



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

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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;

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3 Lumineau and Oliveira, 2018; Agostini *et al.*, 2020), interorganizational collaborations (Van
4 Marrewijk *et al.*, 2016), and interorganizational team building (Manning, 2017). Despite growing
5 interest in interorganizational projects, the existing research continues to report limited evidence
6 of interorganizational knowledge sharing (Swan *et al.*, 2010), particularly in science and
7 technology parks (Balle *et al.*, 2019) and the hospitality industry (Idrees *et al.*, 2018).
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10 Interorganizational projects are temporary and complex, involve interdependent tasks (Lundin
11 and Söderholm, 1995; Jones and Lichtenstein, 2008), and typically involve several organizations
12 (Manning, 2017). Shujahat *et al.* (2017) described how all the elements of knowledge management
13 processes complement each other and are as important as each other but knowledge sharing is
14 more significant as the knowledge resides within an organization is of no importance until shared.
15 Moreover, knowledge sharing is a central process which links other knowledge management
16 processes and practices together. Without knowledge sharing it is difficult for an organization to
17 take full advantage of knowledge creation (Dow and Pallaschke, 2010). Knowledge exists not only
18 within organizational boundaries, but also outside the organization (Silva *et al.*, 2018), i.e. in the
19 organization's internal networks (Thomas-Hunt *et al.*, 2003), as well as in their networks linking
20 them to other organizations (Uzzi and Lancaster, 2003). Organizations tap into outside sources and
21 gain useful knowledge; in particular, they need to access complementary external expertise to help
22 solve novel problems. It is important to use external sources of knowledge, but this topic has
23 received limited empirical research attention to date (Foss *et al.*, 2013). Typically, in an
24 interorganizational project, organizations work together to produce a desired product or service
25 which cannot be achieved by the stand-alone organizations.
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28 Knowledge sharing in interorganizational contexts has become increasingly relevant. However,
29 interorganizational projects encounter challenges in terms of knowledge sharing for the
30 accomplishment of tasks (Alsharo *et al.*, 2017). The *raison d'être* of an interorganizational project
31 is different because it includes diverse participants who have disparate interests and represent
32 various organizational identities, obligations, and commitments (Hu *et al.*, 2019). Moreover, there
33 is a paucity of research on knowledge sharing in interorganizational projects because
34 interorganizational knowledge sharing is more difficult than intra-organizational knowledge
35 sharing (Easterby-Smith *et al.*, 2008). Thus, the current research available consists of: (i)
36 knowledge management as an internal organizational process, addressing the topic of knowledge
37 sharing within an organization; (ii) reviews of the current literature on knowledge management
38 processes and frameworks (Alavi and Leidner, 2001; Nonaka *et al.*, 2006); (iii) different studies
39 competing with one another to generate a significant debate by dealing with one or two knowledge
40 management process, usually either knowledge creation (Nonaka, 1994; Lee and Choi, 2003) or
41 knowledge sharing (Szulanski, 1996; Hansen, 1999); and (iv) how interorganizational knowledge
42 sharing contributes towards outcomes such as increased employee productivity, new product
43 development and improved organizational efficiency, as described by Martinkenaite (2011). This
44 suggests a need for (i) a more fine-grained understanding of knowledge sources (internal and
45 external) in interorganizational projects, since knowledge management is not only crucial within
46 an organization but also across organizations; (ii) empirical studies on knowledge management,
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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](#)

