State of Knowledge-based Management in Project Networks: Case in Finnish Infrastructure Construction Sector

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Abstract: Finnish infrastructure construction sector has challenges in productivity and advancing digitalization. We suggest that these problems can be explained with inadequate knowledge-based management (KBM) practices: When information goes missing, employees must collect the information repeatedly. When organizations haven't identified their information needs, data is collected but never used. The purpose of this research is to discover what is the priority of development to improve KBM in project network. A project network in Finnish infrastructure construction sector typically consists of project companies and public customers. This research was conducted by distributing a survey on maturity of KBM to 22 Finnish organizations in infrastructure construction. 10 of these organizations are customer organizations and 12 are project companies. The results are analyzed with a framework suggested for the maturity survey. The results show that, in the project network, customer organizations have less developed KBM practices than project companies, which is not surprising. The interesting point, however, is that the results highlight the importance of the customer organizations in information sharing in the project network. Therefore, the inadequate KBM practices of customer organizations seem to weaken the productivity of the whole project network.

1 INTRODUCTION

Digitalization is a breakthrough way of operating in many fields affecting our daily operations as the organizations need to consider their effectiveness and competitive edge in relation to their counterparts. This has been so already for many years (Lindgren et al. 2019). Digitalization, with its many novel tools and functions enable faster operating, better handling, more efficient time consumption, and improved information availability (Parviainen et al. 2017, Isaksson et al. 2018).

The need for productivity improvements, seen also in the infrastructure construction sector, necessitates the efficient utilization of knowledge resources to improve organisations' decision-making and advance digitalization. Several studies show that amount of available data or information is not an issue (e.g. Myllärniemi et al. 2019). However, the organisations need to practice knowledge-based management, as in determine which information is relevant, how to make information more useful and meaningful, and how to use it in decision-making (Kaivo-oja et al. 2015; Choo 1998). Optimizing the use of existing knowledge in order to make the best of it helps organisations, for example, to enhance its decision-making and knowledge processes.

Infrastructure covers commodities provided for public use (Kasper 2015), including roads and bridges. As described in figure 1, in Finnish infrastructure construction sector the customer organization typically orders infrastructure design from design consultancies, and infrastructure construction and maintenance from contractors. The information needs and information are shared in the network mainly through the customer organization. The customer organization can have multiple projects on going simultaneously with different consultancies and contractors, which makes the project network even more complex. Larsson et al. (2013) report a similar infrastructure construction process in Sweden.

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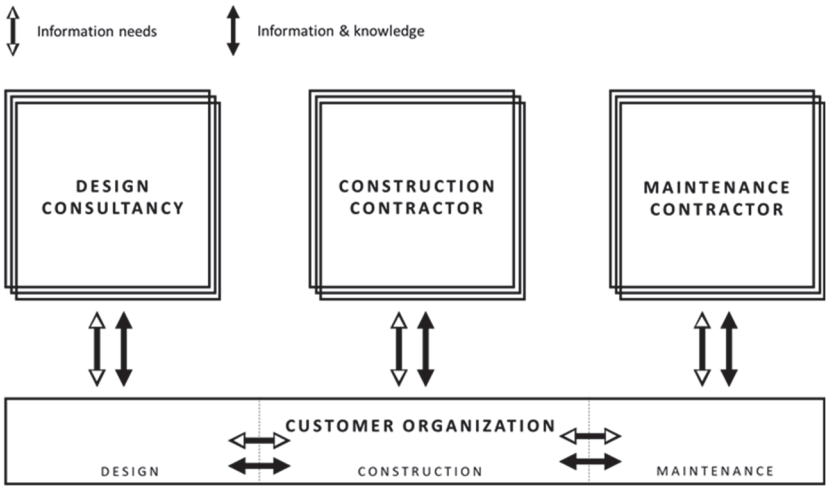

Figure 1: Project network in infrastructure construction sector.

To research digitalization and productivity challenges in infrastructure construction we answer the question "How is knowledge-based management perceived and dealt with in Finnish public sector project networks?" by studying KBM in project networks in large Finnish cities. We also offer some propositions to solve the challenges and make some generalizations regarding the approach to these issues to be considered also in larger extent. In next chapter the related research is illuminated. Chapter three shows how the study is conducted and how the material was gathered. Chapter four presents the results. Chapter five discusses the meaning of the previous, and chapter six concludes the research.

This research provides new knowledge on KBM in project networks. Research on interorganizational KM or KBM in project networks is quite narrow (Agostini et al. 2020). This research took a quite wide perspective on KBM, not focusing only on information sharing or protection. In addition, we focus on a specific type of project network in which customer organization has a key role. The practitioners can derive ideas for developing KBM in their project network, whether they represent a customer organization or a project company.

