Opening the black box of knowledge management mechanisms: exploring knowledge flows at a consultancy

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Abstract

Purpose – Based on an exploratory case-based approach, the purpose of this paper is to open the KM black box and examine the relationships that link knowledge management (KM) inputs (i.e. knowledge resources and KM practices) via knowledge processes to KM performance. This paper aims to identify the underlying mechanisms and explain how KM performance is enabled.

Design/methodology/approach – This in-depth case study conducted at a medium-sized consultancy in the supply chain management industry empirically examines knowledge flows to uncover the relationships between KM inputs, knowledge processes and KM performance. We adopt the viable system model (VSM) as a theoretical lens to identify KM mechanisms.

Findings – By identifying six KM mechanisms, we contribute to the theoretical understanding of how KM inputs are interconnected and lead to KM performance via knowledge processes.

Originality/value – Based on the insights gained, we provide propositions that organizations should consider in designing viable KM. Our findings help organizations in understanding their KM with the help of knowledge flow analysis and identifying how critical KM elements are interconnected.

Keywords Knowledge management, Case study research, Viable system model, Mechanisms, Knowledge flows, Consultancy

Paper type Research paper

1. Introduction

Knowledge management (KM) comprises practices and processes that enable effective and efficient management of knowledge resources (Alavi and Leidner, 2001). Given the increasing knowledge intensity in business environments (Anand *et al.*, 2007; Imran *et al.*, 2022), organizations are continually intensifying their KM efforts due to its critical role in organizational performance (Gold *et al.*, 2001; López-Cabarcos *et al.*, 2020; Massingham, 2020). In this context, *information technology (IT)* is seen as a crucial element for storing, processing and communicating knowledge (Alavi and Leidner, 2001). For example, IT-based KM systems (KMS) such as Microsoft's SharePoint are nowadays a de-facto standard (Pah *et al.*, 2018). Yet, KM remains a significant challenge. Due to its complexity, benefits of investments into KM are seldom predictable (Haas and Hansen, 2007; Setia and Patel, 2013), organizations struggle to

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achieve the expected return on investment and KM initiatives are challenged by drawbacks (Haamann and Basten, 2019; Choi *et al.*, 2020).

Recent research suggest that it is not crucial grasping all available knowledge. Rather it is important to evaluate *which* knowledge is relevant and *how* it flows through the organization (Barley *et al.*, 2018). Combining two major lines of inquiry, earlier works emphasize the importance of combining both technology-driven and behavioural-research approaches in a social-technical perspective on KM and KMS (Schacht *et al.*, 2015). Respective studies focus on *what* social, technical and organizational KM inputs contribute to KM success. *KM inputs*, which can either be knowledge resources or KM practices (see Section 2.1), are factors investigated in relation with successful KM implementation. Exemplary KM inputs in previous research comprise employee training, IT infrastructure, top management support and human resource management (Anand *et al.*, 2015). However, our current understanding of how KM inputs should be organized, managed and integrated in order to contribute value to the organization is still limited (Engwall and Kipping, 2002; Donnelly, 2008; McIver *et al.*, 2013). More specifically, theoretical explanations are missing that suggest how and why to develop processes in alignment with the nature of knowledge work organizations do (McIver *et al.*, 2013). Accordingly, realistic, granular and context-specific studies are needed to open the KM black box (Carlile and Rebentisch, 2003; McIver *et al.*, 2013) since we are missing an understanding about how KM inputs systemically lead to KM performance. Rather than taking an abstract view that masks concrete operational processes, we propose a systemic theoretical stance based on *knowledge flows*. If knowledge flows are improperly designed, the interdependent processes of KM are likely to exhibit substantial inefficiencies leading to financial losses and missed business opportunities (Nissen, 2005; Mehta *et al.*, 2007). The focus on knowledge flows implies viewing knowledge as a process of simultaneously knowing and acting (Alavi and Leidner, 2001). Knowledge flows are dynamic knowledge and depict changes, movements and applications of knowledge over time (Nissen, 2005; Nonaka and Takeuchi, 2019). Thus, they are a useful element to analyse linkages between KM inputs and performance via KMS.

Hence, we ask the following research question (RQ): *How does the intertwinement of KM inputs (knowledge resources and KM practices) contribute to KM performance?*

For answering this question, we follow a case-based research approach (Yin, 2009) in an a medium-sized consultancy operating in the supply chain management industry. With the qualitative case study, we follow a research approach that is widely disseminated in KM research (Martins *et al.*, 2019; Barros *et al.*, 2020) and complies with research that is realistic, granular and context-specific and is needed to open the black box under investigation (Carlile and Rebentisch, 2003; McIver *et al.*, 2013). We relied on the viable system model (VSM) to analyse the organization's project-based structure. Due to its systemic nature, the VSM is particularly helpful when describing and analysing complex systems such as organizations' KM and KMS. Furthermore, the VSM provides a language for describing and understanding organizational structures and knowledge flows (Rosenkranz and Holten, 2011). To explain how and why KM inputs contribute to KM performance, our VSM-based empirical analysis of the case company yielded explanations in the form of six *KM mechanisms:* (1) project-based knowledge generation, (2) standardization of KM practices and resources, (3) putting people in the KM centre, (4) cyclic refinement of knowledge into a strategic asset, (5) allowing deliberate misalignment of KMS, KM identity and processes and (6) combining operational and strategic view.

The remainder of this study is structured as follows. In Section 2, we present the theoretical underpinnings of both systemic research on KM mechanisms and knowledge flows in the context of the VSM. In Section 3, we explain our research approach in terms of case study design, data collection and data analysis. Our results concerning KM mechanisms based on the VSM perspective at a consultancy are presented in Section 4. Our study concludes with propositions, implications and future research avenues in Section 5.

2. Theoretical background

2.1 Systemic research on mechanisms to open the black box of knowledge management

Despite recognizing the importance of enabling KM inputs (i.e. KM resources and practices), considerable gaps exist in the current understanding of how KM inputs relate and interact, and of the manner in which organizations generate and manage knowledge using KM inputs (Engwall and Kipping, 2002; Donnelly, 2008). *Knowledge processes* are generic activities, such as the acquisition, sharing and creation of knowledge (Alavi and Leidner, 2001; Massingham, 2020), and can be viewed as dynamic links between KM inputs. Each of these knowledge processes is heavily supported by IT in modern organizations to help creating value and competitive advantage (Yee *et al.*, 2019; Di Vaio *et al.*, 2021).

While it is acknowledged that organizational structures and IT systems require fit in knowledge-sharing contexts, the understanding of "how to organize, manage, and integrate activities for managing knowledge [. . .] is limited" (McIver *et al.*, 2013, p. 597). For example, investments in IT and related practices supporting KM do not necessarily lead to better KM if they are not combined with social KM practices such as human resource management (Andreeva and Kianto, 2012). Furthermore, if KM initiatives are not properly steered and orchestrated to control for vicious and virtuous circles, negative effects can amplify themselves via feedback mechanisms and endanger viability of the overall KM approach (Garud and Kumaraswamy, 2005).

Quantitative assessments (e.g. Lam *et al.*, 2021) provide limited theoretical in-depth explanations of how knowledge resources and KM practices (i.e. KM inputs) lead to intended performance. It is thus crucial to open the KM black box to arrive at a deeper understanding concerning the linkage between KM inputs and performance (Carlile and Rebentisch, 2003; Andreeva and Kianto, 2012; McIver *et al.*, 2013). For the purpose of filling the gap of realistic, granular and context-specific studies concerning the missing understanding how KM inputs systemically lead to KM performance (Carlile and Rebentisch, 2003; McIver *et al.*, 2013), case study research is a suitable approach (Yin, 2009), which is commonly applied in diverse KM research domains (Martins *et al.*, 2019; Barros *et al.*, 2020).

For describing and analysing these linkages, the concept of *mechanisms* is suitable. While "it is difficult to propose a mechanism definition that would both be informative and cover all examples of mechanisms" (Hedström and Ylikoski, 2010, p. 50), mechanisms are commonly seen either as causal processes leading to an effect of interest or as critical elements of these causal processes (Hedström and Ylikoski, 2010). The structure of mechanisms is disclosed when "a mechanism-based explanation opens the black box [. . .] and turns the black box into a transparent box" (Hedström and Ylikoski, 2010, p. 51). Accordingly, we refer to *KM mechanisms* as the relationships that relate KM inputs (i.e. knowledge resources and KM practices) via knowledge processes to KM performance.

Of particular importance in understanding KM mechanisms is the manner in which knowledge flows through the organization (Argote *et al.*, 2003; Levallet and Chan, 2019; Pateli and Lioukas, 2019), revealing interactions of people, work structures, processes, IT and culture within the organization. The concept of *knowledge flows* refers to dynamic knowledge that flows from one place to another, and is an indicator of related concepts such as knowledge conversion, transfer, sharing, integration, reuse and others depicting changes, movements and applications of knowledge over time (Nissen, 2005). Here, knowledge flows represent the dynamic, nonlinear character of KM associated with continuous adaption (Barley *et al.*, 2018). Our study uses the fundamental knowledge process model of knowledge creation, storage, retrieval and application (Alavi and Leidner, 2001; Massingham, 2020). We understand knowledge flows as the foundation of knowledge processes and thus adopt what is referred to as the process perspective on knowledge (Alavi and Leidner, 2001).

