International Journal Of Engineering Research And Development
e- ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com
Volume 16, Issue 1 (Jan. 2020), PP.39-51

Innovation andKnowledge Processes: A Framework andLiterature Review

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ABSTRACT
Due to the globalization of the economy, organizations have intensified their search for strategies, which provide them with a continuous and sustainable competitive advantage. Such strategies often result in actions and plans that define how organizations improve the goods and services they product and differentiate them in order to take into account the diversity and the needs of their customers. This is notably the case of knowledge intensive services-oriented organizations where services delivered to customers do not have the same legal protection as material goods. Banks, insurance companies, and software industry are examples of such organizations, which must be constantly innovative to be competitive. Knowledge creation is among the most important enablers of innovation within modern organizations. Let us note that innovation management and knowledge management are often studied separately by academics. Certainly, knowledge management and innovation management refer to two different management areas within organization. Nevertheless, we think that these processes are connected through continuous and complex interactions and have important impacts on one another. Moreover, to be continuously competitive, organizations must integrate the knowledge and innovations processes in order to create better, faster, and cost-effective goods and services innovations. In this paper, we propose a framework that links knowledge management activities and innovation activities and demonstrate how such a framework can contribute to help organizations innovate and obtain a sustainable competitive advantage.

KEYWORDS:*knowledge creation, knowledge transfer, innovation, social network, problem solving*

Date of Submission: 20-01-2020 Date of Acceptance: 05-02-2020

I. INTRODUCTION

Due to the globalization of the economy, organizations have intensified their search for strategies, which provide them with a continuous and sustainable competitive advantage. Such strategies often result in actions and plans that define how organizations improve the goods and services they product and differentiate them in order to take into account the diversity and the needs of their customers. This is notably the case of knowledge intensive services-oriented organizations where services delivered to customers do not have the same legal protection as material goods. Banks, insurance companies, and software industry are examples of such organizations, which must be constantly innovative to be competitive. There is a strong agreement among academics on the importance of innovations for modern organizations. Many authors have analyzed the critical role of innovation in modern organizations. For instance, [Wolfe 1994] points out that innovation is related to organizational competitiveness and effectiveness while [du Plessis 2007] and [Adams and Lamont 2003] stress the contribution of innovation to competitive advantage. The strong correlation between innovation and long-term survival of organizations was underlined by [Scott and al. 1994] who confirm the analysis of [Tidd, and Bessant, 2018] who consider innovation as the key means of adapting to change. Furthermore, knowledge creation is among the most important enablers of innovation within modern organizations. Nowadays, innovation management and knowledge management are often studied separately by academics. Certainly, knowledge management and innovation management refer to two different management areas within organizations. Nevertheless, we think that these processes are connected through continuous and complex interactions and have important impacts on one another. Moreover, to be continuously competitive, organizations must integrate the knowledge and innovations processes in order to create better, faster, and cost-effective goods and services innovations. In this paper, we propose a framework, which links knowledge, and innovation processes activities and demonstrate how such a framework can contribute to help organizations innovate and obtain a sustainable competitive advantage. Our paper is organized as follows. Section 1 describes the context, the problem and introduces the proposed framework. In section 2, we review the concepts of knowledge and innovation prior to presenting a model of organization derived from the Leavitt model [Leavitt

1963] [Stohr and al. 1992], which illustrates the critical role played by knowledge in modern organizations survival. This model underlines that knowledge, innovation, strategy and information technology are interdependent. Section 3 provides a synthetic presentation of the knowledge and innovation processes and identifies their interdependencies. In section 4, we propose a framework, which integrates knowledge and innovation, processes. Section 5 concludes this paper by listing the contribution of the proposed framework as well as future research directions.

II. THE CONCEPTS OF KNOWLEDGE AND INNOVATION

In this section, we define the concepts of knowledge and innovation and prove that they are interdependent through a model of organization derived from the Leavitt model [Leavitt1963] [Stohr and al. 1992]. In order to demarcate the concept of knowledge, we use the data and information concepts.