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3 degree of expression. Tacit knowledge is known as embedded, sticky and experience-based
4 knowledge which is undocumented in nature (Nonaka, 1994). It is deeply embedded in an
5 individual's actions and experience, and can only be observed through its application (Kogut and
6 Zander, 1992; Nonaka and Von Krogh, 2009) and learned through practice (Nonaka and Konno,
7 1998, Oliva, 2014), which makes it difficult to communicate (Nonaka and Takeuchi, 1995; Rutten
8 *et al.*, 2016). On the other hand, explicit knowledge is articulated and can be documented (Nonaka
9 and Von Krogh, 2009). It is revealed by communication. Ease of communication is the
10 fundamental property (Grant, 1996) for sharing explicit knowledge. Explicit knowledge is
11 transmittable in systematic language (Kogut and Zander, 1992), codified, and communicated in
12 symbolic form and/or natural language (Nonaka, 1994). Explicit knowledge, also sometimes called
13 leaky knowledge, is objective and rational; it can be documented and distributed to others (Nonaka
14 and Konno, 1998; ~~Kakabadse *et al.*, 2001~~).

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16 Knowledge management is required to ensure the right flow of knowledge to the right person
17 at the right time and in the right place (Shujahat *et al.*, 2017). The objective of knowledge
18 management is not to manage all knowledge, but to manage the knowledge which is most essential
19 to the organizations (Karadsheh *et al.*, 2009). Knowledge sharing is a focal element of knowledge
20 management (Alavi and Leidner, 2001; Earl, 2001). ~~Knowledge sharing is the process of~~
21 ~~making knowledge, skills, expertise and information available to others (Ipe, 2003; Lee *et al.*,~~
22 ~~2018). Knowledge sharing is defined as the provision and reception of know-what and know-how~~
23 ~~to enable organizational members to perform tasks (Foss *et al.*, 2010). The sharing of relevant~~
24 ~~knowledge has the potential to lower costs, optimize processes, etc., whereas lack of sharing may~~
25 ~~harm organizations and even render their processes ineffective (Rutten *et al.*, 2016). Knowledge~~
26 ~~sharing is defined as the provision and reception of know-what and know-how to enable~~
27 ~~organizational members to perform tasks (Foss *et al.*, 2010). Knowledge sharing is the process of~~
28 ~~making knowledge, skills, expertise and information available to others (Ipe, 2003; Lee *et al.*,~~
29 ~~2018). Knowledge sharing tools are defined as the means through which knowledge flows.~~
30 ~~Knowledge sharing channels focus on formal means of knowledge sharing, taking informal~~
31 ~~practices into equal consideration (Olander *et al.*, 2016; Manning, 2017). Formal knowledge~~
32 ~~sharing comprises all the forms of knowledge sharing that are institutionalized by the management~~
33 ~~(Taminiau *et al.*, 2009). According to Alavi and Leidner (2001), formal sharing tools, such as~~
34 ~~scheduled meetings, requests for information, training sessions and visits, apprenticeships or~~
35 ~~personnel transfers, may ensure a greater distribution of knowledge. Informal knowledge sharing~~
36 ~~includes all forms of knowledge sharing which exist alongside these institutionalized forms. It~~
37 ~~relates to resources, services and activities which are used to facilitate knowledge exchange, but~~
38 ~~which are not necessarily designed for that purpose (Taminiau *et al.*, 2009). Informal tools such as~~
39 ~~unscheduled meetings, informal seminars, mobile applications such as WhatsApp, or coffee break~~
40 ~~conversations are effective for knowledge sharing (Argote *et al.*, 2003; Zhang *et al.*, 2018).~~
41 ~~According to Ali *et al.* (2018), both formal and informal knowledge sharing tools have a significant~~
42 ~~impact on knowledge sharing practices.2016). Knowledge~~
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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~~ knowledge is generated within an organization and are generally controlled by the organization itself. External ~~sources are outside~~ knowledge originates from the interaction of the organization with its external environment 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 Petruzzelli, 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

Oliveira, 2018). 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).

