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To cite this article: Ermal Hetemi, Joaquin Ordieres & Cali Nuur (2022) Inter-organisational collaboration and knowledge-work: a contingency framework and evidence from a megaproject in Spain, Knowledge Management Research & Practice, 20:4, 641-653, DOI: [10.1080/14778238.2022.2027827](https://doi.org/10.1080/14778238.2022.2027827)

To link to this article: <https://doi.org/10.1080/14778238.2022.2027827>



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Inter-organisational collaboration and knowledge-work: a contingency framework and evidence from a megaproject in Spain

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ABSTRACT

This paper provides an exploratory understanding of the process of knowledge-work in the inter-organisational setting of a large-scale infrastructure project. Taking a process perspective, it explores why an autonomous project-owner organisation in the rail industry sector finds difficulties to transform and exploit the project network-related knowledge in a cooperative context. The paper builds on a case study of a High-speed Rail Line (HSL) project in Spain. Based on the longitudinal qualitative secondary analysis, the authors put forth a contingency framework that proposes four contexts linking the transformation and exploitation of the knowledge from the inter-organisational network to the project-owner organisation; whether (i) the interplay between industrial setting and the project arrangement empowers product or process knowledge and (ii) the senior, and programme management awareness to feed-forward learning relies on individual- or institutionalised-based learning. These four contexts and their underlying conditions pose different knowledge-work related problems and suggest implications for practice in inter-organisational collaboration and beyond.

ARTICLE HISTORY

Received 21 April 2020
Accepted 3 January 2022

KEYWORDS

Inter-organisational collaboration; knowledge and learning boundaries; knowledge transformation and exploitation; network and project level knowledge; case study

1. Introduction

The development of networks and the use of inter-organisational project networks for sustainable competitive advantage and value creation are growing. Organisations are increasingly positioning themselves in networks, in collaborative and synergistic modes of working, seeking timely access to state-of-the-art knowledge, technology, and resources (Agostini et al., 2020). Such endeavours, the blurring of organisational boundaries reflect the “networks of learning” in the seminal work by Powell et al. (1996), and manifest at the time when more and more industries are adopting the project network organisation (cf., Manning, 2017). The prospect of capturing and transforming the project-network related knowledge and making it useful to the wider organisation is particularly attractive to managers (Carlile, 2004; Scarbrough et al., 2004). However, inter-organisational collaborations and networking pose challenges to the management of *knowledge-work*, its capture and “transfer” across boundaries (Vuori et al., 2019). It is the different ways in which the actors (organisations and individuals alike) in particular situations make sense, understand what they do, and differentiate or use certain technologies that we refer to as knowledge-work. Such approach and understanding of knowledge-work builds heavily on process and practice perspectives that put acts as a locus of knowledge or

knowing (see Cook & Brown, 1999; Newell et al., 2009). The main barriers to effective organisational knowledge capture and “transfer” – to knowing – are closely linked to the knowledge nature, i.e., its stickiness, tacitness (Polanyi, 2009), and foremost its context-dependence, equivocality, and dynamic character (Newell et al., 2009). The issue is compounded when considering the complex sharing arrangements and the network-level knowledge-specific barriers in the inter-organisational network setting. Such barriers underlie the power dynamics, and the knowledge (a) symmetries due to diverse purposes and interests that the collaborating organisations have (Baptista et al., 2010).

An industry in which these challenges hold is the infrastructure industry. In particular, in megaproject, or Large-scale Infrastructure Project networks (LIPs) as a setting, where multiple organisations (public and private) work jointly to produce complex goods or services in a limited amount of time, and numerous knowledge flows co-occur (Manning, 2017). LIPs may be viewed as an inter-organisational setting with cooperative network relations in play (Hetemi et al., 2020). LIPs are complex project networks with the explicit purpose to arrange for collaborations that cross-institutional divides and “knowledge boundaries” bringing about innovation and sustainable infrastructure development. These characteristics imply that

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 Supplemental data for this article can be accessed [here](#).

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transforming and exploiting the knowledge that arises from LIPs is a challenging endeavour. While organisations in practice and researchers have recognised this as a problem, the mechanisms introduced (e.g., project learning reviews and maintaining project review) to enable knowledge transformation and exploitation from projects are in-effective (Newell et al., 2006; Swan et al., 2010). Particularly, the issues related to the network-level knowledge and the transdisciplinary practices in LIPs are seldom empirically studied.

In many reminiscences of the above perspectives, existing studies have discussed the links and made a distinction between knowledge and learning. However, the diversity of these studies makes it almost impossible to account for them all (Agostini et al., 2020). Yet, it is worth noting that assuming that network-level related knowledge can be easily transferred downplays the actual translation processes and the complex boundary settings in the inter-organisational project networks (Carlile, 2004; Marabelli & Newell, 2014). Few studies on learning from such settings have considered the knowledge-work perspective (cf., Newell et al., 2009), and hardly any discussed explicitly the mechanisms to transform instead of merely transfer the project network-related knowledge in a cooperative context.

Against this backdrop, the paper is positioned in and follows the emerging literature that sees knowledge-work and learning as a social and organisational activity, an iterative process among action and reflection (Newell et al., 2009). This paper aims at analysing the process of knowledge-work in LIPs as inter-organisational setting from the perspective of the project-owner. It is guided by the research questions of *How project-owners organise learning processes in LIP settings? Which mechanisms are more effective for transforming the knowledge from the inter-organisational setting to the project-owner organisation?* In conveying the research questions, the focus is particularly upon the knowledge transformation within LIPs level and the inflows and outflows of that knowledge and its exploitations in the project-owner organisation. This focus addresses and takes into consideration the existing research suggesting that knowledge transformation depends upon the pre-existing distribution of knowledge setting (Scarborough et al., 2004), and the organisational context and the extent to which the organisation is centred on the delivery of projects (Swan et al., 2010). Methodologically, the paper builds on a case study of a High-Speed Rail Line (HSL) in Spain. It uses qualitative secondary data analysis consisting of documents, semi-structured interviews, and observation notes.

