learning in inter-organizational contexts (Bengtsson & Kock, 2014; Inkpen A., 1998a; Martinsuo & Ahola, 2022). Therefore, Martinsuo and Ahola (2022) suggest more research into the mechanisms that promote inter-organizational transfer of knowledge in a multi-project setting, where knowledge obtained from old projects is reused in new projects. The study of De Groot et al. (2022) does address learning across teams in infrastructure programmes, but is not focused on the inter-organizational perspective.

This study aims to contribute to the academic gap on the functioning of mechanisms for achieving learning in an inter-organizational multi-project context. Considering that learning is an important factor for realizing programme results (Lycett et al., 2004), providing Dutch infrastructure clients insight in the mechanisms for achieving inter-project learning is useful when a programme-based approach is adopted in an environment of existing project-based structures. The question this research aims to contribute to is *"How can inter-project learning be achieved in multi-contractor infrastructure programmes?"* In this study two cases will be explored at clients that have adopted a programme-based approach for the maintenance of their infrastructure assets with the involvement of multiple market parties. Inter-project learning is defined as applying the experience from a previous project to improve the use of resources and knowledge in a new project. The inter-organizational context is a result of multiple parties being involved in the programmes.

In this paper the theoretical background to learning and knowledge sharing in an inter-organizational context is presented in chapter 2. A theoretical framework in Table 1 is created by combining literature on inter-organizational learning and knowledge sharing and programme management. The data collection and analysis methodology are discussed in chapter 3, which also includes an introduction to the two cases. In chapter 4, the results of the study are presented, highlighting the conditions in which inter-project learning can occur and the relationship, interaction, organizational and programme factors that can contribute towards achieving inter-project learning. In chapter 5 the research is concluded by a discussion and reflection on its results, including recommendations for clients and for future research.

2. Theoretical Background

2.1. Learning in programmes

Learning in programmes can occur at individual, group and organizational levels, (Dutton et al., 2014) and whether learning is achieved depends on the characteristics of the programme that can function as a driver or barrier to learning. In infrastructure programmes learning at individual and group level corresponds to intra- and inter-project learning. Intra-project learning involves

individual and collective interpreting of knowledge in project teams, while inter-project learning involves the collective interpreting of knowledge or transfer between project teams (De Groot et al., 2022). Learning at organizational level in infrastructure programmes corresponds to meta-project learning, which involves integrating and institutionalizing knowledge within the organization (De Groot et al., 2022). Intra-and inter-project learning within a programme are important to programme success, as they consider the improvements that can be made in projects and between projects (De Groot et al., 2022). Integration and institutionalization of knowledge on the organizational level is aimed to benefit goals beyond the scope of the programme. New knowledge and the development of innovations should be accomplished by learning over multiple projects within a programme, whereas individual projects focus on using existing knowledge to efficiently deliver the project (De Groot et al., 2022). The context of a programme can serve as a stable environment to experiment with innovations in projects and provides project teams with freedom to develop new knowledge (De Groot et al., 2022). In order for learning to take place, strong relationships are important between individuals or groups, while distant relationships to other groups restrain learning between the groups (Dutton et al., 2014). A more autonomous programme is more likely to stimulate intra- and inter-project learning, whereas meta-project learning is less likely to occur due to a large perceived distance to the parent organization (De Groot et al., 2022).

2.2. Learning in interorganizational context

Learning beyond the boundaries of multiple organizations or firms is challenging due to differences in organizational objectives, norms, culture, structure and business interests of actors involved (Battistella, De Toni, & Pillon, 2016; Dutton et al., 2014; Easterby-Smith, Lyles, & Tsang, 2008). While learning together will contribute to achieving the programme goals, it does not have to align with the interests of the individual organizations or firms participating (Bengtsson & Kock, 2014). Allowing competitors to learn or gain knowledge, can be a competitive disadvantage (Argote & Ingram, 2000; Inkpen A., 1998a). Different business objectives that different firms have, are seen as a restraint to knowledge sharing in programmes (Dutton et al., 2014).

An important condition for learning to occur in an interorganizational context is the presence of trust between the involved actors (Bacon, Williams, & Davies, 2020; Battistella et al., 2016; Dutton et al., 2014; Easterby-Smith et al., 2008). Trust can be present or absent at the individual, group, or organizational level, which relates to the level at which learning is desired to take place (Battistella et al., 2016). Development of trust can be stimulated by strong ties between people or groups (Bacon et al., 2020; Battistella et al., 2016; De Groot, et al., 2020). Ties can be more easily developed if physical distance is small and the cost of communication low (Battistella et al., 2016; Dutton et al., 2014). Relational ties allow access to the knowledge of other individuals, groups, or organizations (Battistella et al., 2016; Dutton et al., 2014; Scarbrough et al., 2004). Stronger ties, indicate more frequent interactions at which knowledge can be shared and increase likeliness that effort is spend on making sure that recipients understand new knowledge (Battistella et al., 2016). Frequent interactions allowed for by a low physical distance also facilitate the development of trust (Battistella et al., 2016; Scarbrough et al., 2004). A significant difference in norms and culture can increase the threshold for contact between employees or groups, and can cause misunderstanding in contact aimed at transferring knowledge (Battistella et al., 2016; Easterby-Smith et al., 2008; Scarbrough et al., 2004). Organizational norms determine practices on the work floor, significantly affecting how employees work together and how knowledge is transferred (Battistella et al., 2016; Dutton et al., 2014). A large perceived distance by project employees between their work and their central parent organization will hinder the integration of lessons learned in projects towards the organization and institutionalization of project experiences at the organizational level (Dutton et al., 2014).

Furthermore, business objectives of the involved organizations influence the likelihood of learning taking place, if different organizations have similar business objectives, there is common interest in learning (Dutton et al., 2014). A boundary condition for learning is the absorptive capacity of the recipient party, as involved actors must be able to understand and process knowledge effectively (Bacon et al., 2020; Easterby-Smith et al., 2008).

The characteristics of a programme can stimulate and drive the process of learning or restrain learning, as the context of a programme determines whether the programme can function as a firewall for learning and offer room for implementing innovations (De Groot et al., 2022; Dutton et al., 2014). Through extra rewards related to delivery objectives or making improvements over the course of the programme, incentives can stimulate learning (Dutton et al., 2014). An important driver for inter-project learning in infrastructure programmes is similarity in project characteristics (De Groot et al., 2020). These include sharing physical interfaces, sharing similar stakeholders or having similar project time, phase, environment, or contract (De Groot et al., 2020). If projects have high similarity in characteristics, inter-project learning can have potential benefits on a broad area of project characteristics. In order to realize inter-project learning, time must be spent on formal learning mechanisms to capture the learning gained in projects, codify and share it with other teams (Brady & Davies, 2004; Scarbrough, et al., 2004). Delivery pressure of these projects can be a barrier to learning, as pressure caused by a lack of time, resources or personnel can cause a focus on quick wins and discourage proactive knowledge sharing with others (Dutton et al., 2014; Zika-Viktorsson, Sundström, & Engwall, 2006).

