

INNOVATION AS A KNOWLEDGE-BASED OUTCOME

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Abstract

Purpose – We aim to provide clarity to the concept of innovation and its various definitions.

Design/methodology/approach – We review the innovation literature and propose that innovation has been conceptualized either from a process or from an outcome perspective.

Also, we show that there is a substantive difference between innovation seen in the traditional innovation literature and innovation as conceived in the knowledge management literature.

Findings – We propose a general framework to categorize the existing views of innovation and show that innovation as an outcome has not been clearly defined from a knowledge perspective. To address this gap, we develop a new definition of an innovation outcome based on knowledge elements.

Research limitations/implications – We lay the groundwork for more comprehensive methods of measuring innovation and innovativeness, which is particularly useful for the study of service innovation.

Practical implications – Our framework and definition expand the ability of managers to measure and understand the key factors of innovation.

Originality/value – We contribute to the literature by developing a comprehensive knowledge-based, outcome-oriented definition of innovation.

Keywords: Innovation, Knowledge, Process, Outcome, Definition

Paper Type: Review/Conceptual

1. INTRODUCTION

A clear understanding of what *an innovation* represents is crucial to assess the *innovativeness* of organizations. Innovativeness can be defined as the capacity of an organization to produce innovations continuously (Galunic and Rodan, 1998) and is considered to entail important organizational outcomes. For example, evidence suggests that the generation of innovations leads to a dominant competitive position (Banbury and Mitchell, 1995; Bates and Flynn, 1995) and that new product innovations serve as a key driver of firm performance (Lee *et al.*, 2003). Additionally, an organization's capacity to continuously generate innovations is considered a primary source of sustained competitive advantage (Lengnick-Hall, 1992; Porter, 1990). Understanding the innovativeness of organizations is therefore critical to managers, and this requires an accurate specification of what constitutes an innovation.

Innovation as an organizational phenomenon has a long tradition of research and has been studied in many different fields. Perhaps because of its long history, "the term 'innovation' is notoriously ambiguous and lacks either a single definition or measure" (Adams *et al.*, 2006, p. 22). Part of this ambiguity stems from the complexity of the phenomenon itself, which can be conceptualized in a variety of ways: the introduction of new products or processes (West and Farr, 1990), the innovative activity of organizations (Armour and Teece, 1980; Terziovski, 2010), innovation diffusion (Hoffman and Roman, 1984), innovative capability (Subramaniam and Youndt, 2005) or innovation involvement (Obstfeld, 2005). A consequence of the multiplication of concepts and definitions is that many empirical studies either do not mention a definition for innovation or, if they do, use an established definition that is often unrelated to the operationalization of the construct chosen in the article. This makes the comparison of the results from these studies an arduous task.

In this article, we review the literature on innovation and propose a framework to characterize the different conceptualizations of innovation based on two dimensions. Our first dimension relates to the possibility for an innovation to be either a process or the outcome of this process (Van de Ven, 1986; West and Farr, 1990). Innovation as a process refers to the activities that companies undertake in order to develop innovations and is described with concepts such as production and emergence (Gupta *et al.*, 2007), discovery and creation (Dosi, 1988), development, solving and implementation (Myers and Marquis, 1969), or introduction and application (West and Farr, 1990). Innovation as an outcome of this process is considered in terms of new ideas (Gupta *et al.*, 2007; Schulze and Hoegl, 2008; West and Farr, 1990), combinations (Obstfeld, 2005), solutions (Dosi, 1988; Myers and Marquis, 1969) or processes, products and procedures (Greve and Taylor, 2000; Myers and Marquis, 1969; West and Farr, 1990). Our second dimension relates to the importance given to the concept of knowledge in the conceptualization of innovation. We propose that there is a clear distinction in the way that innovation is conceived in the traditional innovation literature (e.g., Damanpour, 1991; Van de Ven, 1986), which conceptualizes innovation without explicitly considering the underlying knowledge, and in the knowledge management literature where knowledge is the essence of the innovation process (e.g., Galunic and Rodan, 1998; Nonaka and Takeuchi, 1995).