A. Defining data, information and knowledge

Intel Corporation CEO Brian Kzanich (in [Gharib 2018] called data the 'new oil' that is essential to organizational agility and survival. Data is a set of signs and alphanumeric characters. Information results from applying an interpretation model to data. 10122009 is an example data, which may be associated with many kinds of information. For instance, applying a French interpretation model of date to "10122009" results in "December 10, 2009" while applying an English interpretation model of date to the same data results in "October 12, 2009". The actual occurrence of a conflict between two persons can be considered as data. Let us assume that three different persons have witnessed this conflict. Communicating what they have seen generally results in three sets of information corresponding to their versions of what happened. Knowledge is defined as information that is relevant for executing certain business actions. According to [Boisot 1995] and [Boisot 1998], knowledge builds on information that is extracted from data whereas data can be characterized as a property of things, knowledge is a property of agents predisposing them to act in particular circumstances. Therefore, information establishes a relationship between things and agents. Furthermore, [Boisot and al. 2006] refine the above argument by stressing that stimuli is the input for data. Perceptual filters convert incoming stimuli to data while conceptual filters convert the data into information. The information in turn becomes knowledge inside the agent. The filters depend on the prior knowledge of the agent. Thus, stimuli are the raw material of which data is formed and data is viewed as the raw material for information, which in turn enables knowledge. Information is the intermediary between data and knowledge. [Zack 1999] formulates a less technical distinction than does [Boisot and al. 2006]. According to this author, data represents observations or facts out of context that are, therefore, not directly meaningful. Information results from placing data within some meaningful context, often in the form of a message. Knowledge is that which we come to believe and value on the basis of the meaningfully organized accumulation of information through experience, communication, or inference. Knowledge can be viewed both as a thing to be stored and manipulated and as a process of simultaneously knowing and acting. Consequently, [Zack 1999] also underlines the more or less cumulative relationships between data, information and knowledge and he introduces the role of context. [Davenport and al. 2000] underline that on the one hand, data is a set of discrete, objective facts about events. On the other hand, information is the data that makes a difference. Finally, knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a frame work for evaluating and incorporating new experiences and information. Knowledge originates and is applied in the minds of knowledge workers. Moreover, knowledge often becomes embedded not only in documents or repositories but also in products, services, organizationalroutines, processes, practices, and norms. According to [Newell and al. 2002] and [Nonaka 1995], knowledge may be understood as a justified true belief. This definition emphasizes the temporary nature of knowledge. The knowledge and information concepts are mutually dependent. On the one hand, information is external to human beings and is stored in various supports like books or databases while knowledge in internal to the minds of knowledge workers. On the other hand, information is converted to knowledge through the internalization process and knowledge is transformed into information once it is externalized [Alavi and al. 2001]. Internalization consists in transforming information, which is external into knowledge, which is internal to the minds of knowledge workers. Learning and information processing by knowledge workers facilitate internalization and result in creation of new knowledge, or alteration of existing knowledge. Externalization consists in articulating internal knowledge in order to making it external to the mind of a knowledge worker. Externalized knowledge is called explicit knowledge or information while tacit knowledge is knowledge, which cannot be, articulated [Zack 1999]. Writing a book is an example of externalization of knowledge owned by an author. Knowledge is tacit if it is difficult to express using some understandable symbols like written notations or spoken language. The concept of tacit knowledge was introduced by [Nonaka 1994], drawing on the more philosophical work of [Polanyi 1967] which considers that tacit knowledge is the type of knowledge we use to carry out the actions that we perform routinely without thinking consciously about how to carry these actions.

Another important characteristic of knowledge is that it is related to action [Brooks 1987] [Nonaka 1994] [Nonaka 1995]. This means that the value of knowledge results from the ability of knowledge workers to impact the real environment in which they operate. Moreover, the action of knowledge workers within the environment where they operate generates feedback information which facilitates organizational learning. In particular, tacit knowledge can take the form of embodied knowledge, which is materialized by action of knowledge workers [Blackler 1995]. In this paper, we define individual knowledge as the interaction between an organizational actor, an operational or decision-making process, and a organizational context. Therefore, knowledge determines how an organizational actor contributes to value creation when he carries out tasks associated with his role within an organization. This definition suggests three remarks. Firstly, it underlines the dependence of knowledge owned by an organizational actor on how he perceives tasks and business functions. Secondly, it recalls that organizational actors create knowledge by processing information. Finally, this definition takes into account the relationships between knowledge and action as well as the temporary nature of knowledge. Indeed, interaction between an organizational actor, a business process, business functions, and informational entities depends on existing knowledge owned by this actor. Such knowledge is continuously updated through processing of informationprovided by the organizational environment and the business entities manipulated during the organizational actor action.

B. Defining innovation

The concept of innovation is often defined as a new idea or approach that challenges the present state of an organization Many definitions of innovation refer to the application of something new [Baregheh and al 2009]. Therefore, innovation is different from invention. Many additional aspects are emphasized by academics to demarcate innovation from invention. For instance, [Sundbo 1998] and [Satchell 1998] stress the stirring up that innovation brings by talking about renewal and conversion of an idea into an outcome. Moreover, [Satchel 1998] refers to continuous rearrangement, emphasizing the incremental and economic aspects of innovation. Such definitions of innovation show similarities with the more economic and well-known view of Schumpeter [Shumpeter 1942], which combines the elements of creation and destruction [McCraw 2007]. Definitions of innovation proposed by [Maguire and al. 1994] and [Rogers 1995] focus on organizational processes and include concepts like marketing. [West and al. 1990] define innovation as the intentional introduction and application within a role, group or organization of ideas, processes, products or procedures, new to the relevant unit of adoption, designed to significantly benefit the individual, the group, organization or wider society

The above definition on innovation grasps the essence of applying something new in combination with intention, relevance, and benefit. Furthermore, it emphasizes newness in relation to the unit of adoption. There are different types of innovation. [Jorna and al. 2006] use a typology proposed by [Garcia and al. 2002] to identify five types of innovation, which they place on a continuum of newness: radical innovations, really new innovations, discontinuous innovations, incremental innovations, and imitations. Radical innovation is very far-reaching and generally trigger many important innovations. It innovation consists in introducing a new product or service that leads to a discontinuity and newness in the market. Such an innovation includes newness in either technological or marketing sense. Discontinuous innovation provides performance improvement, costs reduction or introduce an existing item with completely new characteristics. Incremental innovations consist in adaptation, refinement and enhancement of existing markets and technology. Imitative innovation is the opposite of radical innovation since it is new to a particular organization, but not new in terms of product or process. According to [Slappendel 1996], in addition to newness which is a widely accepted key distinguishing feature of innovation, the perception of newness also serves to differentiate innovation from change. [Gopalakrishnan and al. 1997] identify three contrasting categories of innovation: radical versus incremental, technical versus administrative, and product versus process. These authors note that the distinction between technical and administrative innovations is intended to reflect a more general distinction between social structure and technology. Moreover, distinguishing technical and administrative innovations makes it easier to understand the organizationaldifferences in response to these different types of innovation. On the one hand, technological innovations change organizations through enhancements made in products and services, or in the way those products are produced or services are rendered. On the other hand, administrative innovations change the structure or the administrative process of an organization. In this way they indirectly change the basic work activity and more directly to the management.