Distances between project teams should be small if inter-project learning is pursued, as these distances must be overcome in order to achieve inter-project learning. If project teams do not feel connected to other project teams in a programme, this will be a barrier to inter-project learning (De Groot et al., 2022; Dutton et al., 2014). High autonomy for project teams in a programme stimulates intra-project learning. Meanwhile, the distance between project and organization forms a barrier for integrating learning into the own organization (De Groot et al., 2022). A means to overcome distances between projects in a programme is through learning platforms, which allow knowledge sharing between participants of the same specialization (De Groot et al., 2020, 2022). Internal knowledge platforms can enhance inter-project learning, whereas external knowledge platforms can benefit meta-project learning between organizations (De Groot et al., 2020).

2.3. Procurement choices for programmes

Procurement choices are an important context factor in collaborations between a public client and market parties, as they determine the relationship between client and selected contractor (Eriksson, 2008). Learning depends on the relation between client and contractor and can be stimulated through the presence of incentives in the contract (Eriksson, 2016). Procurement choices determine the reliance on trust between parties in a collaboration (Eriksson, 2008), which is an important relationship factor for learning.

Framework agreements are a potential driver towards creating programme collaborations, as a long-term agreement offers more room for innovation and reduces the burden of continuous competitive tendering per project (Vosman, Volker , & Boes, 2020). In a framework agreement two parties sign an agreement for a long-term supply of a similar set of works or services that is to be provided by the contracted party (Glover, 2008). Framework agreements are not universally praised, as they restrict market access to work for the duration of the contract (Lam & Gale, 2014). In case market conditions change to the point where the contractor no longer provides market level performance, the client does not necessarily have the freedom to contract a better performing party over the course of the agreement (Lam & Gale, 2014). However, framework agreements do guarantee continuity of work for market parties, which can enable knowledge sharing within a programme (Vosman et al., 2020).

2.4. Framework: barriers and drivers towards learning in programmes

Altogether, findings on learning in an interorganizational context and more specifically in the context of programmes, can be combined into a framework (Table 1). The framework refers back to the three levels of learning of Dutton et al. (2014) applied to the context of the infrastructure programmes by De Groot et al. (2022). Learning at individual and group level is represented by intra-project learning, learning between groups is represented by inter-project learning and learning at organizational level is represented by meta-project learning. The findings on barriers and drivers for learning in Table 1 are derived from literature on learning in an interorganizational context, with some sources referring more specifically to infrastructure programmes. Findings are grouped per category associated to the characteristics of the relationship between organizations participating in a programme, the characteristics of the organizations involved in the programme and the characteristics of the programme itself.

#	Category	Factor	Relation factor on learning	Source	Level
1	Characteristics Relationship	Level of tie strength	High = driver Low = barrier	Argote & Ingram, (2000), Bacon et al. (2020), Battistella et al. (2016), Dutton et al. (2014), Easterby-Smith et al. (2008)	Intra, Inter, Meta
2		Level of trust	High = driver Low = barrier	Bacon et al. (2020), Battistella et al. (2016), Dutton et al. (2014), Easterby-Smith et al. (2008)	Intra, Inter, Meta
3		Physical distance	Large = barrier Small = driver	Bacon et al. (2020), Battistella et al. (2016), De Groot et al. (2022), Dutton et al. (2014)	Intra, Inter, Meta
4	Characteristics Parent Organizations	Differences in culture and norms	High difference = barrier	Bacon et al. (2020), Battistella et al. (2016), Dutton et al. (2014), Easterby-Smith et al. (2008)	Intra, Inter, Meta
5		Differences in business objectives	Large = barrier Small = driver	Dutton et al. (2014)	Inter, Meta
6		Presence of competition	Firms are competitors = barrier	Argote & Ingram, (2000), Inkpen (1998a)	Intra, Inter, Meta
7		Level of learning capacity	Low = barrier	Bacon et al. (2020) Easterby-Smith et al. (2008)	Intra, Inter, Meta
8		Presence of learning intent	High = driver Low = barrier	Bacon et al. (2020), Inkpen (1998b)	Intra, Inter, Meta
9		Organizational distance towards parent organization	Large = barrier for meta; driver for intra	Battistella et al. (2016), De Groot et al. (2020), Dutton et al. (2014), (Scarbrough, et al., 2004)	Intra, Meta
10	Characteristics Programme	Presence of contractual incentives	Present = driver	Dutton et al. (2014)	Intra, Inter, Meta
11		Similarity in project characteristics	Similar projects = driver	Argote & Ingram, (2000) De Groot et al. (2020)	Inter, Meta
12		Programme design	Firewall for learning = driver	De Groot et al. (2022), Dutton et al. (2014)	Inter, Meta
13		Distance between project teams	Large = barrier	De Groot et al. (2020), Dutton et al. (2014)	Inter, Meta
14		Level of delivery pressure	High = barrier	Dutton et al. (2014)	Inter, Meta
15		Learning platforms	Existence platform = driver	De Groot et al. (2020, 2022)	Inter, Meta

Table 1 Barriers and drivers to learning in programmes in an interorganizational context

2.5. Inter-project transfer of project experience and knowledge

In order to realize inter-project learning, teams have to communicate lessons learned to subsequent projects (Brady & Davies, 2004), allowing for developing an optimized use of resources within the programme (De Groot et al., 2022). Without a transfer of lessons learned between a project team and subsequent projects, the experience and knowledge gained within a project is lost at project completion when teams dissolve (Brady & Davies, 2004). Within a programme, experience and knowledge gained in projects can be preserved either by retaining the same teams for subsequent projects or through transfer towards subsequent project teams. By retaining a team with the same composition for multiple subsequent projects, the team is able to develop collective experience that it can apply to their projects, as a result of learning by doing (Scarbrough, et al., 2004). Within this multi-project team, reflections on experience in projects result in learning according to intra-team learning processes (De Groot et al. 2022; Dutton et al., 2014). Both client and contracted market parties must assign the same group of employees to subsequent projects in order to realize a team that retains its member composition.

In order to realize an inter-team transfer of knowledge, a connecting medium must be present between the boundaries of different project teams (Hawkins & Rezazade, 2012). This can be accomplished through client project employees working on different projects interacting to share project experience and knowledge, or through contractor team members transferring experience and knowledge to other teams. When contractor team members transfer knowledge towards teams of different contractors, the inter-organizational context must be considered where knowledge is transferred across organizational boundaries (Berg, et al., 2012; Easterby-Smith et al., 2008). Depending on the contract form, client and contractor are responsible for different elements of the project work, therefore it is desired to involve both team members of clients and contractor in transferring project knowledge to other teams. Alternatively, documents provide a means to transfer knowledge between projects without requiring interactions between members of different project teams. Transferring knowledge through documents is limited to codified knowledge (Hawkins & Rezazade, 2012), which misses out on tacit knowledge that is deemed extremely important in the construction industry (Gann & Salter, 2000).