Knowledge flows across units are not cost-free. If knowledge flows are improperly designed, interdependent processes are likely to exhibit substantial inefficiencies leading to financial losses and missed business opportunities (Nissen, 2005; Mehta *et al.*, 2007; Nonaka and

Takeuchi, 2019). Particularly, with complex organizational structures such as in project-based organizations this can have dramatic impacts on knowledge management (Koskinen, 2010).

Table 1 summarizes the key KM concepts relevant for our study.

Organizational survival is highly dependent on organizations' ability to rapidly create and effectively manage knowledge (Bettis and Hitt, 1995) and KM aims "to make the enterprise act as intelligently as possible to secure its viability and overall success" (Wiig, 1997, p. 1). As KM is a complex activity, it requires organizational rather than operational capabilities for managing knowledge (Zahra and George, 2002; Lane *et al.*, 2006; Roberts *et al.*, 2012). Of particular importance in understanding the mechanisms in KM is the way knowledge flows through the organization, revealing interaction of people, work structures, processes and culture within the organization. One approach that is specifically geared towards making such flows visible and pertains to the overall viability of a system is the VSM. The VSM, which builds on systems theory, cybernetics and especially the concept of viability, is deemed suitable for assessing organizations and their complexity, as it allows their structure and information flows to be analysed (Rosenkranz and Holten, 2013).

The VSM is appropriate for engaging in the analysis of organization-wide phenomena such as KM because it makes the entities and the flows of knowledge between them visible in the

Concept	Description	Sources
KM inputs	Knowledge resources: static stock or knowledge base of the organization *Example: a KMS such as a knowledge repository*	Mariano and Awazu (2016)
	KM practices: a set of purposeful organizational and managerial activities aimed at efficient and effective management of organizational knowledge resources and processes *Example: a supervisor instructs staff to document project results in a knowledge repository*	Andreeva and Kianto (2012), Inkinen *et al.* (2015), Hussinki *et al.* (2017)
Knowledge processes	Generic KM-related activities such as acquisition, sharing and creation of knowledge; can be observed via knowledge flows *Example: a project team member documents lessons learned of a project in a knowledge repository*	Alavi and Leidner (2001)
KM performance	Consequences that are associated with successful KM *Example: timeliness in completing a knowledge assignment during project work and doing it right the first time*	Andreeva and Kianto (2012), Inkinen *et al.* (2015)
KM mechanisms	Relationships that link KM inputs (i.e. knowledge resources and KM practices) via knowledge processes to KM performance *Example: by using a corporate intranet, employees can access relevant information such as policies and standards (and changes to these directives) faster, which has a positive effect on reaction time of the organization*	Hedström and Ylikoski (2010)
Knowledge flows	Dynamic knowledge depicting changes, movements and applications of knowledge over time *Example: knowledge is stored to a knowledge repository, at a later point in time retrieved, and then applied to a different situation; as a result, knowledge is appropriated, modified and stored again in the repository*	Nissen (2005)

Table 1.
Central KM concepts

form of a common language (Rosenkranz and Holten, 2013). Furthermore, the VSM's capacity to delineate and decompose organizational structures as well as interlinking flows can be used as a key to open the black box that has thus far made the relationship between KM inputs and performance opaque. In this regard, the VSM's language helps to model the information flows between an organization's parts (Rosenkranz and Holten, 2011). Although researchers generally view the VSM as a suitable theoretical lens for analysing KM, pertinent studies are limited to discussions of this relationship from an abstract, theoretical perspective, thus rarely providing suitable empirical grounding for the arguments and findings put forth (e.g. Leonard, 1999; Leonard, 2000; Achterbergh and Vriens, 2002; Yang and Yen, 2007). Achterbergh and Vriens (2002) applied the VSM to KM by identifying the domains of knowledge an organization should possess to be steered and maintain its viability (recently advanced by Preece and Shaw (2019) in a case study of a design and printing company). However, in the absence of physical goods, knowledge-intensive organizations create value primarily through employing their expertise in solving customers' problems, making knowledge exchange even more crucial (Pan *et al.*, 2015). Consequently, in these types of organizations, knowledge that creates value becomes an essential part of resources required for organizational viability. We argue that in these organizations it is adequate to conceptualize KM itself as a viable system whose viability reflects to a large degree viability of the overall organization.

However, it remains unclear how specific KM inputs produce certain outcomes that lead to viability, which is critical on the backdrop of the knowledge economy (Bell, 1976; Drucker, 2011; Stark, 2011). In order to mitigate this issue, in this work, we aim to elucidate the linkage between KM inputs and performance as well as contribute to the limited empirical research in this field by using the VSM as a theoretical lens through which to examine KM in a particular case of a consultancy, for which KM is especially important because knowledge is its core product (Sarvary, 1999; Lahti and Beyerlein, 2000). As such, our research is in line with recent calls for pursuing KM research across different models and contexts (Ferreira *et al.*, 2018).

2.2 Knowledge flows and the viable system model

According to Beer (1985), the VSM specifies the minimum functional criteria by which a given system (e.g. an organization) is capable of independent existence in a changing environment. If a system meets these criteria, it is viable, that is, able to maintain and sustain its identity, and responding and adapting to changes in the environment. Each viable system performs five distinct functions to ensure its viability, namely (1) production, (2) coordination, (3) execution, (4) planning and (5) identity (Beer, 1985, 1994a, 1994b). According to the VSM, five subsystems correspond to these functions referred to as *System 1 to 5*. The five subsystems form a logically closed entity that constitutes the viable system. Only System 1 (S1) is action-oriented, while the remaining four subsystems (System 2 to 5) are responsible for management and control.

Recursion as the essential principle for structuring within the VSM leads to the fact that viable systems on lower levels of the organization need the same structural composition as the whole viable system; each level of the organization is a recursion of its super-system (Beer, 1994b). Specifically, the inclusion of recursion allows us to investigate multiple levels of analysis.

In a VSM, System 1 serves as an interface between two levels of recursion. System 2 is a service function for System 1 and serves to damp oscillation and other disruptions that occur between the operational units on an operational level. System 3 supervises all internal operational activities of all operational units from a higher point of view of the total system. System 3* is an audit channel, which gives System 3 direct access to the state of affairs in the operational activities. System 4 deals with the diagnosis of the long-term connection of the organization to its outside environment and its adaptation to future trends. System 5 embodies supreme values (ethos), rules and norms for the stabilisation of the entire system. Each subsystem is connected to others via explicit *communication channels*, which are prime

candidates for identifying knowledge flows. The combined operational subsystems' capacity to process a variety of states exceeds that of those subsystems that manage and control them. To manage variety, subsystems use techniques of acceleration and attenuation to increase and decrease the variety of information communicated. For example, management subsystems formulate standard procedures that apply to a group of operational units (amplification) and operational subsystems report aggregated information on operational activities (attenuation). For illustration, we appropriate the five subsystems of the VSM to KM in a project-based organization (outlined in Table 2).

	Sub-system	Name	KM function description
Action	System 1 (S1)	Production & Application of Knowledge	KM-related activities to fulfil the organization's overall KM purpose of using the right knowledge at the right time in the right place. S1 can consist of several viable systems on a lower level of recursion (due to a nested organizational structure) *Example: the business areas of a company, projects and sub-projects*
Management and Control	System 2 (S2)	Coordination and Support of Knowledge Operations	Service function for S1 and oscillation dampening by supporting transfer and awareness of available and visibility of contradicting knowledge *Example: regular coordination meetings concerning required knowledge for operational units, supporting standard procedures of KM such as how knowledge should be collected, aggregated and shared across operational units*
	System 3 (S3) & System 3* (S3*)	Supervision of Knowledge Operations	S3: Supervision and resource management for internal KM operations S3*: Audit channel and direct line of communication to operational KM units *Example (S3): the executive management responsible for matching and allocating knowledge resources for specific business areas of the company, but not responsible for managing the business areas directly, defining standard procedures of KM* *Example (S3*): special studies and surveys to audit whether knowledge is shared appropriately, management by walking around and checking whether knowledge is accessible and stored correctly*
	System 4 (S4)	Strategic Planning of KM	Diagnosis of the long-term knowledge requirements to environment and adaptation to future trends *Example: Leading KM and business experts who analyse future trends in the market and evaluate knowledge requirements for customer services and products*
	System 5 (S5)	KM Identity	Supreme values, rules and norms for KM *Example: management board defines KM vision and values and guidelines for general conduct*

Table 2.
VSM Subsystems appropriated to KM (adapted from Rosenkranz and Holten, 2011, p. 28)

3. Method

3.1 Case study design and setting

We conducted an in-depth single case study because the boundaries between our phenomenon of interest and its context are not clearly demarcated (Yin, 2009). Our case study is exploratory in nature (Keutel *et al.*, 2014): since specific KM inputs produce certain outcomes that lead to viability, our aim is to open the KM black box and arrive at a deeper understanding of KM mechanisms that link KM inputs to performance. Following a case-based approach, we contribute in-depth insights based on the VSM perspective to the limited empirical research. We follow established recommendations and guidelines for theory-generating case studies (Eisenhardt, 1989) and qualitative data collection and analysis (Miles *et al.*, 2014). We chose a consultancy as a revelatory case (Dubé and Paré, 2003) since they have been identified as the epitome of knowledge-based organizations (Anand *et al.*, 2007, p. 407). Consultancies need to fully capitalize on their collective knowledge base since employees' expertise and competence are their main assets. Managing the critical resource knowledge thus forms a core function for consultancies (Singh *et al.*, 2006).