After this introduction, the paper proceeds as follows: Section 2 provides the conceptual background. First, the authors contextualise the theorising by

discussing the peculiarities and challenging nature of the inter-organisational knowledge-work, and its transformation at the project-owner organisation. Section 3 presents the research design and methods, followed by the findings in Section 4. Finally, Section 5 concludes the paper by discussing some of the theoretical and practical implications, limitations, and suggestions for future research.

2. Conceptual background

2.1. Knowledge-work in the context of LIPs: a project-owner organisation perspective

Large-scale infrastructure projects (LIPs) endeavours are mainly delivered through a public-private partnership. Usually, the project-owner is a public organisation, which typically acts as both investor in and operator. These types of projects have a life cycle that often extends for decades and are mainly found in the telecommunications, aerospace, and energy industries, such as railroads, roads, and pipelines. LIPs are complex endeavours embedded in highly institutionalised social structures (Hetemi, 2021; Hetemi et al., 2021), probing innovation and high project interdependencies among the actors (organisations and individuals alike) involved are the norm (Newell et al., 2009; Willems et al., 2020). LIPs as an inter-organisational project context pose significant knowledge management and organisational challenges (Grabher & Thiel, 2015). Particularly, the inter-organisational project facet that allows multiple organisations to collaborate has received limited attention (cf., Sydow & Braun, 2018). Therefore, the knowledge-work within LIPs and the project processes in general are better understood through a closer examination of the project context and its history (Engwall, 2003). Precisely their relatively temporary nature, the structural hybridity and the complex institutional nature of large-scale projects, calls for explicitly connecting them as projects in context (Grabher & Thiel, 2015; Hetemi, 2021).

LIPs are a meeting point among different specialised organisations underpinning diverse interconnected practices with the purpose to create valuable specialised knowledge. Yet, the specialised knowledge developed in LIPs context concerning the project-owner organisational performance is rather paradoxical. Because, the purpose with LIPs to overcome the knowledge boundaries poses significant barriers to the integration of that very specialised knowledge created, its transformation and exploitation with the project's owner strategy and operations because there are often pragmatic knowledge boundaries, which are acute in LIPs (cf., Newell et al., 2009). Such pragmatic knowledge boundaries underlie the multi-organisational actors' specialisation and their differences in backgrounds, and interests in the

collaborative effort (Carlile, 2004). That is, whilst knowledge boundaries exist within LIPs and operate horizontally in the project setting, the learning boundaries, according to Newell et al. (2009, p. 109), “operate vertically, across nested levels of learning”. So, it is because of this learning boundaries that barriers for transforming knowledge across projects or to the project-owner organisation manifest. The issue of knowledge transformation from LIPs as coepetitive context is peculiar because there are some intrinsic differences in inter-organisational collaborations involving public actors that prevent knowledge transformation to the owner organisation and across the sectors. These differences stem from the idiosyncratic nature and the extra-organisational linkages posed by public actors. For instance, public actors are characterised as having higher-level interdependence across organisational boundaries, and red tape (Teo & Koh, 2010), which affects how activities such as information technology (IT) and others related to knowledge-work are carried out.

2.2. Knowledge-work, knowledge transformation, mechanisms, and learning processes

Few studies in inter-organisational project learning have considered and discussed knowledge-transformation mechanisms. Prencipe and Tell (2001) and Zollo and Winter (2002) introduced the notion of knowledge-sharing mechanisms in inter-organisational projects. Prencipe and Tell (2001) also distinguish three learning processes: experience accumulation, knowledge articulation, and knowledge codification. The effectiveness of these processes, however, is contingent on the organisational learning context (Swan et al., 2010), particularly upon the heterogeneity, frequency, and interdependencies between the actions required to perform the task at hand.

Fang et al. (2013) have critically reviewed the barriers of inter-organisational knowledge transfer through the perspective of knowledge governance and proposed a conceptual model to address the mismatch among the transfer barriers and knowledge governance mechanisms. The idea that knowledge-sharing mechanisms allow for active learning across projects has also been discussed in depth by Boh (2007). In this view, knowledge-sharing mechanisms provide the basis for showing how, on the one hand, individuals capture knowledge and, on the other hand, how knowledge in an inter-organisational context becomes organisational knowledge. Thus, as an analytical framework, the four knowledge-sharing mechanisms identified by Boh (2007) for distributed knowledge within and from the project-setting were employed:

- (1) individualised-personalisation,
- (2) individualised-codification,
- (3) institutionalised-personalisation, and
- (4) institutionalised-codification concerned the inter-organisational knowledge transformation.

According to Newell et al. (2009, p. 117) in complex projects as LIPs context “pragmatic knowledge boundaries are likely to be acute”. Therefore, the nature of inter-organisational relationships, e.g., networks, alliances, severely influences the knowledge transformation across projects and to the wider organisation (Agostini et al., 2020). Given the coepetitive relations in the LIP setting, knowledge transformation requires efforts and resources to foster interaction and develop collaborative mechanisms (Salvetat et al., 2013). Mainly because LIPs are characterised by ongoing innovation underlying project interdependencies, and asymmetric modes of collaboration, where the focal organisation – the project-owner – can only achieve efficient operational performance but finds it difficult to engage in relational, synergistic collaboration with other organisational actors (Hetemi et al., 2020). Given the above, this paper is anchored within the emergent approach to knowledge-work that views the relation of knowledge, its transformation and organisational performance as highly socially and politically constructed (Marabelli & Newell, 2014; Newell, 2015). This concerns understanding the nature of the complex interactions in the socio-technical systems. Following this view, innovation activities are highly relevant to knowledge-work. That is, the application of knowledge to new situations that help developing products, processes, and services are central for knowledge-work (cf., Newell et al., 2009).