2 RELATED RESEARCH

2.1 Knowledge-based Management

Factors, such as reducing resources, citizens' expectations, and public pressure give the need to constantly develop the operations (Gunasekaran 2005; Hellsten and Pekkola 2019). In today's public sector, the objective for KM is to provide means to better understand the needs of the people on all levels but also to offer the inhabitants of the city with better and more inclusive services in the most resource-efficient and sustainable way, in addition to mere improving the operation. (Hellsten et al. 2021). According to Wiig (1997) knowledge management (KM) aims to improve organizations' effectiveness and performance by stressing the importance of knowledge creation, development, management, and finally, leveraging. KM is an umbrella term of understanding, defining and utilizing available knowledge that provides the decision-makers a useful tool for managing their organizations (Moss 1999). KBM, on the other hand, is defined as an approach in which organisational knowledge assetts, including data, information and knowledge, is processed and utilised to support decision-making. KBM is about KM policies, practices and processes that are understood as managerial practices designed to support effective and productive information management for the benefit of the organisation (Inkinen 2016). Jalonen (2015) says it aims to reduce uncertainty due to lack of information and to manage the ambiguity arising from the amount of information.

Knowledge is processed from data through information into knowledge. One way to structure knowledge process is the process model of information management created by Choo (2002). The model consists of six phases. It starts by defining information needs to later be satisfied as efficiently as possible by information acquisition from both internal and external information sources. The model's third phase is information organisation and storing. The following phases relate to information analysis for systematic and advanced information products or service, information sharing and usage.

After the latter, possible changes in the organisational activities take place and the cycle starts over.

Choo's model forms a basis for Jääskeläinen et al.'s (2022) maturity model designed for information and knowledge management (IKM) in public sector. The IKM expands Choo's model from both the technical side of information handling and the utilization of the information by humans (Jääskeläinen et al. 2022). Jääskeläinen et al. add sections called Vision & strategy and Governance and organisation to their model. The IKM offers useful and practical way to *determine the state of an organization's information and knowledge management and identify development needs* (Jääskeläinen et al. 2022). Later on Choo's model phases are called sections which consist of KBM practices.

2.2 Knowledge-based Management in Project Network

Projects are temporary systems formed by individuals or organizational actors to accomplish complex and unique tasks (Lundin & Söderholm 1995; Obstfeld 2012). An interorganizational network working on a common project can be called a project network (Alin et al. 2013). Because of the complexity, uniqueness, and uncertainty of project activities, they require increased focus on KBM (Ajmal et al. 2010). Projects involving multiple organizations have become increasingly important (Bakker 2011) which creates additional challenges for knowledge sharing: organizations need to balance between the risks and benefits of knowledge sharing, the information systems might be misaligned, and employees might not share their knowledge in the network (Vuori et al. 2019).

Riege (2005) has identified dozens of barriers for knowledge sharing, in individual, organizational and technological levels. These barriers include e.g., lack of time, low awareness on the value of the knowledge possessed, fear of losing expert status when sharing knowledge, differences in experience levels, lack of leadership, missing integration of KM strategy and business strategy, internal competitiveness, inadequate IT systems, a mismatch with employees needs and the tools, and lack of training. Vuori et al. (2019) built on Riege's (2005) model with the purpose to leverage it to network level. They found that Riege's barriers are relevant in the network level and there are also network-specific barriers in addition. They suggest that geographical or cultural distance, strength of the organizational ties and trust, value positioned on the interorganizational knowledge all have an important role in the network level.

Knowledge-based theory argues that organisations' success depends strongly on their knowledge-based resources (Grant, 1996; Spender and Grant, 1996). The early studies on KM focused on the intra-organizational level (Nonaka 1994, Nonaka and Takeuchi 1995, Grant 1996). The interest for interorganizational KM or KBM in networks has followed as the value of interorganizational relationships for accessing and combining knowledge has been recognized (e.g., Buckley et al. 2009). External partners have an increasingly important role in filling internal knowledge gaps (Bojica et al. 2018) and to benefit from the knowledge partners acquire, organizations need to manage and align inbound knowledge flows with the internal activities (Brunswicker and Vanhaverbeke 2015). KBM in networks has become increasingly important, as it can be defined as managing the acquisition, sharing, and co-creation of knowledge between organizations (Lancini 2015), which enables organizations to benefit from the knowledge in the network.

