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Knowledge network creation methodology selection in project-based organizations: An empirical framework

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Abstract

Purpose – In today's knowledge-based economy, knowledge networks (KN) increasingly are becoming vital channels for pursuing strategic objectives in project-based organizations (PBO), in which the project is the basic organizational element in its operation. KN initiatives often are started with the selection of a creation methodology, which involves complex decisions for successful implementation. Thus, the purpose of this paper is to address this critical selection of methodology and proposes a holistic framework for selecting an appropriate methodology in this kind of flatter, speedier, and more flexible organizational form.

Design/methodology/approach – In the first step, the study established a theoretical background addressing the problem of KN creation in PBO. The second step defined selection criteria based on extensive literature review. In the third step, a holistic framework was constructed based on different characteristics of existing methodologies categorized according to the selected criteria. Finally, the suggested framework was empirically tested in a project-based firm and the case study and the results are discussed.

Findings – A holistic framework was determined by including different aspects of a KN such as network perspectives, tools and techniques, objectives, characteristics, capabilities, and approaches. The proposed framework consisted of ten existing KN methodologies that consider qualitative and quantitative dimensions with micro and macro approaches.

Originality/value – The development of the theory of KN creation methodology is the main contribution of this research. The selection framework, which was theoretically and empirically grounded, has attempted to offer a more rational and less ambiguous solution to the KN methodology selection problem in PBO forms.

Keywords Decision making, Knowledge sharing, Macro techniques,
Organizational knowledge network formation, Pharmaceutical R&D organizations,
Project-based businesses

Paper type Research paper

1. Introduction

In today's information-based, knowledge-driven, and service-intensive economy, knowledge has become the source of products, services and business models that provide a basis for the competitive advantage of organizations (Argote and Ingram, 2000; Kearns and Lederer, 2003; Harris *et al.*, 2013). Recently, a large number of firms have become concerned about a shift from mass production to a more innovative, information-technology oriented, and mostly undiscovered production paradigm in which they must consistently provide and support creative and competitive products, services, and business models in order to continually stream new value to the customers (Story *et al.*, 2015). Consequently, the knowledge that provides valuable capital dispersed from inside and outside the organization becomes increasingly important. Accordingly, it

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is not surprising that strategic knowledge management (KM) initiatives and systems have been utilized in organizations for integrating, growing, and reconciling this competitive knowledge (López-Nicolás and Meroño-Cerdán, 2011).

On the other hand, building project-based organizations (PBOs) has been addressed as a solution to dynamic knowledge integration by the most advanced modern and international corporations which transformed their traditional hierarchical organizational form to a flatter, faster, and more flexible and horizontally integrated structure based on teams and projects. Moreover, it has been implied that PBO is the optimal organizational form for the management of internal and external knowledge that plays a significant role in creating new business models of products and services. While early literature mostly focussed on the achievement of project goals and therefore considered solutions that increased the efficiency and effectiveness of projects (White and Fortune, 2002), more recent research has suggested knowledge and its management as a key performance driver in PBOs (Ajmal and Koskinen, 2008; Ajmal *et al.*, 2010; Boh, 2007; Reich *et al.*, 2012). Besides, among diverse existing KM techniques, initiatives, or strategies, the concept of knowledge network (KN) has gained increasing attention due the collaborative nature of project-based environments (Capó-Vicedo *et al.*, 2011; Chinowsky *et al.*, 2009; Di Vincenzo and Mascia, 2012). Bourouni *et al.* (2014) state that a primary key to performance for PBO is the development and management of organizational networks in the form of KN and communities of interest.

Although, several researchers have addressed the importance of KNs, their applications, and related creation methodologies (Pugh and Prusak, 2013; Enkel, 2002; Allee, 2000; Back *et al.*, 2005; Capital, 2005; Elisberg *et al.*, 2006; Egger *et al.*, 2006; Seufert *et al.*, 1999), only a few articles have addressed how organizations can select an appropriate methodology for creating a KN (Enkel, 2002). Thus, the main goal of this paper is to develop and present a framework for KN creation methodology evaluation and to illustrate its application. Consequently, the purpose of KN creation methodologies systematic comparison can be summarized as follows: better understanding in academic research of the nature of methodologies for better classifications and developing the resulting KN, selecting methodologies for practical purposes for specific application in project-based and dynamic environments. However, these two reasons are not distinct from each other. It has been observed that academic studies help in practical decision making and practical reasons have influence on the defined criteria in academic studies (Avison and Guy, 2006).