A review of the literature based on these two dimensions enables us to identify a missing element in the conceptualization of innovation as an outcome from a knowledge perspective (see Table 1). We find that while several models of the innovation process have been proposed in the literature (e.g., Galunic and Rodan, 1998; Nonaka and Takeuchi, 1995; Tsai and Ghoshal, 1998) they usually consider the outcome of the innovation process to be new knowledge, which is implicitly equated with innovation. We see this as a shortcoming of the conceptualization of innovation from a knowledge perspective as it prevents existing

knowledge-based models of innovation from specifying which knowledge processes are more likely to generate a radical innovation, accelerate the implementation of an innovation, or sustain organizational innovativeness.

Take in Table 1

Consequently, we propose a definition of innovation as an outcome from a knowledge perspective. This definition allows for more precision as to what should be measured when assessing the innovativeness of an organization, while also reaching beyond mere technological types of innovation to include service innovations. Besides proposing a definition of innovation, this article contributes to the innovation literature by providing a framework to understand the innovation literature and make sense of the multitude of definitions and operationalizations of the innovation concept. While the difference between innovation as a process and innovation as an outcome is intuitive, we believe that a contribution of this review is to clearly distinguish between the two and to attempt to make the mechanisms that link them explicit. A final contribution of this paper is to provide criteria to clearly differentiate between innovation and new knowledge.

The structure of this article is based on the framework proposed above. First, we examine the traditional innovation literature exploring both the definition and operationalization of innovation as a process and innovation as an outcome. Then, we explore the knowledge-based innovation literature, also distinguishing between innovation as a process and innovation as an outcome and show that the link between the process and the outcome is unclear, due to a lack of definition for innovation as an outcome. Finally, we propose a new definition of innovation as a knowledge-based outcome and conclude by discussing its implications for innovation research and practice.

2. A FRAMEWORK FOR ANALYZING DEFINITIONS OF INNOVATION

Our framework is composed of two distinct dimensions. In the first dimension, we distinguish between innovation as a process and innovation as an outcome, and in the second dimension we separate the traditional innovation literature from the knowledge-based innovation literature based on the importance that they place on knowledge in their conceptualizations of innovation. In this section, we present a review of the literature guided by these two dimensions (see Table 1). This review reveals a gap in the literature concerning knowledge-based definitions of innovation as an outcome. We also introduce a review of the operationalizations of innovation in empirical research (see Table 2). We find that, while different innovation measures exist, researchers do not always align these measures with the underlying definition of innovation they use.

Take in Table 2

2.2 Traditional Definitions of Innovation

Innovation entails an outcome and the process to reach this outcome at the same time. Based on the seminal work by Schumpeter (1934), innovation has been defined as the first introduction of a new product, process, method, or system. This definition highlights the dual nature of innovation as both a process (the introduction of) and an outcome (product, process, method, system). Innovation as a process is described as the “bringing into use” (Kanter, 1984, p. 20), “introduction and application” (West and Farr, 1990, p. 9) or “development and implementation” (Van de Ven, 1986, p. 590) of an idea. When the definition focuses on the outcome, innovation is defined as a product, process, software, idea, concept, etc., considered new in the environment into which it is introduced (Damanpour, 1991; Dougherty, 1992a; Howell and Higgins, 1990; Marcus, 1988; Pennings and Harianto, 1992).

Innovation as a process. Defining innovation as a process allows researchers to investigate the constituting activities of innovation (Greve and Taylor, 2000; Myers and Marquis, 1969). For example, researchers investigate activities concerning the creation of social ties that lead to innovation (Adner, 2006; Obstfeld, 2005). The sequence of activities required for innovation can be grouped into different phases. At least two phases are typically recognized in the innovation process: the idea generation phase and the implementation phase (Axtell *et al.*, 2000; Clark and Guy, 1998). The idea generation phase includes all the steps from idea creation to the decision to implement the idea (Amabile *et al.*, 1996). This phase is often initiated by the perception of a new market and/or service opportunity (Garcia and Calantone, 2002). The implementation phase is seen as an experimentation process, where trial and error is repeated in an effort to achieve an innovative result (Eisenhardt and Tabrizi, 1995). There is a link between the idea generation phase and the idea implementation phase as an increased number of ideas during the idea generation phase leads to an increased number of innovations being implemented (Clegg *et al.*, 2002). Commercialization or diffusion phases have also been added to the innovation process by some authors, and often refer to products or services for which a commercial gain is expected (Kanter, 1988; Rogers, 2003; Strebel, 1987).