The implementation of an idea for a new policy pertaining to the recruitment of personnel, the allocation of resources, or the structuring of tasks are examples of administrative innovations. The distinction between process and product innovations is intended to stress the differences in effects of these innovations on areas and activities within organizations. [Damanpour and Gopalakrishnan 2001] note that a process innovation involves new tools, devices, and knowledge in throughput technology that mediate between inputs and outputs while product innovations introduce new outputs or services for the benefit of customers.

C. Integration of knowledge and innovation in a model of organization

According to [Leavitt 1963], an organization is made of four interacting components: tasks, structure, people, and production technology. [Stohr and al. 1992] improved this model by adding information technology as a central component which help organizations in taking into account environment economic, political, legal, social and technological constraints (Figure 1).

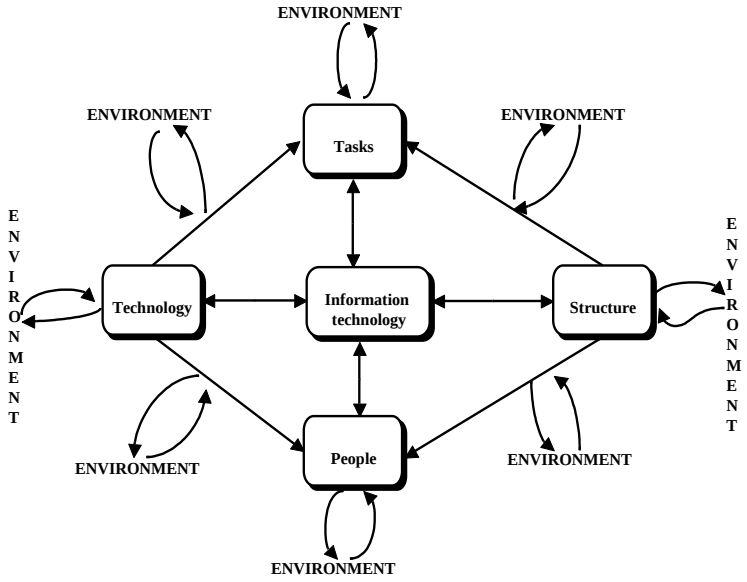

Figure 1: The Leavitt model (improved by [Stohr and al. 1992])

Despite its richness, the Leavitt model of organization presents many weaknesses. Firstly, it doesn't provide information about how people work together within an organization. Secondly, this model doesn't describe how information technology helps organizations adapt to their continuously changing environment. Certainly, organizational informationsystems support organizations operational and decision-making processes.Nevertheless, the Leavitt model doesn't specify how such a support constitutes an instrument for integration and absorption of environment constraints and signals by modern organization.

We think that information technology is not sufficient to help organizations take into account environment constraints. Moreover, survival of modern organizations rests on innovation and organizational knowledge, which determine the right organization reactions to environment pressure. Organizations strategies identify the nature and the scope of organizations reactions. Such reactions consist in modifying organizational processes, production technology, organization's structure, and organizational actors' roles. Therefore, to improve the Leavitt model, we identify three interrelated additional components of modern organizations: knowledge, innovation, and strategy. Together with information technology, these components provide instruments, which facilitate organizations reactions to environment pressures through sustaining competitive advantage. Firstly, organization's strategy determines global organizational solutions to problems resulting from environment pressures. Secondly, knowledge and innovation facilitate designing business solutions i.e. processes, products, and services associated with global organizational solutions. Finally, information technology provides computer solutions needed to support business solutions designed to help organizations adapt to its continuously changing environment. Figure 2 illustrates the proposed model of organization – called **SIKIT** – which improves the model due to [Leavitt 1963] and [Stohr and al. 1992] by taking into account knowledge and innovation. The acronym SIKIT refers to **S**trategy, **I**nnovation, **K**nowledge, and **I**nformation **T**echnology as the critical components of modern organization in their continuous struggle against environment pressures.