The paper is organized in seven sections. In Section 2, the problem of KN creation in project-based business environments and its different dimensions are introduced. This section also establishes a theoretical background addressing the methodology selection problem in PBOs. In Section 3, existing KN creation methodologies are discussed comprehensively based on the problem defined in Section 1. Following that in Section 4, a holistic framework for KN methodologies is proposed based on defined evaluation criteria including network perspectives, tools and techniques, objectives, characteristics, capabilities, approaches, etc. In Section 5, the suggested framework is empirically tested in a project-based firm as the case study and the results are discussed thoroughly. Finally, Section 6 summarizes the discussions and Section 7 presents the concluding remarks.

2. Theoretical background

2.1 PBO

Organizing firm operation according to project-based form is prevalent in the current knowledge-based economy. DeFillippi and Lehrer (2011) highlight that PBOs denote a

variety of organizational forms that encompass the creation of provisional systems for the performance of project tasks whereby the organization is more than a set of contracts that ceases to exist once the project is completed. In order to deal with exceedingly dynamic situations, wherein products, services, and business models change rapidly and unpredictably, PBOs integrate diverse and specialized knowledge resources and gather practitioners to work as a team and use their expertise in any activity with no expectation of subsequent cooperation after the successful completion of a specific goal (Cattani *et al.*, 2011; Manning and Sydow, 2011).

Sydow *et al.* (2004) identify PBOs as companies that do most of their work in projects and/or have a main focus on a project's scope rather than the functional structure and processes of organizations. Based on Gann and Salter (2000), project-based is the only organizational form that is able to effectively harness and reproduce an organization's technological capabilities by integrating project and business processes within the firm. A PBO is an intrinsically innovative form as it produces new organizational structures around the demands of each project or customer (Hobday, 2000). DeFillippi and Arthur (1998) identify project-based firms as single-purpose organizations that contain all required functions within a temporary project organization setting, whereas the main processes of marketing and distribution of the company's products are accomplished by permanent independent organizations. Organizations with a project-based form are more likely to overcome traditional barriers to organizational change and innovation, based on the fact that each project is provisional, and comparatively short-lived. Therefore, it reduces the corresponding risks of establishing new permanent departments or divisions and it also allows low-cost experiments (Sydow *et al.*, 2004). In recent years, the project-based organizing has been adopted in many diverse industries, such as complex products and systems producers (Davies *et al.*, 2011), engineering (Bartsch *et al.*, 2013), digital content (De Vaan *et al.*, 2013), construction (Eriksson, 2013; Di Vincenzo and Mascia, 2012), oil and gas (Ahola *et al.*, 2013), and many other industries (Keegan and Turner, 2002).

2.2 PBO form and knowledge resources

Based on the knowledge-based theory of the firm, organizations need to efficiently and continuously identify, integrate, and apply knowledge resources that are distributed among the employees and different teams in a company in order to remain competitive (Grant, 1996; Gold *et al.*, 2001). In addition, reliable knowledge integration requires cooperation, interaction, and knowledge sharing among individuals (Mazdeh and Hesamamiri, 2014; Hesamamiri *et al.*, 2013). However, PBOs face many challenges in knowledge dissemination, integration, and utilization as projects are dispersed and peers collaborate long distance (Boh, 2007). Fernie *et al.* (2003) introduced knowledge sharing among individuals working in different teams or contexts as an essential source of competitive advantage for project-based business environment environments. Ruuska and Vartiainen (2005) state that due to the one-off nature of projects, high mobility of staff, and the numerous subsequent discontinuities in methods of organization and flow of employees, resources, and information, PBOs encounter a dramatic knowledge loss after the dissolution of the projects. At the same time, projects provide excellent preconditions and potential for creating new knowledge (Sydow *et al.*, 2004).

In order to address these important challenges, the enhancement of KM capability is proposed (Bresnen *et al.*, 2003). Pemsel and Wiewiora (2013) emphasize the role of the project management office (PMO) as the knowledge broker among projects. Reich *et al.* (2012) introduce the new concept of project-based knowledge including technical design

knowledge, organizational change knowledge and business value knowledge, and suggest that KM enables the creation and alignment of these types of knowledge. Pemsel and Müller (2012) propose the appropriate patterns of knowledge governance practices in PBOs. Knowledge governance encompasses "choosing organizational structures and mechanisms that can influence the process of using, sharing, integrating, and creating knowledge in preferred directions and toward preferred levels" (Pemsel and Müller, 2012). Furthermore, different types of inter-organizational grouping forms are developed and discussed by researchers as a main aspect of knowledge governance (Gooderham *et al.*, 2011; Wang *et al.*, 2011). Subsequently, many researchers highlighted the role of social capital, network capital, and learning in PBO form in recent years (Bourouni *et al.*, 2014; Bartsch*et al.*, 2013; Di Vincenzo and Mascia, 2012; Huggins *et al.*, 2012; Maurer *et al.*, 2011). These studies demonstrate how social capital dimensions affect the collaboration of knowledge among project members in PBOs. Moreover, it is proposed that organizations with a project-based form have to design, implement, and evaluate different types of KN as a significant mechanism to enhance performance in PBOs that enable knowledge collaboration among project members (Bourouni *et al.*, 2014; Di Vincenzo and Mascia, 2012).