Our case company *ConsultCorp* is a medium-sized consultancy in the supply chain management industry headquartered in Germany. ConsultCorp operates in almost 40 countries worldwide and has around 250 employees, with an annual turnover of 45 million Euro. Its customer base includes more than 100 of the Global 500 companies. Thus, it can be regarded as one of the leading companies within its industry. Consequently, we assume that our particular case organization has a well-developed and innovative KM approach that exhibits high relevance and learning potential for research and practice. We had three reasons for our choice of the type of organization. First, small and medium-sized enterprises (SMEs) are viewed as prime knowledge generators (Ruiz-Mercader *et al.*, 2006). Second, as our goal is to gain a comprehensive understanding of KM and related processes, practices and resources, we deemed such an investigation more feasible in an SME than in a large multinational organization. Third, the supply chain management industry's "knowledge accumulation process [. . .] can be considered an interesting topic to understand more deeply" (Marra *et al.*, 2012, p. 6109).

3.2 Data collection

We collected both on-going and retrospective data. Our data sources comprised semi-structured interviews and a detailed case description generated through participant observations (including informal talks), diverse types of documents (e.g. process descriptions and presentations) and extensive field notes, taken by the participant researcher working with the company for six months.

We conducted nine semi-structured interviews, each lasting between 25 and 60 min. We pretested the interview guide within our research group. Since knowledge processes take place at all organizational levels (Nonaka, 1991), we selected our interviewees based on maximum variation sampling (Paré, 2004). We interviewed individuals in various positions and levels within the company, ranging from consultants to Chief Information Officer (CIO). Table 3 provides an overview of the interviewees' characteristics.

We deviated from the interview guide where necessary (i.e. to accommodate the specific position of the interviewee, to follow up on emerging topics and ideas, and to clarify questions that arose during analysis). All interviews were audio-recorded and transcribed, and the transcripts were reviewed by the respective interviewees.

3.3 Data analysis

Analysis proceeded in three broad steps: (1) open coding, (2) integration of coding schemes and (3) analysis of mechanisms. The analysis covered data from the semi-structured interviews, documents and field notes, and were also triangulated with observations from the

Hierarchy	Pseudonym	Position (Years)	Responsibility	Organizational unit
Strategic	Stephen	CIO (3)	IT strategy	Company-wide
	Marcus	System manager (3)	KM system (managing)	Company-wide
	George	Head of system development (3)	KM system (development)	Company-wide
Tactical	Michael	Senior manager (3)	Department lead	PQM
	Alannah	Project manager (6)	KM structures	Company-wide
	Peter	Project manager (6)	Department Lead NEO, Training programs	Company-wide
Operational	Ben	Senior consultant (3)	Project operations	PQM
	Paul	Consultant (2)	Project operations	PQM
	Sharon	Consultant (2)	Project operations	PQM

Note(s): Abbreviations: NEO – Network Enabled Operations; PQM – Project Quarter Master

Table 3. Interviewees' characteristics

researcher working on-site. Accordingly, the analysis covered various sources of insights, which were used to triangulate findings as well as to find differences between the case company's governance and the knowledge processes as applied by the employees. While the company operates in counties world-wide, our focus was on the knowledge work in the company headquarter in Germany.

In Figure 1, we depict our procedures. In the first two steps, we aimed for identification of KM inputs. In the third step, we identified KM performance indicators and mechanisms at ConsultCorp. We present exemplary codings for KM inputs and performance indicators in Table 4, respectively, Table 5. Each mechanism is defined as logical linkages between KM inputs and performance via knowledge processes (i.e. knowledge creation, retrieval, storage and application) – Figure 2 depicts our model of analysis for identifying the KM mechanisms. The model links KM inputs via knowledge processes to KM performance indicators. In our empirical setting, we used knowledge flows to discover these processes. For a better understanding, the model is supplemented with exemplary codings from our analysis of the case data.

Before starting the formal coding and subsequent modelling process, we prepared the data to be analysed. Three of the authors generated a rich description of the case being investigated. For dependability and credibility reasons (Miles *et al.*, 2013), we shared our descriptive results with a company insider, who confirmed that we captured all aspects associated with KM at ConsultCorp. We applied established quality criteria to our research approach such as different forms of triangulation.

We employed the VSM as a theoretical lens and analysis framework to guide our investigation. Applying the VSM resembled the process of following a coding scheme, where the VSM's elements were matched to data gathered from the organization. Two of the researchers performed this coding together. In our VSM visualizations, we relied on the notation introduced by Rosenkranz and Holten (2011) and decided to stay with an accurate resemblance of the original VSM approach to arrive at a high degree of flexibility in our analysis. We commence our analysis at the company level to ensure that no important KM-related information is omitted. We proceeded with our assessment of ConsultCorp by recursively decomposing the organizational units from the company level down to the level of individual employees with the help of the VSM.

4. Findings

4.1 A viable system perspective on ConsultCorp and its knowledge management

In the following, we present the viable system model of KM at our case company by providing a description of each subsystem (S5-S1 and knowledge flows). An overview of the organization's

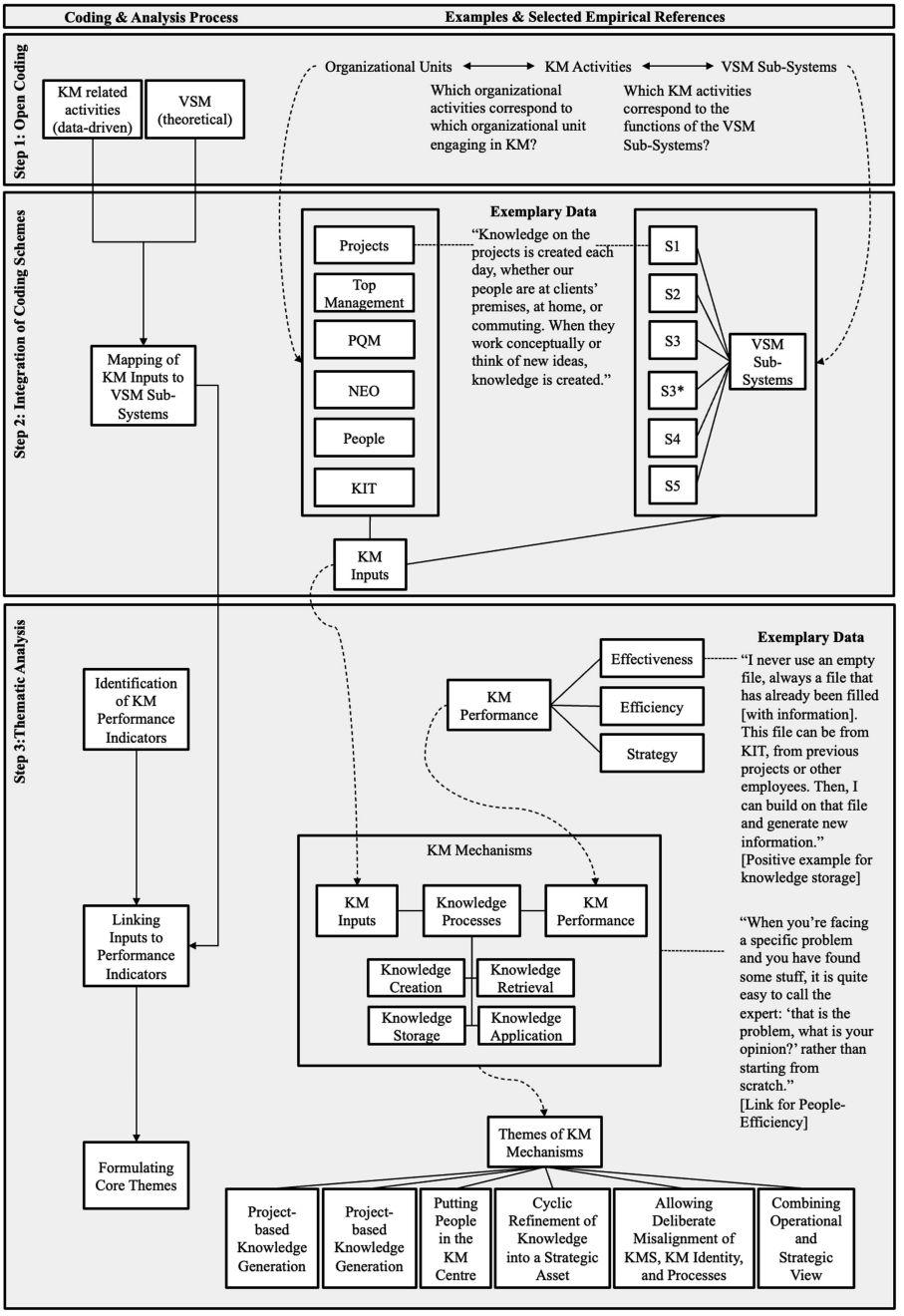

Figure 1.
Overview of analysis process with illustrations

Category	Code	Coding example
ConsultCorp	Projects	"Knowledge on the projects is created each day, whether our people are at clients' premises, at home or commuting. When they work conceptually or think of new ideas, knowledge is created."
	Top Management[a]	"Each CEO needs to understand and participate in KM in order to lead and steer his company. John [CEO] realized this. He introduced PQM to the company. He pushes on with many tasks related to this initiative. This truly is KM at the corporate level, and I think this is what we will see [in the industry] in the next years."
	PQM[b]	"PQM accompanies projects and ensures quality and efficiency of the projects"
	NEO[b]	"The Department of Network Enabled Operations, short NEO, is mainly the interface between PQM and KIT. The main task of NEO employees is to check the content that is provided by PQM and to [technically] integrate it into the so-called knowledge supply chain."
	People	"And I presume that, simply, each new employee has an asset, some new content, even if it is only a small one. There is always something."
	KIT	"KIT includes the option to provide virtual rooms for projects. At the project kick-off, such a room is created and all team members are granted access. Thereby, an initial structure is provided and selected documents are provided by the system in order to ensure that project documents, such as milestone planning and status reports, are predefined and ready for use by the project team."
VSM	S5	"Knowledge management at ConsultCorp starts at the executive level. The concept was developed by the top management and resulted in establishing two departments that are predominantly in charge for the knowledge management domain."
	S4	"PQM effectively strives toward and is in charge of maintaining KIT, taking care that things are up-to-date, and also taking care that things you find are accessible for the teams."
	S3	The PQM team "harmonizes and synthesizes project knowledge."
	S2	PQM acts as "a small group of power users [. . .] who generate extremely high benefits and strive to transfer the method of working with KIT."
	S1	"Knowledge on the projects is created each day, whether our people are at clients' premises, at home or commuting. When they work conceptually or think of new ideas, knowledge is created."