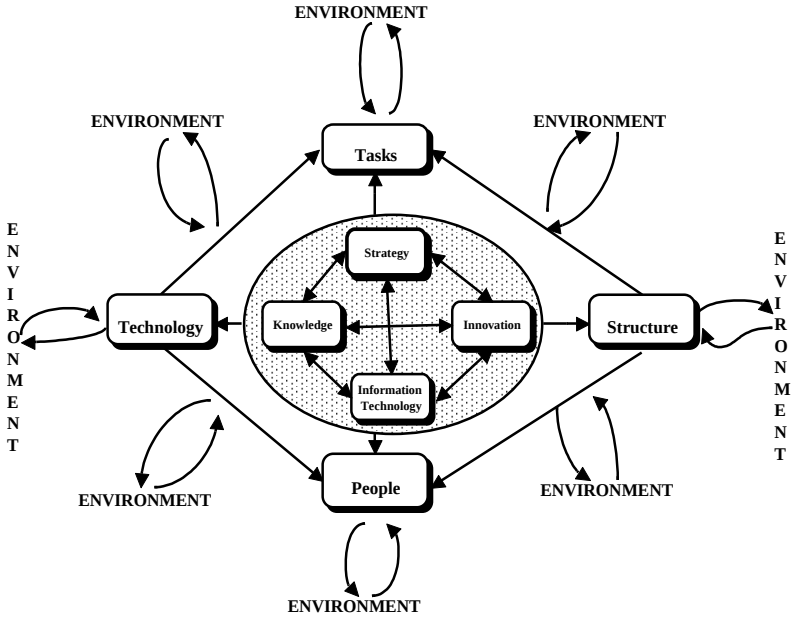

Figure 2: The SIKIT model of organization

III. INTERDEPENDENCIES BETWEEN KNOWLEDGE AND INNOVATION PROCESSES

In this section, we present synthetically the knowledge and innovation processes prior to demonstrating that these processes are interdependent.

A. The knowledge processes

There are two main knowledge processes identified in the literature: knowledge creation and knowledge transfer. Firstly, [Nonaka and al. 2000] consider that the knowledge creation process relies on three components:

- A knowledge conversion process called SECI,
- A context-knowledge place called Ba,
- A set of knowledge assets

The SECI process describes how knowledge is created through the interaction of explicit and tacit knowledge by means of socialization, externalization, combination, andinternalization. Ba refers to the fact that to be created, knowledge needs a context, which can be physical, space, mental space and may be time-specific. The knowledgeassets are inputs and outputs of the knowledge creation process. That means that organizational knowledge is not created from scratch. That is new knowledge is created out of existing knowledge and accumulated prior knowledge increases both the ability to acquire new knowledge and the ability to use it [Cohen and al. 1990].

Secondly, the knowledge transfer process allows existing knowledge to be leveraged across the organization when different organizational components overlap in terms of required knowledge. Cummings and Teng model is among the most important models of the knowledge transfer process proposed in the literature [Cummings and al. 2003]. This model is based on two components: a source and a recipient. On the source side, the authors cite that knowledge articulability and embeddedness as important factors. On the recipient side, they stress that learning culture and the priority of the knowledge to be transferred constitute success factors. The source and the recipient are related by a context made up of organizational, physical, knowledge and norm distances.

B. The innovation process

The traditional model of the innovation process is linear and relies on science push and market pull models. The basic idea of this model consists in describing innovations as causal linear chains. According to the chain of the science push model, theoretical knowledge is generated in basic science. Then, the generated knowledge flows down to a practical context in which the knowledge is applied in problem solving. Undertaking these steps may result in an innovation. The chain of the science push model runs only in one direction. That is all the questions and information come into the process from an earlier or the present state of the chain. The chain of the market pull model is similar to the chain of the science push model. Nevertheless, the questions and information come from the market. Both models consider innovation assomething far from practical, everyday life. Moreover, neither model can explain success or failure of innovation processes.

The stage-gate model provides more details to better understand the innovation process [Cooper and al. 1995]. This model suggests that innovation can be seen as a process consisting of a series of stages with gates in between. It introduces a formal methodology, which today can be observed as a widely adopted standard. Each stage is composed of various prescribed activities and cut across functional boundaries. The gates provide a set of criteria against which a project is evaluated, followed by a decision about the next stage. Let us note that the stages follow sequentially but activities within each stage may be executed concurrently.

C. Relationships between the knowledge and innovation processes

Both innovation and knowledge share the consideration that they influence competitive advantage. The main knowledge-related studies in innovation literature underline the role of knowledge as a constraint to start the innovation process. In particular, many authors have demonstrated that knowledge and innovation processes are strongly dependent. They notably indicate that knowledge is considered an important factor in innovation. For example, [Jorna and al. 2006] regards knowledge to be the starting point of innovation. [Nonaka 1994] was among the first authors to stress that innovation is based on knowledge. This author underlines that new knowledge in organizations, and consequently innovation, is created, shared, developed and justified simultaneously by individual cognitive processes and by a collaborative social process. [Nonaka and al. 1995] suggest knowledge creation to be at the heart of innovation processes. For [Leonard-Barton 1995], knowledge constitutes the main building blocks for sustaining innovation. Moreover, innovation is a knowledge-intensive process in which existing knowledge is rethought and new knowledge is created. Consequently, more and more works bring nearer knowledge management to innovation management. In the same way, knowledge transfer is regarded as a challenging and critical process in innovation-related activities by [Kazanjian and al. 2000]. Moreover, many authors note that innovation is viewed as a learning interactive process in which the participants improve their knowledge and their know-how by exchange and experimentation [Harkema and al. 2003] [Nonaka and al. 1995]. [Sorensen and al. 2001] focus on the codification process of knowledge in the innovation process while [Cohen and al. 1990] consider that prior related knowledge within an organization is an important indicator of its innovative capabilities. [Glynn 1996] views organizational innovation as fundamentally cognitive and [Greif and al. 1990] link the understanding of innovation to knowledge, with a special focus on individuals. To take into account the strong relationships between innovation and knowledge processes within modern organizations, we present in the next section a framework, which integrates these processes and provides more details about their interactions.

