**Knowledge sharing in an interorganizational setting: Empirical evidence from the Orange Line metro train project**

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Knowledge sharing in an interorganizational setting: Empirical evidence from the Orange Line metro train project

Abstract
Purpose: This paper focuses on knowledge sharing process in an interorganizational setting. For this purpose, the context examined is the Orange Line metro train project in Pakistan, in which multiple organizations are involved.
Design/methodology/approach: This article adopts a single case study approach. Our empirical data comprises semi-structured interviews and archival data. Thematic analysis is used for analyzing the data.
Findings: We identify distinct mechanisms of knowledge sharing which include (i) knowledge sharing tools, both formal and informal; (ii) types of knowledge, i.e. tacit and explicit knowledge; and (iii) levels of units such as individuals, teams, organizations (internal knowledge sources), and the interorganizational level (external knowledge sources). Based on our findings, we propose an integrative model of the interplay between knowledge sharing tools, types of knowledge, and levels of units. Furthermore, the findings depict that the knowledge sharing tools and types of knowledge are important at different levels of units, but their importance may vary depending on whether they are primary or supporting for different levels of units.
Originality/value: This paper contributes to the literature on knowledge-based theory by examining knowledge sharing in an interorganizational project. The proposed model deepens our understanding of the practices and processes of interorganizational knowledge sharing.
Keywords: Knowledge sharing tools, Types of knowledge, Levels of units, Interorganizational project

Introduction
In the strategic management literature, knowledge is emerging as the most strategically significant resource of the firm (Inkpen, 2000; Zack et al., 2009). Knowledge is defined as a resource that is valuable, rare, difficult to imitate and non-substitutable (Thornhill, 2006). In this sense, knowledge management can be seen as consistent with resource-based theories of the firm (Grant, 1996), while competing on knowledge as a single resource could be quite difficult for others to imitate (Earl, 2001). Knowledge management within organizations is widely recognized as being important (Jarvenpaa and Staples, 2000). The management and processing of organizational knowledge is increasingly being viewed as critical to organizational success. Although most knowledge management processes are effective (Inkpen and Dinur, 1998), academic attention is particularly given to the knowledge management processes which aim to improve organizational performance (Earl, 2001; Zack et al., 2009; Shujahat et al., 2017).

Researchers have investigated knowledge management factors such as enablers, processes, and performance (Szulanski, 1996; Syed-Ikhsan and Rowland, 2004). Prior research has mostly been concerned with the storage, sharing, and creation of knowledge (Powell et al., 1996; Argote et al., 2003; Shujahat et al., 2017), knowledge application (Alavi and Leidner, 2001), knowledge integration and acquisition (Grant, 1996), and knowledge management barriers (Oliva, 2014; Oliva and Kotabe, 2018). In addition, recent research on interorganizational projects has mainly focused on interorganizational relationships such as joint ventures or alliances (Inkpen, 2000;
Lumineau and Oliveira, 2018; Agostini et al., 2020), interorganizational collaborations (Van Marrewijk et al., 2016), and interorganizational team building (Manning, 2017). Despite growing interest in interorganizational projects, the existing research continues to report limited evidence of interorganizational knowledge sharing (Swan et al., 2010), particularly in science and technology parks (Balle et al., 2019) and the hospitality industry (Idrees et al., 2018).

Interorganizational projects are temporary and complex, involve interdependent tasks (Lundin and Söderholm, 1995; Jones and Lichtenstein, 2008), and typically involve several organizations (Manning, 2017). Shujahat et al. (2017) described how all the elements of knowledge management processes complement each other and are as important as each other but knowledge sharing is more significant as the knowledge resides within an organization is of no importance until shared. Moreover, knowledge sharing is a central process which links other knowledge management processes and practices together. Without knowledge sharing it is difficult for an organization to take full advantage of knowledge creation (Dow and Pallaschke, 2010). Knowledge exists not only within organizational boundaries, but also outside the organization (Silva et al., 2018), i.e. in the organization’s’ internal networks (Thomas-Hunt et al., 2003), as well as in their networks linking them to other organizations (Uzzi and Lancaster, 2003). Organizations tap into outside sources and gain useful knowledge; in particular, they need to access complementary external expertise to help solve novel problems. It is important to use external sources of knowledge, but this topic has received limited empirical research attention to date (Foss et al., 2013). Typically, in an interorganizational project, organizations work together to produce a desired product or service which cannot be achieved by the stand-alone organizations.

Knowledge sharing in interorganizational contexts has become increasingly relevant. However, interorganizational projects encounter challenges in terms of knowledge sharing for the accomplishment of tasks (Alsharo et al., 2017). The raison d'être of an interorganizational project is different because it includes diverse participants who have disparate interests and represent various organizational identities, obligations, and commitments (Hu et al., 2019). Moreover, there is a paucity of research on knowledge sharing in interorganizational projects because interorganizational knowledge sharing is more difficult than intra-organizational knowledge sharing (Easterby-Smith et al., 2008). Thus, the current research available consists of: (i) knowledge management as an internal organizational process, addressing the topic of knowledge sharing within an organization; (ii) reviews of the current literature on knowledge management processes and frameworks (Alavi and Leidner, 2001; Nonaka et al., 2006); (iii) different studies competing with one another to generate a significant debate by dealing with one or two knowledge management process, usually either knowledge creation (Nonaka, 1994; Lee and Choi, 2003) or knowledge sharing (Szulanski, 1996; Hansen, 1999); and (iv) how interorganizational knowledge sharing contributes towards outcomes such as increased employee productivity, new product development and improved organizational efficiency, as described by Martinkenaite (2011). This suggests a need for (i) a more fine-grained understanding of knowledge sources (internal and external) in interorganizational projects, since knowledge management is not only crucial within an organization but also across organizations; (ii) empirical studies on knowledge management,
particularly on knowledge sharing especially in interorganizational settings; and (iii) converging the process of interorganizational knowledge sharing rather than the outcome of the process.