Innovation as an outcome. Definitions of innovation as an outcome detail characteristics of the outcome such as being novel, useful, in use, or nontrivial (Jaffe *et al.*, 1993; Levitt, 1960; Utterback, 1971). These definitions help to identify what constitutes an innovation, but also classify innovations into categories for further analysis. Damanpour (1991) presents three well-established categories of innovation: technical versus administrative, product versus process, and radical versus incremental, each of which focuses on innovation as an outcome. For example, the distinction between incremental and radical innovation is represented by the difference in novelty between the innovation and the existing product or process that it improves (Dewar and Dutton, 1986; Henderson and Clark, 1990).

Novelty is at the heart of the definition of innovation as an outcome. In essence, the innovative outcome (i.e., innovation) is something new (Greve and Taylor, 2000; Gupta *et al.*, 2007; Obstfeld, 2005; West and Farr, 1990). Yet, the degree of novelty of an innovation (from incremental to radical) is not intrinsic to the idea; it is linked to the individuals judging that novelty. In the literature, the individuals that constitute the context into which an innovation is introduced are assumed to judge its novelty (Damanpour, 1991; Dougherty, 1992a; West and Farr, 1990). This is clear in Marcus' (1988, p. 1) definition of innovations as "ideas, formulas, or programs that the individuals involved perceive as new". However, an innovation can be new to a specific context but not to the rest of the world. In that case, Van de Ven (1986, p. 2) proposes that as "long as the idea is perceived as new to the people involved, it is an 'innovation', even though it may appear to others to be an imitation or something that exists elsewhere." Similarly, Daft (1978, p. 5) suggests that "the idea can be old with regard to other organizations so long as the idea has not previously been used by the adopting organizations." We will discuss the notion of unit of analysis and novelty in the final section of this paper. Here, we wish to emphasize that novelty is relative to the individuals judging it and, as a result, the distinction between adopting an innovation and creating an innovation is often not clear in the literature.

Operationalizations of innovation. The most common outcome-oriented operationalizations of innovation are the number of patents and their derivations (patent citations, active patents)^[1] (Archibugi, 1992; Hull and Hage, 1982; Jaffe *et al.*, 2007; Narin and Olivastro, 1988; Rothaermel and Hess, 2007; Tortoriello and Krackhardt, 2010; Whittington *et al.*, 2009). Coombs *et al.* (1996) suggest the literature-based innovation output indicator as an alternative to patent measures of innovation. Another popular measure is the adoption of innovations (Bell, 2005; Daft, 1978; Frambach *et al.*, 1998; Leiblein and Madsen, 2009), which reflects innovation definitions such as "the first or early use of an idea" (Becker

and Whisler, 1967, p. 463). Patent and adoption measures are considered so well established that authors using these operationalizations often omit defining innovation altogether (Frambach *et al.*, 1998; Rothaermel and Hess, 2007; Whittington *et al.*, 2009) or draw on definitions in the literature (Bell, 2005; Daft, 1978; Tortoriello and Krackhardt, 2010).

The traditional, process-oriented innovation literature cannot use patents or adoption measures, since these measures are limited to the innovation outcome. In general, process-oriented operationalizations are less frequent in the traditional innovation literature than outcome-oriented ones. Innovation is usually defined as activities (Armour and Teece, 1980, p. 471; Terziovski, 2010, p. 894) or events (Van de Ven and Polley, 1992, p. 92) but most authors measure the innovation process as a function of its outcome. For example, Armour and Teece tackle the difficulty of measuring innovative activity by using R&D expenditure as a proxy, whereas Terzovski (2010, p. 895) measures five different outcomes of the technical, design, manufacturing, management and commercial activities which compose innovation. Van de Ven and Polley measure positive and negative event outcomes during the process of transforming “a novel idea into an implemented reality” (Van de Ven and Polley, 1992, p. 92).