The empirical work in the following will aim to identify, firstly, the knowledge-transformation mechanisms in LIPs context in an attempt to elaborate a close to the context contingency framework that proposes conditions effectively linking knowledge-work from the LIPs inter-organisational project network setting to the wider project-owner organisation.

3. Research design and methods

The research design for this paper is based on an in-depth case study (Rowley, 2002). This approach was chosen for two reasons. Firstly, because it offers the opportunity to investigate knowledge-work processes in-depth and is widely accepted suitable for gaining an understanding of a multidimensional phenomenon. Secondly, it allows for a stream of multiple sources of evidence through, for example, direct observations, interviews, and document analysis, which improve the overall quality of the study analysis and enable corroboration.

3.1. Research setting

The case study was conducted on the Madrid–Barcelona high-speed rail line LIP (HSL) in Spain. The HSL project setting was a nexus activity that allowed multiple organisations to collaborate. It was without a doubt, a complex LIP, with an extended-over two decades life cycle. Apart from Adif (the project-owner and manager of the Spanish railways), the project network organisation also involved other actors (e.g., specialised suppliers and other contractors). Adif used a network of over 20 worldwide partners to develop the HSL project. For example, Siemens and Talgo/Bombardier were cooperative partners and designed the train, while Thales and Siemens provided rail safety and traffic control technologies.

There were three main criteria for selecting this particular case. Firstly, the authors wanted to explore not only how Adif employed the mechanisms for knowledge transformation and related to exploiting the knowledge created in the HSL project but also what one could learn from the owner context and its position in the delivery of projects. Secondly, the studied project had to be partly completed to allow knowledge-sharing patterns to be analysed. Thirdly, most importantly, it provided access to potentially rich critical data including official and newspaper reports, meeting minutes, etc.

3.2. Data collection

The data for this study span over 15 years. It involved secondary data including project documentation, 17 semi-structured interviews with the management of Adif, PPM, PMs, and other members from specialised suppliers and contractor and (participant) observations (2015–2018). In the following, the primary data collected subset, which is utilised for the secondary data analysis is described (Dufour & Richard, 2019). The employed data subset involved two data collection periods; the first period concerned what took place between 1996 and 2010. During this period of data collection, nine interviews with those involved in the project were performed in addition to the document analyses of the HSL project. To gain an in-depth insight and to reach theoretical saturation, the second period of data collection at Adif was conducted. This second period of data collection took place between 2015 and 2018 and involved 13 more interviews. At this stage, an insider/outsider approach (Louis & Bartunek, 1992) was used where one of the authors acted as an “insider” while performing interviews and observations within a management environment. The other authors acted as “outsiders”, thereby integrating diverse perspectives on empirical settings.

Given the suggestions of earlier studies that portfolio managers have a greater overview of the knowledge created across projects (e.g., Newell et al., 2009). In both periods, two types of interviewed respondents were considered: the Project Portfolio Manager (PPM), i.e., those responsible for multiple projects (high-level interviews), and Project Manager (PM), i.e., those responsible, in some capacity, for a single project (low-level interviews). The interviews in both periods were semi-structured and lasted 60–90 minutes. All interviews involving the management of Adif, PPM, PMs, and other members from specialised suppliers and contractors (Organisations A, B, and C) in the HSL project were audio-recorded and transcribed with the interviewees’ consent. In between the formal interviews, informal contact was maintained with the management via email and telephone. For space reasons, the subset of the primary data collected, which is utilised for the secondary analysis is summarised as a data supplement, see Table S1.

3.3. Data analysis

In this qualitative secondary data analysis, an in-depth examination of the emergent narratives of the data that were not addressed in the earlier studies was undertaken. The approach to data analysis followed the guidelines and the criteria to overcome the limitations of the qualitative secondary data analysis (Dufour & Richard, 2019). The analysis process was more iterative than linear in character, involving revisiting and progressively refining the data. The first and second authors who participated in the research data collection teams revisited each transcript to ensure that they were all anonymous. Following the case study protocol (Rowley, 2002), during the first-order analysis, the case history was revisited and the first and second authors gave insights about the primary studies, bringing on board the third author with the research and social context.

In line with the purpose of process studies (Langley, 1999; Langley et al., 2013), the authors scrutinised the subject by relying on observation notes. This close perspective throughout both data collection periods helped to understand how the management team organised its activities. Moreover, the interviews helped to explore further how the project workers coped with different issues. However, other events required a more general view, stepping back to detect, for example, the effects of the industrial practice. Following the process view, the concept of “temporal bracketing” was used (Langley, 1999), creating two distinct periods, T1 (1999–2010) and T2 (2009–2018), to sequence the processes and events chronologically for analytical purposes.

In the first-order analysis, the case description was discussed to make sense of the project-owner learning processes in LIP set. Particularly, regarding how the industry level and the peculiarities of the (inter-)organisational project context – their temporary dimension influenced the project owner’s knowledge-work. To this end, the interviewees’ descriptions and other documents (i.e., industry regulations, and the entire project folder) were analysed to understand how Adif organised the learning processes. The focus was directed on events considered essential, and that could be traced back to several years. Besides, the project documentation and reports were considered concurrently with the interviews and observations, both as a continuous data validation effort and to increase understanding of the interviews and observations. In the second-order analysis, the authors aimed to understand which mechanisms were more effective for knowledge transformation from HSL project as the inter-organisational setting to the project-owner organisation. At this point and given the longitudinal analysis, certain dimensions needed to remain stable throughout the analysis, allowing meaningful conception.