In total this means that there are two main strategies towards achieving inter-project learning that can be defined: *'Team retention'* and *'Inter-team interaction'*. Three different means of transferring learned lessons can be assigned to inter-team interactions: through client colleagues, through contractor employees or through documents from previous projects.

Team retention	***Inter-team interaction***
Retaining a project team with the same composition for a series of subsequent projects allows for the development of experience and knowledge in the team from cumulative learning by doing.	Transfer of experience and knowledge gained by (client) project employee towards colleague working on subsequent project.
	Transfer of experience and knowledge gained by contractor project employee towards member of subsequent project of different contractor.
	Transfer of codified knowledge through documents.

Table 2 Team retention and inter-team interaction: two strategies towards inter-project transfer of experience and knowledge

3. Method

3.1. Research approach

A qualitative research approach is taken in this study, as it is suitable for studying real-world phenomena such as learning in infrastructure programmes (Yin, 2015). As learning concerns the interaction between organizations and people within their work, their perceptions are important for this study (Yin, 2015). The context of the study requires to include the social, cultural, and

business environment that employees within infrastructure programme operate in. Considering that the researcher has little control over the events subject to the research, it is not possible to replicate the situation in an experiment and the application of a real-world case study is proposed (Yin, 2015; Rashid, Rashid, Warraich, Sabir, & Wasseem, 2019). In addition, a case study allows for capturing a holistic view of the problem context (Verschuren & Doorewaard, 2010).

Eisenhardt and Graebner (2007) state that cases in qualitative research should not be chosen randomly but based on theoretical sampling, to allow for theory building. It is recommended to select cases that are representative for other cases or likely to replicate (Eisenhardt, 1989). In this research, two cases from existing infrastructure portfolio programmes were chosen that feature collaboration between a client organization and multiple contractors. In portfolio programmes the repetitive nature of projects stresses the importance for achieving learning to improve the use of common resources (Pellegrinelli, 1997; De Groot et al., 2022). The two chosen cases allow for comparisons and offer potential for developing more generalizable theory than single cases (Eisenhardt & Graebner, 2007). The selected cases allow the researcher to investigate the barriers and drivers to inter-project learning as perceived and observed in practice. The outcomes from the cases can be compared to the theoretical framework to provide theoretical explanation for the findings in practice.

3.2. Case study choice

3.2.1. Case 1: client Beta, a regional water treatment agency. At client Beta water treatment infrastructure projects are divided in three different parcels that feature three or four construction firms signed to a framework agreement for 8 years, as seen in Figure 1. Only in exceptional cases do the contractors have to bid for projects, in principle all projects within the programme are assigned to the contractors without the element of competition. The three parcels consider water treatment facility projects, wastewater pumping stations renovations and wastewater pipe projects. Each parcel can be seen as a sub-programme in which the similar objects subject to renovation or replacement feature a common theme that can be exploited when learning from projects. An early contractor involvement approach is taken for the design phase of projects and the client explicitly focuses on collaboration with the contractor, supported by collaboration coaches. The client does not use designated teams to work with the same contractor in every project. For most projects in the water treatment facility parcel and pumping station parcel, different project managers and engineers are assigned to the project. Contractors are obligated to designate a key project team member to all their projects at client Beta. The client does not actively initiate contact between project teams of different contractors. Internal discipline or department meetings at client Beta allow for sharing lessons learned between colleagues of the same discipline working on different projects. In order to assure the commitment of contracted firms towards the collaborative philosophy in projects, meetings are held between directors and higher management of Client Beta and the contractors.

3.2.2. Case 2: client Delta, a regional water authority. At client Delta, three contractors are signed to a 4-year framework agreement to work on the replacement and renovation of weirs and pumping stations. Projects are bundled with a highly repetitive nature, allowing for exploitation of a common theme and similar objects. Projects get assigned evenly over the three parties based on their own expertise and preference, there are no competitive elements attached to the distribution of work. The contractor project leader and design engineer work together with the same project leader at client Delta, together forming a set team in all projects. Within this team, the contractor is involved in the early design process and is fully responsible for the realization of the projects. Three compact project teams are supported from the client by programme management, technical specialists and representatives from the asset management department. There are weekly meetings in which project leaders provide updates towards the supporting group on the status of their

projects. Additionally, there are monthly knowledge sharing meetings between the three project teams, including team members from the contractors. The main focus of the programme is set towards increased efficiency and a continuation of water management functionalities at all times.

	Client Beta	**Client Delta**
Infrastructure	• Water treatment facilities • Pumping stations wastewater • Pipes	• Pumping stations • Weirs
Programme layout (number of contracted parties per parcel)	Programme split in 3 parcels: • 'Multidisciplinary' (4) • 'Pumping stations' (3) • 'Pipes' (3)	1 programme: • *'Pumping stations and Weirs'* (3)
Programme type (Pellegrinelli, 1997)	• All parcels: portfolio • Elements of: Goal-Oriented/Heartbeat at *'Multidisciplinary'* parcel	• *'Pumping stations and Weirs'*: Portfolio, elements of Heartbeat
Duration framework agreement	8 years	4 years
Project team composition	Per project team composition can change, among compact group of colleagues	Team composition stable over series of projects
Meetings	• Discipline meetings, weekly among project managers and among project engineers	• Weekly status update meetings across all projects of programme • Monthly knowledge sharing meetings between project teams

Table 3 An overview of the programme features at client Beta and Delta

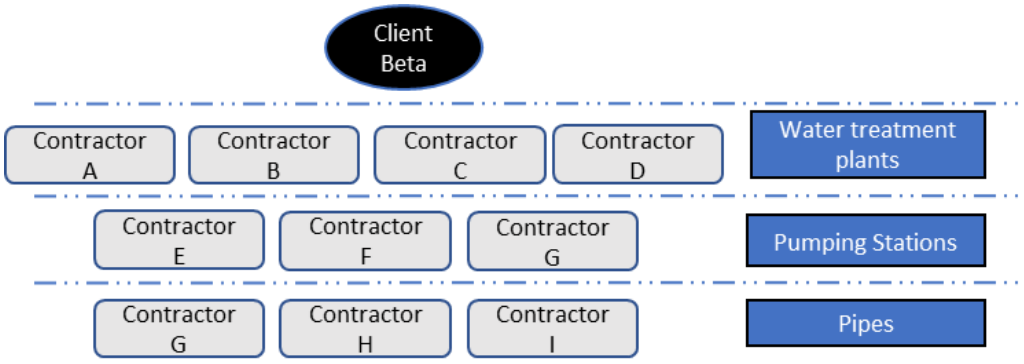

Figure 1 Overview of programme of client Beta with the contractors assigned to each parcel