2.3 KN

In today's knowledge-driven economy, the value of networks is increasingly emphasized in different approaches to KM strategies for organizations. The term "knowledge network" is defined as a collection of individuals and teams who come together across organizational, spatial, and disciplinary boundaries to invent and share a body of knowledge with the aim of coordination, learning, innovation, translation/local adaptation, and support of individual members (Pugh and Prusak, 2013). Based on Elisberg *et al.* (2006), a KN is a formalized mechanism for supporting the identification, creation, and sharing of professional knowledge. KN are concentrated on knowledge creation, dissemination, and utilization within or across organizational boundaries (Dyer and Nobeoka, 2002). Furthermore, Papailiou *et al.* (2006) introduce KN as key ingredients of KM in professional business services.

Many researchers have addressed the advantages of KN, such as helping employees develop job-related skills and competencies, providing a stable sense of community with coworkers, staying current and challenged (Capital, 2005), becoming more productive, making better decisions faster, accessing relevant knowledge more easily (Seufert *et al.*, 1999), and helping firms to minimize the costs associated with finding, organizing, and leveraging knowledge and to increase the quality of knowledge (Allee, 2000).

Pugh and Prusak (2013) developed a framework for KN effectiveness, including three dimensions of design or construction, dynamics, and behavior (Figure 1). In this framework, the first and the most critical step is KN design. Moreover, highly successful KN leaders believe that the design phase is a significant positive leverage for network effectiveness. Additionally, unsatisfactory outcomes through the layers of behaviors and dynamics are traced back to an overlooked design (Pugh and Prusak, 2013). Therefore, to achieve final effectiveness, companies cannot simply design effective KN without any systemic analysis of related methods and steps. Accordingly, different researchers initiated the development of quantitative and qualitative methodology for KN creation as a collection of methods, practices, procedures and rules.

3. KN creation methodologies

There are different methodologies regarding the creation of KN. Each of these methodologies has a specific set of tools, approaches, objectives, and characteristics.

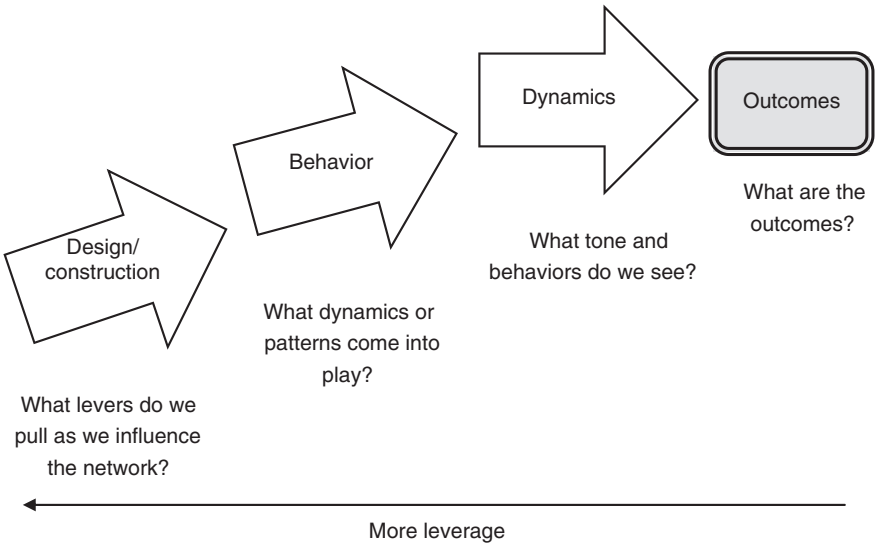


Figure 1.
A framework for knowledge network effectiveness

Source: Adapted from Pugh and Prusak (2013)

In this section, these methodologies are described in two categories of quantitative and qualitative methodologies. Qualitative methodologies have a more managerial approach to the creation of a KN and mainly utilize conceptual frameworks to depict different aspect of the methodology. Qualitative methodologies normally consist of guidelines for leaders, managers, and practitioners. On the other hand, quantitative methodologies have a more mathematical approach to the KN creation problem and encompass related mathematical modeling and notations.