This paper will develop our understanding of how knowledge is shared within an organization and across organizational boundaries (considering different levels of units: individual, team, organization, and across organizations) addresses an important empirical question by providing empirical evidence. Knowledge management is required to facilitate the processes within and across organizational boundaries (Lawson et al., 2009; Oliva et al., 2019). This paper offers insights into how knowledge is shared in an interorganizational project in which multiple organizations are involved.

This paper answers the following research questions:

1. What are different types of knowledge shared at different levels of units in an interorganizational project?
2. How different types of knowledge are shared at different levels of units in an interorganizational project?

The unit of analysis is an interorganizational project: a nexus of activities that allows multiple organizations to collaborate to achieve their individual and collective goals. Our study makes three contributions. The first contribution is to explore different types of knowledge shared at different levels of units (individual, team, organization, and across organization) (Hedlund, 1994; Argote et al., 2003). Second, we describe knowledge sharing tools encompassing both the intra-organizational (internal sources) and the interorganizational level (external sources), which has been largely ignored. Third, this paper presents a comprehensive model of interorganizational knowledge sharing that captures the interplay between knowledge sharing tools, types of knowledge, and levels of units. The development of the model is an effort to refine and extend knowledge management processes in general and knowledge sharing processes in an interorganizational setting in particular.

Literature review

Knowledge sharing

Knowledge is considered to be a complex, cross-functional and multifaceted concept with multilayered meanings (Nonaka, 1994; Alavi and Leidner, 2001; Lee and Choi, 2003). Knowledge is often ‘sticky’, difficult to codify and share (Szulanski, 1996; Inkpen, 2000). Knowledge is made up of experiences, information, values and systematic attitudes that provide a proper framework for the evaluation of information and experience (Xue, 2017), that can be used in making decisions and informing actions (Chang and Lin, 2015). Knowledge can be defined as information stored in people’s minds, experience or understanding (Alavi et al., 2005). It contains information that can be used in making decisions and informing actions (Chang and Lin, 2015). Anand and Walsh (2016) claimed that knowledge consists of information, skills and expertise.

Knowledge is often classified as tacit knowledge (knowing how) and explicit knowledge (knowing what) (Nonaka and Takeuchi, 1995; Shujahat et al., 2017). Nonaka, (1994) and Zahedi et al. (2016) categorized knowledge into tacit knowledge and explicit knowledge based on the
Tacit knowledge is known as embedded, sticky and experience-based knowledge which is undocumentd in nature (Nonaka, 1994). It is deeply embedded in an individual’s actions and experience, and can only be observed through its application (Kogut and Zander, 1992; Nonaka and Von Krogh, 2009) and learned through practice (Nonaka and Konno, 1998, Oliva, 2014), which makes it difficult to communicate (Nonaka and Takeuchi, 1995; Rutten et al., 2016). On the other hand, explicit knowledge is articulated and can be documented (Nonaka and Von Krogh, 2009). It is revealed by communication. Ease of communication is the fundamental property (Grant, 1996) for sharing explicit knowledge. Explicit knowledge is transmittable in systematic language (Kogut and Zander, 1992), codified, and communicated in symbolic form and/or natural language (Nonaka, 1994). Explicit knowledge, also sometimes called leaky knowledge, is objective and rational; it can be documented and distributed to others (Nonaka and Konno, 1998; Kakabadse et al., 2001).

Knowledge sharing is the process of making knowledge, skills, expertise and information available to others (Ipe, 2003; Lee et al., 2018). Knowledge sharing is defined as the provision and reception of know-what and know-how to enable organizational members to perform tasks (Foss et al., 2010). The sharing of relevant knowledge has the potential to lower costs, optimize processes, etc., whereas lack of sharing may harm organizations and even render their processes ineffective (Rutten et al., 2016). Knowledge sharing is defined as the provision and reception of know-what and know-how to enable organizational members to perform tasks (Foss et al., 2010). Knowledge sharing is the process of making knowledge, skills, expertise and information available to others (Ipe, 2003; Lee et al., 2018). Knowledge sharing tools are defined as the means through which knowledge flows. Knowledge sharing channels focus on formal means of knowledge sharing, taking informal practices into equal consideration (Olander et al., 2016; Manning, 2017). Formal knowledge sharing comprises all the forms of knowledge sharing that are institutionalized by the management (Taminiau et al., 2009). According to Alavi and Leidner (2001), formal sharing tools, such as scheduled meetings, requests for information, training sessions and visits, apprenticeships or personnel transfers, may ensure a greater distribution of knowledge. Informal knowledge sharing includes all forms of knowledge sharing which exist alongside these institutionalized forms. It relates to resources, services and activities which are used to facilitate knowledge exchange, but which are not necessarily designed for that purpose (Taminiau et al., 2009). Informal tools such as unscheduled meetings, informal seminars, mobile applications such as WhatsApp, or coffee break conversations are effective for knowledge sharing (Argote et al., 2003; Zhang et al., 2018). According to Ali et al. (2018), both formal and informal knowledge sharing tools have a significant impact on knowledge sharing practices.
Moreover, knowledge can be shared at four different levels of units: the individual, the team, the organization, and the interorganizational domain (including important customers, suppliers, competitors, etc.), which enhances their capacity to define a situation or problem, and apply their knowledge in order to act and to solve the problem (Hedlund, 1994; Nonaka et al., 2006). At the individual and team level, knowledge sharing requires the employees’ motivation to actively communicate with colleagues, as well as to consult with colleagues to learn from them. At the organizational level, knowledge sharing includes capturing, organizing, reusing and disseminating the knowledge which resides within the organization (Razmerita et al., 2016). The interorganizational domain is also critical for sharing valuable knowledge with partners, such as subcontractors, suppliers or clients, to develop new capabilities and opportunities for effective actions (Cheng et al., 2008).