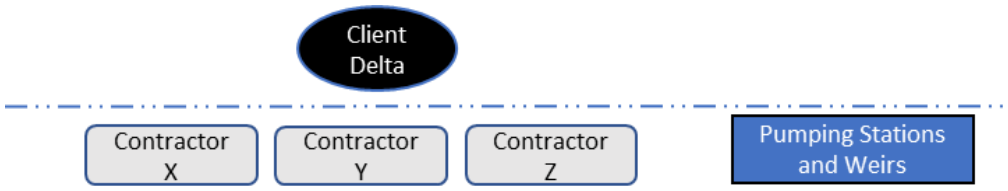

Figure 2 Overview of programme of client Delta and the contracted parties for their programme

3.3. Data Collection Strategy

A crucial factor for a robust research design is triangulation (Bowen, 2009), which in a case study is suggested for methods and sources (Verschuren & Doorewaard, 2010). For this study the perspective of participants is different depending on role, firm, personal experience, and project context. A combination of observations, surveys and in person interviews were done for cases of

client Beta and Delta. Observations and surveys functioned to gain insight in how project teams learn from each other, so what knowledge is transferred between teams, how this is done and how inter-project meetings play a role in learning. Subsequently, interviews were conducted to gain understanding of the conditions that allow for inter-project learning and what perceived barriers and drivers there are to inter-project learning. The approach was mirrored at both clients, but deviated where programme design and organizational structure differ.

3.3.1. Observations. Over a two month period, the researcher observed various meetings geared towards exchanging project experience and knowledge at the programmes of client Beta and Delta. At client Beta a weekly project management department meeting was attended, where project managers could share lessons learned from their projects with colleagues. At client Delta, digital weekly meetings were attended between client employees of the project teams and an overarching supporting group consisting of programme management and maintenance specialists. During these meetings the project employees would share their project progress and experience with other teams and the overarching supporting group. In addition, monthly knowledge sharing meetings between the project teams, including members from the contractors, were attended. These meetings were specifically aimed at transferring project experience and knowledge on a certain theme to allow for inter-project learning. The observations served well to support the latter interviews, as the real-time action is a good supplement to the retrospective nature of interviews (Eisenhardt & Graebner, 2007). Furthermore, the researcher went to the offices to client Beta and Delta to see in person how project employees work there.

3.3.2. Surveys. Surveys were held among the participants of the observed meetings to examine how the individual participants perceive the meetings to function in relation to inter-project learning. Partially functioning as validation for the observations. Open questions were raised on what project experience or knowledge is exchanged between teams and how this occurs. Respondents had to fill in 5-point Likert scale questions on their attitude towards spending time on learning from projects, transferring knowledge and on the perceived contributions of the attended meetings. To project team members that were not part of the attended meetings, questions were limited to how teams learn from their projects and how project experiences are exchanged between teams. At client Beta fifteen client employees responded and ten contractor employees participated, while at client Delta nine employees responded, with four contractor team members participated. In order to decrease the likeliness of nonresponse, the size of the surveys was limited to 8 open and 8 closed questions (Rogelberg & Stanton, 2007). Moreover, the survey was announced during the attended meetings before online distribution. Altogether, the results from the survey allowed the researcher a better understanding of the process of learning from projects and between projects at the two case studies. This information was used as preparation for the interviews as it allowed the researcher a better understanding of the role and context of the interview participants.

3.3.3. Interviews. Observations and survey results provided the researcher with increased understanding of the practices at client Beta and Delta. This allowed for in depth interviews with various employees of the programmes of client Beta and Delta. Semi-structured interviews were conducted to allow for a free flow of the conversation with supplementary questions to be asked when desired (Easawaramoorthy & Zarinpoush, 2006). The interviews were opened by asking the participants to reflect on the collaboration between client and contractor within the programme. Further questions related to how learning takes place within the programme, how project experiences are shared and how teams of different contractors interact, if they interact at all. At the end of the interview, participants were asked for their suggestions on how to improve inter-project

learning within the programme. Interviews took between 40 and 60 minutes, of which eighteen face-to-face and two via Microsoft Teams.

As part of the interview preparation with participants from the contractor employees, documents on the procurement of the programmes were studied (Bowen, 2009). Most interview participants were selected in advance, a few of the interviewees were selected from a snowball-strategy, by asking participants to suggest other interviewees. Interview participants were selected with the aim of covering different perspectives, from different project roles, organizations and functions. This meant that at least from every parcel of client Beta a contractor employee was to be interviewed. These participants held the roles of project manager, department manager, and construction team manager. At client Beta multiple project managers were interviewed, as well as the project management department manager, the contract manager and a project engineer. At client Delta, an employee from every contractor was interviewed, with the perspective as a project manager or firm director. At client Delta, the project leaders were interviewed, as well as the programme manager, contract manager, construction supervisor, asset management department manager and maintenance specialist.

3.4. Data processing

At first, processing of data was done per separate case, allowing the researcher to recognize unique patterns per case, before moving on to create patterns between multiple case observations (Eisenhardt, 1989). Survey results and notes from observations were used to create understanding of the context of the participants of interviews and develop relevant questions for the interviews. Transcriptions derived from the interviews were the main source for the results for this study. In order to analyze and process data, ATLAS.ti was used. Factors from the theoretical framework were used as foundation for codes applied to the transcriptions of the interviews. Recategorization of the initial codes took place after further analysis to improve the categorization of findings from the transcripts. Initially the codes were divided into categories reflecting the relational, organizational and programme characteristics. Further analysis allowed for simplification of the categories and codes and some codes referring to the factors for learning were eventually merged together. During this process, the researcher focused on data with a high density of codes, to find potential relations between different factors or relevant examples to highlight in the results chapter. In addition, the product and process improvements realized through learning within the programmes were categorized and grouped together to create a few categories. The categories of learning products were linked to the conditions for them to take place within the programme as seen in Table 5.

4. Results

Through interviews, the survey questionnaire and observations at client Beta and Delta, factors for achieving inter-project learning in multi-contractor infrastructure programmes were identified. Table 4 provides an overview of how relationship, interaction, organizational and programme factors influence the ability to learn using the team retention and the inter-team interaction strategies introduced in Table 2. An overview of the improvements made at client Beta and Delta is presented together with conditions that allowed for inter-project learning to achieve these improvements in Table 5. In Table 6 a separation is made between critical factors necessary for achieving inter-project learning and factors that can stimulate the presence of these critical factors. A model on the conditions for achieving inter-project learning is presented in Figure 3.