3.1 Theoretical background

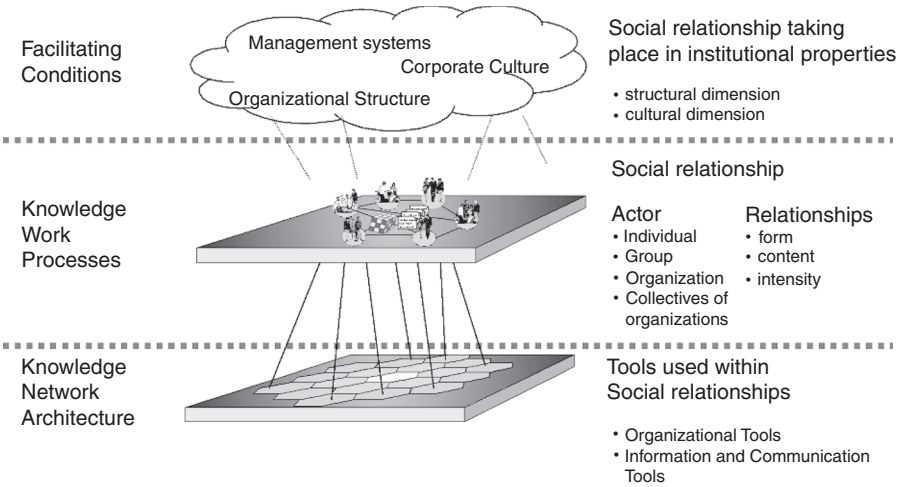
Pugh and Prusak (2013) proposed a methodology that consists of eight dimensions of network design that enables leaders of KN to achieve desired behaviors and outcomes. These dimensions encompass strategic, structural, and tactical issues. Strategic aspects include leaders' shared theory of change, objective/outcome, role of expertise, inclusion, and participation. Structural dimensions combine operating model, convening structures and infrastructures, and facilitation and social norm development. Finally, tactical dimension includes measurement, feedback, and incentives. Based on these different dimensions, leaders are able to design and manage KN. Back *et al.* (2005) introduced a methodology consisting of five key phases including illuminating the knowledge vision, determining if the KN is the best option, the choice of the right network mode, the creation of the selected mode, and the incorporation of related performance measures with a balanced scorecard approach. The illuminating of the knowledge vision together with the choice of an appropriate tool might be considered preliminary work in the sense that they probably have already been accomplished in the course of other KM initiatives. Moreover, the methodology explains how to select the suitable mode of KN as well as how to create the network. Using performance measures for KN facilitates corrective actions and adaptation within the architecture of the KN. Seufert *et al.* (1999) develop a framework for knowledge networking based on

micro-perspective and a macro-perspective (network perspective). This framework of KN consists of actors, groups, organizations, the relationships among them which are categorized by form, content and intensity, required resources, and structural and cultural dimensions of organization. The micro-perspective of KN is depicted in Figure 2. Egger *et al.* (2006) introduced a comprehensive methodology for establishing and managing networks with five major phases of concept development, proposal preparation, network creation, network management, and network evaluation. This framework is based on more managerial perspective and suggests vision and mission formulation for networks, design network organization, risk assessment, core team development, cross-network learning, appropriate funding, team relationships, and preparing a financial plan. This methodology is a collection of strategies, operational techniques, steps, and important concerns addressing KN management. Buchel and Raub (2002) explained that the most valuable activities in KM are concentrated on value-creating KN that extend beyond the traditional concept of communities of practice . Thus, in order to foster this value-creating networks, they have developed a four-stage process. The steps of the proposed process focus on the KN, creating a knowledge context, routinizing network activity, and leveraging network results. These steps and further details about each step are depicted in Figure 3.

On the other hand, other researchers have developed quantitative approaches to network creation using mathematical modeling and notations. These methodologies consist of random graphs (Erdós and Renyi, 1959), generalized random graphs (Bender and Canfield, 1978), small-world networks (Watts and Strogatz, 1998), and scale-free networks (Barabási and Bonabeau, 2003). These methodologies are thoroughly discussed by Boccaletti *et al.* (2006).

