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The transformation between exploration and exploitation applied to inventors of packaging innovations

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ABSTRACT

While the inventor is often the driver of an invention in the early stages, he/she needs to move between different social networks for knowledge in order to create and capture value. The main objective of this research is to propose a literature-based framework based on innovation network theory and complemented with C–K theory, in order to analyze the invention/innovation process of inventors and the product concepts in a packaging industry context. Empirical input from three case studies of packaging inventions and their inventors is used to elaborate the suggested framework.

The article identifies important gaps in the literature of innovation networks. This is addressed through a theoretical framework based on network theories, complemented with C–K theory for the product design level. The strength-of-ties dimension of the theoretical framework suggests, in agreement with the mainstream literature and the cases presented, that weak ties are required to access the knowledge related to exploration networks and strong ties are required to utilize the knowledge in the exploitation network. The transformation network is an intermediate step acting as a bridge where entrepreneurs can find required knowledge. The transformation network is also an intermediate step where entrepreneurs find financing and companies interested in commercializing inventions.

1. Introduction

While the entrepreneur or inventor is often the driver of an invention in the early stages, she or he needs to move between different social networks for knowledge in order to create value and capture it. The creation of innovations requires highly specialized knowledge in different fields, and, networks are a breeding ground for the creation of radical innovation through new knowledge.

Studies of the drivers of entrepreneurship also indicate that traditional innovation processes are becoming increasingly networked. The recent evolution, in which "ideal" models are moving from the perspective of a business unit towards a network also supports this trend (Harryson, 2008). Network theory is therefore a suitable complement in the study of innovation processes and repeals the common view that people or companies develop innovations alone. It is more likely the case that innovations involve a larger structure in the form of networks to enable access to resources and specialized knowledge.

Regarding product innovation, inventors have preset knowledge when a conceptual idea appears in their minds. The C–K theory presented by Hatchuel and Weil (2003) reflects the assumption that the design of a new product can be modeled as the interplay between two interdependent spaces with different structures and logics: the space of concepts (C) and the space of knowledge (K). However, C–K theory alone is not sufficient to describe the role and process of the inventor in achieving a final invention; it is instead a complement to the innovation process, which describes the evolution of the product from an idea to a concept and eventually to a commercial product. Although the development of the product is integrated into the process of activities carried out by the entrepreneur, most research articles focus on either the process or the product. The authors of this article have chosen to integrate the two.

One distinct school of thought in the innovation network literature has emerged that discusses the most favorable network structures for innovation, considering both exploration and exploitation networks (Autry and Griffis, 2008; Gilsing and Duysters, 2008; Gilsing et al., 2007; Gilsing and Nooteboom, 2005; Harryson, 2008; Harryson et al., 2008). In spite of this, no better configuration of firms within the network has been

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identified, and the literature seems to agree that exploration networks have the essential characteristics that facilitate value creation. In a complementary situation, though, exploitation networks are essential to capture this value creation. Although all contributions relate to how the very different forms of exploration and exploitation networks influence innovation, these authors make no link between the dynamics of innovation in generating new concepts, objects and knowledge and the different network structures that are used along the way to support the search for novel knowledge (exploration) and knowledge application (exploitation). Another gap in the mainstream literature is that it has devoted less attention to the transformation networks used to support the change from exploration networks to exploitation networks, and vice versa.

It is important to understand how firms make the transition from exploration to exploitation and what the implications are for its network of alliances (Gilsing et al., 2007). Two features are central for this process: how firms combine their resources of knowledge, and how firms get information on potential partners (Cowan et al., 2007). Harryson et al. (2008) introduced the term "transformation networks", and they see a strong need to understand the role of these networks. However, the literature seems to have missed these two intermediate steps of the transformation of networks from exploration to exploitation and vice versa, helping in this process. This is required to understand how the entrepreneur starts with an imaginary concept/idea and moves through different types of networks in order to access the knowledge required for this concept/idea's validation and to commercialize the results of this innovation.

The main objective of this research is to propose a literature-based framework, based on network theory, to analyze the invention/innovation process of three packaging innovations in a packaging industry context with regards to the transformation between exploration and exploitation. The framework is complemented with the C–K theory to visualize the simultaneous evolution of the packaging innovation, per se. Three case studies of packaging inventions and the inventors of these are used as examples to elaborate and test the framework.