4.1. Team retention

The main reasoning behind the team retention strategy is to improve the efficiency of the team by repeatedly collaborating in projects. For contractors that apply team retention, the repetitive involvement of projects at the same client will allow their team members to become familiar with the client and context of their projects. The department manager at Contractor E explained the advantages: "*Because we attach a set team to clients, teams know our clients very well, allowing them to recognize irregularities in projects and thereby filtering out potential mistakes in advance"*. If set team members at contractors are coupled to set team members at the client, relationships between team members can be developed. As team members become familiar with each other and the organization they collaborate with, more efficient project processes can be developed. A construction supervisor at client Delta mentioned: *"The two longer contracted contractors know their way around the departments of our organization, when they have to make important design decisions they know to contact the end user without involvement of our project manager".* In addition, working in the same team allows for developing collective experience that the group can fall back to when repeatedly doing projects together. The manager of department Project Management at client Beta stated: *"There is nothing better than learning on the job, it will make a team remember that three project ago they faced a similar situation and now know what to do better".*

4.1.1. Achieving retained team composition for a series of projects. Whether teams can be retained depends on choices of the client and to a lesser degree choices of the contracted market parties. Both client Beta and Delta contractually oblige contractors to have key project members retain attached to all their projects within the programme. In addition, some contractors designate an entire team to work on all their projects within the programmes of client Beta and Delta. These contractors indicated that it is important that they receive clarity from the client on when projects are planned, so that they can reserve capacity necessary for the projects. If clients are not able to communicate project plannings in advance to their contractors, they risk that the designated team is not available and that others have to fill in. Client Delta plans projects together with their contractors, so that they are certain that the contractor has the capacity to work on projects of client Delta. In addition to demanding contractors to work with the same key project members, the client should plan their project personnel to work with the similar contractor team to achieve a stable composition of the team over a series of projects.

4.1.2. Achieving learning when retaining team. A central factor for learning within a team is the relationship between different team members, concerning relational and competence trust and tie strength between team members. Trust within a team stimulates members to have an open attitude, increasing the willingness to share lessons learned or pro-actively ask team members to share their personal experience and knowledge. Repeated work within the team allows ties to be developed between team members. Co-location can be a driver for this process as working together in person better enables the development of a relationship and especially trust, as a project manager at client Beta experiences: *"I want to meet with my team in person to get to know them, see what their attitude is and develop a team relationship, I don't want us to hide behind our laptop screens".*

When retaining similar teams, documentation of lessons learned from project experiences can serve to support collective memory by documenting otherwise tacit knowledge. A main risk of relying too much on tacit knowledge is losing said knowledge when a member leaves the team. Documents can stimulate the integration of new team members, as discussed with a project leader at client Delta. He explained that client Delta is developing documentation of risk management in every project and stated: "*Working with such a list [of project risks] allows you to look back at previous projects, also providing a support tool when people leave"*. Within the team it is important that team members are allowed to address issues and provide honest evaluations to

projects. Whether the open culture necessary for successful evaluations can be developed is partially based on the motivation to learn of members within a team. If team members see the added benefits of learning they will be more motivated to spend time on evaluating their projects and be more likely to proactively address points for improvement.

Whether teams are motivated to learn can depend on the stimulus that the structure of the programme provides. In the programmes of client Beta and Delta the contractors have a partial responsibility for design work in their project. This stimulates team members of the contracted party to learn from previous design mistakes within the team, as a project leader at contractor Z indicated: *"Since we are involved in the design, we are more likely to reflect on avoidable mistakes, considering that mistakes cost us money"*. Repeatedly working on projects with highly similar characteristics, provides an opportunity for learning by further developing old designs or project approaches. In case the programme allows for testing out innovative solutions in pilot projects, a team that completed a pilot project can exploit their experience in later projects to further build upon the pilot project.

4.2. Inter-team interactions

Inter-team interactions depend on the ability of teams to bridge the distance between their teams. Inter-team interactions are stimulated by the presence of a developed relationship and trust between individual members in different teams or teams as a whole. A developed relationship with strong ties and trust between members of different teams allows for interactions in which project-related knowledge can be transferred. A project manager at Client Beta stated: *"I regularly run into issues regarding financial control of complex projects and then I go to my experienced colleague to discuss how he managed this in his projects".* In this example the project manager has developed a relationship with his colleague and trusts his colleague to share experience useful to his own project.

A further enabling factor to sharing lessons with other teams are co-location of teams or colleagues in different teams. Co-location allows (client) colleagues from different teams to informally discuss their project work, creating an opportunity to share experience applicable to other projects or ask for advice. In addition, discipline or department meetings between client colleagues working on different projects can provide an opportunity to discuss project work and transfer knowledge applicable to other projects or programmes. An electrical engineer at client Beta stated that: *"since we discuss the state of our projects at the discipline meeting, it is easier to share something potentially helpful for colleagues".* In response to the survey at the project management department of client Beta many project managers indicated that they share lessons learned with their colleagues informally at office rather than formally during the weekly department meetings, providing indication that co-location is important. A limitation to discipline meetings appears to be a difference in experience between senior and more junior colleagues, as senior project managers at client Beta indicated that there was less they could learn from their colleagues. This could lead to a situation where some project managers can learn from the experience of a colleague, while others do not. If there is little benefit for senior individuals to participate in these discussions, this might suppress their motivation.

Bringing teams from different contractors together in person will allow them to develop a relationship and exchange information. At client Delta monthly knowledge meetings were held to exchange project experience and knowledge between key members from all teams within the programme, including employees of both client Delta and the contractors. In this meeting employees of the contractors were open to each other, allowing for discussing project design choices, material usage and supplier choices. A project leader from contractor X explained the reason for being open towards potential competitors: *"The designs are not rocket science [complicated] and are not patented so why should we avoid sharing things with each other"*. In a programme, the client is responsible for bringing members of different contracted parties together.

Besides a direct opportunity to share project experience and knowledge, knowledge meetings allow for contractor employees participating in the programme to develop a relationship in the long term. As a client Delta project leader indicated: *"contractors would never speak to each other, but now as part of our programme we ask them to monthly present interesting project decisions or designs. Now they more often approach each other directly".*

In addition to in person interactions, documents can provide a transfer of knowledge between projects. Including projects from long ago, as a project manager at client Beta explained: *"we are now looking at how the concrete structure was designed 10 years ago, as we still have the design laying around".* Using documented designs can also aid the process of standardization, as both client Beta and Delta have developed standards for their designs based on reviewing designs of a series of completed projects. Moreover, sharing calculations or designs can allow contractors to learn from the design process of other teams. It appears that the use of documentation for inter-project learning has its limits, as reflected by the client Beta project manager that stated the digital logbook for sharing project experiences between project managers was "*too long and unstructured to make sense of what experiences should be taken into account for future projects*". A colleague added that learning from colleagues can occur by talking to them but not by reading about their reported experience. In addition, various project managers shared the concern that spending too much time on documentations will demotivate employees if it is uncertain whether these will be of future use.