Knowledge sharing involves focusing both on internal and external knowledge and is executed by disseminating knowledge from the organization, whether the source is internal or external (Martin-de Castro, 2015; Silva et al., 2018). Internal sources are inside the organization and are generally controlled by the organization itself. External sources are outside the organization and are controlled by other entities, such as competitors, sponsors, clients, contractors, universities, research laboratories, suppliers and customers (Powell et al., 1996; Parikh, 2001; Ardito and Petruzzielli, 2017; Secundo et al., 2019). In an interorganizational project, external knowledge sources are required to share knowledge with different stakeholders such as the client, contractors, sub-contractors, and consultants (Manning, 2017; von Danwitz, 2018). In this competitive world, the continuous exchange of internal and external knowledge is a necessity for survival and success (Parikh, 2001; Papa et al., 2017). Thus, it is important for an organization to manage knowledge internally, and equally important to effectively manage external knowledge (El Sawy et al., 2000). Specifically, it is interesting to know how organizations share knowledge outside their boundaries (Inkpen, 2000). Knowledge sharing emphasizes the dissemination of knowledge between individuals, groups within an organization, and within and between the organizations (Karadsheh et al., 2009). Organizations cannot focus on the creation of internal knowledge alone; they also have to seek complementary knowledge from outside the organization (Cohen and Levinthal, 1990).

**Interorganizational project**

An interorganizational project is defined as a project in which multiple organizations temporarily work together on a shared activity, to coordinate and realize complex products and services (DeFillippi and Arthur, 1998; Jones and Lichtenstein, 2008). An interorganizational network leads to project outcomes that could not have been achieved by the individual organizations (Schulz and Geithner, 2010). It requires different organizations to work together to pool various resources and types of expertise to complete the project successfully (Oliveira and Lumineau, 2017). It involves multiple legally independent, yet functionally interdependent, organizations working towards accomplishment of complex products and services (Jones and Lichtenstein, 2008; Lumineau and
A central characteristic of interorganizational projects is (a) temporariness: projects are temporary because they have a specific beginning and a defined endpoint which is known to all project participants (Lundin and Söderholm, 1995); and (b) temporal embeddedness: this refers to the time periods before and after a focal project, during which the participants may already have worked together or may expect to work together again (Jones and Lichtenstein, 2008). Interorganizational projects coordinate activities only for the lifespan of the project, which may extend for five days or twenty years (DeFillippi and Arthur, 1998). An important feature of interorganizational projects is the flexibility they offer, i.e. lead organizations create and recreate new organizational structures around the demands of a project or the needs of clients, and because the project is a temporary organizational setting, organizing through projects is thus inherently flexible and reconfigurable (Bechky, 2006). When new projects are initiated, lead organizations can select partner organizations which they perceive to be best suited to performing the task at hand, and these partner organizations can adapt their involvement in different projects to their capacities (Ligthart et al., 2016).

The literature on interorganizational knowledge sharing has widely recognized the critical role of a firm’s external constituents, such as suppliers, clients, customers, etc., as a source of knowledge and competitiveness (Feng et al., 2010; Manning, 2017). Interorganizational knowledge sharing involves two or more organizations that may be from the same branch, from complementary branches or even from competing organizations (Lawson et al., 2009). An interorganizational network is a form of aggregated structure, where a set of organizations are linked to each other through multiple interconnected relationships. These relationships are the key building blocks of networks. It is typical for an organization to have relationships with different types of actors, for example with customers, distributors, suppliers, competitors, etc., which usually share common interests and, hence, motivate them to establish and engage in network relationships with each other for their mutual benefit (Johanson and Vahlne, 2003). Such relationships are a common means of enlarging the scarce resource base of the organizations through the exchange of different kinds of resources such as money, goods, services and knowledge (Håkansson and Ford, 2002) to cope with the tasks required in a complex project.

**Knowledge-based theory**

According to the knowledge-based view, knowledge is an intangible resource, the most important asset that can sustain an organization’s competitive advantage (Kogut and Zander, 1992; Grant, 1996). The main idea of knowledge-based theory is that organizations exist because of their ability to manage knowledge efficiently within different types of organizational structures (Foss, 1996; Nickerson and Zenger, 2004). In other words, organizations are social entities that use and store internal knowledge, competencies, and capabilities that are vital for organization’s survival, growth, and success (Håkansson, 2010). Organizations that are more effective than other organizations at finding, absorbing, and exploiting new knowledge from both their internal and external environments will tend to perform better than their competitors (Martin-de Castro, 2015).
This theory assumes that organizations are heterogeneous, knowledge-bearing entities that apply their knowledge to the production of their goods and services (Foss, 1996).

**Methodology**

**Research design**

We conducted a single case study to understand the knowledge sharing process in an interorganizational project. The case study method is particularly suited to addressing research questions that require detailed understanding; this is because of the richness of data that can be collected in a case study context (Hartley, 2004). Our study focuses on the Orange Line metro train project in Lahore, Pakistan. We selected this particular case to explore and understand the knowledge sharing process in an interorganizational project, focusing on how multiple organizations share knowledge in such a project. We address our research questions through an inductive and in-depth study.