2.3 Innovation in the Knowledge Literature

The knowledge-based innovation literature examines the knowledge content of an innovation with a focus on three particular areas: the definition of the concept of knowledge in organizations, knowledge creation in the innovation process and mechanisms by which knowledge relates to innovation. These three focus areas are usually oriented towards explaining the role of knowledge in the process of innovation. Several models of a knowledge-based process of innovation can be found in the literature (e.g., Galunic and Rodan, 1998; Nonaka and Takeuchi, 1995). These models explore the characteristics of knowledge and their impact on the knowledge creation process whose output is implicitly

viewed as an innovation. For example, Tsai and Ghoshal (1998) and Tsai (2001) present models of organizational innovativeness that draw a parallel between knowledge creation and innovation. While these models highlight the role of various processes of knowledge creation and recombination for the generation of new knowledge they usually fail to establish whether this new knowledge can be directly considered an innovation.

Knowledge in organizations defined. There is ambiguity in the definition of knowledge and the distinction between information and knowledge when developing relationships between knowledge and innovation. Knowledge, information, ideas and skills are often equated (Woodman *et al.*, 1993). This ambiguity in conceptualization is particularly problematic if our understanding of the innovation process includes creative processes. As creativity is a cognitive process, differentiating between existing knowledge and incoming information or ideas affects how we conceptualize the mechanisms involved. Similarly, whether knowledge is purely an individual phenomenon or can exist at group or organizational levels has implications for how we view multi-level effects within the innovation process.

When knowledge is defined, major differences between approaches exist in the knowledge literature. Analyses of organizational knowledge can view knowledge as an objective commodity (Bohn, 1994; Bollinger and Smith, 2001) or as a socially constructed process (Blackler, 1995; Cook and Brown, 1999). These different viewpoints can be considered to be in conflict because of differing epistemological assumptions (Empson, 2001). There is also considerable theoretical debate about the definition of knowledge and organizational knowledge within both camps (Nonaka and von Krogh, 2009; Tsoukas and Vladimirou, 2001). Nonaka (1994) uses an individual model of knowledge focused on tacit and explicit types, and the relationships between these types serve as the core basis of his model of innovation. Glynn (1996) uses an individual model of knowledge as part of

individual creativity, which serves as the starting point for organizational creativity. The social capital perspective (Nahapiet and Ghoshal, 1998), which stresses collective interaction in innovation, tends to use a more complex view of knowledge that includes some form of collective knowledge. The definition of knowledge used in this literature often coincides with the level of analysis and the perspective taken in the innovation model.

Knowledge and innovation. The knowledge literature differs in its approach to the scope of the innovation process. Machlup (1962, 1980) presents a model of the inventive process and represents it as the flow of ideas through four stages: research, invention, development and application. In this inventive process, the innovation process only entails the last stage of application and only where this application is not imitation. In contrast, work in organizational creativity sees organizational creativity as a subset of innovation, which is in turn a subset of organizational change (Woodman *et al.*, 1993). In this view, innovation “can also include the adaptation of preexisting products or processes, or those created outside of the organization” (Woodman *et al.*, 1993, p. 293), implying that imitation is part of the innovation process whereas creativity is developing knowledge that is new to the world. Part of the issue with this lack of clarity as to what should be considered innovation is not only the breadth of the process, but that the level of analysis under consideration is often not clearly differentiated.

The knowledge literature identifies that existing knowledge is a pre-requisite for the innovation process to occur, making path-dependency a critical issue. For example, absorptive capacity is equated to a firm’s innovative capability and this is seen as a function of prior knowledge (Cohen and Levinthal, 1990). A very low level of knowledge can cause innovative capability to be “locked-out” if the level of knowledge is so far behind that it becomes unfeasible to accumulate the necessary path-dependant knowledge. Existing knowledge is also linked to creativity: “The prior possession of relevant knowledge and skill is what gives

rise to creativity, permitting the sorts of associations and linkages that may have never been considered before” (Cohen and Levinthal, 1990, p. 130).