In interactions between different contractors a difference in culture and norms can be a barrier to be open. Department manager of the more regionally operating contractor E explained: *"Collaboration is easy with parties that share our culture, vision and interests. However, if we have to work together with a large and international company [contractor F] I don't know if we trust each other enough to be open".* At client Delta there was a similar experience during the first iteration of the programme, as a project leader stated: *"the employees of the large contractors would never consider to ask things to the smaller contractors".*

When aiming to realize interactions between contractors, it is important that there are no elements of competition present between the organizations within the programme. Long term framework agreements with guaranteed annual turnover present at client Beta and Delta can provide a condition in which a contractor can share project knowledge without the risk of losing a competitive advantage over the other contractors. A project leader at client Delta explained that when the opposite is true contractors will not help other contractors within a programme: *"If projects are separately procured to the lowest bidder then having a smart way of realizing the project can be a benefit to your bids. This will disincentivize contractors to share smart ideas in their projects as this might cost them future work".*

Members that are motivated to increase their project's performance are willing to spend more time on identifying and gathering knowledge to improve project performance. Motivation for learning can stem from contractual responsibilities and incentives. At client Beta and Delta, the contractors are (partially) responsible for the design, meaning that contractors are motivated to learn from design experience. Project leader at contractor Z indicated: *"Since we are involved in the design, we are more likely to reflect on avoidable mistakes, considering it requires more work and costs us money"*. This motivates client Delta contractors to share designs with each other and reflect on designs of completed projects during knowledge meetings, allowing for the improvement of designs and the design process. A different contractual motivation for learning can be financial incentives. At client Beta contractors can gain a part of the unused money allocated to project risks, stimulating contractors to learn from projects to be able to better manage project risks.

	Team retention	Inter-team interaction
Relationship factors		
Relational and competence trust	Trust between team members stimulates having an open attitude and trust source of information.	Trust between members of different project teams stimulates having an open attitude and trust the source of information.
Tie strength	Ties within team offer opportunities to interact and build trust.	Ties between members of different project teams offer opportunities to interact and build trust.
Interaction factors		
Co-location	Co-location of team stimulates developing team relationships and allows information to be understood enabling succesful project reflections.	Co-location of members of different project teams facilitates interactions between teams. Informally allows for development of relationships between teams.
Learning/ knowledge meetings within programme	-	Discipline meetings at the client allow colleagues to share project knowledge within their discipline. Learning or knowledge meetings within the programme allow for sharing lessons learned between project teams, including teams of the contractors. An important condition is that the client initiates these meetings to bring teams together. Participation of project members allows to integrate shared knowledge into their project teams.
Documentation	Documents can support team memory, allowing to retain some knowledge when members leave, while stimulating integration of new team members	Project documents can offer an explicit source of project knowledge to transfer between teams.
Organizational factors		
Culture and norms organizations	Organizational culture determines the perceived importance of spending time on learning versus actual production for their employees. Similar culture among team members lowers the threshold for developing a relationship.	Organizational culture determines the perceived importance of spending time on learning versus actual production. Differences in culture between organizations can be a barrier towards being open. A cooperative culture at the client and contractor allows for the development of trust between the parties.
State of competition	-	An absence of competition between market parties allows organizations to be open about factors critical to project performance.
Programme factors		
Similarity project characteristics	A team doing projects with similar characteristics motivates a team to learn from project experience and exploit this knowledge in subsequent projects.	Similarity in project characteristics offers common ground between project to learn from and can motivate teams to learn from each other.
Contractual responsibilities and incentives	Contractor responsibility for design motivates to improve their designs and process. Incentives related to improving project performance can stimulate contractor to learn from projects.	Contractor responsibility for design motivates to improve their designs and process. Incentives related to improving project performance can stimulate contractors to learn from projects.

Table 4 Overview of factors that stimulate inter-project learning in programmes, split per type of inter-team interaction

4.3. Conditional factors for achieving inter-project learning: similarity in project characteristics and open and proactive attitude

In order to successfully apply the two strategies for inter-project learning in Table 2 there are two main additional conditions. 1) There has to be some kind of project experience that is relevant to subsequent projects and 2) participants must transfer experience from their project to the team of an other project to allow them to apply this knowledge. As client Beta project managers indicated, they will not share experiences from their projects if they do not see use for subsequent projects. This leaves with three apparent conditions: 1) a team must gain experience in a project

that is relevant to be shared with subsequent projects, 2) there has to be an opportunity to transfer project experience and knowledge to a subsequent project and 3) this opportunity must be converted allowing the team of the other project to apply this knowledge.

To allow for having relevant project experience towards subsequent projects it is necessary to have similarity in project characteristics between projects. There is little that can be learned from projects that have no characteristics in common. Both programmes of client Beta and Delta feature projects with a high degree of similar characteristics. More can be learned from projects that share a very high degree of similar characteristics, such as objects with similar function and size on different locations. This means that knowledge has to be transferred to a broader extend, but that the potential benefits of achieving learning are also higher. The frequency of recurring projects with similar characteristics also determines how many opportunities there are to learn from and to apply the lessons learned to. Knowing that projects are part of a series of projects with similar characteristics will motivate project members to put effort into achieving learning. The importance of this factor is not limited to achieving inter-team interactions but also within a team that works together for a series of projects in retained team composition.

For addressing potential improvements to projects during reflections, sharing experiences to others and applying knowledge transferred by others it is important that team members have an open and proactive attitude towards learning and transferring lessons learned. This relates to the motivation and capability to 1) identify and articulate relevant experience for subsequent projects, 2) transfer relevant experience to teams of other projects and 3) apply knowledge transferred by others to their own projects. The presence of an open and proactive attitude among team members within a team will improve the team's ability to reflect on their own project experiences and learn from them. An open attitude is related to the willingness of team members to share their experience with other team members or members of other teams. A proactive attitude is related to the motivation to spend time and effort on retrieving knowledge from others, in order to learn from their experiences. Factors related to an open attitude towards sharing lessons learned are 1) good relational ties, 2) trust, 3) similar organizational culture and 4) an absence of competition between the parent organizations. Related to a proactive attitude towards learning are 1) contractual obligations and incentives, 2) a series of projects with similar characteristics and 3) a culture that stimulates learning. In order to successfully realize a transfer of knowledge between projects, team members of both projects require to have an open and proactive attitude for the identification, transfer and application of relevant knowledge.

4.4. Improvements made as a result of learning within programmes

At client Beta and Delta, the realization of inter-project learning has resulted in various steps towards optimization of the use of resources within the programme. Five categories of improvements can be defined, of which 1) further implementations of innovations, 2) standards for design, suppliers and materials and 3) improved processes in design and realization phase are the result of inter-team interactions. Whereas team retention allowed for 4) applying collectively developed experience in future projects and 5) improving the collaboration process within the team and between parent organizations.