4. A framework for KN creation methodologies

Based on presented KN creation methodologies, each methodology has its own characteristics. Although they have a lot of similarities, there exists differences among



Source: Seufert *et al.* (1999)

Figure 2.
The micro-perspective of knowledge networks

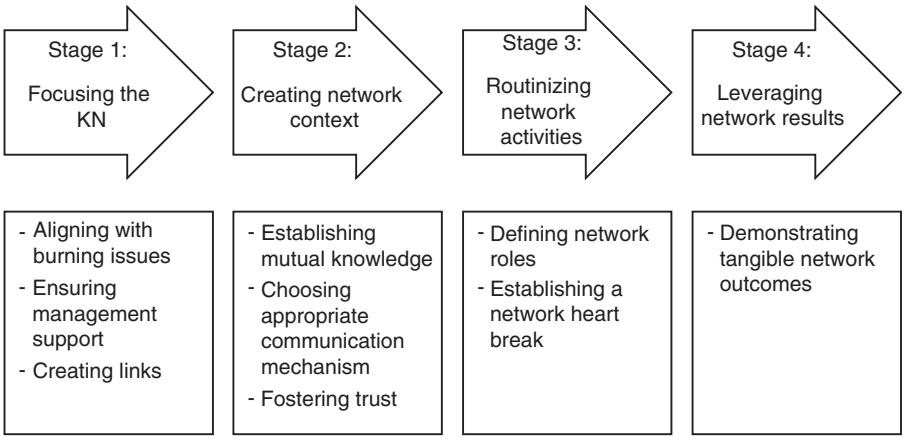


Figure 3.
The four steps of knowledge network development

Source: Buchel and Raub (2002)

them that are critical in the selection process for each organization. Therefore a PBO should select a methodology to create its KN in the manner the methodology supports its expectations and adapts with the organization's characteristics.

4.1 Suggested criteria

In this section, some comparison criteria are developed to highlight different characteristics of KN creation methodologies. This step provides a foundation for PBO for the construction of a framework for selecting among KN creation methodologies.

4.1.1 Network perspective. The perspective of a network creates distinctions (Enkel, 2002). This preference has been made between macro- and micro-perspectives on networks. Macro-perspective focusses on strategies and conceptuality, while micro-perspective aims attention at actors and situations (Seufert *et al.*, 1999, 2002). Micro-perspective highlights KN architecture including organizational and communication tools, and knowledge work processes (network structure) including actors (individual, group, organization, collection of organizations) and relationships such as form (e.g. duration and closeness of the relationship), content (e.g. products or services, information, emotions), and intensity (e.g. communication and frequency). On the other hand, macro-perspective focusses on strategic concerns of KN including its relationships to existing management systems, corporate culture, organizational activities and structure. Recently, there has been much attention on the study of the structural dimension of KN by applying a network perspective (Mueller-Prothmann and Finke, 2004; Liebowitz, 2005; Helms and Buysrogge, 2005; Cheuck, 2006).

4.1.2 Tools applied for KN validation. These tools help the analyst in assessing the KN validation (Bosua and Scheepers, 2007; Vestal, 2005; Helms *et al.*, 2010). KN validation is an independent procedure that is used for checking that the KN meets the operational needs of the user, specifications, and that it fulfills its intended purpose. It is a process of establishing evidence that provides a high degree of assurance that a KN accomplishes its intended requirements. It is sometimes said that validation can be expressed by the query "Are you building the right KN?" KN validation assessment tools are usually checklists, tables, simulation models, and, etc.

4.1.3 Objectives. Several objectives can be achieved when undertaking a KN creation exercise. Network creators are often faced with challenges of having to work with a KN creation approach that is not intended nor adapted to the objectives they are pursuing. KN Objectives are overall goals, purpose, and mission of a KN that have been established by its creators and communicated to its members. The objectives of a KN typically focus on its long-range intentions for operating and its overall philosophy that can provide useful guidance for network members seeking to please their higher-level managers and KN owners. Therefore, a suitable methodology with adopted objective should be selected (Lecocq, 2006). These objectives can be long-term or short-term. The primary difference is the time required for KN to achieve them.

4.1.4 Characteristics and capabilities. The word "characteristics" is used to refer to a special quality or trait that makes a methodology different from others and a KN creation methodology can be used based on such characteristics. The characteristic of any KN creation methodology are discussed as specific features for the representation of a network (Machado and Ipiranga, 2013). Based on Williams and Lee (2009), KN characteristics are defined as KN size (employees), degree of internalization, and age. Back *et al.* (2005) suggests these characteristics including network size, personal relationships, common activities, face-to-face contact, knowledge culture, closeness, communication requirements, structuring of network, support potential of ICT-tools, support of ICT-tools, support of organizational tools, media richness, knowledge base, importance of context, and structuring of knowledge.

4.1.5 KN creation approaches. Like other forms of networks, KN have been used in various forms (Nohira, 1992; Sydow, 1992). There are different approaches for network creation: structural, relationship-orientated, and process orientated. Structural approaches focus on formation, characteristics, and organization. Relationship-orientated approaches concentrate on interaction and relationship dimensions, while process-orientated approaches focus on development and the content of processes (Seufert *et al.*, 2002).