Note(s): [a] While our coding recognizes top management as an organizational entity, in the thematic analysis, we focused on its role in relation to KM, that is, the promotion of the KM identity
[b] We used the coding from these inputs for the analysis of KM Lead

Table 4.
Code system and coding examples for KM inputs and VSM subsystems

Code	Coding example
Effectiveness	"I never use an empty file, always a file that has already been filled [with information]. This file can be from KIT, from previous projects or other employees. Then, I can build on that file and generate new information." (positive example for effective knowledge storage)
Efficiency	"You really need to find your way around in KIT in order to know where to find what you are looking for [. . .]. You stumble around stuff, but you actually do not find what you are looking for." (negative example for efficient knowledge retrieval)
Strategic Outcomes	"In which direction do I steer my company? In which direction do I want to make decisions that ultimately affect productivity? And also to make decisions concerning the maturity level of the company in different areas. [. . .] The system is a business intelligence system."

Table 5.
Code system and coding examples for KM performance indicators

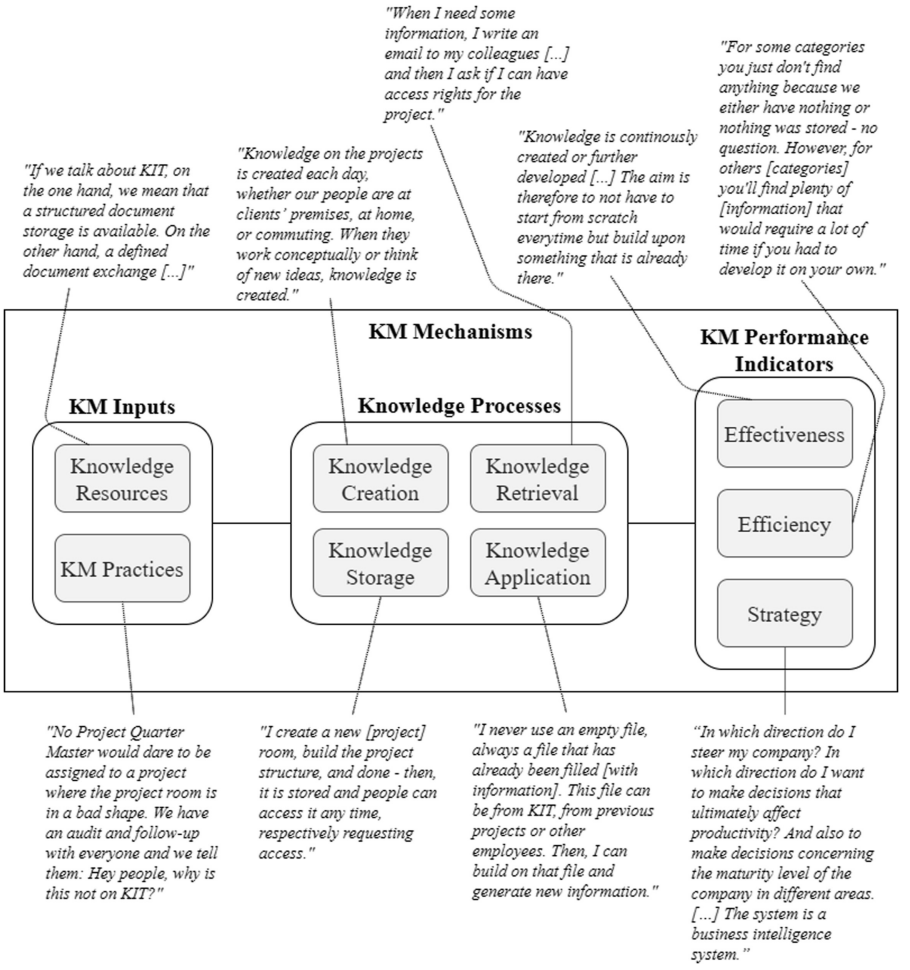

Figure 2.
Model of analysis

units and their association to the VSM subsystems can be found in Table 6. Figure 3 depicts ConsultCorp and the overall structure of its subsystems as well as their interrelatedness using the VSM. While the left part of Figure 3 illustrates ConsultCorp's environment, the right part is divided into two segments. In the upper segment, we illustrate the subsystems that are responsible for management and control. In the lower segment, we illustrate the action-oriented subsystem S1 in relation with the VSM systems on lower levels of recursion. In the following, we explain each of the subsystems and their interrelatedness in detail.

S5 – Top Management. The top management has the responsibility of managing ConsultCorp's daily business activities. It provides guidance for the company's processes and operations. Thus, top management shapes and promotes the organization's KM identity, which stands for knowledge sharing by and among employees. According to Michael, *"Each CEO needs to understand and participate in KM in order to lead and steer his company. John [CEO] realized this. He introduced PQM to the company. He pushes on with many tasks related to this initiative.*

Name (abbreviation)	VSM subsystem	Knowledge resources	KM practices
Top Management	S5	Board members	Defining and managing the overall KM strategy and approach
Project Quarter Master (PQM)	S4, S3, S2	KM experts	Project control, auditing project knowledge documentation, supporting staffing and knowledge provision
Department of Network Enabled Operations (NEO)	S4, S2	Developers and technical staff	Support for technical quality of KM, interface services for PQM and IT providers, development of KM system
Projects	S1	Project team members, external and customer experts	Project management practices
Knowledge Information Technology (KIT)	Knowledge Flows	Integrated knowledge storage and repository (for internal purposes and for collaboration with external parties), expert catalogue, search engine	Affords the employees to use the system according to company's KM strategy

Table 6.
KM Entities in our Case Company

This truly is KM at the corporate level, and I think this is what we will see [in the industry] in the next years."

S4 – Knowledge Management Lead. PQM Leads and NEO Leads meet monthly to discuss experiences and future KIT development. These department leaders also strategize on future developments and opportunities in the area of KM. We refer to this group of individuals as KM Lead, as they play a crucial role in shaping future KM at ConsultCorp.

S3 – PQM. PQM consists of about 20 employees – the so-called Project Quarter Masters (in the following, we refer to PQM as the organizational unit and to Project Quarter Masters as its members). PQM provides basic project control services, such as tracking a project's contribution margin, schedule and personnel deployment. Additionally, PQM staff continually audit the ongoing projects and are given authority to demand project documentation.

In addition to requesting information essential for project control, Project Quarter Masters have the authority to demand knowledge-related project material from employees. In this role, they are fulfilling S3* functionality by auditing the projects (S1) and monitoring for missing or incomplete content.

S2 – PQM/NEO. NEO serves purposes that assist in ConsultCorp's operations related to KM. First, NEO acts as an interface between the PQM department and the external IT provider responsible for developing and maintaining the KM system (KIT). Second, NEO provides technical support to all management processes (S2) via the technical platform that offers the requisite KM functionality.

PQM fulfils S2 functions, as it coordinates projects by facilitating dissemination of the most recent knowledge pertaining to the entire organization. Sharon noted: *"The PQM team is dedicated to, and responsible for, ensuring that content in KIT is the current and most relevant knowledge and that it is accessible for all projects."* Members of PQM (i.e. Project Quarter Masters), always strive to identify synergies, as they aim to *"take something [from one project] and utilize it in another project."*

S1 – Projects. ConsultCorp's daily business is performed in a project organization. Most of the revenue and knowledge is created during project work. In addition to the knowledge employees contribute to projects, at least one external expert is involved full time in each project, supporting it with her/his expertise.

