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Standardization efforts: The relationship between knowledge dimensions, search processes and innovation outcomes

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ABSTRACT

We explore how a standardization effort (i.e., when a firm pursues standards to further innovation) involves different search processes for knowledge and innovation outcomes. Using an inductive case study of Vanke, a leading Chinese property developer, we show how varying degrees of knowledge complexity and codification combine to produce a typology of four types of search process: *active*, *integrative*, *decentralized* and *passive*, resulting in four types of innovation outcome: *modular*, *radical*, *incremental* and *architectural*. We argue that when the standardization effort in a firm involves highly codified knowledge, incremental and architectural innovation outcomes are fostered, while modular and radical innovations are hindered. We discuss how standardization efforts can result in a second-order innovation capability, and conclude by calling for comparative research in other settings to understand how standardization efforts can be suited to different types of search process in different industry contexts.

1. Introduction

This paper focuses on how a firm's standardization efforts impact its knowledge search processes, and the resulting innovation outcomes. Standardization is the process of developing and implementing specifications based on the consensus of the views of firms, users, interest groups and governments (Sherif, 2006; Saltzman et al., 2008). The resulting standards are intended to promote compatibility, interoperability and quality. An early example of standardization is the regulation of the sizes of the threads that we find on nuts, bolts and screws, which was achieved by the development of a screw-cutting lathe that could repeatedly produce these products to specific standards with universal applications.

Standards can be developed and governed by Standards Development Organizations (SDO) or independently, for example, by firms who have a first mover or dominant position in the market (Utterback, 1996). When a firm pursues a standard to produce an innovation outcome, this what we call a 'standardization effort'. More specifically, a standardization effort is when a firm pursues a leadership role in developing standards to further innovation. For example, Google followed a standardization effort when acquiring and developing the innovations for its mobile operating system, Android (Grøtnes, 2009).

Scholars have argued that standardization has a significant impact on the creation and diffusion of innovations (Dolfsma and Seo, 2013; Grøtnes, 2009; Lecocq and Demil, 2006; Tassey, 2000; Wrighta et al., 2012). However, prior research on the relationship between standardization and innovation remains inconsistent. For example, some studies have proposed a positive relationship (Rysman and Simcoe, 2008), where standardization fosters the diffusion of innovation (Hashem and Tann, 2007) and changes industrial structures (Lecocq and Demil, 2006), whereas others have argued that it constrains innovation, by inhibiting creativity (Hamel, 2006) and postponing the gestation period between invention and successful commercialization (Hill and Rothaermel, 2003). A number of studies have noted this unclear relationship between innovation and standardization (Gilson et al., 2005; Kano, 2000; Wrighta et al., 2012; Yoo et al., 2005). In one case, Damanpour (1991) argues that standardization can establish managerial control when implementing innovation in a

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Table 1
Standardization and innovation in management research.

Example study	Dimensions of knowledge embedded in a firm's standardization effort	Types of innovation outcome
Tassey (2000)	High codification, high complexity	Modular/architectural/incremental/radical
Kano (2000)	High or low codification, high complexity	Systematic/stand-alone
Tether et al. (2001)	High codification, high complexity	Service/process
Yoo et al. (2005)	High or low codification, high complexity	Diffusion/system/process
Rysman and Simcoe (2008)	High codification, high complexity	Diffusion/cumulative
Leiponen (2008)	High or low codification, high complexity	No classification
Grøtnes (2009)	High or low codification, high complexity	Outside-in/inside-out/coupled process
Viardot (2010)	High or low codification, high complexity	Incremental/radical
Wrighta et al. (2012)	High codification, high or low complexity	Incremental/radical management innovation
Narayanana and Chen (2012)	High or low codification, high complexity	Modular/architectural/incremental/radical/product/process/institutional/industrial/technological
Hytönen et al. (2013)	High or low codification, high complexity	No classification
Dolfsma and Seo (2013)	High codification, high complexity	Discrete/cumulative
Gao et al. (2014)	High or low codification, high complexity	Diffusion/capability
Groesser (2014)	High or low codification, high complexity	System/diffusion/incremental
Lopez-Berzosa and Gawer (2014)	High codification, high complexity	Collective innovation

manufacturing context, but it might also constrain the producer–client relationship in a service context. Given such inconsistencies, better understanding the inter-play and relationship between standardization and innovation is an important research opportunity.