4.1.6 Create static or dynamic KN. There are two types of KN creating methodologies – static and dynamic creation methodologies. Static methodologies create links between a fixed numbers of nodes so that the network topology mimics the networks seen in real systems. On the other hand, dynamic techniques aim to reproduce how the network was built and evolved. Thus, their goal is to capture the network dynamics rather than its structure (Newman *et al.*, 2006; Ray and Roychowdhury, 2014).

4.1.7 Support inter- or intra-organizational network. Intra-organizational networks are emergent relationships of individuals who are dispersed across the organization yet who work on similar tasks using a similar base of knowledge and as such are to be distinguished from dispersed teams that are formally mandated and goal-oriented (Teigland, 2003). An inter-organizational network is defined as a set of organizations related through common affiliations or through exchange relations (Kessler, 2013). KN creation techniques support at least one network type which is defined above.

4.1.8 Network structure. There are three types of network structures – hierarchical, core-peripheral, and ego-centric (Smedlund, 2010). In the hierarchical network structure, there is a leader who facilitates performing processes of subordinates. This makes accurate transfer of knowledge from the focal individual to subordinates possible, and also transfers feedback from the subordinates to the focal individual. Therefore, the knowledge must be allowed to flow from the top of the hierarchy to the bottom and back in a timely and precise manner (Cummings and Cross, 2003). The core-peripheral structure (Borgatti and Everett, 1999; Cummings and Cross, 2003) is ideal for network

development. This structure has a dense, cohesive core and a sparse, unconnected periphery. The core-peripheral structure allows certain individuals to be interconnected with the others, but it also makes it possible to transfer knowledge from individuals outside the network. In an ego-centric network structure, as described by Cummings and Cross (2003), certain individuals function as hubs in the network who gather knowledge from all other individuals of the network. This structure often understood in idea generation networks.

4.1.9 Network uncertainty. Koppenjan and Klijn (2004) categorize three types of network uncertainty including substantive, strategic, and institutional network uncertainties. Substantive uncertainty is the lack of knowledge about the problem or overload of non-definitive information. Strategic uncertainty arises because networks contain multiple actors who retain some measure of strategic autonomy, creating uncertainty about what choices they will make. Institutional uncertainty arises from trying to coordinate actors who have their own perceptions, norms, and objectives and who come from different institutional backgrounds, administrative levels, or organizations.

4.1.10 Weaknesses and limitations. Each methodology has weaknesses and limitations which should been recognized in order to identify probable challenges ahead of the organization and devise adequate solutions for dealing with them (Dyer and Nobeoka, 2002). These limitations are usually based on special characteristics and strategic orientation of KN creation and development methodologies such as goals, tools and techniques, perspective, procedures, main focus, operational model, facing barriers, and governance structure.

4.2 A framework for comparison

Methodology comparison is a very challenging and complex activity and there are diverse viewpoints by different experts. As explained before, ten main comparison criteria are considered in this framework. This framework is not expected to be completely comprehensive. However, the framework provides a guideline as a basis to methodology comparison while evaluating a methodology. These features are not exclusive and there could be relationships among them. Based on addressed KN creation methodologies and the described selection criteria, a framework for choosing among KN creating methodologies are developed as depicted in Table I (qualitative approaches), and Table II (quantitative approaches).

5. Empirical evaluation

In order to illustrate the applicability and usefulness of the proposed framework, the developed framework was verified and validated using data from a pharmaceutical research and development (R&D) organization. The incentive behind selecting a pharmaceutical R&D organization as the case study is that these organizations use the most highly developed project management models and have the highest level of project management maturity (Cooke-Davies and Arzymanow, 2003). These type of companies are also typically known for their project-based form (Taylor and Levitt, 2004). Moreover, knowledge-based innovation is a vital aspect of competitiveness in this kind of organization (Munos and Chin, 2011). The PBO used for the case study is among the three largest pharmaceutical R&D organizations in the country, and in recent years it has been planning to create KN as one of its KM initiatives. This (anonymized) PBO agreed to use the proposed framework to choose the most appropriate KN creation methodology after its KM initiative implementation in 2013.