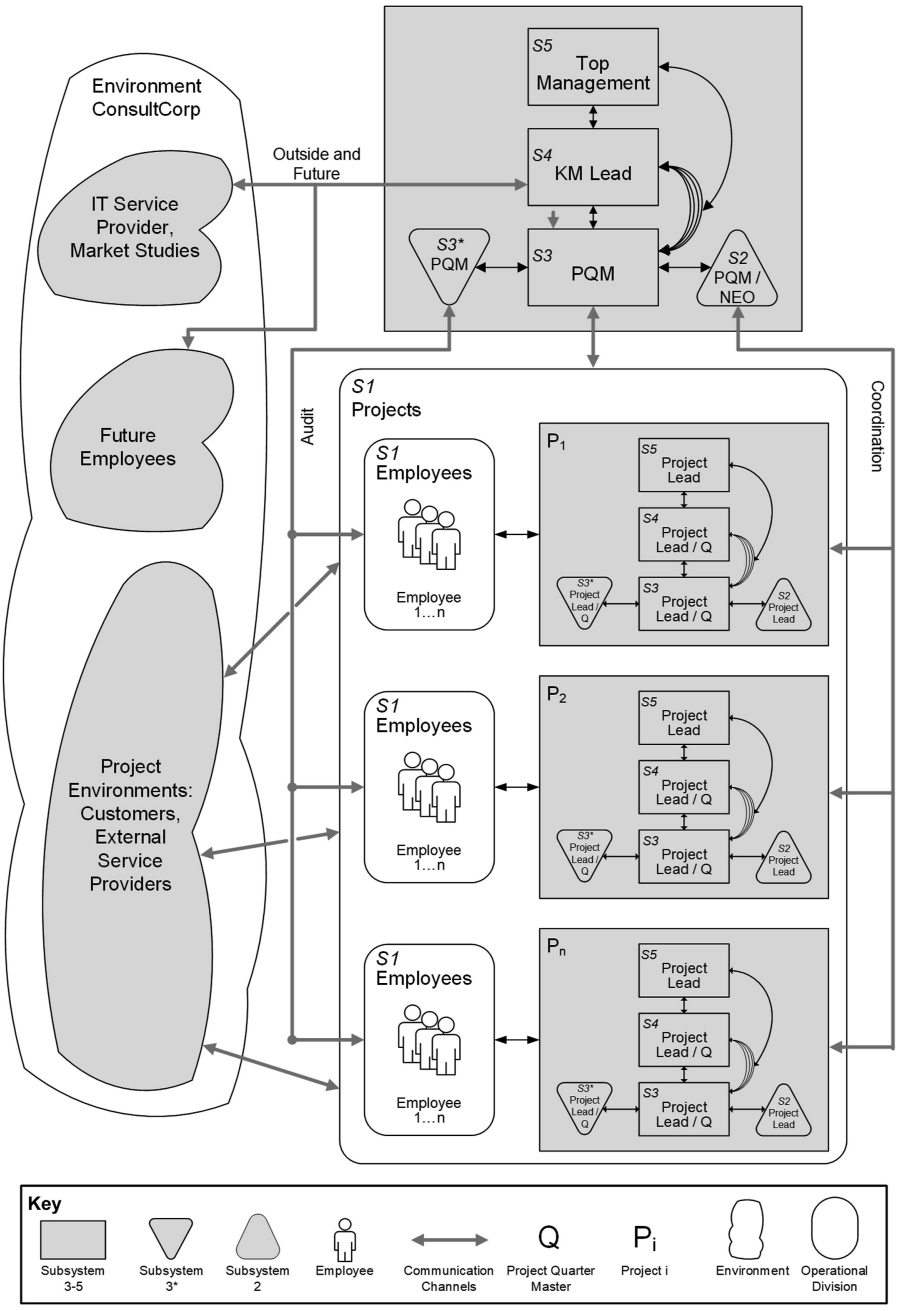

Figure 3.
Viable System Model of ConsultCorp and its KM

Each project likewise can be identified as a viable system within the viable system of KM on the organizational recursion level (whereas the project level being a subordinate recursion level). In the following, we refer to subsystems on the project level of recursion as "projects-S1",

"projects-S2", . . ., "projects-S5". This recursive structure is indicated for exemplary projects in Figure 3. The project lead and the assigned Project Quarter Master constitute the management unit of this viable system, whereas – in the simplest case – other project team members represent the collection of elemental organizational units (projects-S1). Naturally, project structures with further subordinate levels of recursion (e.g. those comprising of several sub-teams) exist as well. Concerning the project's management unit, the project lead is exclusively assigned to projects-S5 defining the project's overall identity and projects-S2 coordinating the project team, while the functions of projects-S3, -S3* and -S4 are performed in collaboration with the Project Quarter Master. In these functions, traditional project management responsibilities are associated with project lead, whereas the Project Quarter Master primarily focusses on KM practices and related activities.

Concerning projects-S3, the Project Quarter Master is responsible for providing the project with relevant knowledge for its operations. One of the Project Quarter Masters, Sharon, explained that this extends to *"the whole topic of competence outsourcing. We are really supporting the projects in their operations by, for example, performing data analysis, or providing information on a specific class of goods."* The VSM functions projects-S3* and projects-S4 pertain to the Project Quarter Master, for example, by auditing project documents from a KM perspective (projects-S3*) and forecasting future knowledge requirements for the project (projects-S4). In context of projects-S4, the Project Quarter Master strives to identify opportunities and threats of the project in close cooperation with the project leader. Sharon shared her views on this issue, stating: "*Then we have what we call 'sparring'. In principle, this means staying in close contact with the project leader to identify further opportunities [. . .] asking questions, such as are there any problems, what should we change, etc.*"

Knowledge Flows – Knowledge Information Technology (KIT). Consult Corp considers the highly integrated information system KIT as an KM "enabler", thus, contributing to value generation. Since its custom development that took place in 2010, the Microsoft SharePoint-based system has served ConsultCorp's daily operations by comprising a significant portion of the value-added chain, from project acquisition to completion, and providing support for central processes and workflows. For corporate management, KIT provides tools that facilitate review and analysis of project classes, their corresponding value-added, projects' degree of standardization or personnel deployment, in order to develop informed business strategies. At the operational level, KIT fulfils functions directly pertaining to KM such as project and collaboration rooms, expert catalogue, document tagging, search engine and project control and management.

4.2 Opening the black box: identifying KM mechanisms

Based on the VSM analysis, we subsequently explain how KM inputs (i.e. knowledge resources and KM practices) at ConsultCorp contribute to the company's KM success. Successful KM includes efficiency, effectiveness and strategic outcomes at the same time. Coherent sets of linkages between KM input, a knowledge process and KM performance (i.e. efficiency, effectiveness and strategic outcomes) form a KM mechanism. The section's structure is aligned along the six identified KM mechanisms (summarized in Table 7). Figure 4 presents an exemplary linkage for each mechanism. Each linkage is presented along a representative quote that highlights how an KM input is linked via a knowledge process to KM performance. A KM mechanism is formed by a set of linkages that are thematically coherent and jointly support a causal effect. For example, the first mechanism of project-based knowledge generation subsumes linkages that focus on the KM input of projects. Associated linkages include knowledge creation and storage that primarily enable KM effectiveness because all new knowledge generated in projects represents the basis for the organization's knowledge.

No.	KM mechanism	Description and explanation
1	*Project-based Knowledge Generation*	Projects provide major contributions to effective knowledge creation and storage; experiences gained in projects (e.g. stored in documents in KIT) are shared with the whole organization
2	*Standardization of KM Practices and Resources*	A disciplined commitment by employees to store knowledge in KIT is central to successful KM; this behaviour is supported by two KM inputs: (1) a standard delivery process supported by audits to ensure compliance, and (2) KIT's ease of use and the usefulness for employees, supported by PQM members as 'power users'
3	*Putting People in the KM Centre*	People are key assets since they work with KIT and are required to follow the prescribed processes; an area of concern are individuals not using KIT or not following the processes; a key countermeasure for ensuring quality of the content are Project Quarter Masters assigned to individual projects
4	*Cyclic Refinement of Knowledge into a Strategic Asset*	Knowledge is the key asset of the company; PQM plays a central role in linking management units to the projects (systems S1) and their environment; it is responsible for analysing the knowledge and assessing its utility for other projects, thus ensuring a knowledge cycle from and to the projects by using KIT and setting up a knowledge supply chain
5	*Allowing Deliberate Misalignment of KMS, KM Identity and Processes*	Despite standard KM processes being in place, employees (i.e. operational units at the lowest level of VSM recursion) use workarounds; this reflects a misalignment of KIT, KM identity and processes; this non-adherence to the prescribed processes and frequent use of workarounds impairs the knowledge supply chain
6	*Combining Operational and Strategic View*	KIT provides communication channels for knowledge transfer (i.e. knowledge storage and retrieval) on an operational level, while also serving the company's strategic KM outcomes; it enables the strategic staffing of projects and allows to analyse existing knowledge to gain insights for strategic decisions at the company level. This is enabled by KIT supporting communication channels and flows across the company

Table 7.
Summary of identified KM mechanisms

Mechanism 1: Project-based Knowledge Generation. Projects (S1) at ConsultCorp contribute to effective knowledge creation and storage. As explained by all our interviewees, ConsultCorp creates knowledge from project experiences that are based on developing concepts and solving problems for the clients. As Ben noted: *"The knowledge is generated on the projects. Almost all knowledge is re-processed or revised in some cases. That really happens locally in the respective project teams."* Besides the creation of knowledge, the projects are part of ConsultCorp's KM inputs aimed at ensuring that pertinent knowledge is stored. For instance, employees upload documents to project rooms in KIT or copy files directly to the system, which is enabled by KIT's integration in the Windows Explorer. By performing these tasks, employees share the knowledge they created on projects with the organization.