While knowledge is a pre-requisite for innovation it is not generally considered to be the initiator of the innovation process. Nonaka and Takeuchi (1995) outline an innovation process that begins with an organization creating and defining problems. Similarly, Machlup (1962, p. 180) sees the initial process being driven by a combination of existing knowledge and “scientific problems and hunches.” Interestingly, these hunches are also the output of initial research. That is, basic inquiry into particular hunches generates further problems, hunches, and ideas that then feed the beginnings of other innovative explorations. These initial ideas are often considered to be sourced from outside the organization (Cohen and Levinthal, 1990; Tsai and Ghoshal, 1998). This view of innovation beginning with a problem is consistent with the development of tacit knowledge. This is well summarized by Polanyi (1967, p. 24):

“Tacit knowing is shown to account (1) for a valid knowledge of a problem, (2) for the scientist’s capacity to pursue it, guided by his sense of approaching its solution, and (3) for a valid anticipation of the yet indeterminate implications of the discovery arrived at in the end.”

When innovation begins with a problem, then tacit knowledge becomes critical, partly due to the impact of path dependency, but also because it acts to direct the further development of knowledge or anticipate the ultimate solution.

Mechanisms linking knowledge and innovation. The dominant perspective in the knowledge literature is to consider that an innovation comes from a process of knowledge exchange and recombination (Galunic and Rodan, 1998; George *et al.*, 2008), which is also consistent with the model developed by Nonaka (1994). This includes the re-use of existing knowledge and capabilities in a new application setting (Hargadon and Sutton, 1997;

Henderson and Clark, 1990). However, knowledge-based process-oriented views such as Galunic and Rodan's (1998) model fall short of defining what the outcome of a process of knowledge exchange and recombination is and how this outcome relates to innovation. Similarly, the model of knowledge creation developed by Nonaka (1994) implies the creation of new knowledge. While studies have explored the empirical validity of this model (Martinde-Castro *et al.*, 2008) and the conceptual relationship between knowledge creation and innovation (Popidiuk and Choo, 2006), studies linking knowledge creation to innovation are just beginning to emerge (Schulze and Hoegl, 2008). Further research is required to understand how this new knowledge relates to an innovation outcome. Is all new knowledge, created either through exchange and recombination or by the various methods proposed in Nonaka's (1994) model, an innovation?

The mechanisms relating knowledge and innovation are also initially explored in discussions of organizational capabilities and the knowledge-based view of the firm. Kogut and Zander (1992) argue that a firm's combinative capability drives innovation. That is, the firm's dynamic capability to synthesize and apply knowledge in combination with "the unexplored potential of the technology" (Kogut and Zander, 1992, p. 391) allows a firm to generate new applications from existing knowledge. Similarly, Grant (1996) argues that the integration of knowledge is critical to competitive advantage and that this integration occurs through direction, routines and a hierarchy of capabilities.

In empirical studies in the knowledge literature, knowledge and innovation are often seen as moderating or mediating variables for more generic models of performance. For example, Yli-Renko *et al.* (2001) view knowledge acquisition as a mediator between social capital and new product development. Cohen and Levinthal (1990) utilize absorptive capacity as a moderating variable in their model of R&D expenditure. Other approaches such as dynamic capabilities (Eisenhardt and Martin, 2000; Teece *et al.*, 1997), core competence

(Prahalad and Hamel, 1990) or core capabilities (Leonard-Barton, 1992; Stalk *et al.*, 1992) focus primarily on strategic issues. As such, they do not directly link knowledge and innovation, although the implication of these approaches is that knowledge is the antecedent to capability and strategic advantage comes in the form of providing innovative products, services or processes in a rapidly changing industrial context.