Table I. The comparison framework of qualitative knowledge networking methodologies

Researchers	Network perspectives	Tools used for KN validation	Objectives	Characteristics and capabilities	KN creation approaches	Static or dynamic	Inter- or intra-network	Network structure	Network uncertainty	Weaknesses and limitations
Pugh and Prusak (2013)	Macro	Checklist that is completed by network leader	Offering a holistic approach for achieving collaboration, network cohesion and broad connectivity to help yield the important outcomes of coordination, learning/ innovation, translation/ local adaptation and participant support	Designing with three main dimensions: strategic, structural and tactical	Structural approach	Dynamic	Inter-organizational	Hierarchical	Institutional perception	Focussed just on network's leader, not members
Back *et al.* (2005)	Macro	The internal and external measurement system and checking success factors	Designing, operating and refining most if not all of Knowledge Network variants	Combining knowledge theory with business practices	Structural approach	Dynamic	Inter-organizational	Core-peripheral	Substantive uncertainty	Operation model is not defined
Seufert *et al.* (1999)	Micro or Macro (depends on knowledge management perspective)	n/a	Developing a framework for knowledge networking which can be used as a basis in order to structure and reveal interdependencies	Supporting both micro- and macro-perspective	Relationship-oriented approach	Dynamic	Intra-organizational	Hierarchical	Institutional perception	It is not determined how to overcome knowledge barriers by this networking methodology

(*continued*)

Table I.

Researchers	Network perspectives	Tools used for KN validation	Objectives	Characteristics and capabilities	KN creation approaches	Static or dynamic	Inter- or intra-network	Network structure	Network uncertainty	Weaknesses and limitations
Egger *et al.* (2006)	Macro	Survey, interview, workshop with members and stakeholders, document analysis and SWOT analysis	Establishing and managing networks to effect change or achieve an impact in a certain area	Involving decision-makers in a network; focussing on communication, leadership and culture in network and planning; development and management of networks	Process – oriented approach	Dynamic	Both of inter and intra-organizational	Core-peripheral or Ego-centric (depend on governance structure)	Strategic uncertainty	It is not planned from the inception of the project
Buchel and Raub (2002)	Macro	n/a	Foster value creating network that they can contribute to the organization and individuals	Focussed on strategic business/corporate priorities; network context is created; network activities are routinized and network outcomes are leveraged	Structural approach	Static	Inter-organizational	Ego-centric	Institutional perception	The network governance is not addressed

Methodology	Researchers	Network perspectives	Tools used for KN validation	Objectives	Characteristics and capabilities	KN creation approaches	Static or dynamic	Inter- or intra-network	Network structure	Network uncertainty	Weaknesses and limitations
Random graphs	Erdós and Renyi (1959)	Micro	Defining appropriate reference systems such as simulation methods by using real data sets	Designing networks by means of probabilistic methods: properties of graphs as a function of the increasing number of random connections	Each node connects to others with a specific probability	Relationship-oriented approach	Dynamic	intra-organizational	Core-peripheral	Substantive uncertainty	The graphs are uncorrelated, since the edges are connected to nodes regardless of their degree. But in real networks, nodes tend to connect to those nodes with highest degree
Generalized random graphs	Bender and Canfield (1978)	Micro	Defining appropriate reference systems such as simulation methods by using real data sets	Designing networks and determining at what stage a particular property of the graph is likely to arise	Admitting different values of probabilities for its edges rather than a single probability uniformly for all edges as in the random graph	Structural approach	Static	Intra-organizational	Core-peripheral	Both of Substantive and Strategic uncertainty	This model is simple in presentation, but significantly complex in analysis, in particular when the probabilities are connected with a set of Bernoulli random variables that are not independent
Small-world networks	Watts and Strogatz (1998)	Micro	Defining appropriate reference systems such as simulation methods by	Designing random networks with short average path lengths and high clustering	high clustering coefficient and defining property that the mean-shortest path length be small	Relationship-oriented approach	Static	Inter-organizational	Ego-centric	Institutional perception	Larger networks with similar clustering and path length tend to have higher values of the small-coefficient than do their smaller counterparts. It's not

(*continued*)

Table II.
The comparison framework of quantitative knowledge networking methodologies

Table II.

Methodology	Researchers	Network perspectives	Tools used for KN validation	Objectives	Characteristics and capabilities	KN creation approaches	Static or dynamic	Inter- or intra-network	Network structure	Network uncertainty	Weaknesses and limitations
			using real data sets								possible to know whether a network has properties that tend to be more lattice-like or random-like
scale-free networks	Albert and Barabási (2000)	Micro	Defining appropriate reference systems such as simulation methods by using real data sets	Designing networks whose degree of distribution follows a power law, at least asymptotically to describe the class of networks that exhibit a power-law degree distribution	The number of links originating from a given node exhibits a power law distribution and powerful nodes become more powerful	Process – oriented approach	Static	Both of inter and intra-organizational	Ego-centric	Institutional perception	The largest number of hops required to get from one node to another by following the shortest route possible but ignoring the details of their individual links and nodes and also the frequency and duration of contact for those links

Thus, a group of three experts—consisting of a chief knowledge officer (CKO) and two professional project managers who were highly educated and experienced in the PBO – was formed to select the KN creation methodology. In the first introductory meeting, all members of the group confirmed that the project-based form is adopted in the organization and there are intra- and inter-organizational active projects in the organization. On the other hand, the CKO clarified that KN creation had been part of the KM plan of organization for about one year and as the first step, they could not find a systematic solution to their selection problem. The group aimed to use the proposed framework and choose their appropriate KN creating methodology systematically. It was determined that all members would have complete information about the details of KM plan, current active projects, and project-based form of the PBO. Consequently, different aspects of KM strategy, the PBO's cultural environment, related organizational policies, initiated KM tools and systems, management support, current project configurations, and project-based structure of the organization were discussed thoroughly with no conflicts.