**Case description: The Lahore Orange Line Metro Train**

The Orange Line (OL) commences in Lahore. The main line of OL is about 27.1 km long in total. A total of 26 stations have been designed along the whole line, including 24 elevated and 2 underground stations. The speed of the proposed train is 70 km/hr with a passenger capacity of 1000 passengers per hour in each direction. In April 2015, administrative approval was given for an amount of Rs. 162.628 billion (USD 1.626 billion), while the planned duration of the project was 27 months. The OL will offer a well-organized, effective form of transportation to the public, providing a high-quality transportation service and improving job access. The OL will improve the efficiency and effectiveness of the region’s current transit system. It will also reduce the traffic load on adjacent main roads, and reduce traffic jams and noise and air pollution. The design capacity of the system was 245,000 per day.

The project was divided into (i) civil works and (ii) electrical and mechanical (E&M) works. The civil works were further divided into 4 packages (sub-projects) assigned to 4 different contractors. Civil works started in October 2015 for packages 1 and 2, and in January 2016 for packages 3 and 4. The E&M works were assigned to foreign organization. The civil and E&M works have been completed; the project is expected to be operational in August 2020 (Archival data).

**Data collection**

We collected data using interviews, and archival documents. We relied on interviews as the primary source of data. The archival data served as an important source for building the case background. We conducted 11 interviews with 11 participants, ranging from 52 minutes to 164 minutes in length (details are provided in Table I). We conducted interviews with project directors, project managers, general managers and other team members (deputy project manager, planning engineer, technical advisor and quantity surveyor). Informants included members of the client team, the design consultant, contractors and the executing agency. The interviews were semi-structured. Informants were asked a core set of structured questions and open-ended probes. We
also encouraged informants to use their own terminology and to steer the interview toward issues and concepts that they felt best represented their own experiences. Initially, we utilized a snowball technique, asking each informant who they believed could help us to understand knowledge sharing process. The interviews were recorded and transcribed.

We also utilized archival sources of data provided by informants. The archival data consists of 180 internal and publicly available data, including PowerPoint presentations, an environmental impact assessment report, design details (layout and drawings), monthly and weekly progress reports, a project feasibility report and a planning commission (PC-1) document. We asked the client, contractors and design consultant to provide the necessary documents. Archival data was useful in developing a better background understanding of the case context.

**Data analysis**

For data analysis, we used thematic analysis. Thematic analysis systematically identifies, organizes, and offers insights into meaningful patterns (themes) (Braun and Clarke, 2012). The thematic analysis in this study was highly inductive (Howitt and Cramer, 2007), and was driven by what is in the data, meaning that the themes identified emerged from the content of the data (Braun and Clarke, 2012). We followed Braun and Clarke’s (2012) practical guide for applying thematic analysis. The steps were: (i) familiarizing ourselves with the data collected, reading the transcripts several times; (ii) coding: labeling related and interesting text that helped to answer the research questions; (iii) searching for themes through the identification of salient features of meaningful patterns within the data set; (iv) reviewing themes to determine whether the themes identified fit well with the coded data; (v) defining and naming themes; and (vi) writing the report about the themes identified (Braun and Clarke, 2012). First, the transcriptions were read and explored inductively to identify different activities for knowledge sharing process. Second, sub-themes of formal tools, informal tools, tacit knowledge, explicit knowledge, knowledge sharing between individuals, knowledge sharing between teams, knowledge sharing within organization and knowledge sharing across organizations were developed. Third, by reviewing the sub-themes, the main themes were defined. Table II below illustrates how the sub-themes are derived from the interview transcriptions and how these sub-themes then lead to themes.

**Findings**

Three major themes emerged as elements of knowledge sharing in this complex interorganizational project: knowledge sharing tools, types of knowledge, and levels of units. For knowledge sharing tools, we find sub-themes of formal and informal knowledge sharing tools. Types of knowledge contain the sub-themes of tacit and explicit knowledge. Levels of units contain four sub-themes of knowledge sharing between individuals, within teams, within an organization and across organizations.

**Knowledge sharing tools**
There are different knowledge sharing tools, which may be formal or informal. Formal knowledge sharing comprises resources, services and activities which are carried out by the organization with the purpose of sharing knowledge with each other (Taminiau et al., 2009). Formal sharing tools, such as formal meetings, training sessions and apprenticeships, etc., are used to disseminate knowledge (Alavi and Leidner, 2001). We find that formal knowledge sharing tools (formal meetings, training programs, workshops, internship programs, documents, and letters) are the main means of knowledge sharing. As illustrated below:

*With other organizations we communicate through letters. Whatever problems we are having on site, or all the site constraints, we write them a letter for that. Even if we have them visit the site and show them everything on site and they might take a decision on site as well but everything will have to be done in written form.* (Deputy Project Manager, Contractor 1)

Informal knowledge sharing tools facilitate smooth knowledge exchange within and between organizations (Taminiau et al., 2009). Swap et al. (2001) suggest that knowledge is often unconsciously exchanged by individuals through informal interaction. Knowledge is shared not only face-to-face but also over the telephone, by e-mail, and via WhatsApp, SMS, etc., which enables people to stay connected and keep updated anytime and anywhere (Zhang et al., 2018). As illustrated by our informants:

*We have WhatsApp groups in which we communicate with all the utility departments. Then there are technical groups which includes consultant, client and contractors, for them we have separate group. There is a separate group for Chinese organization, and the group in which only our own department people are there, that is a different group. So, we have separate groups for separate people and our coordination keeps going on accordingly.* (Project Director, Executing agency)

Formal methods are used less these days. If things are too formal then no one shares anything. One of the main reasons for this is that informal means of knowledge sharing (such as mobile applications that allow people to interact with each other in real-time) are faster than formal means of communication.