After sampling the primary data collected, i.e., the data were arranged by categories and unit of observations, then transcripts were compared over time. The already arranged data into different arrays were noted for the frequencies of different events and initial coding themes emerged through pattern matching (i.e., comparing the empirical-based pattern with the theoretical logic about each learning process and knowledge transformation mechanism). Given the limitations and to avoid the pitfalls of the secondary data analysis (Dufour & Richard, 2019), the authors coded each dimension and the identified knowledge transformation-related mechanism (personalisation vs. codification, institutionalise vs. individualise). Hence, the effectiveness of each identified mechanism was considered, and the authors identified the positive and negative statements from the interviewees on the knowledge transformation. Both co-authors independently coded the text for each knowledge transformation-related mechanism. After the final coding process, the coding was shared and agreed on 92% of coding as perceived from the interviews, and then the authors discussed the disagreement. The summary of the results of the final coding is shown in Table 1.

Finally, the authors focused on axial coding to identify the second-order themes (Gioia et al., 2013). From this part of the analysis six themes emerged:

- (1) Industrial practice effects,
- (2) Organisational arrangement,

- (3) Individualised personalisation,
- (4) Individualised codification,
- (5) Institutionalised personalisation, and
- (6) Institutionalised codification.

4. Findings

4.1. Period T1: the antecedents of knowledge transformation linked to the industry and organisational arrangement (1999–2010)

4.1.1. Industrial practice effects

On November 17 2003, during the HSL project, the railway sector was reorganised, laying the foundation for new players to enter the market. Adif was adopting a “learning by doing the process” as project-owner. At this point, the impact of project learning transformation was manifested through the industry-specific guidelines. When the adoption of standardised industry practices spread from project to project (including the international market), the actors involved developed a shared understanding, which helped them to coordinate their objectives and accomplish their work. In the HSL project, these practices were implemented partly through the European Rail Traffic Management System (ERTMS 2) to ensure compliance with the signalling and safety requirements (Report, 2012). Besides, the management and project learning practices at the project level were influenced by both industry practices and the regulatory framework in the public sector.

The public procurement law [Spanish: *Ley del Contratos del Sector Publico*, Ley 30/2007, p. 4391] shaped the management’s choices and activities by reinforcing work divisions based on cost limitations. The project was divided into multiple packages, and the project management had to make regular choices of individual work packages that simultaneously influenced each other. In this context, the management at Adif and the private actors performed their work through repeated interactions in several work packages. Continuously combining and repeating the practices of two or more project actors generated added value for private operators, but not for the project owner or the project in general. According to the informants, the actors in the project pursued joint objectives, which helped them complete the work instead of implementing the best available options and, thus, fostering the knowledge for the project-owner:

Within the project, we were pursuing joint objectives with our partners: we adhered to the use of complementary management systems set by the owner (the public arrangement), even though we were more advanced in some ways – in technology adoption, for instance. (Interview with the engineer at Organisation B, June 2008)

Table 1. Summary of results: coding of positive and negative statements for each knowledge-sharing mechanism.

Code	Mechanism description	Madrid–Barcelona HSL project		Adif permanent organisational setting	
		temporary inter-organisational setting		Positive	Negative
<i>M 1</i>	<i>Individualised – personalisation</i>				
M 1.1	Word of mouth sharing through senior staff	11	2	9	-
M 1.2	Personal networks	19	1	15	-
M 1.3	Collaboration tools	8	-	11	-
<i>M 2</i>	<i>Individualised – codification</i>				
M 2.1	Sharing prior project documents informally	4	1	5	2
M 2.2	Manuals are written voluntarily	1	-	2	-
<i>M 3</i>	<i>Institutionalised – personalisation</i>				
M 3.1	Meetings among high-level staff	2	4	2	1
M 3.2	Project reviews	1	5	3	2
M 3.3	One senior person coordinating all staffing needs	3	3	2	-
M 3.4	Having a common project director shared across projects	2	-	3	-
M 3.5	Cross-staffing across projects	5	1	7	3
M 3.6	Setting up a community	-	-	1	-
M 3.7	Support centres	-	-	1	-
M 3.8	Staff deployment policies	3	1	5	2
<i>M 4</i>	<i>Institutionalised – codification</i>				
M 4.1	Database	3	8	2	7
M 4.2	Use of templates	2	1	1	-
M 4.3	Broadcast emails and forums	-	2	3	-
M 4.4	Expertise directory	2	1	5	-
M 4.5	Standardised methodology	3	7	2	1

^aNumbers in the cells refer to the number of interviewees who have provided positive and negative comments about each knowledge-sharing mechanism.

Adif approved an internal guideline in 2005 that regulated in detail the internal procedures for contracting the public entity. This strengthened the management position within the HSL setting. Because it was under government regulation, Adif's management established a phased review-based model. Surprisingly, the authors observed a lack of motivation among Adif's management to implement good learning practices for the organisation itself. Instead, the behaviour that reinforced repetitive choices gained legitimacy and greater acceptance from the project members. After reaching the project's half-way point, the Head of Infrastructure described the importance of continuous learning in the project:

[It] is important to have a strong relationship with the partners for smooth delivery of infrastructure and the purpose of learning. We need to learn more about the capabilities and the behaviour of our collaborators. (Interview, Head of Infrastructure at Adif, June 2008)