This article provides a recent literature review of network theory applied to innovation along with the C–K theory for the development of the product. The extent to which these two theories complement each other describes the integrated pathway of the networked inventors and the simultaneous development of the product, which is the central focus of this study. First the two theories are presented. Then the framework on a process and product level is suggested. The empirical input from the three case studies is then elaborated in the context of the suggested framework. The paper is finalized by an analysis of the theoretical framework with the empirical input and concluding remarks.

2. Innovation networks

As partly captured in the literature, innovation processes are becoming increasingly networked. This means that the "ideal" models of and processes for innovation have experienced a linear evolution from a traditional closed system towards more or less exclusively open and strategically networked systems (Harryson, 2008). An innovative network is normally realized as a cluster of activities involving interaction and knowledge exchange between people and organizations (Muller and Pénin, 2006). They are intellectual assets that companies can call to resolve problems and find ideas, while beginning to think of these assets as an extended part of their own organization (Knowledge@wharton, 2007).

In this article we have chosen network theory to analyze the relationships across the different levels and between different actors of innovation networks. According to Brass et al. (2004 in Harryson, 2008), it is necessary to distinguish the multilevel perspective of networks in interpersonal or social networks, interunit networks and interorganizational networks. Network relationships take place between individuals and the way they form networks, influences the formation of organizational networks (Harryson, 2008).

Network ties are regarded as embedded, which refers to the structure of a network and the social relations in a network (Gilsing et al., 2007). The relations between organizations offer strategic opportunities for actors, but also influence the choices and restrict the action through agreements and operational standards of behavior. Granovetter (1973, 1985) suggests that the actors do not behave with perfect economic rationality because they are embedded in social networks with other actors, who are able to provide greater access to resources and information. Accordingly, the actors are affected by their social behavior, so the choices of behavior are formed by balancing the internal economic rationality with external social forces. Granovetter (1985, 2005) suggests that two forms of embeddedness affect the network: *structural embeddedness* describes the general architecture of a network specifically defined by the presence or absence of ties, while *relational embeddedness* focuses on the strength of ties, which is the extent by which the actors or network nodes are connected to each other.

Granovetter (1985) suggests that the ties between the actors are best represented by social relationships, and that the strength of ties is defined by the extent to which the relationship between two actors is strong, weak or absent. Strong ties are solid relations, and based on mutual trust between partners (Granovetter, 1973).

Granovetter (1973) introduces "the strength of weak ties" concept and suggests that while strong ties promote efficient interaction (and even performance), weak ties serve as a bridge for newer information. He suggests that the predominant presence of relationships with strong ties is favorable for networks focused on implementation. In the opposite way, actors cultivating connections of weak ties gain access to more unique perspectives and information from outside, and are better positioned for innovation than their group of colleagues with strong ties (Granovetter, 1973). The ability to identify, assimilate and exploit knowledge of the environment is a function of the level of previously related knowledge obtained. The density of ties indicates the potential of this cognitive variety in a network. A large number of ties provide access to many different kinds of knowledge possessed by others (Cohen and Levinthal, 1990). Consequently, an innovative network faces a duality in terms of the strength *and* weakness of ties needed simultaneously. On one hand, they need to develop access to sources of knowledge with cognitive distance and thereby create access to novelty. This requires an emphasis on diversity and disintegration of the structures in a network. On the other hand, firms must make sure that this new knowledge is accessed and evaluated. If it proves to be of value, it needs to be adequately absorbed and related to the existing base of knowledge and skills. This process apparently favors more homogeneous structures of networks in view of the integration of various inputs obtained from distant partners. Here a dense structure favors a rapid diffusion among the partners and thus supports the possibility of "triangulation" (Gilsing et al. 2007).

For Gilsing and Duysters (2008), variety in cognition is created through weak ties (weak in all dimensions, except for frequency) while knowledge is subject to triangulation and evaluation in a dense network of strong ties. This implies that there is a trade-off between non-redundancy in networks to access cognitive variety,