Mechanism 2: Standardization of KM Practices and Resources. Since knowledge is a strategic asset for both companies and their employees, companies must motivate employees to share their knowledge. As Peter explains: *"In other words, what the key is, is employees' discipline to store knowledge [. . .] in KIT."* In ConsultCorp, this behaviour is fostered by two

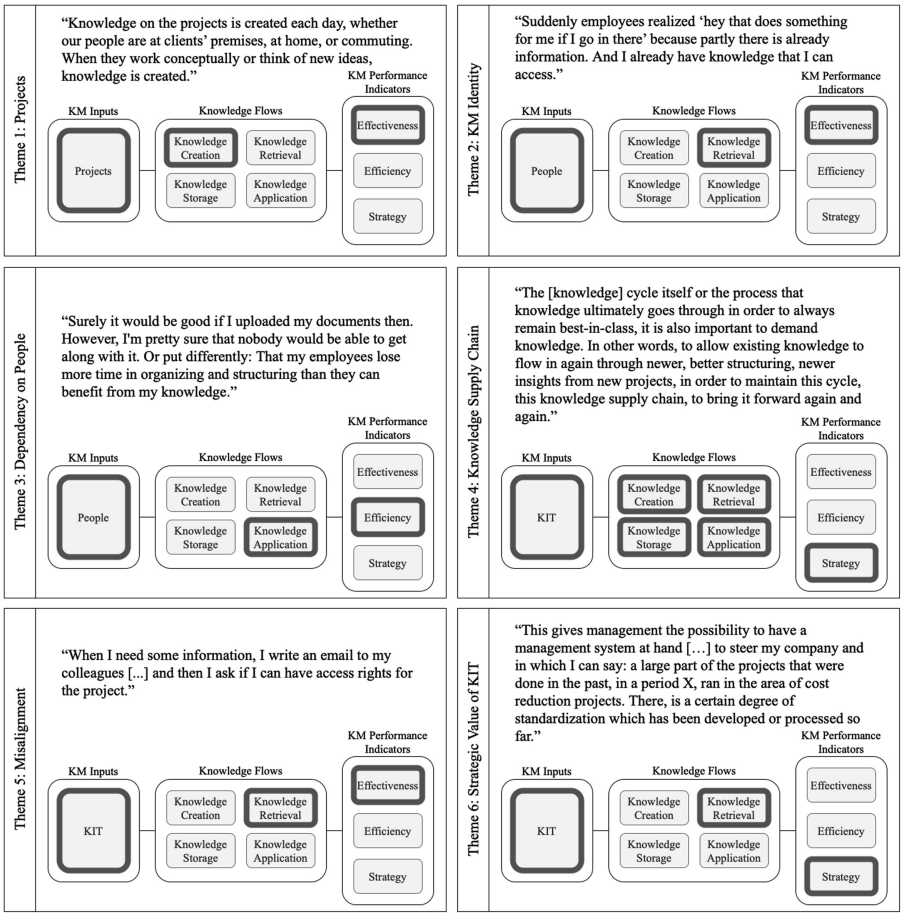

Figure 4.
Overview of KM mechanisms via an exemplary linkage

major inputs. First, ConsultCorp's management unit (S5, S4 and S3) has established the standard delivery process, which is mapped on KIT and defines work processes that employees assigned to projects (projects-S1) should follow. The standard delivery process includes rules that *"structure the channels, so the information flows [represented in KIT] work. For example, by pressure from above, one is constantly forced to use the channels"* (Paul), which leads to a high willingness to share knowledge (Alannah). As Marcus observed: *"The most important facet, however, is that we have audits in the field of compliance that ensure storing of information during this process. So, we have already put some pressure on the projects that employees who work on the projects contribute the information because, otherwise, the process cycle arrives at the audit and then you are asked to provide the information by a deadline."*

Interlocking the KM practices (such as auditing) with the operations is key to success (Stephen). Second, KIT's ease of use and the value that employees derive from its ongoing utilization fosters knowledge sharing. According to Stephen, an employee *"always receives more than he invests."* In this regard, PQM plays an essential role in establishing the desired behaviour. Since PQM oversees coordination (S2) and execution (S3) at ConsultCorp, its members guide the projects and their employees by dedicating Project Quarter Masters. They

function as *"a small group of power users [. . .] who generate extremely high benefits and strive to transfer the method of working with KIT"* (Michael) to the rest of the organization. PQM (in its role pertaining to S2 and S3) thus conveys the idea of the standard delivery process to the company's production subsystem (S1, i.e. the projects).

Mechanism 3: Putting People in the Centre of KM. Although ConsultCorp has established standardized processes for project and knowledge work, the company highly depends on its employees (and especially project team members located at the lowest level of VSM recursion) because they work with KIT and are required to follow the prescribed procedures. As argued above, knowledge creation and storage are accomplished by the employees working on various projects. Yet, not all employees, for instance, use KIT to retrieve information on a new topic. As Peter explained: *"No, not at all. I have no clue how to retrieve information from [KIT]."* This assertion indicates that, as the KM efforts are not deemed beneficial by everyone, the intended knowledge retrieval and application effectiveness is compromised. The quality of the knowledge stored in KIT also depends on the dedication of individual employees to the KM practices and goals. As Paul observed: *"The structure of a project room [. . .] is only as good as the user that creates it."*

Some employees strive to provide high quality: *"I have really documented it like a storybook in KIT. Now everyone is able to understand its essences"* (Marcus), while others might be less inclined to invest the time required. Another issue that limits the KM utility at ConsultCorp is the use of personal, non-standardised structures in KIT, which may result in teams primarily building on their own knowledge rather than on that of others. Paul described this as follows: *"However, this is my way of presentation and my accumulated knowledge that I organize according to my own structure [. . .]. Using documents from KIT usually means that I use my own documents. [. . .] I am pretty sure that no one finds a way to use that"*. Consequently, resulting content is not accessible to others and quality of the content needs to be ensured by the Project Quarter Masters assigned to individual projects.

Mechanism 4: Cyclic Refinement of Knowledge into a Strategic Asset. ConsultCorp is a knowledge-driven company: *"We offer knowledge and methods to our customers and that is what we sell. Insofar, knowledge is the asset that we have as a company"* (Peter). For this purpose, *"PQM accompanies projects and ensures quality and efficiency of the projects"* (Paul). While performing the S2, S3 and S3* functions, PQM plays a central role in ConsultCorp's KM operations, linking the management unit – consisting of ConsultCorp's KM identity (S5) and planning (S4) – to the projects and their environment. More precisely, *"PQM effectively strives to and is in charge of maintaining KIT, taking care that things are up-to-date, and also taking care that things you find are accessible for the teams"* (Sharon). While the project teams are primarily concerned with creating knowledge and uploading documents, PQM is responsible for analysing the knowledge and assessing its utility for other projects. Its members also develop standards and generate packages than can be sold to customers (Ben). The company regards this process as a strategic asset as Stephen noted: *"We already show the customer in the sales pitches that we have this asset through our competency and knowledge provision."* The company has adopted the image of a knowledge supply chain explaining how knowledge flows within the company. According to George, it is thus essential *"to ensure that newly created knowledge from projects and on-going consultations finds its way back to the knowledge cycle, the knowledge supply chain."*

Marcus views PQM as the organizational unit that enables the knowledge supply chain by pushing knowledge back into the projects. To accomplish this, KIT – as the technological platform – represents the organization's backbone through which knowledge is shared across the entire organization. Hence, PQM analyses the available knowledge and utilizes the findings to organize work at all organizational levels in a more effective and efficient way. The goal is to reach optimal productivity and quality, which is the essence of consultancies: *"At this point, you win the war; you win the war in the entire KM"* (Michael). PQM thus

contributes to the effectiveness and efficiency of knowledge retrieval and application. Concluding, the knowledge supply chain does not merely represent figurative language used by employees but entails a mechanism of cyclic refinement and transformation of knowledge, which continuously flows through the organization. The KM activities performed by organizational entities represent a transfer of previously refined knowledge. The "upstream" and "downstream" flows of knowledge link organizational entities on different levels of the system. Considering the upstream flow, projects (S1) transform knowledge from individual knowledge of project employees to an aggregated form of project knowledge, project knowledge is then transformed by the central KM unit (S2, S3) toward industry-specific knowledge packages. The KM Lead and top management synthesises generally relevant knowledge to the organization such as about its strategy and customers. Concerning the downstream flow, the central KM unit provides projects with packages of industry-specific knowledge and general knowledge that are relevant for the specific project scope. These projects then create project-specific knowledge grounded in relevant general and industry knowledge. The combined knowledge is then made available to the project employees. On the individual level, knowledge can then be used, refined and fed back into the knowledge supply chain. The mechanism of the knowledge supply chain explains how knowledge is transformed within the organization. For an overview of the knowledge supply chain and how entities relate to the VSM see Figure 5.