4.1.2. The organisational arrangement and its influence on the organisational project learning

There were delays in the HSL project process that resulted in significant adjustments that affected its implementation and knowledge management (Report, 2013). The PM at Adif outlined the implications as follows: "There is no time to carry out a feasibility study properly or to evaluate infrastructure needs. There is no time to lose". (Interview with former HSL PM, December 1997.) This posed challenges for the project owner's organisational learning, requiring specific competence and technical skills. Within Adif, projects were, in most cases, divided between specialist teams located at the Spanish regional headquarters. These specialist teams (the internal project stakeholders at Adif) worked with a range of suppliers and (sub)contractors. The project involved three main internal stakeholders: (1) the construction and engineering team, with a focus on large-scale projects; (2) the operations and engineering team; and (3) the infrastructure exploitation team. These specific teams were not involved in the project at the same time, posing severe challenges for the project's learning and implementation process. For instance, only the engineering team was involved early on in the project and not the other two teams, which influenced the future interactions and their understanding of the knowledge build. The issues were discussed locally, and the specific teams were not aware of the challenges and potential barriers that they faced. Therefore, the attempts to manage knowledge were locally focused. The project workers had to relate to and make sense of different teams' opinions and processes, but not all of them were aware of the implications. The Adif PM described how the management was affected:

It was challenging to deliver our part of the project. I had to relate to and analyse the work repeatedly and intensively, not only for the task at hand but also concerning the following package(s). (Interview with Adif PM, October 2016)

However, not all team members had access or sufficient time to resonate and relate to the macro level. Because of the uniqueness of context, the technology, and due to the project organisation's experience of change in structure, there was an impact on project learning. A member of the Adif project team highlighted the following:

Lots of unforeseen issues occur. We experience pressure, and we have to fulfil our work responsibilities promptly. The problem is that the line is segmented, and each segment is subdivided. We provide the platform, and then other actors come along. We are engaged in civil work – not in telecommunications, electrification, or signalling, each of which influences the work differently. (Interview with a project team member at Adif, March 2017)

The organisational members performed their work under different team structures. Thus, the team members were focused on getting the work done, while at most concerned with capturing the product knowledge but not the process knowledge: “[Everyone] works for it and gets it done” (Transcript of a research-related meeting with Adif management, April 2006.) The issue of alignment within the internal teams was raised by a member of Adif’s management, who highlighted the following:

I work closely together with the engineering and design team, and I prioritize and reprioritize work according to their requests. They are flexible to some extent, but they have a program pattern, and they need to deliver accordingly. We could improve the learning process and gain mutual benefits, which we currently do not have. (Transcript of a research related-meeting with Adif management, June 2017)

Nevertheless, Adif’s senior staff were somewhat concerned with the knowledge gained from the project halfway through the process. But this only became obvious halfway through the project. In contrast to the local teams, the management saw potential learning paths and possibilities. The project’s uniqueness as conceptualised by project members was not appropriate, as many related projects within the organisation dealt with similar technology- the management foresees. Our project informants (senior staff) highlighted the importance of continuous improvement through learning:

[My] job is to run the development and construction program: to put in place arrangements for developing and implementing projects that enable continuous performance improvement. One obvious objective is to make Adif a modern owner by improving our working routines while learning from projects in the international market. (Transcript of a research-related meeting with Adif management, May 2008)

Several reasons emerged from the data, and we realised that in the HSL context, even though Adif owned almost all rail infrastructure by law. The organisation did not have sufficient in-house resources to manage large-scale projects without the support of external actors. Other project management organisations and consultants were used to fill this gap. However, Adif’s in-house resources were sufficient to assess contracts and to check to some degree their operational and technical implications. These and the context of knowledge-work mechanisms are described next.

4.2. Period T2: knowledge-sharing mechanisms in action (2009–2018)

4.2.1. The predominant use of individualised-personalisation mechanisms

Since the guidelines did not help the project members and there was no formal documentation or learning lessons from other projects described the problems

encountered, Adif’s management postponed the decisions they had to make in each phase in an attempt to solve their problem. Throughout the HSL project, the fundamental mechanisms for sharing and transforming the knowledge were the individualised mechanisms, which were mostly oriented towards personalisation. Here, the more senior staff were used as a point of reference and as knowledge-springboards. That is, many project members at Adif used word-of-mouth methods and contacted senior staff in their network to find answers to their questions. As shown below, the interviewees developed their understanding mainly based on interpersonal contacts. The Adif project member reflects:

[I] have approached the senior quality controllers in our team several times. They seem to have an overview of the project, and they have many years of experience in the field which helps them come up with good solutions related to the project work and the knowledge created in work packages. (Interview with an engineer at Adif, April 2016)

However, there was a serious threat in depending on personal networks because of the project size and the difficulty encountering the source of knowledge – the more senior staff – when they were needed the most. Other forms of communication, e.g., emails, were used but were less appropriate for the Adif project team. As described, Adif members adopted a strategy of relying on more senior individuals, which were not reached out easily. As an Adif project team member recalled:

Many times, I would look to find someone. [But] no to no avail as they reported to different work sites within the project. I then decided to drop an email, or better, call directly and ask about their suggestions. So, I learned that [It] takes a bit of time actually to get their view and help. (Transcript of a research-related meeting, April 2006)

In such a context, the schedule slippage proved detrimental for the project (Report, 2017). The project member at Adif recalled these circumstances:

There are times when you simply cannot foresee the solution to something, and within our project, this seems to be the norm. (Interview with a PM member at Adif, March 2017)

There was no ongoing register describing what could be done apart from picking brains and contacting more senior and experienced individuals. Adif project team members relied on informal communication: “Me and my team, we want to do the right thing. [But] . . . there is no guideline or protocol as to how we deal with this . . .” (Interview with Engineer at Adif, June 2008.)