1) *Further implementation of innovation after successful pilot.* After a team has implemented an innovation during a (pilot) project, it can share the knowledge gained from the project with the other teams. This allows further implementation or potential development of the innovation through the other projects. At client Delta a post project review of the application of sustainable concrete allowed for further implementation of this innovation on some of the subsequent projects.
2) *Standards for designs, suppliers and materials are developed.* If experience that project teams gain with various choices for designs, suppliers and materials is exchanged between

project teams and reflected upon, the best working solutions can be identified and used as a basis for developing standards for a larger series of projects. As a result, teams are able to work more efficiently during the design phase of projects. Similarly designed objects allow for a standardized maintenance approach after they are delivered. At both client Beta and Delta, standards for object designs were developed based on successful previous designs and maintenance requirements. Furthermore, at client Delta the experience with suppliers was shared between the contractors.

3) *Processes in design and realization phase improved to increase efficiency.* Over time project teams gain experience with processes during the design and realization phase. If experience on how teams have improved their way of working is exchanged between project teams and reflected upon within the programme, then the processes for all subsequent projects can be improved. This allows teams to work more efficiently, decreasing project time and avoiding miscommunication. In both cases participants highlighted that especially during the design phase they profited from improved processes as a result of learning from the experience in previous projects.
4) *Collective experience within team applicable in future projects.* When a team works together for multiple projects, experience is gained with the challenges faced in projects done together. This type of learning by doing creates collective experience that can be applied in later projects, to avoid earlier mistakes and make better decisions.
5) *Improvements in collaboration process within team and between parent organizations.* After working together with the same team for multiple projects, familiarity is developed with the other team members and their parent organizations. This allows to make project processes more efficient, especially when having to involve project stakeholders of the other organization.

The improvements were realized under certain circumstances as shown in Table 6. For making improvements by building upon project experience over multiple projects, as for types 1,2,3 and 4 in Table 6, it is necessary to have a series of projects with similar characteristics to gain knowledge from that can be exploited in subsequent projects. Improvement type 5 relies on the repeated collaboration to improve project processes. An open and proactive attitude was required to identify, articulate or transfer, and apply the potential for project improvements to subsequent projects. For improvement type 2 documents were seen as means to especially improve the designs, but as already stated, participants see a limited use in documents and transfers should be accompanied by in person interactions. Altogether this leads to the notion that documents are not a stand alone route to achieve inter-project learning and must be accompanied by either inter-team interactions or team of retained composition.

#	**Improvement resulting from achieving inter-project learning**	**Conditions for this development**
1	Further implementation of innovation after successful pilot	• Innovation is applicable in future projects • Inter-project transfer • Open and proactive attitude
2	Standards for designs, suppliers and materials are developed	• Similarities in project characteristics • Inter-team interactions • Open and proactive attitude • Transfer via documents
3	Processes in design and realization phase improved to increase efficiency	• Similarities in project characteristics • Inter-team interactions • Open and proactive attitude
4	Collective experience within team applicable in future projects	• Similarities in project characteristics • Team retention • Open and proactive attitude

5	Improvements in collaboration process within team and between parent organizations	• Team retention

Table 5 Overview of types of lessons learned from programmes at client Beta and Delta

4.5. Conditional and stimulating factors for achieving inter-project learning

To achieve the full benefits of inter-project learning as seen from the cases of client Beta and Delta, four elements must be present at an infrastructure programme: 1) similarities in project characteristics, 2) team retention, 3) in person inter-team interactions and 4) an open and proactive attitude among team members. These four elements are described to be conditional factors for achieving inter-project learning. As seen in Table 6 and Figure 3 there are several factors that can stimulate the presence of the four conditional factors. The presence or absence of stimulating factors does not determine that inter-project learning will take place or not, but the presence of stimulating factors does increase the likelihood of a conditional factor to be present or not. In Figure 3 the stimulating factors are depicted by a blue outline, the conditional factors by a black rectangle outline. It is important to note that the factor 'similarities in project characteristics' is both a conditional factor and a stimulating factor, as knowing that there will be projects that learned lessons can be applied to, will motivate members to successfully learn from previous projects. This will increase the likeliness that an open and proactive attitude is present.

Condition for inter-project learning	Experience relevant for subsequent projects	Opportunity to transfer relevant experience and knowledge to subsequent projects		Convert the transfer opportunity to allow subsequent projects to apply this knowledge	
Conditional factor	Similarities in project characteristics	Team retention	In person inter-team interactions	Open and proactive attitude	
Requires	Series of similar projects	Client and contractor to retain team composition	Teams or their members come together in person	Open attitude	Proactive attitude
Stimulating factor	• Programme featuring projects with the same type of objects	• Collaborative planning projects • Contractual obligations • Documentation	• Co-location • Learning meetings • Good relations • Documentation	• Trust • Similar organizational culture • Tie strength • No competition	• Contractual obligations and incentives • Similarity in project characteristics • Organizational culture

Table 6 Overview of conditions for achieving inter-project learning, conditional factors and stimulating factors

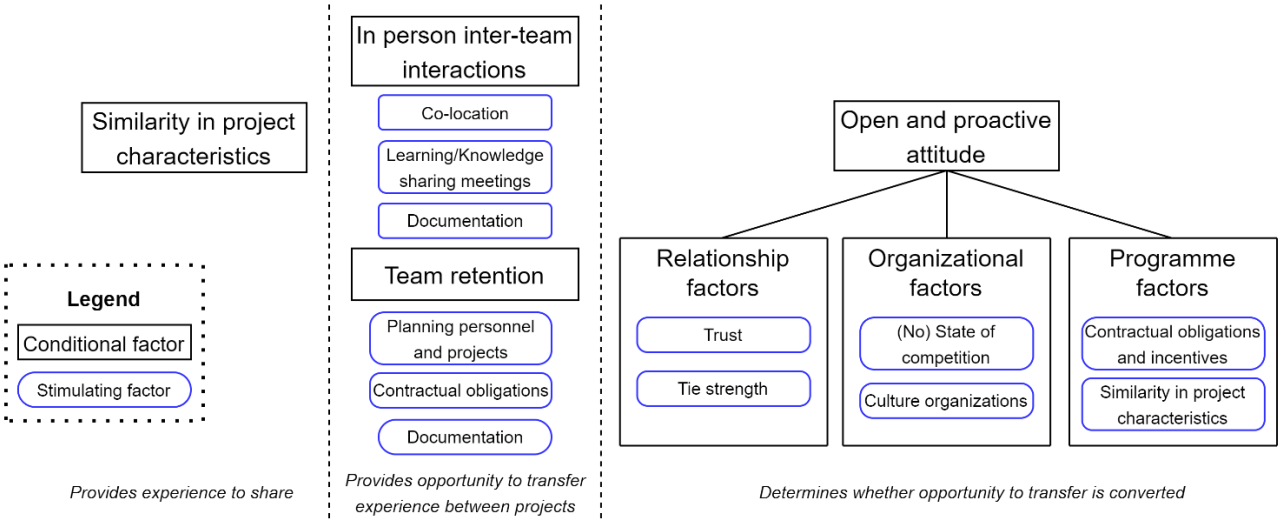

Figure 3 Model depicting the four conditional factors for achieving inter-project learning and their related stimulating factors