**Types of knowledge**

There are two main types of knowledge, tacit and explicit knowledge. Grant (1996) defines knowledge broadly as including both “explicit” knowledge, which can be written down, and “tacit” knowledge, which cannot. Within types of knowledge, we find sub-themes of both tacit and explicit knowledge. As illustrated below:

*There are different types of knowledge. There are things that if I tell someone verbally, they will be able to understand them. But for some things, I'll have to show him documents and drawings and have to explain my viewpoint, give my technical inputs and have his too so that he gets convinced on what I am saying.* (Deputy Director 1, Executing agency)
Sharing knowledge with others helps individuals to build their capacity. Capacity building or enhancement will eventually be beneficial for the team and for the organization. Tacit and explicit knowledge are mutually complementary (Nonaka and Takeuchi, 1995). We find that for tacit knowledge sharing, informal tools are used, while for explicit knowledge sharing, formal tools are considered useful. As one of the informants illustrated:

"Tacit knowledge can be observed at the site. If someone is at the site, he’d be able to observe it. Either it is within the organization or any outsider, it can be observed at site and it can be shared at site. For tacit knowledge, I believe, an informal way is better. So, there is an informal way of carrying out that communication, sharing that knowledge. But for explicit knowledge, obviously, we can go to other methods like emails, creating drives and sharing knowledge with others." (Planning Engineer, Consultant)

**Levels of units**

The unit within which knowledge is shared could be an organization, an individual or a group within the organization (Argote *et al*., 2003), or across organizations (Hedlund, 1994). We focus on the interaction between the individual, the group, organizational and interorganizational levels. We use the terms “team” and “group” interchangeably, for convenience. We find knowledge flows vertically within the organization and the team, and horizontally across organizations. As illustrated below:

"Consultant issues drawings to us with the approval of client... We evaluate them according to our knowledge, whether they are according to the site conditions and whether the drawings are accurate or not. We look at all these aspects and then we forward them to the contractor. If there is some change required in that, we write it back to the consultant and copy it to client as well because they have to be kept in the loop." (Project Director, Executing agency)

The above quote describes knowledge sharing, i.e. explicit forms of knowledge across organizations, but the organization is part of an interorganizational project. However, there is also the possibility that the knowledge is shared with other organizations which are not part of the project network. As one of the informants states below:

"Like [consultant name], there are other consultancies working as well. We can get to share our knowledge with them and there are a couple of people who are working as planning engineers in other renowned consultancies and they do share a lot of their knowledge with us and asked us a couple of things." (Planning Engineer, Consultant)

Interestingly, however, we find that tacit knowledge is shared within teams and organizations primarily through informal tools (Table II). It can be shared during formal gatherings such as conferences and training programs, but the majority of tacit knowledge sharing takes place through informal interactions (Holste and Fields, 2010). However, when knowledge is shared with other organizations, formal methods or tools such as formal meetings, visits, etc. are predominately used,
while the discussion is also documented for the record. However, we did not find any evidence in
our data which shows that tacit knowledge and informal knowledge sharing tools are not utilized;
their role is complementary, while explicit knowledge and formal knowledge sharing tools are
predominately utilized for interorganizational knowledge sharing.

\[\text{When sharing with other organizations, we mostly have formal meetings... With other organizations, we mostly focused on documentation. Verbal communication is only involved to this much extent that if [organization name] is shifting some utility, we just ask them over telephone to confirm if they are doing it by tomorrow or not, and what would be the duration of shutdown. This type of verbal communication we do with them but the major thing is done through documentation. (Deputy Director 2, Executing agency)}\]

**Discussion**

Knowledge sharing involves the dissemination and exchange of knowledge among individuals or
networks of individuals, from small groups of people to the organization and across organizations
(ALAVI ET AL., 2005). The main purpose in sharing knowledge is to make the knowledge visible, to
show the role of knowledge in organizations and to encourage employees to foster behaviors such
as knowledge sharing and building the knowledge infrastructure (ARGOTE ET AL., 2003; MERLO,
2016). Knowledge sharing is a process through which knowledge is communicated, executed by
distributing and employing knowledge from the organization, whether the source is internal or
external (KARADSEHEH ET AL., 2009).

**Knowledge sharing tools** are defined as the means through which knowledge flows. Knowledge sharing channels focus on formal means of knowledge sharing, taking informal practices into equal consideration (OLANDER ET AL., 2016; MANNING, 2017). Formal knowledge sharing comprises all the forms of knowledge sharing that are institutionalized by the management (TAMINIAU ET AL., 2009). Formal sharing tools, such as scheduled meetings, requests for information, training sessions and visits, apprenticeships or personnel transfers, may ensure a greater distribution of knowledge (ALAVI AND LEIDNER, 2001). Informal knowledge sharing includes all forms of knowledge sharing which exist alongside these institutionalized forms. It relates to resources, services and activities which are used to facilitate knowledge exchange, but which are not necessarily designed for that purpose (TAMINIAU ET AL., 2009). Informal tools such as unscheduled meetings, informal seminars, mobile applications such as WhatsApp, or coffee break conversations are effective for knowledge sharing (ARGOTE ET AL., 2003; ZHANG ET AL., 2018). According to ALI ET AL. (2018), both formal and informal knowledge sharing tools have a significant impact on knowledge sharing practices. Our findings also show that both formal and informal knowledge sharing tools were utilized.