4.2.2. Individualised-codification mechanisms

The individualised-codification mechanisms involved individual documents and other project artefacts shared at the individual level in an ad hoc manner

(Boh, 2007). Such mechanisms encompass all existing knowledge related to the individual and their experience from previous projects and lessons learned, including various artefacts, e.g., project plans, project reports, project-owner presentations, and other lessons learned. According to the informants, in addition to the strategy of following senior individuals, they learned to cope with the drifting context by drawing on multiple (note) informal project document resources. Besides, Adif project team members stressed the fact that the issue was not about finding useful information but instead revolved mainly around the idea of what type of information was available during the project and where to find it. One interviewee noted:

(D)iscussing over a cup of coffee, help and ideas for potential solutions like a presentation or a drawing of similar tasks or informal process manuals, were shared. (Transcript of a research-related meeting, November 2017)

Besides, as described by the project engineer from the construction engineering team, “When I worked on the Madrid–Lleida HSL segment, we dealt with unexpected issues . . . I considered any relevant template for the process and asked for directives. At some point, and after many challenges, I learned to set some useful steps aside, created my tasking method, and went back to those when needed”. Many of those who participated in the Adif team continued to rely on sharing previously useful documents informally. They continuously combined and edited their own “manuals” by repeating the practices at project sites.

4.2.3. Institutionalised-codification mechanisms

The institutionalised-codification mechanisms involved the use of IT-mediated mechanisms that create electronic repositories for storing, searching for, and retrieving information. For example, databases, expertise directories, standardised methodologies, best practice portfolios, design templates, etc. Thus, the authors approached the empirical site, enquiring whether the HSL project and, in particular, the Adif team relies on lessons learned or solutions developed from past projects and whether these were formally stored in an organisational database. The authors found, the HSL project folder was not stored in the cloud, and the folders that reflected the organisational structure and other process works were mainly paper-based at initial. The fact that the implementation of high-speed technology had been recently introduced in the Spanish context was not without consequences. Still, the project team relied on interpersonal learning and adhered to the “get it done” strategy to cope with it. Nevertheless, concerning the codification on its own, one of the senior managers at Adif commented that

We store data and information relating to project procurement. We have a basic platform that relies on Excel and other file types storing information on our organisational hard disks [storing data/information on contractors’ bidding processes] including information on the tendered amount, contract winner, etc. (Transcript of a research-related meeting with Adif management, April 2017)

The contents of this folder were based on a hierarchical structure. There were five types of contracts that were reported, according to Adif’s strategy of procuring five different kinds of arrangements based on specialities. However, the folder was shared only with a few relevant individuals within the Adif organisation (mainly from the financial department!), and it was not available for general purposes within the project learning process. Nor was it properly structured or user-friendly. Halfway through the project in 2009, Adif migrated the data to the SAP Enterprise Asset Management. Yet, the constraints remained, i.e., the access was still limited, and the focus was on knowledge output. Some of our interviewees reflected on the fact that it contained a lot of content, but that this information was difficult to find and make use of. The account manager who maintained and updated this database/folder at Adif provided an example of its impractical state:

The idea is to capture the changes in the scope of work and track and address them properly in the next line segment. [But] after multiple entries, it became messy, and it is difficult to update it accordingly as it is not system-based. It relies on manual updates [. . .]. (Transcript of a research-related meeting with Adif management, November 2017)

Finally, the main pitfall of such a folder based on IT artefacts was that while it helped to track key IDs, for instance, and find out who the leading partner of the particular work package is. It did not contain any explanation of the process work, the reasons why specific contracts were delayed, or any other “softer” lessons that could help the project management team.

4.2.4. Institutionalised-personalisation mechanisms

Considering the complexity and the large scale of the HSL project, the Adif project team members, although site-based, as indicated earlier, they had also interactions remotely with their peers and more senior staff in particular. Given the simultaneity of the various works, the multiple changes within the project, and the fact that Adif was understaffed to manage the work performed, a committee was created. The committee’s purpose was to monitor the work and enable an exchange of knowledge beyond the focal (Adif) organisation itself, with an emphasis on monitoring. The follow-up committee meetings were unified at joint

sessions where the subjects of all the works being carried out were discussed. All the minutes are available except for the last one (Report, 2013, 2017).

The minutes corresponding to the second, seventh, and twelfth sessions are unsigned. Yet, again the committee did not respect the established quarterly periodicity. It did not carry out rigorous follow-ups to minimise and learn from the numerous irregularities in the implementation of the work, and in the HSL project learning process. However, in the HSL project context, a successful institutionalised-personalisation mechanism seems to be the cross-staffing across the project. To illustrate this, one of our interviewees participated in all stages of the project, first as an engineer (2002–2007), then as PM and Technical Coordinator (2008–2016), and more recently (post-2016) as part of the senior management team involved in finalising the work issues related to the first-line segment. Hence, Adif focused on exchanging staff back-and-forth for learning purposes (Report, 2012). Finally, because many work packages at project level required modifications, and there were no useful guidelines, the authors conclude that Adif management's actions to cope with the circumstances relied foremost on interpersonal relationships.

5. Discussion and conclusions

The findings illustrate that initially the industry norms and regulations provided the platform and the span of knowledge through practices and procedures and their role expectations, thus, facilitating the activities to consolidate knowledge-work at the project level. This occurred particularly during the project arrangement – the first period – when neither the problem nor its solution was well defined. That is not to say that internal purposeful knowledge-sharing and transforming mechanisms were not operating during the first period. Indeed, they did co-exist, but the emphasis was on the influence of industrial features and organisational arrangements. The first aspect of this research supports other findings from qualitative studies (e.g., Swan et al., 2010), which argue for a more contextual approach, and reaffirms the importance of institutionalised knowledge governing. While not entirely new, such an understanding is highly relevant for project-owners operating in a competitive context. In this context, the industrial features and, to some extent, the organisational arrangements took the place of the institutionalised mechanisms, particularly at initial but also throughout the project implementation. Nevertheless, as illustrated, Adif's management faced severe difficulties to align the knowledge-work and learning processes with the industrial features, i.e., it did not transform them in their knowledge governing process. For instance, the industry practice and

norms were often seen as another requirement to be fulfilled during the project implementation, noted by the tendency to “satisfice” in deadline situations.