IV. INTEGRATION OF INNOVATION AND KNOWLEDGE PROCESSES

Integration of organization's innovation and knowledge processes aims at improving efficiency and effectiveness of these processes through the optimal allocation of organization's resources they use and the management of their interactions. Therefore, integration of innovation and knowledge processes requires identification of the main aspects of such processes, which has significant impacts either on the interactions between organization's innovation and knowledge processes or on the outcome of innovation. Besides, we stress the social-oriented nature of organization's knowledge and innovation processes prior to presentation of the framework, which integrates them.

A. The social-oriented nature of knowledge and innovation processes

Drawing on the SIKIT model of organization (Figure 2), we note that organizational actors constitute a critical component of organizations innovation and knowledge processes. Firstly, organizational actors own tacit knowledge and create new knowledge by interacting. Secondly, innovation depends on new ideas developed by organizational actors. Finally, the activities of organization's knowledge and innovation processes are undertaken by organizational actors with different interests, points of view, and backgrounds. Consequently, the organization's knowledge and innovation are social-oriented. Moreover, since organizational actors interact with all components of organization while realizing their daily activities, the organization's knowledge and innovation processes are influenced by organization's strategy, structure, production technology, tasks, and information technology. Such components may behave either as facilitators or as inhibitors of knowledge and innovation processes. Agility of the organization's structure and information system are examples of facilitators of knowledge and innovation processes while conflicts between organizational actors and rigidity of organization's structure may be considered as inhibitors of these processes. These conclusions are compliant with existing academic research related to innovation and knowledge management within modern organizations. For example, [Weick 1995] stresses that the development of a new thing is similar to a sense making process that takes place in a specific social and institutional context and brings about large structural relations between departments, services, work groups with different skills and their environment. The distributed constructionist theory used by [Toffolon and al. 2007] as a foundation of the social-oriented nature of software engineering confirm our previous conclusions. The constructionist theory is based on two hypotheses. Firstly, it asserts that

individuals build knowledge from their experiences in the world. In that way, the constructionist theory refers to constructivism. The second hypothesis stresses that the effectiveness of the knowledge construction process depends on the creation of personally meaningful products. [Resnik 1996] defines distributed constructionism as an extension of the constructionist theory, which focuses on situations in which many individuals contribute to knowledge construction activities. He refers to the distributed cognition theory [Salomon 1994] which states that cognition and intelligence result from interactions of a person with the surrounding environments including artifacts, other persons, organizational context …

The innovation process is viewed by many authors as an « interconnected chain » of actions that opens to external information and knowledge and implies an iterative and entangled development. These authors observe a complex and disorderly progress of events while carrying out the innovation process which evolves and diverges in multiple and interdependent stages of activities. The multipleinteractions between organizational actors and the collective learning intrinsic to innovation call for a complex and dynamicview of the innovation process. Such a view emphasizes the uncertain, emergent, and self-organized nature of the innovation process and suggests the use of the complexity paradigm to analyze it [Carlisle and al. 2006] [Cheng and al. 1996][Harkema and al. 2003]. According to [Van de Ven and al. 1992], innovations have an iterative nature, more complex and uncertain than the stage type models suggest. [Van de Ven and al. 1992] emphasize this iterative nature in their adaptive model leaving an important role for trial-and-error. Knowledge flows between organizational actors' determinate the state of the innovation process viewed as a complex human self-adaptive system. Furthermore, innovation within modern organization rest on cooperation between organizational actors who interact continuously while contributing to the organizational processes realization. Finally, innovation within modern organizations is not radical since social, organizational and technological changes are incremental by nature. Consequently, innovations are not just the results of scientific work in a laboratory-like environment.

Certainly, the science push may trigger an innovation process within an organization but innovations often result from collective contributions of organizational actors with different backgrounds, interests, and points of view. These actors interact and build innovative processes, products, and services based on collective learning and trustful relationships. Cooperation during the innovation process means knowledge production within groups of people that have a common interest, determined by the practical context in which the group is working despite the discrepancies between their backgrounds, culture, activity fields, and interests [Shariq and Vendelo 2011]. Analyzing innovation and knowledge processes as a social phenomenoncontrasts with the innovation diffusion model [Rogers 1995], the stage-gate model and the technology acceptance model [Venkatesh and al. 2000]. In the next sub-section, we present a synthetic view of the organization's innovation and knowledge processes activities taken into account in the proposed framework.

B. A synthetic view of the knowledge and innovation processes activities

The goal of the framework presented in this paper consists in integrating the main activities of organization's knowledge and innovation processes rather than providing a deep analysisof each process. Therefore, we propose a synthetic view which permits us on the one hand, identify – for each process - the activities, which contribute to the interactions between the two processes and on the other hand, understand how interactions between the two processes take place. We think that the innovation process within modern organizations is triggered by a set of decisions made at the strategic level in order to bridge an organizational performance gap. A performance gap may be defined as the discrepancy between the actual situation « as-is situation» and the desired situation « to be situation » of a set of organizational entities or processes. A performance gap may be related to various problems stemming generally from the organization's environment political, legal, economic, social, and technological pressures. Strategic decisions determine the global organizational solutions to bridge an organizational performance gap. The design of processes, products, and services required to implement organizational solutions required to bridge an organizational performance gap is called shared creative problem solving [Leonard-Barton 1995]. Analysis of the shared creative problem solving activity points to many characteristics inherent in the innovation and knowledge processes. Firstly, this activity takes into account the diversity and the limits of organizational actor's backgrounds. This means that organizations have to facilitate the integration of skills and knowledge among organizational actors in order to ensure the effectiveness of the shared creative problem solving. Secondly, bridging the organizational performance gap through carrying out the shared creative problem solving activity is incremental due to the incremental nature of innovation. Therefore, the shared creative problem solving innovation activity may be considered as a project based on a roadmap permitting to move from an « as-is situation » to a « to be situation ». Nevertheless, in addition to difficulties inherent in conventional projects, the innovation shared creative problem solving activity presents additional specific difficulties resulting from the difficulty to specify either the products and services or the processes required to bridge the organizational performance gap. In particular, through the innovation process, organizational actors try to develop a new process, a product, or a