In response, this study aims to improve our understanding of how the search for knowledge associated with a firm's standardization effort can result in more effective innovation management. According to Nelson and Winter (1982), understanding how firms search for knowledge helps to explain innovative behavior, a perspective that has since been widely applied within the innovation discourse (Chiang and Hung, 2010; Cillo and Verona, 2008; Fabrizio, 2009; Laursen and Salter, 2004; Mahdi, 2003). For example, Rosenkopf and Nerkar (2001) explored how a local search for solutions, using current knowledge, contrasts with distant search, or what Rosenkopf and Almeida (2003) call explorative learning. Katila and Ahuja (2002) focused on search depth (how deeply existing knowledge is reused) and search scope (how widely new knowledge is explored), while Greve (2003) investigated problematic search caused by low performance and slack search caused by excess resources.

In addition to how variations in search scope can impact innovation, studies have also highlighted the importance of different approaches to search. Broadcast search is suited to external solvers self-selecting themselves to create a solution (Jeppesen and Lakhani, 2010). In contrast 'pyramiding', a search process based upon the view that appropriate experts will know other appropriate experts, is used for identifying individuals who have more of a given attribute by "moving up to the pyramid" (Hippel et al., 2009:1398). Furthermore, search processes can vary in terms of the extent to which alliance partners jointly search for new knowledge across different knowledge domains (Zack, 1999) or use search processes to selectively target knowledge sources from product market, science and suppliers (McCarthy et al., 2006; Nicholson and Sahay, 2004).

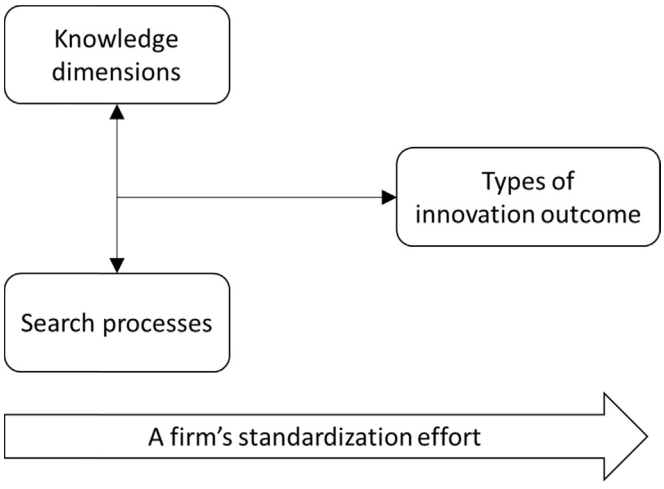

Fig. 1. Standardization efforts and the relationship between knowledge dimensions, search processes and innovation outcomes.

We present our arguments in four sections. First, we review the literature on standardization and innovation to identify how different dimensions of knowledge, embedded in the standardization effort, can impact different types of innovation outcome (see Fig. 1). We also examine and illustrate the potential relationships between the different dimensions of knowledge, search processes and innovation outcomes involved in a standardization effort. Second, to investigate and illustrate the relationships between these elements of a standardization effort, we present a case study on Vanke Co., Ltd. (Vanke), the largest residential property developer in China. For almost 16 years, Vanke has undertaken a standardization effort in housing design and construction. This resulted in standards and innovations for mass off-site fabrication (referred to as 'housing industrialization'), which have since been adopted by the Chinese construction industry and influenced related Chinese government policies. Third, we discuss the case findings and present a typology of four types of search process: active, integrative, decentralized and passive, along with four different types of innovation outcome: modular, radical, incremental and architectural. Finally, we conclude the paper by discussing theoretical and practical implications of our research.

2. Standardization and innovation in management research

Looking across the literature that explores the relationship between standardization and innovation, we identify two recurring main themes – knowledge embedded in standardization and types of innovation outcome (see Table 1). In this section we specifically discuss knowledge in the context of a firm's standardization effort. In addition, we discuss innovation from the perspective of searching for knowledge during a standardization effort. Although widely acknowledged as a key to understanding innovative behavior, search is only alluded to in the standardization discourse. The dearth of research in this area is reflected in its absence from our literature summary table (Table 1).