The focus on interorganizational KM research has been narrow, concentrating mainly on specific types of interorganizational relationships, knowledge transfer among organizations and on knowledge protection (Agostini et al. 2020). There are challenges in capturing and reusing knowledge produced in projects, and in utilizing the lesson's learned. Bhargav and Koskela (2009) suggest that KBM in project networks can be effective in capturing project-based knowledge, if it includes top management support, an easy-to-use KM system, and creating the right environment for knowledge sharing. The strategies for knowledge management, information technology and business need to be aligned to achieve KBM objectives (Wang and Wang 2009). As Omotayo (2015) puts it, if people are willing to share knowledge, technology can enable a further reach. However, applied tools and systems only won't get people to share their knowledge.

3 METHODS

The research was conducted by distributing a maturity survey on KBM to 22 Finnish organizations in infrastructure construction sector. These organizations represent the three stages of infrastructure construction: design, construction and maintenance. 10 of these organizations are customer organizations and 12 are project companies. In total, we received 68 responses to this survey. The survey is based on maturity survey on information and knowledge management by Jääskeläinen et al.

(2022). The survey includes eight different sections on KBM: vision and strategy of an organization (A), governance and organization of a project (B), information needs in a project (C), information acquisition in a project (D), information organization and storage in a project (E), information products in a project (F), information and knowledge sharing in a project (G) and information usage in a project (H). Each of these sections included between five and ten statements on the development of practices. In addition, each section included one statement concerning the satisfaction to these practices. The respondents chose in Likert scale if they strongly or somewhat disagreed, neither disagreed nor agreed, somewhat or strongly agreed, or didn't want to respond the statement. In addition, each section included an open question, where respondents could describe their thoughts more freely.

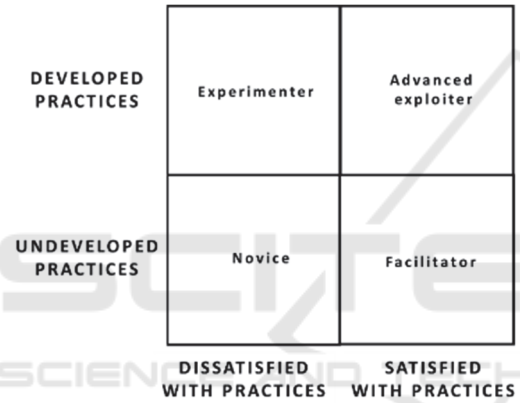

Figure 2: A framework for analyzing maturity survey on KBM (Jääskeläinen et al. 2022).

Since the intervals between the Likert scale values are not equal (Cohen et al. 2007), the responses were grouped to two categories: agree and disagree. The distribution of responses between these two categories was calculated as a percentage while leaving out the neutral responses. The responses agreeing with the development of each KBM section were based on five to ten statements each, and the percentages representing the satisfied were based on a single statement. When responses are distributed equally between satisfied and dissatisfied, or agreement and disagreement, the responses are interpreted as dissatisfied and disagreement, as there is a significant amount of respondents not satisfied with the practices or thinking the practices are not developed.

The results are analyzed using a framework suggested for this maturity survey by Jääskeläinen et al. (2022). The framework is a matrix with four categories: novice, facilitator, experimenter, and advanced exploiter (see figure 2). Jääskeläinen et al. (2022) present the novice as having the practices in a rather primitive level and suggest that these practices should be prioritized in development. Facilitator describes those practices that may not be very developed but meet the needs of the organization. Practices that fall into the experimenter area are developed and even novel, but not implemented fully. Advanced exploiter is described as the desired situation: the practices are advanced and exploited. In section 5, each section of KBM will be placed on this framework separately for customer organizations, and for project companies.

4 RESULTS

The results are presented in three tables. Table 1 presents the percentage of responses in agreement with the development of the KBM. Table 2 presents the percentages of respondents who were satisfied with each section of KBM. Table 3 gathers the open answers.

Table 1: The percentage of responses in agreement with the development of the KBM practices.

Sections of KBM	Customer organizations	Project companies
A. Vision and strategy of an organization	66%	88%
B. Governance and organization of a project	47%	61%
C. Information needs in a project	57%	78%
D. Information acquisition in a project	71%	70%
E. Information organization and storage in a project	52%	62%
F. Information products in a project	45%	61%
G. Information and knowledge sharing in a project	59%	69%
H. Information usage in a project	62%	86%

Table 2: The percentage of respondents who were satisfied with the KBM practices.