service, which has not occurred before. The use of new processes, products, and services issued from the innovation shared creative problem solving activity generally requires a support of information technology. In addition, many iterations are needed to obtain the right processes, products, and services, which bridge the whole performance gap. This is related in particular to the time-dependent evolution of the performance gap due to the continuously changing environment pressures on organizations. Organizational knowledge creation and transfer are required either to build organizational solutions to bridge organizational performance gap, or to carry out the shared creative problem solving activity, or to use and improve the new processes, products, and services. Firstly, to build organizational solutions to bridge a performance gap, organizational actors belonging to the strategic level combine simultaneously their own knowledge with knowledge issuedeither from actors belonging to the tactical and operational levels or from external resources like market or consultants. Consequently, building organizational solutions to bridge a performance gap result at the same time in knowledge creation and knowledge transfer at the strategic level. Secondly, the definition of new processes, products and services associated with the organizational solutions to a performance gap require knowledge distributed among organizational actors belonging to the tactical and operational levels. Such a knowledge may be theoretical or practical and may originate from various fields. Consequently, knowledge transfer between organizational actors is a critical success factor of the shared creative problem solving activity. Finally, the use and improvement of newprocesses, products, and services dedicated to performance gap bridging is associated with knowledge creation and transfer. This kind of knowledge results from learning during iterations. Solutions to information technology support problems constitute an additional source of knowledge creation. We note that at allthe organization's levels, interactions and knowledge transfer between organizational actors trigger knowledge creations. New knowledge either created by individual organizational actors or by interactions between organizational actors may be a solution to bridge a knowledge gap identified while bridging the performance gap. That knowledge creation and transfer play a critical role in the main activities of the innovation process is compliant with [Leonard-Barton 1995] conclusions. This author points to knowledge as the building blocks for sustaining innovation. Knowledge accumulates slowly, and it is constantly being created. Moreover, knowledge can be viewed as a non-static reservoir for new ideas and corporate renewal. These building blocks can be created by linking people and their capabilities to organizational activities. Consequently, within modern organizations, activities taking place in the innovation space and the knowledge space are intertwined. Figure 3 illustrates interactions between the activities of the innovation and knowledge activities described previously.

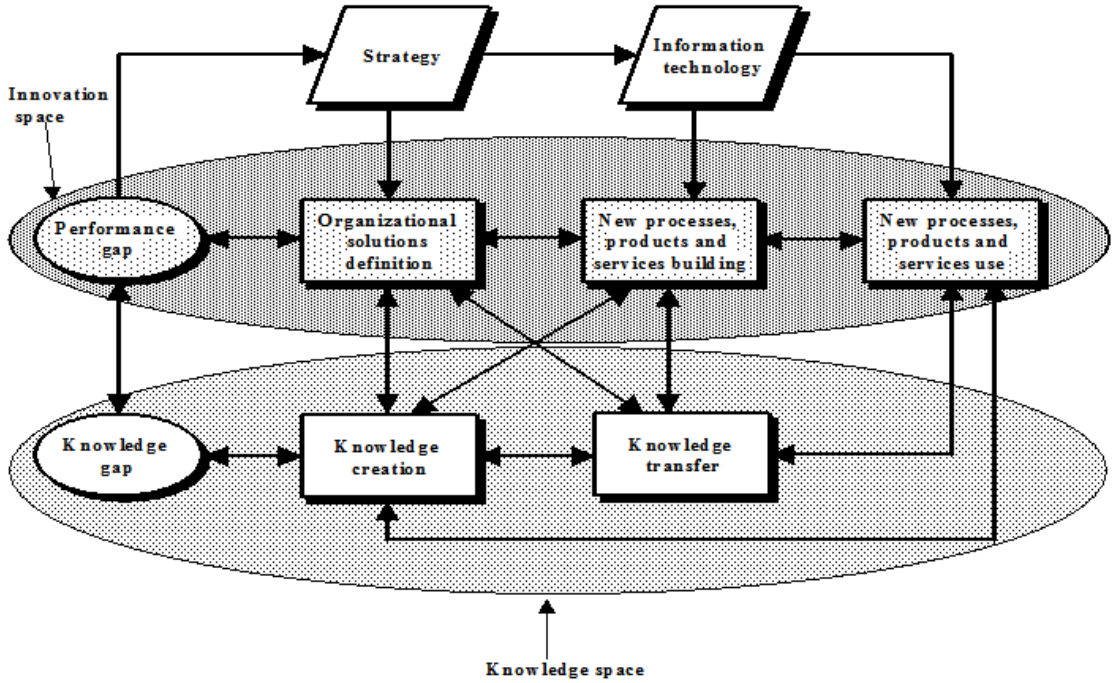

Figure 3: Interactions between the innovation and knowledge processes

C. The theoretical foundations of the innovation and knowledge processes integration

As we stressed above, organizations innovation and knowledge processes are social-oriented. Therefore, we use the social network paradigm to integrate innovation and knowledge processes activities and describe their