Knowledge is made up of experiences, information, values and systematic attitudes that provide
a proper framework for the evaluation of information and experience (XUE, 2017). There are
different types of knowledge. NONAKA (1994) and ZAHEDI ET AL. (2016) divided knowledge into tacit
knowledge and explicit knowledge based on the degree of expression. Grant (1996) identifies “knowing how” with tacit knowledge, and “knowing about” facts and theories with explicit knowledge. Our findings provide evidence that both tacit and explicit knowledge are shared in an interorganizational setting.

Knowledge resides in different levels of units such as the individual level, the team level, the organizational level and the interorganizational level (Casillas et al., 2009). Moreover, knowledge sharing is the result of the exploration and exploitation of both internal and external sources; organizations benefit from the combination of both (Martin-de Castro, 2015; Silva et al., 2018). Our findings provide evidence that both formal and informal knowledge sharing tools were utilized to share tacit and explicit knowledge which resides in different levels of units such as the individual level, the team level, the organizational level and the interorganizational level in an interorganizational setting. In this study, we explored internal knowledge sources (Alavi and Leidner, 2001), and exploited external knowledge sources (Katila and Ahuja, 2002) such as the client, consultants, contractors, competitors, suppliers, and universities (von Danwitz, 2018). External knowledge originates from the interaction of the organization with its external environment, while internal knowledge is generated within an organization (Secundo et al., 2019).

**Knowledge sharing model in an interorganizational project**

This paper examines relationships between knowledge sharing tools, types of knowledge, and levels of units. An integrative knowledge sharing model (Figure 1) is developed. It builds on the interplay between tacit and explicit knowledge, and formal and informal knowledge sharing at four different levels of units: the individual, the group, the organization, and the interorganizational domain. The model has three dimensions. The levels of the units, i.e. the individual, group, organizational and interorganizational levels involved in knowledge sharing are represented on one dimension. Types of knowledge, i.e. tacit and explicit knowledge, are represented on the second dimension, and the third dimension is the knowledge sharing tools used for formal and informal knowledge sharing.

*Figure 1: Knowledge sharing model in an interorganizational setting*

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<th>Knowledge sharing tools</th>
<th>Internal sources</th>
<th>External sources</th>
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<td>Tacit</td>
<td>Individual P</td>
<td>Organization P</td>
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<td></td>
<td>Project (group/team) S</td>
<td>Interorganizational S</td>
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<td>Explicit</td>
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<tr>
<td>Informal</td>
<td>*</td>
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</table>

P=Primary, S= Secondary, *= Compulsory, x= Supporting
Knowledge sharing occurs within individual, group, organizational and interorganizational levels (Casillas et al., 2009; Razmerita et al., 2016). Zellmer-Bruhn (2003) found that units are more likely to share knowledge with units that are part of the same organization than with units that belong to a different organization. However, organizations cannot rely on internal knowledge alone; they also have to seek knowledge outside the organization (Matusik, 2002). External knowledge sources are mostly used to share specialized knowledge such as knowledge about clients’ preferences; consultants are obvious sources of external knowledge, and may provide specialized knowledge (Simao and Franco, 2018). For example, in our case, the design consultant provides drawings to other organizations such as the client and contractors; this acquisition of new specialized knowledge is often the motivation for establishing interorganizational collaborations (Hamel, 1991). Moreover, internal and external knowledge sources are not substitute for each other, but are complementary (Arora and Gambardella, 1994; Foss et al., 2013). Knowledge from both internal and external sources (Ferraris et al., 2017) is imperative for organizational performance (Szulanski, 1996; Sher and Lee, 2004). It is crucial to understand how units are connected to and interact with each other and how knowledge is shared between the individual, group, organizational, and interorganizational levels. In an interorganizational project such as this one, the units are connected with different types of knowledge and different knowledge sharing tools.

Our model shows that explicit and tacit knowledge exists at all levels (Hedlund, 1994). However, tacit knowledge is the primary form of knowledge at the individual, team and organizational levels, while explicit knowledge plays a supporting role. According to Nonaka et al. (2000) and Sánchez et al. (2012), tacit knowledge is meaningless without explicit knowledge. Moreover, at the interorganizational level, explicit knowledge is the primary form of knowledge and tacit knowledge is complementary. The reason for this is that explicit knowledge without tacit insights quickly loses its meaning (Nonaka et al., 2000). Thus, both types of knowledge are valuable and, in fact, essential (Nonaka and Takeuchi, 1995; Xue, 2017), each in its own right (Taminiau et al., 2009). Tacit knowledge forms the background necessary for assigning the structure to develop and interpret, use and implement explicit knowledge (Inkpen, 2000). The sharing of both tacit and explicit knowledge (Johnson et al., 2002) facilitates the knowledge sharing process.