Mechanism 5 Allowing Deliberate Misalignment of KMS, KM Identity and Processes. While ConsultCorp has standard processes in place, employees in projects (at the lowest level of VSM recursion) use workarounds, mostly because these are faster. When contacting colleagues concerning information retrieval, Peter sends an email rather than using KIT's expert catalogue: *"I believe it is quite optimistic to expect that everyone would have a profile, allowing the user to directly find an expert."* Similarly, Alannah stated that the effort-intensive tagging of documents can be circumvented when using KIT via the Windows Explorer: *"Typically, you do not have the time [. . .]. You create a document and simply use the Explorer in KIT. Then, you do not have to set tags if you simply drop the document. You have no obligation."* Michael concurred with this view, indicating that the issue of document tagging is seen as an additional burden by employees, rather than a benefit. Hence, it reflects misalignment of KIT, KM identity and processes at ConsultCorp. While, according to Ben, the use of KIT is *"strongly enforced"*, the system is not uniformly used by all employees, and their adherence to the processes and guidelines depends on the willingness of everyone to invest time into following standard procedures. For example, employees are not motivated to tag documents in their free time. Paul succinctly summarized the issue by stating, *"I do not know of anyone having the time to routinely tag all documents. No one rewards you for that."*

Mechanism 6: Combining Operational and Strategic Views. While KIT's main function is providing the communication channels for the knowledge transfer (i.e. knowledge storage and retrieval) at ConsultCorp, it also serves the company's strategic KM outcomes. Thereby, KIT establishes strategic linkages to different organizational levels including both ConsultCorp's identity (S5) and production (S1). First, KIT enables the strategic staffing of projects (projects-S1). Stephen succinctly describes this mechanism: *"When an employee is working on a project and you have assigned him a role, that [information] is automatically transferred to the database. So, when viewing a profile, someone sees that [the employee] worked for the client on a subject in a given period"*. The system offers an aggregated overview of these statistics, which enables managers to assign employees to projects that fit the context best. Second, KIT – as the central IT system – offers business intelligence and supports the strategic management of the company (S5). George observed: *"KIT is an enabler for the management [. . .]. The system offers analytics and numbers that ultimately allow the management to determine the gross margins in various stages"*. Stephen elucidated the importance of the analytics for ConsultCorp's CIO: *"I have my dashboard where I can*

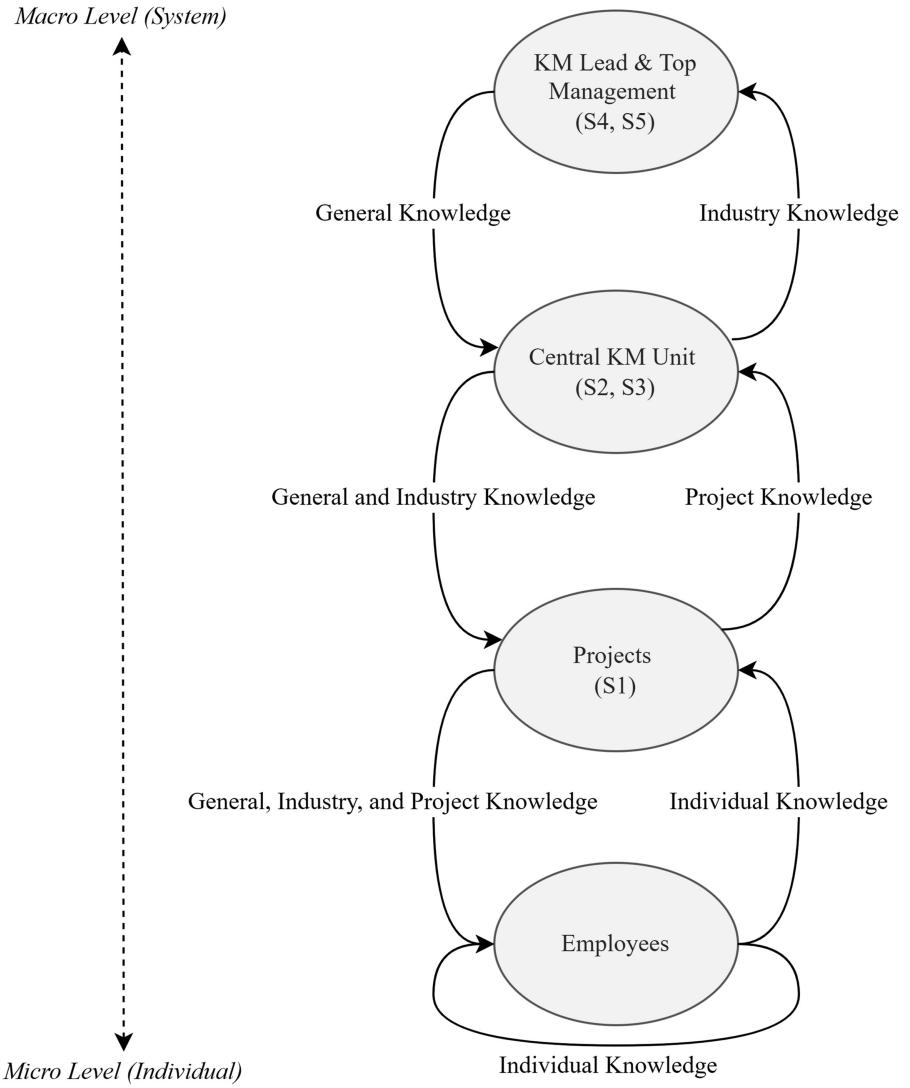

Figure 5.
Transformation of knowledge within the knowledge supply chain

see the invoice status (paid, overdue, . . .) on a daily basis; which employees have not reported their days yet. This allows me to establish the status of the audit or the knowledge clean-up. Naturally, that is quite interesting for me as an entrepreneur."

Based on the information pertaining to a wide range of issues, ranging from project staffing to project results, KIT allows knowledge aggregation for strategic decisions at the company level. According to George, such knowledge is used to answer a variety of questions, such as, *"In which direction do I steer my company? In which direction do I want to make decisions that ultimately affect productivity? And also to make decisions concerning the maturity level of the company in different areas. [. . .] The system is a business intelligence system."* Given these options, KIT can provide reports on the status of on-going projects concerning the company's

strategy, enabling the management to take counteractions early on. From the VSM perspective, KIT supports a wide range of mechanisms to attenuate incoming information for management since it provides an aggregated view of the company-wide processes. Owing to this essential function, KIT drives efficiency. It also helps ConsultCorp to use knowledge for strategic purposes beyond customer acquisition and product sales. Strategic usage of knowledge within ConsultCorp is enabled since KIT supports VSM communication flows and thereby knowledge processes that occur, unlocking immense potential for knowledge distribution across the company and a holistic KM approach.

5. Discussion

5.1 Propositions

Based on the six KM mechanisms, we present three propositions for designing KM in knowledge-intensive project-based organizations.

New knowledge that represents the basis for organizational knowledge is generated in projects through project members (*Mechanism 1*). From a VSM perspective, these local operational units address all required VSM functions required for viability. Thus, they can better decide how to fulfil their purpose and hence most adequately decide on their knowledge requirements concerning usage and creation. Knowledge transfer between local and higher organizational levels can be controlled via recursion principles. Recursion interfaces (e.g. Project Quarter Masters in projects) serve as control points for downstream and upstream knowledge flows between local entities and higher levels of the organization (downstream: avoiding overloading local entities with irrelevant organizational knowledge; upstream: sharing only insightful knowledge to higher levels of the organization). Hence, we formulate our first proposition as follows.

Proposition 1. Recursion enables effective localized knowledge creation and usage.

Although all six KM mechanisms explain contribution of KM inputs to performance, several mechanisms seem conflicting. The organization has rules in place that pertain to the standardization of KM resources and practices (*Mechanism 2*). While a minimum set of features is enforced by organizational entities such as PQM, the organization sets a strong focus on the autonomy of knowledge experts in the projects to decide how to conduct their knowledge work and how to use available tools and processes (*Mechanism 3*). Giving people the flexibility to deviate from KM procedures can unlock further efficiencies. Workarounds to deviate from standard procedures are even tolerated and features in support for such behaviour are implemented in the information system (*Mechanism 5*). Considering the necessity of managing the order or rather disorder in knowledge processes, we can link our findings to research on managing knowledge entropy in organizations (Brătianu, 2019). Allowing higher levels of disorder will result in larger knowledge entropy that is associated with creativity and innovation. Resulting conflicts in mechanisms pertain to achieving partially conflicting goals in KM performance such as in effectiveness and efficiency. Clearly, KM initiatives primarily striving for effectiveness will look different than those for efficiency. While effectiveness has a stronger forward-thinking notion, efficiency is anchored in the present. In the VSM, these antagonistic aspects are associated with the two different subsystems S3 (present) and S4 (future). We argue that opposing KM mechanisms represent the capacity of a successful KM organization to manage these conflicts and finding a viable balance within the organization. This capacity is reflected in the functions of S3 and S4, and their conflict. Therefore, we formulate our second proposition.

Proposition 2. Using different KM mechanisms for KM efficiency and KM effectiveness enable an organization to balance these two conflicting goals.

An important aspect to ConsultCorp's KM approach is the concept of a knowledge supply chain that supports continuous refinement of organizational knowledge (upstream) and distribution of organizational knowledge (downstream) (*Mechanism 4*). KIT affords the organization with linkages along organizational levels such as the strategic and operational levels (*Mechanism 6*). Designing KM along the prescribed VSM structures and principles provides an organizational design template to support these two mechanisms. First, the VSM is a multi-level structure that connects various company levels (organization, project and individual) through knowledge flows. Second, the VSM prescribes to match information processing capacity between two organizational entities (e.g. a project team entails a higher information processing capacity than its Project Quarter Master).

To enable knowledge refinement and redistribution between different company levels, two knowledge transformation processes are suggested by the VSM: (1) amplification increase the variety of information transferred while (2) attenuation decreases it. Organizational units on a lower company level have a higher level of information processing capacity. Thus, the variety of knowledge flowing from lower to higher levels in the organization is required to be attenuated, whereas knowledge flowing in the other direction is required to be amplified. Attenuating knowledge flowing upwards will result in applicability to more general situations (e.g. generalization of project knowledge to industry knowledge). Vice versa, amplifying knowledge flowing downwards will result in applicability to more specific situations (e.g. contextualizing industry knowledge to project situations). Knowledge amplification and attenuating processes are represented by KM practices and resources used by organizational entities (e.g. rules on how project knowledge must be systematically stored so that Project Quarter Master can use it to generate more general knowledge). Thus, we submit our third proposition.