Challenges	Customer organizations	Project companies
Difficulty of implementing practices	9	1
Insufficient skills	4	4
Insufficient resources	3	1
Lack of common practices	11	4
Undefined responsibilities	2	6
Inadequate information systems and interfaces	3	1
Inadequate information management processes	5	13
Inadequate information products	2	0
Undefined information needs (of one's own organization)	7	1
Undefined information needs (of other organizations)	2	5
Sharing implicit knowledge	1	2

Table 3: Challenges mentioned in open-ended questions.

Sections of KBM	Customer organizations	Project companies
A. Vision and strategy of an organization	52%	59%
B. Governance and organization of a project	21%	50%
C. Information needs in a project	36%	62%
D. Information acquisition in a project	36%	65%
E. Information organization and storage in a project	38%	54%
F. Information products in a project	33%	73%
G. Information and knowledge sharing in a project	44%	64%
H. Information usage in a project	54%	65%

As shown in table 1, the respondents in customer organizations are mostly agreeing with the development of the practices in KBM. However, they are clearly agreeing only on the development of the practices in information acquisition. The sections of governance and organization of projects and the creation and usage of information products seem to have undeveloped practices.

The project companies' respondents are significantly agreeing with the development of the practices in most of the sections. The lowest development of the practices seems to be in governance and organization of projects, information storage, and the usage of information products. However, even these sections have more than 60% of the respondents thinking the practices are developed. Whereas the respondents in customer organizations had more than 60% agreeing with the practice development in only three sections.

Table 2 shows that customer organizations' respondents were only satisfied with the practices regarding organizational strategy, and information usage. And even with these sections, the percentage of satisfied respondents is only slightly more than 50%. The least satisfied they are with the practices in governance and organization of projects.

Respondents in project companies are clearly more satisfied with the KBM practices than their counterparts in the customer organizations. They are quite significantly satisfied with the usage of information products, and slightly dissatisfied with governance and organization of projects. With the other sections, they are satisfied.

A significant number of respondents from customer organizations reported challenges with implementation, and a lack of common practices. Multiple respondents mentioned that there is a lot of development done in strategic level, but the practices do not change in operational level. However, reasons for this difficulty were not reported and therefore it is not possible to state if this results from resistance to change, insufficient efforts to implement the practices, or other reasons. Lack of common practices includes working in siloes, which results in time-consuming information acquisition. In addition, respondents mentioned not having rights to all information they need, which increases the fragmentation of work in the network. Lack of common practices makes it also more difficult to share information, as reported by the respondents.

Undefined information needs of the customer organization were reported by the respondents from both categories of organizations. It seems that the undefined information needs of customer organization creates challenges to gathering information in both kinds of organizations. Interestingly, same challenge in project companies

was not reported as many times by respondents in either one of the categories of organizations.

Some respondents from project companies mentioned that customer organizations do not understand their information needs. This challenge was not identified by customer organizations as it was not mentioned even once. One respondent stated that as customer organization has not identified their own information needs, it is difficult to define roles and responsibilities in the project company side too. Another responder claimed it's the other way around: if the roles and responsibilities are not clear, the information needs cannot be clearly defined either. Thus, the unidentified information needs, and unclear roles and responsibilities seem to be connected, even if the cause-and-effect relationship is unclear.

Respondents from project companies stressed the central role of the customer organization in multiple other responses too, including the mentions of inadequate information management processes. Information gets disorganized and stored in multiple different locations, which results in information getting outdated and disappeared. The respondents from project companies highlight how the information acquisition is even more difficult when it's managed by customer organization. Respondents from the customers' side did not stress the role of other organizations in information management. Another difference between customer organizations, and project companies, is that the latter reported insufficient skills mainly related to information products whereas the first reported insufficient skills relating to KBM.

5 DISCUSSION

The results are visually presented in figure 3. This figure shows how the KBM practices are less developed in customer organizations than in project companies. The most striking is the difference of satisfaction with these practices: respondents from customer organizations are mostly dissatisfied with KBM practices whereas other respondents are mostly satisfied. Jääskeläinen et al. (2022) state that the organizations with high employee satisfaction to KBM practices have in common that they link their KBM better to strategy (A) and have better structures supporting KBM (B), more advanced information products (F), and better systems and processes for storing information (E). This seems to apply for project companies too.

As presented in figure 3, customer organizations can be interpreted as experimenters with novice tendencies. According to Jääskeläinen et al. (2022), for experimenter and novice organizations it is essential to focus on aligning their KBM practices with their strategy i.e., implementing the practices that have been developed in a strategic level. The difficulty of implementing practices was also mentioned by multiple respondents in the open answers. The misalignment of KBM and business strategies, and technology are known barriers for knowledge sharing (Riege 2005; Wang and Wang 2009). The whole project network would benefit if customer organizations would also focus on identifying their information needs (C) as it was reported as insufficient by both categories of organizations. Diversified and systematic fulfilment of information needs facilitates decision-making (Hellsten and Myllärniemi 2019) and helps organization-wide knowledge management.