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3 This theory assumes that organizations are heterogeneous, knowledge-bearing entities that apply
4 their knowledge to the production of their goods and services (Foss, 1996).
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7 **Methodology**

8 ***Research design***

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

23 The Orange Line (OL) commences in Lahore. The main line of OL is about 27.1 km long in total.
24 A total of 26 stations have been designed along the whole line, including 24 elevated and 2
25 underground stations. The speed of the proposed train is 70 km/hr with a passenger capacity of
26 1000 passengers per hour in each direction. In April 2015, administrative approval was given for
27 an amount of Rs. 162.628 billion (USD 1.626 billion), while the planned duration of the project
28 was 27 months. The OL will offer a well-organized, effective form of transportation to the public,
29 providing a high-quality transportation service and improving job access. The OL will improve
30 the efficiency and effectiveness of the region's current transit system. It will also reduce the traffic
31 load on adjacent main roads, and reduce traffic jams and noise and air pollution. The design
32 capacity of the system was 245,000 per day.
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36 The project was divided into (i) civil works and (ii) electrical and mechanical (E&M) works.
37 The civil works were further divided into 4 packages (sub-projects) assigned to 4 different
38 contractors. Civil works started in October 2015 for packages 1 and 2, and in January 2016 for
39 packages 3 and 4. The E&M works were assigned to foreign organization. The civil and E&M
40 works have been completed; the project is expected to be operational in August 2020 (Archival
41 data).
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46 ***Data collection***

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

7
8 *** Insert Table I about here***

9 We also utilized archival sources of data provided by informants. The archival data consists of
10 180 internal and publicly available data, including PowerPoint presentations, an environmental
11 impact assessment report, design details (layout and drawings), monthly and weekly progress
12 reports, a project feasibility report and a planning commission (PC-1) document. We asked the
13 client, contractors and design consultant to provide the necessary documents. Archival data was
14 useful in developing a better background understanding of the case context.

17 18 **Data analysis**

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

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42 *** Insert Table II about here***

43 44 45 **Findings**

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

52 53 54 55 **Knowledge sharing tools**

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

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14 *With other organizations we communicate through letters. Whatever problems we are having on site, or all*
15 *the site constraints, we write them a letter for that. Even if we have them visit the site and show them*
16 *everything on site and they might take a decision on site as well but everything will have to be done in*
17 *written form. (Deputy Project Manager, Contractor 1)*
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20 Informal knowledge sharing tools facilitate smooth knowledge exchange within and between
21 organizations (Taminiau *et al.*, 2009). Swap *et al.* (2001) suggest that knowledge is often
22 unconsciously exchanged by individuals through informal interaction. Knowledge is shared not
23 only face-to-face but also over the telephone, by e-mail, and via WhatsApp, SMS, etc., which
24 enables people to stay connected and keep updated anytime and anywhere (Zhang *et al.*, 2018).
25 As illustrated by our informants:

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29 *We have WhatsApp groups in which we communicate with all the utility departments. Then there are*
30 *technical groups which includes consultant, client and contractors, for them we have separate group. There*
31 *is a separate group for Chinese organization, and the group in which only our own department people are*
32 *there, that is a different group. So, we have separate groups for separate people and our coordination keeps*
33 *going on accordingly. (Project Director, Executing agency)*
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36 Formal methods are used less these days. If things are too formal then no one shares anything.
37 One of the main reasons for this is that informal means of knowledge sharing (such as mobile
38 applications that allow people to interact with each other in real-time) are faster than formal means
39 of communication.
40