During the second period, internal HSL project dynamics were dominant, and the management of knowledge was designed around engineering milestones and conveyed through individualised-personalisation mechanisms. The creative and customised nature of the HSL setting required interpersonal communication and interaction among the project team to foster knowledge-transformation within the individualised network. The role of project leaders and senior staff as intermediates was a prominent source of knowledge in such contexts. These social ties (i.e., the intermediates) should be emphasised in the process structure of knowledge base and its transformation that helps create project-owner organisational learning, which was difficult to find in Adif's organisation (Wannenmacher & Antoine, 2016). Adif engaged with the institutionalised-codification mechanisms by setting up a database. As described, the database was directed to the project knowledge product (i.e., an output-oriented knowledge), and the management was less aware of the process of knowledge creation. Adif focused and stored the contract-related information in the database. However, a proactive approach was not identified, with a system manually based, not providing adequate knowledge of contractors' behaviour about past tasks, and it generally lacked the knowledge process and a life cycle overview of the actual project tasks. As such, it provided access to few Adif HSL team members, oriented primarily as a control tool (still limited), and was in-effectual for the knowledge-transformation and its exploitation purpose. In this regard, our case study shows that there was a tentative purpose for the use of an institutionalised-codification mechanism, but this was not process-oriented and was conclusively in-effective. Hence, and contrary to usual arguments, the adoption of Enterprise Management systems and other ICT-related tools leads to effective knowledge-work. In this case, and for the reasons presented, it did not.

5.1. Implications for theory and practice

Inter-organisational project networks have gained prominence as organisations are blurring their established boundaries and are continuously relying on various forms of external collaboration. Yet, it appears, that while the world of practice has been changing dramatically in a direction that sets ever greater importance on the management of knowledge-work beyond the boundaries of the organisation. Our theorising of knowledge-work is continuous with the individualistic knowledge bias – to “capture” and “transfer” individuals' knowledge – focusing to identify important tacit knowledge, make it explicit, and

convert it back again into the tacit knowledge of others elsewhere in the organisation (Newell, 2015; Newell et al., 2009). Taking a reflective and critical approach, this paper builds on rich empirical research, which enabled a fine-grained understanding, painting an overview of both collective as well as individual knowledge-work processes as asked for by others (see Marabelli & Newell, 2014). That is, by anchoring on the process approach to knowledge-work, the paper examines how the knowledge-work process, its transformation and exploitation were interactively produced.

This paper's contribution to the literature on knowledge-work is twofold. First, it advances the discussion on knowledge-transformation as compared to the mere transferring discourse from the inter-organisational project settings as LIPs. The research case underlines that knowledge-work, in LIPs, thus requires higher-level engagement and the development of dynamic cross-project learning capabilities (cf., Newell & Edelman, 2008), or boundary capabilities as translating, or transforming as compared to the mere transferring ones for managing knowledge-work across the existing threefold boundaries, namely syntactic, semantic, and pragmatic (cf., Carlile, 2004). Also that the "management" of knowledge-work in LIPs is less about control and capture of knowledge in mechanistic terms and more about enabling contexts and fostering collective learning practices. Second, given the LIPs complex arrangements and learning processes as a result, it is not possible to put forth a particular guide or principle that delineates precisely the extent to which the project-owner organisation should enact knowledge-work and transforming mechanisms should be adopted. As Newell et al. (2009) have convincingly argued, narrowly focused prescriptions derived from conventional knowledge-management literature are simplistic, and thus propel functionalist tendencies which are not suitable for turbulent environments as the case of LIPs. With such criticism in mind, in the following, the authors' main contribution is the contingency framework proposed, highlighting both enabling and the existing barrier contexts.

In conclusion, and given the possibility of process or product knowledge emphasis orchestrated by the industrial practice, the project-owner organisational arrangement, on the one hand, and the senior, and programme management awareness or emphasis on individual or institutionalised-based knowledge, on the other hand, feeds into the contingency framework this paper puts forth. Figure 1 outlines the key contextual conditions that give rise or provide processes for different knowledge-work, and the related problems identified in four quadrants. On the horizontal axis, the possibility for different knowledge created is highlighted. On the vertical axis, the individual or institutional-based knowledge is shown.

5.2. Contingency framework of knowledge-work in LIPs

The proposed framework comprising the four contexts and the underlying conditions identified poses different knowledge-work problems. The left-wing quadrants – the silo or limited and controlled contexts – compound product-type knowledge focus with individualised and institutionalised level emphasis. Throughout the LIPs life cycle, these were the dominated contexts and conditions underpinning the project-owners limitations for transforming and exploiting the project-network related knowledge. Mainly due to discontinued work processes, and the knowledge regime that set in motion organisations 'black-boxing' strategies with a short-term focus to capitalise the return from the project, rather than engaging in collaborative and trust-based approaches that propel value for the future (Newell et al., 2009; Ricciardi et al., 2021). In such conditions, there are ramifications and several important practical implications: firstly, knowledge-transforming mechanisms need to be aligned with the organisational arrangement and industry.