Proposition 3. Knowledge transformation in the form of amplification and attenuation between organizational levels enables the organization to achieve strategic outcomes (such as continuous organizational knowledge refinement).

5.2 Implications

In line with our pragmatist research stance, we seek to contribute to practice as well as research. Based on the context-specific in-depth insights into viable KM processes from a consultancy, which can be considered the epitome of knowledge-based organizations, our case study's practical contribution are the descriptions concerning the design of KM in knowledge-intensive project-based companies. The understanding of knowledge flows and related KM mechanisms is our primary research contribution and part of the ongoing discussion concerning the issue of treating KM as a black box (Carlile and Rebentisch, 2003; McIver *et al.*, 2013). The analysis with a focus on knowledge flows enabled us to illuminate the "internal wiring" of the KM black box with the help of the VSM. We identify a set of six mechanisms explaining how the inputs of the black box lead to performance of KM. So far, the ideal of organizations fully capable of embedding knowledge created through transformation of individual experiences in the organizational memory and structures has not been realized. This shortcoming can be attributed to the lack of concrete prescriptions concerning the design of knowledge-intensive companies (Garvin *et al.*, 2008).

By analysing ConsultCorp's KM, our study helps to advance theory, which "has yet to enlighten the work of practitioners with a more instrumental and comprehensive view" (Vera and Crossan, 2004, p. 236). The model of ConsultCorp and its KM as well as the mechanisms thus provide valuable insights into the KM black box in a specific situation (Carlile and Rebentisch, 2003; McIver *et al.*, 2013). We set out to uncover KM mechanisms that connect KM inputs with desirable performance indicators such as efficiency and effectiveness of KM.

We report how certain inputs are connected through which mechanism with performance. Uncovering these relationships presents a rich source for future research that seeks to develop and test causal assertions in how initiatives can lead to KM success (McIver *et al.*, 2013). Our six identified KM mechanisms that occur in project-based knowledge-intensive organizations complement research that is primarily inclined with factor-based determinants of successful KM. We contribute an understanding why certain factors contribute to success. We distilled KM mechanisms in the formulation of three propositions that future research can readily address and implement in testable hypotheses. Our propositions are reflected in other streams of research.

For Proposition 1, we inform conceptual works that have identified recursion as an adequate principle for knowledge production in project-based organizations (Koskinen, 2010) by providing first-hand empirical insights. Proposition 1 has implications for formal localized KM governance structures and complements research on KM strategy development (Zyngier and Burstein, 2012). Additionally, Proposition 1 and the associated KM Mechanism 1 can be readily used in further empirical testing and research for theory building on recursive knowledge creation in organizations.

With Proposition 2, we assert that positive deviance through KM practices and work exist. We seek to connect literature on KM with streams that have investigated positive deviance in other work-related areas such as processes and task performance (Mertens *et al.*, 2016). Greater emphasis should be put on deviant behaviour in the context of KM (Singh, 2019).

Proposition 3 addresses knowledge cycles in the organization. Self-reenforcing cycles have drawn great interest in the context of KM (Garud and Kumaraswamy, 2005). We present the VSM structures and principles as a guiding toolset to investigate these feedbacks in the organization. While positive feedback loops (or self-reenforcing cycles) have been investigated (Garud and Kumaraswamy, 2005), less emphasis has been put on negative feedback loops that can safe organizational entities from overload as our findings have shown.

Commonly, KM investments are substantial, while the derived benefits are seldom predictable (Haas and Hansen, 2007; Setia and Patel, 2013). By focusing on the interplay of KM and value-creating processes based on the central infrastructure system, our study engages in the literature stream focusing on IT's role for creating competitive capabilities (Setia and Patel, 2013). As such, our analysis suggests that the focus should be on the strategic outcomes of KM (i.e. the intended benefits of refining the knowledge). This suggestion is also supported by the findings of previous research in the field of knowledge intensive business services (e.g. consultancy), where authors emphasize the importance of creating value in the form of customized solutions that satisfy client needs by utilizing KM processes (Aarikka-Stenroos and Jaakkola, 2012). The detailed analysis of ConsultCorp's KM approach reported here can be seen as a valuable empirical contribution in this regard (Ågerfalk, 2014).

We have continued the endeavour to investigate IS phenomena with the VSM. While the VSM has found its way into IS research and into some of its premier outlets (Shaw *et al.*, 2004), not much methodological transparency exist in reporting on how authors applied it in their research (Richter and Basten, 2014). We provide a blueprint for VSM analysis and application, so that scholars as well as practitioners can integrate the process in their methods. Our VSM descriptions and modelling of the design of a viable KM can serve as a design template for practitioners. The design of knowledge-intensive project-based companies is an ongoing debate in research and practice (Garvin *et al.*, 2008; Schacht *et al.*, 2015). Based on our findings, practitioners can implement KM initiatives that leverage identified KM mechanisms (comprising inputs, linkages and performance indicators) and extend only factor-based initiatives (e.g. introduction of communities of practice). Our findings advance the understanding of the various benefits resulting from the application of the VSM to real-world organizations (Richter and Basten, 2014). By applying the VSM, we were able to decompose a complex entity (i.e. our case company) and arrive at a modularized

form that can be further investigated. In this process, we deliberately deviated from the established practice of having two researchers analyse the data using the same approach. However, this "pragmatic mode of inquiry" (Goldkuhl, 2004) is coherent with our pragmatist stance, since pragmatists aim to establish what works in practical contexts (Goldkuhl, 2012). Therefore, they have a certain freedom when choosing procedures and techniques, as the goal is to select those best suited to their research needs and purposes (Creswell, 2009). Investigating the unit of analysis through different lenses yielded a more fine-grained picture of the phenomenon under investigation, resulting in more dependable and credible insights. Since authors of extant VSM studies rarely report on how they arrived at the final mapping between VSM subsystems and company entities (Richter and Basten, 2014), we hope that others will be encouraged to follow our example and will be motivated to adhere to these reporting and procedural standards. While previous attempts to apply VSM to real-world systems often lacked transparent reporting of such mappings (Richter and Basten, 2014), we illustrate a practical and transparent means to understand how VSM analyses are conducted. Hence, researchers seeking to analyse real-world systems could adopt our structured approach to VSM application. Finally, we demonstrate that the VSM provides a clearly defined modelling approach that researchers and practitioners alike can adopt to describe and analyse organizational structures, communication flows and system's environment. We utilize VSM and its explicit form of visualization of structures and information flows to transparently report our findings. This transparency allowed us to elucidate and communicate the system in focus in a holistic manner. Thereby, the VSM proves to be very versatile in the context of KM and in combination with concepts and ideas yielded by extant research in this domain.

5.3 Limitations and future research

Focusing the investigation on a single case represents one of the limitations of our study accompanied by threats to generalizability of single accounts. While we acknowledge that generalizability is limited, we argue that the purposeful selection of a typical medium-sized consultancy strengthens transferability of our findings to similar contexts (Miles *et al.*, 2013). We derived KM design propositions, which can be implemented and evaluated in further settings within similar contexts.

Critics of the VSM emphasize its limited utility for analysing networked or distributed forms of organization, such as in the domain of knowledge-intensive business services where collaborative problem-solving – for instance, between the customer and the consultancy – plays a significant role in the value creation process (Bettencourt *et al.*, 2002). Co-production of solution knowledge is not in the focus of our company-internal view. The VSM delineates the customers from our viable system and locates them in the system's environment. We deliberately decided to focus on the internal view since reusable codified knowledge arguably plays a higher strategic importance in consultancies, whose main business model relies on their ability to provide creative, analytically rigorous advice tailored to unique strategic problems (Hansen *et al.*, 1999). As our focus was restricted to the intra-organizational processes, authors of future studies in this field should heed recent calls to advance the understanding of opportunities and challenges pertaining to inter-organizational knowledge sharing (Loebbecke *et al.*, 2016), which is particularly important in the domain of knowledge-intensive business collaboration. A concrete avenue for future research would be advancing our findings by tapping into the value (and knowledge) co-production between the organization and its customers, while considering issue of establishing an intra-organizational KM identity as well as the multi-level character of KM identity and the potential constraints imposed by using IT.

Furthermore, some authors have criticized the concept of knowledge flows as focusing primarily on rational knowledge and they developed a view referred to as knowledge

dynamics that are based on different knowledge fields (e.g. Brătianu and Bejinaru, 2019). We acknowledge that further insights could be gained from distinguishing between rational, emotional and spiritual fields of knowledge (e.g. for gaining deeper insights on intrinsic employee motivation). However, we argue that in our type of case consultancy, rational knowledge plays a crucial role since these organizations heavily rely on refining and reusing knowledge (see our findings on the knowledge supply chain).

As a further limitation, we took an abstracted view on the lower recursion levels of the viable system due to a high level of homogeneity among projects undertaken at our case company. However, we believe that a more detailed analysis at the project level, particularly in organizations with high project heterogeneity or large projects with complex structures, could lead to further insights, this is a promising path for future research. Considering our study as an initial step in the effort to improve the understanding of KM mechanisms, it would be highly beneficial to continue our exploration in future studies that would focus on the subordinate recursion level of single projects, while also addressing the inhibitors to KM scalability.

Lastly, we acknowledge that our research does not extend to an action phase (manipulating the KM system) that would inform those responsible for implementing strategies to solve the identified problems. We focused on understanding the situation at hand and aimed to generate useful knowledge for further action. Nevertheless, we acknowledge that an action phase would be an interesting topic to explore in the future.

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