interactions. [Haythornthwaite 1996] compares social networks to roads between cities. Goods and people are transported to and from cities over roads. Roads appear may be considered as networks of paths between cities. The kind of road to which a city has access determines the resources this city can import and export to and from other cities. Important cities have access to many important roads, while small towns are connected to fewer and less important roads. Social network analysis follows a similar logic in describing the way our social lives are structured, by focusing on nodes and the pattern of relationships existing between different nodes. These relationships are called edges. In this paper, we consider that an organization is a social network including many spaces like the innovation and knowledge spaces. In this social network, organizational actors are linked by different kinds of social relationships. Principal-agent contracts issued from the economic agency theory [Alchian and al. 1972] [Jensen and al. 1976] are examples of such relationships. [Granovetter 2005] points out that social structure, especially in the forms of social networks, affect economical outcomes since the networks affect the flow and the quality of the information. However, it is not clear how – within the organization considered as a social network - social relationships between organizational actors can act as a facilitator of knowledge creation and transfer during the realization of the innovation process. This why we draw on Granovetter's and Burt's works to describe the knowledge creation and transfer activities associated with the innovation process [Granovetter 1973] [Burt 1992] [Burt 2001] [Burt 2004].

Strong relationships between people are thought to be the channels over which useful information and knowledge would flow. [Granovetter 1973] introduces the concepts of strong ties and weak ties in a social network. The strength of a tie is a combination of the amount of time, the emotional intensity, the intimacy, and the reciprocal services, which characterize the tie. Moreover, strong ties are characterized by common norms and high network density. Weak ties are characterized by infrequent communication, a lack of emotional closeness, and no history of reciprocal services. Granovetter argues that strongly tied contacts have a high probability of having access to the same information, as they often belong to the same social group. Therefore, relying on strong ties only for access to information is not always the best strategy, as the diversity of the available information is restricted. According to [Granovetter 1973], weak ties are more useful than strong ties in obtaining new information since they form bridges across strongly tied clusters and are by consequence more efficient. From Burt's point of view, despite there is a correlation between knowledge creation and transfer and weak ties, weak ties are not the main causeof access to the knowledge realms in different social network clusters. According to this author, it is the fact that weak ties often bridge holes in the network that procures the advantages of diversified knowledge. A social network hole is defined as an area between social clusters where no relationships exist. Because of the social constructivist nature of knowledge, different social clusters will contain different knowledge. Accessing these clusters can generate different benefits, resulting from the ability to perform brokerage between the clusters. [Burt 2004] identifies different ways in which brokerage can take place between different social clusters. What they all have in common is that they involve benefits, which are derived from differences in knowledge between the clusters. By importing knowledge from one cluster into another, or by synthesizing knowledge, which exists in the different clusters, an organizational actor who bridges structural holes can obtain benefits that cannot be obtained by the organizational actors who just belong to one cluster. In addition, bridging relationship provides earlier access to knowledge in other clusters, and therefore gives the participants in the relationship an opportunity to recombine the new knowledge with their own knowledge and be innovative before others [Burt 2004]. Granovetter's strength of weak tiesargument and Burt's structural holesmay be considered as instruments for bridging the knowledge gap between organizational actors involved in the innovation process. Weak ties, acting as conduits for knowledge sharing with organizational actors in other knowledge domains have proven important for the access to knowledge required by the innovation process. Thus, organizational groups need weak ties in order to be able to gather knowledge from other groups within or outside the organization. [Burt 1992] argues that innovations are most likely to be found in the structural holes between the dense network structures and stresses that an actor able to span the structural holes in a social structure has a high probability to provide innovative ideas. Such new ideas emerge from selection and synthesis across the structural holes between groups. Therefore, social network rich in structural holes offers many opportunities for new-networked innovation processes. Moreover, [Burt 2004] points out that the optimal network structure to promote innovation in groups should be based on a dense network structure in the group, with edges beyond the group that have no mutual relationships. He argues that the social network structure of the group should be characterized by high internal closure and low external constraint. Burt's idea applies to all sorts of groups in organizations, like departments, task forces, and transient teams, but also to groups composed of members of different organizations.

D. Innovation-oriented knowledge creation and transfer

In the previous two sections, we have firstly presented a synthetic view of the main activities of the innovation and knowledge processes and underlined their interactions based on knowledge flows. Then, we have introduced thetheoretical foundations of the proposed framework, based on the concepts of social network

strong ties, weak ties, and structural holes. The goal of this section consists in describing how interactions between knowledge and innovation activities take place. In particular, we stress how knowledge is created within the knowledge space and transferred between the knowledge and innovation spaces while carrying out the innovation process activities.

To understand the dynamics of knowledge creation and transfer associated with the innovation process, we introduce the notion of knowledge dimensions. Since knowledge is owned, created, and transferred by people, knowledge dimensions stem from the organizational actors' characteristics. We think that five dimensions characterize organizational knowledge used while carrying out the innovation process activities. These dimensions are:

- the knowledge nature dimension,
- the actor background dimension,
- the actor culture dimension,
- the actor activity field dimension,
- the actor theoretical ability.