Secondly, when considering the LIP setting, the organisational complexity, and its size, learning through interpersonal mechanisms, and relying solely on one's network presents a challenge (Bresnen et al., 2003; Hartmann & Dorée, 2015). Yet, although the right-wing quadrants – the substantial and far-reaching contexts – seem promising, different problems emerge there also. The problem in the upper right – the "substantial" context – conflates process and individualised level knowledge-type. Unlike quality controllers and their orientation observed with the product-type knowledge at the individual level in the LIP setting; in this context, PPM did set in motion useful practices for transforming and potentially exploiting the knowledge at the Adif organisational level, unfortunately. Although these conditions allowed parties to effectively collaborate at the HSL project level, they were short-sighted and in long-term fostered the internalisation of uncooperative behaviour at the project-owner organisational level. Adif gave a useful role by promoting programme-managers further, but the knowledge remained with them, perhaps due to the very additional engagements. That is, in the organisational process knowledge structure, interpersonal individualised networks and intermediates should be fostered (Boh, 2007; Bresnen et al., 2003), and more formal institutionalised knowledge-sharing should be aligned with the organisational context and the overall process. Yet, being cautious for potential "dark sides" of knowledge institutionalisation (Baptista et al., 2010). In other words, the standardisation of knowledge underscores the formal

Knowledge work		Product-type knowledge	Process-type knowledge
		Knowledge basis	
Individualised	1. Silo and limited context	2. Substantial yet short-sighted context	
	Characterized with content in alignment with internal project teams' experience and their preferences and with limited degree of collaboration between other actors. It is important to understand how the knowledge created will migrate to the long-term organizational setting, the focus should be in the use of WS or SGs tools to analyze the established policies and adopt them by feeding the newly created knowledge, thus fostering and sustaining learning processes.	Characterized with individual awareness, scrutinizing process learning from industrial guidelines and translate it to the HSL context, the governing process and the individual project member. PMs should work actively to align the actors' desired outcomes by organizing specific thematic workshops, particularly at this early stage enabling collective sense-making, which is key in creating new ideas and generating commitments within the project network. To feedforward learning from the individual to the group by enabling reflective analysis.	
Institutionalised	3. Controlled yet in-effective context	4. Far-sighted yet fragile context	
	Characterized by different databased development settings and the usage of ICT based tools. Fosters learning beyond interpersonal relations; providing 'knowledge map' to project members that depict the location of different types of expertise. Thus, creating a structure supporting functional classification and categories. It enables effective knowledge sharing; Adherence to industrial standards blindly by the Inter-organisational team should be subject to review and validated by the committee with the focus on long-term project serving.	Characterized by supporting structure(s) with a long-term interest in organizational learning. Links the project structure with the knowledge architecture to organize the content and address the adhocracy in a project level. Yet, risks paradoxical effects related to institutionalized knowledge- automatically pushing key knowledge-work issues into the background.	

Figure 1. Contingency framework linking the knowledge-work in LIPs and its transformation to the project-owner organisation.

institutionalised mechanisms, which self-produce the limitations of the reach-and-richness trade-off in LIP settings.

Finally, in the lower right quadrant – the *far-sighted* context – labelled fragile because it propelled paradoxical effects. Hence, although the presence of institutionalised push for process knowledge lacked. There were tentatives observed and when did happen, it discouraged collaboration among the senior, and programme management (cf., Baptista et al., 2010). This context gave the impression that the Adif organisation was learning but it automatically puts key knowledge-work issues in the background (Marabelli & Newell, 2012). Besides, IT-based artefacts can be useful only if they reflect a sense of social bonds and human behaviours together with the complexity in LIP contexts. Indeed, there is potential for IT-based artefacts, they can advance knowledge exploitation, but only if they are aligned with the project members' use of them in their daily operations within the project implementation process.

In conclusion, the contingency framework that this paper puts forth is a step towards a more generic theoretical synthesis that addresses the issue of

the failure to “managing” knowledge-work in and from LIPs, showing that more process knowledge-type that links the individual and institutionalised level knowledge in the LIPs setting is needed. An additional added value for the contingency framework is that it can help organisational structures in identifying appropriate strategies and enabling contexts for knowledge transformation from project individualised perspectives into institutionalised permanent project-owner organisation setting, which is currently missing in practice. Actually, when a classification of product or process knowledge needs is created, representing the time-based actions implemented into the framework will provide additional insights both, about intrinsic and transformations raised sequentially (process perspective), but also about successfulness of paths (in particular when illustrated contexts from other quadrants can provide solutions to the identified needs in other quadrant), and critical mass required for set of actions to define additional endeavors.

Yet, simply noting that LIPs knowledge-work is a multi-layered-embedded knowledge is not a satisfactory theoretical approach. It is very relevant

to emphasise that neither for product-oriented knowledge nor for process-oriented knowledge a single action will transform or disseminate the created knowledge at the organisational level. When the focus is the project-owner organisation, given its role, higher emphasis is needed for the process knowledge-work as relevant part of the knowledge creation starts from partners, but it is needed at the project-owner for further consolidation. Therefore, process knowledge perspective needs to be undertaken as the new normal. However, still is relevant the product-oriented knowledge, and even more when exploitation of assets are concerned; thus, the identified contexts from the whole framework are meaningful.

5.3. Limitations and future research directions

The authors recognise that the single case-study of the Madrid–Barcelona HSL project allowed for only an analytical generalisation of the findings (Eisenhardt & Graebner, 2007). Despite providing an in-depth understanding, however, the authors encourage to examine knowledge-work processes involving multiple-case studies. This line of work can be further extended to compare the contextual conditions identified in the framework provided (see Corallo et al., 2012). Thus, despite these limitations, the authors are convinced that the findings could stimulate future research in several research directions related to knowledge-work in inter-organisational and network collaborations.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This paper is produced as part of the EMJD Programme European Doctorate in Industrial Management (EDIM) funded by the European Commission, Erasmus Mundus Action 1. The authors express their gratitude to Adif Management in Spain, to the interviewees, for their support and openness in discussing all the issues during the research. An earlier version of this paper was presented at the EURAM 2020 European Academy of Management Conference (SIG Project Organizing).

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