Knowledge sharing requires an understanding of how knowledge moves both within an organization and across organizational boundaries. This paper posits that formal and informal knowledge sharing tools enable the sharing of knowledge, which leads to improved performance (as suggested by Lawson et al., 2009). Informal tools are used for sharing knowledge with individuals, groups and organizations, whereas formal tools are complementary. However, at the interorganizational level, formal tools are primarily used for knowledge sharing, while informal tools play a supporting role. Moreover, formal means of knowledge sharing are used to ensure efficiency and to reduce uncertainty (Hwang et al., 2018). Usually, when knowledge is shared across organizations, uncertainty is high, so formal knowledge sharing helps to reduce it. Both tacit and explicit knowledge is shared using formal and informal tools. The effectiveness of a
knowledge sharing tool depends upon the type of knowledge being shared (Inkpen and Dinur, 1998). Nonaka (1994) and Davison et al. (2013), describe tacit knowledge as being shared informally while explicit knowledge is shared formally, which is consistent with the findings. Given the importance of tacit knowledge sharing and its dependence on personal linkages, informal knowledge sharing tools play an important role in organizations (Lawson et al., 2009), while explicit knowledge sharing and formal knowledge sharing tools are utilized at the interorganizational level.

The findings of this study acknowledge that knowledge sharing tools determine how knowledge flows. The next step is to understand the direction in which knowledge flows to the units. Schulz (2001) defines knowledge flows as a volume of know-how and information transmitted per unit. There are two main dimensions of knowledge flow, (i) inflows-outflows, and (ii) vertical-horizontal. Inflows carry knowledge into a unit, while outflows disseminate knowledge from one unit to others (Schulz, 2001; Lee et al., 2019). Vertical flow contains both top-down and bottom-up approaches, knowledge flows between individuals, teams and organizations (Garcia, 2005; Williams and Lee, 2016), mainly using informal tools with formal tools as complementary, whereas horizontal flow occurs on the same hierarchical level, between organizations (Schulz, 2001; Williams and Lee, 2016), primarily used formal tools and informal tools are complementary. This model presents four types of knowledge flows frequently referred to in the knowledge management literature: vertical inflows, vertical outflows, horizontal inflows, and horizontal outflows (Fornell and Larcker, 1981). The vertical inflow occurs as organizations provide their projects with the knowledge needed for execution. The knowledge of project team members is passed to the project level in order to make it possible to implement the knowledge at that level. Meanwhile, vertical outflow occurs as the knowledge is passed from the project level to the organization level in order to distribute it to other projects that are being implemented by the organization (Garcia, 2005). Horizontal knowledge inflows represent the flow of knowledge from other organizations, whereas horizontal outflows provide knowledge to other organizations, such as client, contractors, and consultants.

Conclusion
This paper sought to answer the research questions: What are different types of knowledge shared at different levels of units in an interorganizational project? and How different types of knowledge are shared at different levels of units in an interorganizational project? In doing so, this research began to capture a more comprehensive view of knowledge sharing in interorganizational settings. In this study, we present the main elements of knowledge sharing, i.e. knowledge sharing tools, types of knowledge and levels of units. Knowledge sharing tools, i.e. formal and informal tools, are the means through which knowledge is gained from internal and external knowledge sources and shared among different units (individual, group, organizational and interorganizational levels). Meanwhile, types of knowledge, i.e. tacit and explicit knowledge, also play an important role in defining the knowledge sharing tools used by all units.
This paper contributes to the literature on knowledge-based theory by examining interorganizational knowledge sharing in several ways. First, it extends the dimensions that describe knowledge management in general, and knowledge sharing in particular, to include tools of knowledge sharing, types of knowledge and levels of units. Second, key findings are related to the relationship between knowledge sharing tools, types of knowledge and levels of units, in an interorganizational setting. Although both knowledge sharing tools and tacit-explicit knowledge are valuable for all units, their importance may vary; for instance, formal knowledge sharing tools are the primary tools for sharing explicit knowledge while informal knowledge sharing tools are mainly used for tacit knowledge. Third, the findings and discussion of our model (Figure 1) demonstrate that internal sources (individual, group and organization) primarily use tacit knowledge with informal tools, while external sources (interorganizational) mainly share explicit knowledge via formal tools. There is a complementary relationship between formal tools-explicit knowledge and informal tools-tacit knowledge for internal sources and external sources respectively. Fourth, knowledge flows such as vertical-horizontal and inflow-outflow describe the direction of knowledge flows. Last but not least, we believe that our knowledge sharing model (Figure 1) can serve as a refined basis for further research concerning some of the distinctive features of knowledge sharing in interorganizational projects.

Knowledge sharing seems an obvious imperative in interorganizational settings. The implications of this study are for practitioners concerning proposed knowledge sharing model of knowledge sharing for interorganizational projects. It is worth mentioning that the proposed model of interorganizational knowledge sharing considering knowledge sharing tools, types of knowledge and levels of units which will be able to assist and engage individuals and teams to share knowledge within and across organizations in a holistic manner. Knowledge sharing leads to improvements in knowledge management processes by assigning necessary roles and responsibilities to the people with the appropriate expertise and skills. The application of our Different knowledge sharing model tools such as formal and informal tools would guide managers and teams to share different types of knowledge i.e. explicit and tacit knowledge efficiently, which can affect the way organizations adopt the tools. In an integrated manner, the model provides a roadmap for project participants and organizations to share different types of knowledge at different levels of units, so practitioners will develop understanding of tools needed to share certain type of knowledge when dealing with different levels of units. This contributes to develop better insights of knowledge sharing which could lead to the improved management of interorganizational settings. The knowledge sharing model in this study would be helpful for managers to plan and manage an interorganizational project effectively as it provides a roadmap for project participants and organizations to understand knowledge sharing tools, types of knowledge, levels of units and knowledge flow patterns in order to share knowledge from internal and external sources.