The knowledge nature dimension refers to the two classes of knowledge used in the innovation processes and identified by [Gibbons and al. 1994]. The first class is hierarchical knowledge and tends to preserve its form while the second class is more heterarchical and transient in nature. Hierarchical knowledge corresponds to traditional knowledge, which is produced by single disciplines. Such a knowledge is homogeneous and primarily cognitive knowledge. By contrast, heterarchical knowledge is created in broader, heterogeneous interdisciplinary social and economic contexts within an applied setting. One of the key contrasts between the two classes of knowledge is related to problem solving. The hierarchical knowledge is associated with a problem solving activity carried out following the codes of practice relevant to a particular discipline. Problem solving associated with a heterarchical knowledge activity is organized around a particular application and is more diffuse in nature.

The actor background dimension describes its education level and domains of expertise. This dimension is important since organizational actors involved in the innovation process activities must share a common language in order to communicate. This remark applies to the organizational actor culture and activity field dimensions.

The actor culture dimension reflects his habits and cultural values and norms related to his origin, religion, and community of life. The actor activity field dimension describes the business and decision-making topics directly associated with the actor contribution to the organization's support, decision-making, and business processes.

The actor theoretical ability dimension permits distinguishing research-oriented organizational actors from practice-oriented organizational actors. The first category of organizational actors generates and diffuses knowledgewhile the second category applies it to create new processes, products, and services.

The knowledge five dimensions play two important roles in understanding organizational knowledge creation and transfer associated with innovation. On the one hand, they facilitate the description of organizational knowledge either at the individual level or at the organizational level. On the other hand, the knowledge dimensions constitute instruments, which help understanding how groups emerge in a social network and how strong ties, weak ties, and structural holes result from social relationships between organizational actors. It is true that the knowledge five dimensions don't define completely neither social groups nor ties nor structural holes in a social network. Many subjective factors like emotion and intimacy contribute to structuring a social network in social groups, strong ties, weak ties, and structural holes. Nevertheless, the five knowledge dimensions provide information on how knowledge is created at the individual and organizational levels and transferred between organizational actors and social groups. As we stressed above, an organization may be considered as a social network composed of social groups associated with strong and weak ties. To each organizational actor who belongs to a social group, we associate five coordinates, which evaluate its knowledge against the five dimensions described above. Such coordinates may be a mixture of qualitative and quantitative marks defined according to a score system depending on the organizational context. The five dimensions split into two categories: the principal dimensions and the secondary dimensions. For each organizational actor, a knowledge dimension is principal (vs. secondary) if the associated coordinate of this actor knowledge is high (vs. low). Strong ties are based on principal dimensions while weak ties rely on secondary dimensions. Furthermore, an organizational actor is linked to a specific social group by the principal dimensions of its proper knowledge. Moreover, secondary dimensions link organizational actors to other groups of the social network characterizing an organization. Consequently, for each organizational actor, the principal knowledge dimensions are bonding dimensions which encourage hierarchical knowledge creation while the secondary dimensions contribute to bridge the structural hole between social groups and then encourage hierarchical knowledge transfer and heterarchical multidisciplinary knowledge creation. Our analysis of knowledge creation and transfer associated with innovation is compliant with the conclusions proposed by many academics. For instance, [Autio

1998] defines two subsystems in innovation systems: the knowledge generation and diffusion subsystem, and the knowledge application and exploitation subsystem. According to this author, dialogue is a presupposition of a common innovation process within different subsystems. Even in the same technological field, the mode of language differs in basic research and practical production. This makes it difficult even to picture the innovation potential in the structural hole. The situation is the same between differenttechnological disciplines. There may be a desire to span the structural hole between a partner with research-oriented knowledge interest in one technological field and a partner with practice-oriented knowledge interest in another technological field. A significant part of the difficulties between the potential innovating partners stems from the information asymmetry on the different sides of a structural hole. The partners on the opposite sides of the structural hole have information of different quality and achieved for their own purposes. The difference is often so important that a new kind of expertise is needed. [Burt 1997] identifies the expertise as an information broker in the structural hole. A structural hole is an opportunity to broker the flow of information between people and control the form of cooperation that brings together people from the opposite sides of the hole. Science and technology parks and business development organizations are examples of such brokers.

V. CONCLUSION AND FUTURE RESEARCH DIRECTIONS

In this paper, we have presented a framework, which integrates organizational knowledge and innovation processes. This framework draws on many existing theoretical foundations like the social network theory, the Granovetter's strong and weak ties, and the Burt's structural holes. The SIKIT organization model - aimed at improving the Leavitt's model of organization by integrating three additional components (Strategy, Knowledge, and Innovation) - is among the main contributions of this paper. Indeed, it shows that information technology is not enough to help organizations face constraints issued from their continuously changing economic, political, social and technological environment. Identification of the knowledge process activities involved in innovation as well as interactions between knowledge and innovation processes is another important contribution of our paper. Finally, the introduction of knowledge dimensions is also a significant contribution of this work since knowledge dimensions' permit understanding how strong ties, weak ties, and structural holes belonging to organizational social network are instruments of knowledge creation and transfer. Nevertheless, to be useful, the concept of knowledge dimensions needs a deeper analysis to define how to measure knowledge coordinates. Moreover, an empirical validation of the usability of the five dimensions of knowledge may result in the identification of additional dimensions omitted in the present work. Such improvements of the proposed framework are examples of future research directions.

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Sana Guetat "Innovation and Knowledge Processes: A Framework and Literature Review " International Journal of Engineering Research And Development , vol. 16(1), 2019, pp 39-51.