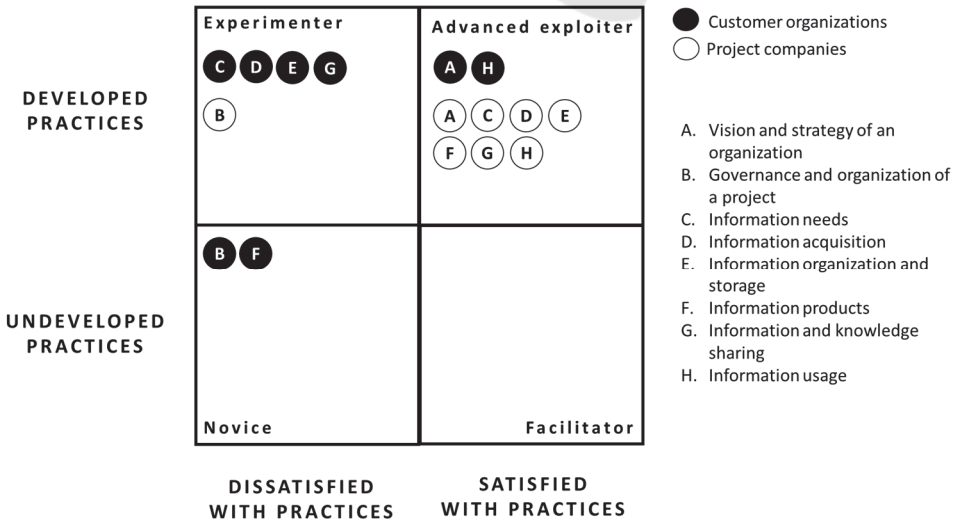

Figure 3: KBM in customer organizations and project companies.

Project companies can be interpreted as advanced exploiters with experimenter-level project governance and organization (B). Advanced exploiters have advanced KBM practices and can exploit them fully (Jääskeläinen et al. 2022). Project companies should focus on better governance and organization of projects (B), including allocating more resources to KBM and especially having more defined roles and responsibilities. However, the open answers highlighted how difficult it is to improve these practices without cooperation with customer organization. It seems that for project companies the priority is to define common practices and processes with customer organizations to enable better information and knowledge sharing and acquisition.

KBM in project networks is cooperation, i.e., organizations need to align their internal activities (Bruswicker and Vanhaverbeke 2015) and communicate actively in the network (Vuori et al. 2019), in order to achieve fluent knowledge sharing and acquisition. Especially the respondents from project companies highlighted the importance of the cooperation with customer organization in their open answers. To make the change, organization and governance in common projects need to develop further: the importance of information and knowledge sharing needs to be made clear for everyone, and time and resources must be allocated sufficiently (Riege 2005). The respondents from both categories of organizations reported that the information management would be of better quality if there was enough time to do it properly. The misalignment of IT-systems is also noted by the respondents and authors such as Vuori et al. (2019) and Riege (2005).

6 CONCLUSIONS

As reported in this research and by others (e.g. Bhargav and Koskela 2009; Lancini 2015; Bojica et al. 2018; Agostini et al. 2020) the interorganizational cooperation is key for successful KBM in project networks. Organizations cannot operate alone, and internal knowledge gaps need to be increasingly filled by cooperating with external partners (Bojica et al. 2018). This research has also shown that customer organizations have a key role in developing KBM further in project network. If they manage to fully exploit their KBM practices, they can improve KBM in project companies too in their common projects

Project companies should invest especially on communication and cooperation with customer organizations. By frequently communicating with the customer organization, they can be more aware of the customers' information needs. Since project companies have more developed practices, they could take a more proactive role in information management in their common projects.

This research provided more insight on KBM in project network. According to Agostini et al. (2020) research on interorganizational KM or KBM in project networks is quite narrow, by focusing on specific types of interorganizational relationships, knowledge transfer among organizations and on knowledge protection. This research took a quite wide perspective on KBM and we had a specific type of project network in which customer organization has a key role, which doesn't seem to be a much-studied network in this field. We were able to discover how important the customer organization's role is in a poject network.

The practical community can derive ideas for developing KBM in their project network, whether they represent a customer organization or a project company. This research is also part of a research programme ProDigial, which aims for further digitalization initiatives and increased productivity in Finnish infrastructure construction sector. Our practical contribution from this research programme is a guide for customer organizations to develop KBM in their project networks.

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