Our study opens up several new avenues for further research. First, we examined an interorganizational project – a unit of analysis in which multiple organizations engaged simultaneously in knowledge sharing – at an aggregate level. Future research might consider the
organization as a unit of analysis and compare the knowledge sharing within different organizations (client, contractors, sub-contractors and consultants) in an interorganizational setting. Second, the knowledge management process refers to knowledge creation, sharing, storing and acquisition among individual, group, organizational (Grant, 1996; Okhuysen and Eisenhardt, 2002) and interorganizational networks. These processes are often concurrent, and do not represent a monolithic set of activities, but an interconnected and intertwined set of activities, and not always in a linear sequence (Alavi and Leidner, 2001). For example, for an organization to share knowledge, the knowledge must be retained. Attempts to share knowledge can lead to the creation of new knowledge (Argote et al., 2003). Song et al. (2003) show how new knowledge is generated and when knowledge should be transferred across organizations. This study ignores the interrelationships between knowledge management processes. Future studies can consider it. Third, this study only considers the knowledge sharing process. Future studies might consider other knowledge management processes. Fourth, we believe that the Orange Line metro train project is an excellent example of an interorganizational setting. However, it raises questions about the transferability of our theory. While caution is always necessary with single-case studies, we believe that our framework is transferable beyond interorganizational projects since our data is collected from a heterogeneous set of organizations.

References


Table I: Interview participants’ details

<table>
<thead>
<tr>
<th>Role</th>
<th>Designation</th>
<th>Education</th>
<th>Experience (years)</th>
<th>Interview duration (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consultant and designer</td>
<td>Project Manager</td>
<td>MSc (UK)</td>
<td>30</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td>Planning Engineer</td>
<td>MSc (in progress)</td>
<td>4</td>
<td>164</td>
</tr>
<tr>
<td>Executing agency</td>
<td>Project Director</td>
<td>BSc</td>
<td>16</td>
<td>118</td>
</tr>
<tr>
<td></td>
<td>Deputy Director 1</td>
<td>-</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Deputy Director 2</td>
<td>MSc (in progress)</td>
<td>9</td>
<td>93</td>
</tr>
<tr>
<td>Client</td>
<td>Managing Director</td>
<td>-</td>
<td>45</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>General Manager</td>
<td>MSc (US)</td>
<td>33</td>
<td>101</td>
</tr>
<tr>
<td>Contractor 1</td>
<td>Deputy Project Manager</td>
<td>BSc</td>
<td>14</td>
<td>74</td>
</tr>
<tr>
<td>Contractor 2</td>
<td>Project Manager</td>
<td>-</td>
<td>29</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>Quantity Surveyor &amp; Deputy Project Manager</td>
<td>Matric</td>
<td>15</td>
<td>92</td>
</tr>
<tr>
<td>Contractor 3</td>
<td>Technical Advisor</td>
<td>BSc</td>
<td>40</td>
<td>125</td>
</tr>
</tbody>
</table>
### Table II: Example of coding procedure

<table>
<thead>
<tr>
<th>Themes</th>
<th>Sub-themes</th>
<th>Illustrative quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge sharing tools</td>
<td>Formal tools</td>
<td>Knowledge can be shared in the form of documents… Documents are to inform contractor-involved for utilities. A hardcopy with signature is an authentic document. (Project Manager, Contractor 2)</td>
</tr>
<tr>
<td></td>
<td>Informal tools</td>
<td>All of us are electronically connected. Everybody is electronically connected; everything is shared either on messaging or email. (Managing Director, Client)</td>
</tr>
<tr>
<td>Types of knowledge</td>
<td>Tacit knowledge</td>
<td>We employ a senior and a young assistant… Both these people have the same work to do but the benefit is that the junior is gaining knowledge from the experience of senior and he is basically learning from him, how to get the work done. So, this is how we try to share experience-based knowledge. (Deputy Director 2, Executing agency)</td>
</tr>
<tr>
<td></td>
<td>Explicit knowledge</td>
<td>We have taken documents from other organizations… like we required some third-party validation, some database, some reports, some cases that other organizations had worked on. (Planning Engineer, Consultant)</td>
</tr>
<tr>
<td>Levels of units</td>
<td>Knowledge sharing</td>
<td>My fellow planning engineer and I have been working together for more than 2 years. We used to share our plans like how we are planning to carry out activities, what kind of delays we are having over here and what are the reasons… If he has already worked on something and the same task for some other package is assigned to me, he would share the document of that package with me. (Planning Engineer, Consultant)</td>
</tr>
<tr>
<td></td>
<td>between individuals</td>
<td>We used to conduct informal meetings with staff- everyone from site engineers to project manager used to be involved in these meetings… Everyone was called in; they were made to sit together and then everyone was individually asked about their experience. They were questioned about things and if they were not able to understand something, they were asked to take details about it from us. Then we used to explain them how to execute the work, what things are to be taken care of while being on site. (Deputy Project Manager, Contractor 1)</td>
</tr>
<tr>
<td></td>
<td>between teams</td>
<td>We discuss any issue, any problem and whatever is happening at site. We discuss it with specialists in our organization, and they guide us. I am looking after the management side of the project. I get technical help from the specialists. If I have some geotechnical issue, I'll go to my geotechnical engineer. If I have some structural issue, I'd go to my structure engineer and he'll advise me and guide me. (Project Manager, Consultant)</td>
</tr>
<tr>
<td></td>
<td>within organization</td>
<td>We do meetings, sometimes in our office and sometimes in the consultant’s office, involving consultant, client, people from executing agency, Chinese organization and us. This whole team was involved where we used to discuss the problems. (Project Manager, Contractor 2)</td>
</tr>
<tr>
<td></td>
<td>across organizations</td>
<td></td>
</tr>
</tbody>
</table>