41 42 **Types of knowledge**

43 There are two main types of knowledge, tacit and explicit knowledge. Grant (1996) defines
44 knowledge broadly as including both “explicit” knowledge, which can be written down, and “tacit”
45 knowledge, which cannot. Within types of knowledge, we find sub-themes of both tacit and
46 explicit knowledge. As illustrated below:
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50 *There are different types of knowledge. There are things that if I tell someone verbally, they will be able to*
51 *understand them. But for some things, I'll have to show him documents and drawings and have to explain*
52 *my view point, give my technical inputs and have his too so that he gets convinced on what I am saying.*
53 *(Deputy Director 1, Executing agency)*
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3 Sharing knowledge with others helps individuals to build their capacity. Capacity building or
4 enhancement will eventually be beneficial for the team and for the organization. Tacit and explicit
5 knowledge are mutually complementary (Nonaka and Takeuchi, 1995). We find that for tacit
6 knowledge sharing, informal tools are used, while for explicit knowledge sharing, formal tools are
7 considered useful. As one of the informants illustrated:
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11 *Tacit knowledge can be observed at the site. If someone is at the site, he'd be able to observe it. Either it is*
12 *within the organization or any outsider, it can be observed at site and it can be shared at site. For tacit*
13 *knowledge, I believe, an informal way is better. So, there is an informal way of carrying out that*
14 *communication, sharing that knowledge. But for explicit knowledge, obviously, we can go to other methods*
15 *like emails, creating drives and sharing knowledge with others. (Planning Engineer, Consultant)*
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18 19 20 **Levels of units**

21 The unit within which knowledge is shared could be an organization, an individual or a group
22 within the organization (Argote *et al.*, 2003), or across organizations (Hedlund, 1994). We focus
23 on the interaction between the individual, the group, organizational and interorganizational levels.
24 We use the terms “team” and “group” interchangeably, for convenience. We find knowledge flows
25 vertically within the organization and the team, and horizontally across organizations. As
26 illustrated below:
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31 *Consultant issues drawings to us with the approval of client... We evaluate them according to our*
32 *knowledge, whether they are according to the site conditions and whether the drawings are accurate or*
33 *not. We look at all these aspects and then we forward them to the contractor. If there is some change*
34 *required in that, we write it back to the consultant and copy it to client as well because they have to be kept*
35 *in the loop. (Project Director, Executing agency)*
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38 The above quote describes knowledge sharing, i.e. explicit forms of knowledge across
39 organizations, but the organization is part of an interorganizational project. However, there is also
40 the possibility that the knowledge is shared with other organizations which are not part of the
41 project network. As one of the informants states below:
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45 *Like [consultant name], there are other consultancies working as well. We can get to share our knowledge*
46 *with them and there are a couple of people who are working as planning engineers in other renowned*
47 *consultancies and they do share a lot of their knowledge with us and asked us a couple of things. (Planning*
48 *Engineer, Consultant)*
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50 Interestingly, however, we find that tacit knowledge is shared within teams and organizations
51 primarily through informal tools (Table II). It can be shared during formal gatherings such as
52 conferences and training programs, but the majority of tacit knowledge sharing takes place through
53 informal interactions (Holste and Fields, 2010). However, when knowledge is shared with other
54 organizations, formal methods or tools such as formal meetings, visits, etc. are predominately used,
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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.

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 ~~shut-down~~shutdown. This type of verbal communication we do have 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 (Karadshah *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~~

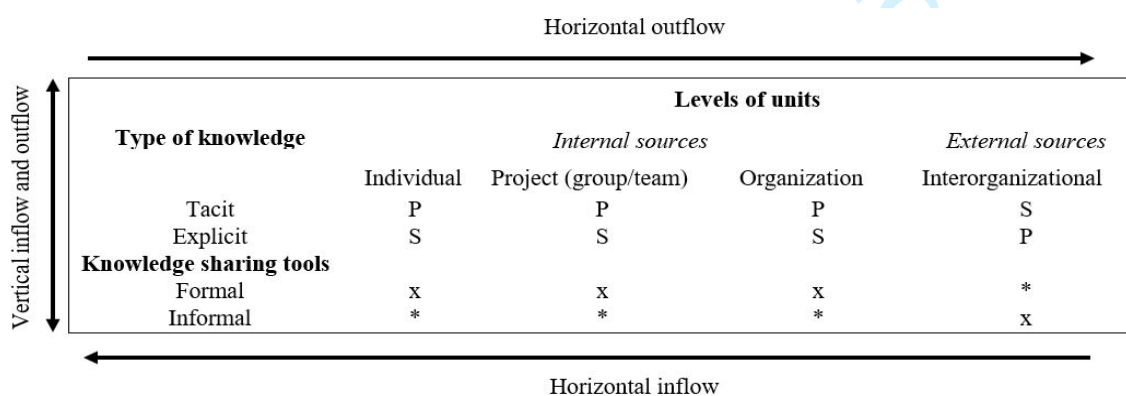
knowledge and explicit knowledge based on the degree of expression. Grant (1996) identifies “knowing how” with tacit knowledge, and “knowing about” facts and theories with explicit knowledge. Our findings provide evidence that both tacit and explicit knowledge are shared in an interorganizational setting.