As the first step, the group identified and prioritized the criteria based on the characteristics and strategic concerns of the group members. In this study, the group ranked the criteria as network perspective, inter- or intra-organizational network, static or dynamic, network structure, and network creation approach. Second, in order to determine the perspective of the network, the group members discussed the importance of the strategic overview capability of the methodology. Consequently, the more strategic, macro-perspective was selected over the more detailed and actor-based micro-perspective. It is also claimed that in the next steps of knowledge networking maturity of the PBO, the organization would be able to select a more detailed micro perspective. As the next step, the domain of the ongoing projects was explained by project manager experts and it was highlighted that there are inter-organizational active projects in the PBO. Thus, the domain of the KN was selected as inter-organization. In the fourth step, node mutation of the network was discussed and it was identified that in the PBO, the nodes are completely dynamic. In the fifth step, the structure of the network was discussed thoroughly. This structure is dependent on the governance structure of the organization. Furthermore, the detailed structure of the PBO was determined as depicted in Figure 4. The structure consisted of management, R&D, and supportive processes. As illustrated in Figure 4, there exists a core peripheral as the focal point of these three processes of the PBO. Based on the governance model

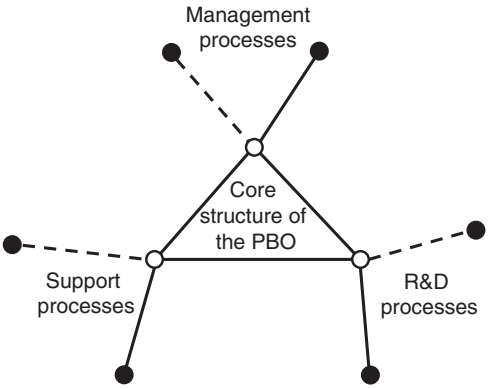


Figure 4.
The governance structure of the project-based organization

presented, the network structure of the PBO is core-peripheral and the networking approach is process-oriented (step 6).

Based on the pre-mentioned discussions and the presented framework in Tables I and II, the most appropriate methodology for the PBO is the methodology presented by Egger *et al.* (2006). Finally, the team started to further discuss the methodology and its different aspects. Following that, all group members accepted the methodology and its implementation was planned by the CKO of the PBO.

6. Discussion and conclusions

A structured framework to select the most appropriate KN creation methodology has been proposed in this paper. This framework encourages the adoption of these methodologies if they have a strong positive relationship with organizational objectives and have no major adverse effects. The framework identifies the key methodologies which improves the KN creation process. This is based on experts' research that determined the most suitable features for comparison framework. Thus, the proposed framework indicates which KN creation methodology will have the greatest effect on the desired KN which is pointed out in KM initiatives.

In order to review the success of a selected methodology in designing an effective KN, measurement should take place to show a clear link between the approach that has been taken and the results that have been gained. Unless efficiency is measured after a methodology is selected by using this framework, it cannot be determined whether this framework has had a positive or negative effect on KN efficiency. Without measurement, any improvements are anecdotal. By demonstrating that the new way of selecting has a positive effect, it will be easier to increase the pace of efficiency improvement. The greatest strength of the framework is in the provision of information to encourage knowledge managers to focus on the objectives to be achieved, link KN creation methodologies to objectives, organizational capability for employing some tools which have not been used before and the type of organization that KM project is implemented in (PBOs).

The comparison framework is represented with attention to key features of each knowledge networking methodology. The represented framework can help knowledge managers to select their suitable methodologies with attention to its features and apply it in PBOs and be sure of successful knowledge networking. They can also adopt KN creation methodologies to support and conceptualize knowledge sharing in their organizations and to help individuals find experts who are looking for.

Limitations of the study are as follows. The findings are based on existing methodologies and further research with similar approach needs to be undertaken to establish points of comparison in different time frames. More case studies and a fundamental study of the types of knowledge and organizations that help managers and practitioners to make better decisions when considering the implementation of the proposed framework should be undertaken.

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