5. Conclusion and reflections

5.1. Conclusions

This study has investigated how inter-project learning can be achieved in multi-contractor infrastructure programmes through a case study at two infrastructure clients. At client Beta and Delta inter-project learning was achieved by converting created opportunities to transfer relevant experience and knowledge to allow teams of subsequent projects to apply this knowledge. This allowed for improvements in the use of resources within the programme. In order to achieve inter-project learning in multi-contractor infrastructure programmes, the following three conditions have to be met: 1) a team has to gain project experience that is relevant to a subsequent project, 2) the team is presented an opportunity to transfer relevant experience and knowledge to a subsequent project and 3) this opportunity has to be converted to allow the knowledge to be applied in a subsequent project.

Four conditional factors for achieving inter-project learning in infrastructure programmes are identified based on the results of the case studies at client Beta and Delta, these include: 1) similarities in project characteristics, 2) team retention, 3) in person inter-team interactions and 4) an open and proactive attitude among team members. Without the presence of these conditions, it is not possible to realize inter-project learning to a full extend as seen in Table 5. Similarities in project characteristics determine whether there is experience relevant to learn from and transfer between projects. Highly similar projects that recur often offer higher potential benefits from learning. Team retention and in person inter-team interactions allow for a means to transfer project experience to subsequent projects. In order to achieve full benefits of inter-team interactions, both client and contractor team members must be involved to transfer relevant knowledge on their expertise. An open and proactive attitude is required to allow for the identification, transfer and application of relevant knowledge between projects.

Relationship, interaction, organizational and programme factors stimulate the presence of the four conditional factors for inter-project learning. Related to in person inter-team interactions are: 1) co-location of members of different teams, 2) presence of knowledge or learning meetings and 3) documentation of codified project knowledge. Related to team retention are: 1) planning personnel and projects, 2) contractual obligations and 3) documentation of codified project knowledge. Related to an open and proactive attitude are: 1) trust between members of different

projects, 2) strong ties between members of different projects, 3) no competition between the participating parent organization, 4) similar organizational culture that regards learning as beneficial, 5) contractual obligations and incentives and 6) similarity in project characteristics. Without the presence of these stimulating factors, it might still be possible to achieve the four conditional factors, but it will likely be harder.

5.2. Implications for research and management

The results from this case study can contribute to literature on learning in programmes in the construction industry. The study provides a case example for the research gap identified by Martinsuo and Ahola (2022), as the study discusses the mechanisms promoting transfer of knowledge in inter-organizational multi-project settings. The findings can contribute to literature on learning in a traditionally project-based industry, providing insights in how organizations can overcome project-based barriers to learning as described by Brady and Davies (2004) Gann and Salter (2000). The specific context of Dutch multi-contractor infrastructure programmes allows to build upon the insights of De Groot et al. (2022), but then with a specific focus on addressing learning between teams of different contractors.

The stimulating factors related to the conditions for achieving inter-project learning, echo previous findings of scholars on knowledge transfer in interorganizational context and learning in programmes. Factors such as: trust, tie strength, co-location, similarities in culture, absence of competition, similarities in project characteristics and contractual incentives reflected existing theory (Table 1) in the model (Table 6 and Figure 3) to some degree (Bacon et al., 2020; Battistella et al., 2016; De Groot et al., 2022; Dutton et al., 2014; Easterby-Smith et al., 2008; Scarbrough et al. 2004). Knowledge sharing meetings within the programme were found to contribute, which could be compared to internal learning platforms as in the work of De Groot et al. (2022). That of documentation can function to transfer codified knowledge is in line with work of Swan and Scarbrough (2010), but the experience at the case studies showed that it can not function as a standalone strategy to achieve inter-project learning.

For programme managers that want to realize their programme goals, understanding how to achieve learning is key (Lycett et al., 2004). This study provides particular use for clients managing an infrastructure programme and provides insight in how inter-project learning can be achieved. For infrastructure clients it is important that the four conditional factors are present within the programme. A very important implication that deviates from classical project-based structures is that the full benefits of inter-project learning can only be achieved when employees of contractors that potentially regard each other as competitors exchange knowledge. This can be facilitated by: 1) bringing members from different teams together to develop a relationship and share experience, 2) providing contractors security of guaranteed work, for example through framework agreements, 3) by contractually incentivizing contractors to work on improving their project processes, for example by giving them (partial) design responsibility through more integrated contract structures and 4) selecting contractors that have a somewhat similar organizational culture. In addition, a client should prioritize learning within their organizational culture and facilitate employees to spend time on exchanging experience and knowledge. Especially at the start of a programme that features projects with a high degree of similarity in project characteristics, investing resources into learning from projects, will help to optimize the use of resources in subsequent projects.

5.3. Limitations and further research

The context of the case studies at client Beta and Delta can be seen as a limitation to this study. In the Dutch water infrastructure sector that client Beta and Delta function, there is very high demand for the service of market parties. Many objects are nearing the end of their life cycle (Bleijenberg,

2021), and many objects need to be renovated to meet demands for the European Water quality goals for 2027 (RIVM, 2019). In markets with more competition the relationship between parties involved in a multi-contractor programme might be different and contractor employees might be less willing to be open to potential competitors.

The technical complexity associated with the programme of client Delta and the pipes and pumping station projects of client Beta is limited. According to theory on knowledge sharing the capabilities of parties to understand knowledge is seen as a requirement for successful transfer of knowledge between organizations or teams (Bacon et al., 2020; Easterby-Smith et al., 2008). However, from the cases at client Beta and Delta this did not come forward as an important condition, which might be explained by the fact that participants assume others to understand the technical context. A study focused on more complex projects might provide better insight into how the capabilities to understand knowledge influence inter-project learning. Within the model of Figure 3 and Table 6 capabilities to understand knowledge would fit under organizational factors related to an open and proactive attitude. A different name might then be more suitable if this conditional factor is also to include the understanding of shared knowledge.

In addition, the understanding of how teams apply knowledge shared was difficult to identify from surveys questionnaires and interviews. Longitudinal observations of project teams functioning within a programme would make a relevant addition. Observations of project teams allow for a deeper understanding of the process of identification and application of project knowledge. Potentially providing a better understanding of how the conditional factor open and proactive attitude. However, for the researcher it was not feasible to accomplish such longitudinal observations within the current study.

Altogether, more research in different market contexts, with more technically complex projects, observing the actions of project teams might provide more certainty on how inter-project learning is achieved in different programme contexts.

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