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



P=Primary, S= Secondary, *= Compulsory, x= Supporting

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3 Knowledge sharing occurs within individual, group, organizational and interorganizational
4 levels (Casillas *et al.*, 2009; Razmerita *et al.*, 2016). Zellmer-Bruhn (2003) found that units are
5 more likely to share knowledge with units that are part of the same organization than with units
6 that belong to a different organization. However, organizations cannot rely on internal knowledge
7 alone; they also have to seek knowledge outside the organization (Matusik, 2002). External
8 knowledge sources are mostly used to share specialized knowledge such as knowledge about
9 clients' preferences; consultants are obvious sources of external knowledge, and may provide
10 specialized knowledge (Simao and Franco, 2018). For example, in our case, the design consultant
11 provides drawings to other organizations such as the client and contractors; this acquisition of new
12 specialized knowledge is often the motivation for establishing interorganizational collaborations
13 (Hamel, 1991). Moreover, internal and external knowledge sources are not substitute for each
14 other, but are complementary (Arora and Gambardella, 1994; Foss *et al.*, 2013). Knowledge from
15 both internal and external sources (Ferraris *et al.*, 2017) is imperative for organizational
16 performance (Szulanski, 1996; Sher and Lee, 2004). It is crucial to understand how units are
17 connected to and interact with each other and how knowledge is shared between the individual,
18 group, organizational, and interorganizational levels. In an interorganizational project such as this
19 one, the units are connected with different types of knowledge and different knowledge sharing
20 tools.
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27 Our model shows that explicit and tacit knowledge exists at all levels (Hedlund, 1994).
28 However, tacit knowledge is the primary form of knowledge at the individual, team and
29 organizational ~~level~~levels, while explicit knowledge plays a supporting role. According to Nonaka
30 *et al.* (2000) and Sánchez *et al.* (2012), tacit knowledge is meaningless without explicit knowledge.
31 Moreover, at the interorganizational level, explicit knowledge is the primary form of knowledge
32 and tacit knowledge is complementary. The reason for this is that explicit knowledge without tacit
33 insights quickly loses its meaning (Nonaka *et al.*, 2000). Thus, both types of knowledge are
34 valuable and, in fact, essential (Nonaka and Takeuchi, 1995; Xue, 2017), each in its own right
35 (Taminiau *et al.*, 2009). Tacit knowledge forms the background necessary for assigning the
36 structure to develop and interpret, use and implement explicit knowledge (Inkpen, 2000). The
37 sharing of both tacit and explicit knowledge (Johnson *et al.*, 2002) facilitates the knowledge
38 sharing process.
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43 Knowledge sharing requires an understanding of how knowledge moves both within an
44 organization and across organizational boundaries. This paper posits that formal and informal
45 knowledge sharing tools enable the sharing of knowledge, ~~which leads to improved performance~~
46 ~~(as suggested by Lawson *et al.*, (2009).~~ Informal tools are used for sharing knowledge with
47 individuals, groups and organizations, whereas formal tools are complementary. However, at the
48 interorganizational level, formal tools are primarily used for knowledge sharing, while informal
49 tools play a supporting role. Moreover, formal means of knowledge sharing are used to ensure
50 efficiency and to reduce uncertainty (Hwang *et al.*, 2018). Usually, when knowledge is shared
51 across organizations, uncertainty is high, so formal knowledge sharing helps to reduce it. Both
52 tacit and explicit knowledge is shared using formal and informal tools. The effectiveness of a
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3 knowledge sharing tool depends upon the type of knowledge being shared (Inkpen and Dinur,
4 1998). Nonaka (1994) and Davison *et al.* (2013), describe tacit knowledge as being shared
5 informally while explicit knowledge is shared formally- which is consistent with the findings.
6 Given the importance of tacit knowledge sharing and its dependence on personal linkages,
7 informal knowledge sharing tools play an important role in organizations (Lawson *et al.*, 2009),
8 while explicit knowledge sharing and formal knowledge sharing tools are utilized at the
9 interorganizational level.

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12 The findings of this study acknowledge that knowledge sharing tools determine how knowledge
13 flows. The next step is to understand the direction in which knowledge flows to the units. Schulz
14 (2001) defines knowledge flows as a volume of know-how and information transmitted per unit.
15 There are two main dimensions of knowledge flow, (i) inflows-outflows, and (ii) vertical-
16 horizontal. Inflows carry knowledge into a unit, while outflows disseminate knowledge from one
17 unit to others (Schulz, 2001; Lee *et al.*, 2019). Vertical flow contains both top-down and bottom-
18 up approaches, knowledge flows between individuals, teams and organizations (Garcia, 2005;
19 Williams and Lee, 2016-;) mainly using informal tools with formal tools as complementary,
20 whereas horizontal flow occurs on the same hierarchical level, between organizations (Schulz,
21 2001; Williams and Lee, 2016-;) primarily used formal tools and informal tools are
22 complementary. This model presents four types of knowledge flows frequently referred to in the
23 knowledge management literature: vertical inflows, vertical outflows, horizontal inflows, and
24 horizontal outflows (Fornell and Larcker, 1981). The vertical inflow occurs as organizations
25 provide their projects with the knowledge needed for execution. The knowledge of project team
26 members is passed to the project level in order to make it possible to implement the knowledge at
27 that level. Meanwhile, vertical outflow occurs as the knowledge is passed from the project level to
28 the organization level in order to distribute it to other projects that are being implemented by the
29 organization (Garcia, 2005). Horizontal knowledge inflows represent the flow of knowledge from
30 other organizations, whereas horizontal outflows provide knowledge to other organizations, such
31 as client, contractors, and consultants.

32 33 34 35 36 37 38 39 40 **Conclusion**

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

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

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52 Our study opens up several new avenues for further research. First, we examined an
53 interorganizational project – a unit of analysis in which multiple organizations engaged
54 simultaneously in knowledge sharing – at an aggregate level. Future research might consider the
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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.

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Table I: Interview participants' details

Role	Designation	Education	Experience (years)	Interview duration (minutes)
Consultant and designer	Project Manager	MSc (UK)	30	61
	Planning Engineer	MSc (in progress)	4	164
Executing agency	Project Director	BSc	16	118
	Deputy Director 1	-	10	
	Deputy Director 2	MSc (in progress)	9	93
Client	Managing Director	-	45	56
	General Manager	MSc (US)	33	101
Contractor 1	Deputy Project Manager	BSc	14	74
Contractor 2	Project Manager	-	29	52
	Quantity Surveyor & Deputy Project Manager	Matric	15	92
Contractor 3	Technical Advisor	BSc	40	125

Table II: Example of coding procedure

Themes	Sub-themes	Illustrative quotes
Knowledge sharing tools	Formal tools	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)
	Informal tools	All of us are electronically connected. Everybody is electronically connected; everything is shared either on messaging or email. (Managing Director, Client)
Types of knowledge	Tacit knowledge	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)
	Explicit knowledge	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)
Levels of units	Knowledge sharing between individuals	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)
	Knowledge sharing between teams	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)
	Knowledge sharing within organization	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)
	Knowledge sharing across organizations	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)