The characteristics of knowledge have been linked to types of innovation in a study by Gopalakrishnan *et al.* (1999) who found that process innovations tend to integrate more systemic and complex knowledge than product innovations. However, the mechanisms by which knowledge and innovation are linked are left unspecified (Williamson, 1999) and are often not dynamic or reflective of interaction effects (Nissen, 2002). Despite these shortcomings, some scholars provide an initial structure that these mechanisms might take. Theoretical models in organizational learning, while not specifically targeted to the process of innovation, have incorporated the interaction effects that occur in the development of knowledge and learning toward the broader goal of organizational change (Crossan *et al.*, 1999; Kim, 1993). These mechanisms have identified social interaction (Nonaka, 1994; Woodman *et al.*, 1993) or political processes (Lawrence *et al.*, 2005; Menon and Pfeffer, 2003) as critical to knowledge development.

Operationalizations of innovation. Knowledge-based, process-oriented empirical studies measure constructs that are related to but do not necessarily entail the creation of an innovation, such as: innovation diffusion, innovative capability, innovation ties, and innovation involvement. For example, Hoffman and Roman (1984, p. 283) measure innovation diffusion as whether managers inform employees about a federal employee alcoholism policy. Subramaniam and Youndt (2005, p. 455) use a survey to measure incremental innovation capability as an organization's capability to reinforce and extend its current expertise and product/service lines. Radical innovative capability is measured as the

capability to make current product/service lines obsolete. Sammarra and Biggiero (2008, p. 809) measure collaborative ties by asking firms to name partners from innovation projects. Anand *et al.* (2007, p. 409) measure innovative knowledge-based structures in the form of practice areas in management consulting firms. Obstfeld (2005, p. 110) measures innovation involvement as self-reported participation in changes during an automotive design process. Herrera *et al.* (2010, p. 514) measure attributes of the innovation process such as R&D expenditures, the degree of organization of R&D activities, and patent propensity.

While there are empirical studies that use knowledge-based outcome measures of innovation – mainly patents (see Table 2) – they usually do not provide a definition of innovation as an outcome (Benner and Tushman, 2002; Chatterji, 2009; George *et al.*, 2008; Katila and Chen, 2008; Makri *et al.*, 2010; Schilling and Phelps, 2007). Some authors use an outcome measure of innovation, for instance patents, but define innovation as a process (e.g., Jansen *et al.*, 2006; Schilling and Phelps, 2007; Tushman, 1977). Others fall short of providing a clear distinction between the knowledge outcome that they measure and innovation. For example, Mors (2010) measures the ability of individuals to create new knowledge and define innovation as a recombination of knowledge (see also George *et al.*, 2008). Finally, the definition of innovation is sometimes left ambiguous or is completely omitted. Dougherty (1992b, p. 183) measures the introduction of innovations, but defines innovation only implicitly as the linking of market needs and technological possibilities. Leiponen (2008) and Leiponen and Helfat (2010) measure the introduction of improved or new services and technological innovations, but provide no definition of the innovation construct. There are thus several knowledge-based, outcome-oriented operationalizations of innovation, but no corresponding knowledge-based definition of innovation as an outcome. One possible reason for the absence of a definition is that there is no room for a theoretically

substantiated definition in an empirical paper. Instead, these studies usually draw on existing definitions from theoretical pieces (e.g., Barnett, 1953; Van de Ven, 1986).

In summary, we have shown that whereas the traditional innovation literature conceptualizes innovation as either a process or an outcome, the knowledge-based innovation literature does not provide a clear conceptualization (and definition) of innovation as an outcome. The next section will therefore propose a knowledge-based reconceptualization of innovation in order to link knowledge-based innovation models to an outcome.

3. INNOVATION AS AN OUTCOME FROM A KNOWLEDGE PERSPECTIVE

In this section, we attempt to clarify the link between knowledge creation and innovation by proposing a definition of the innovation outcome from a knowledge-based perspective. We will do so in two steps: First, we argue that innovation is, in essence, new knowledge. Second, we propose attributes of innovation as an outcome that enable us to distinguish between new knowledge that is an innovation and new knowledge that is not.

3.1 Innovation as New Knowledge

The literature has long conceived of innovation as knowledge-intensive (Kanter, 1988), and knowledge has been recognized to play an important role as an organizational attribute in fostering innovation (Dougherty, 1992b). In the knowledge literature, models of innovation detail the type of knowledge processes that facilitate the creation of knowledge (Nonaka, 1994; Galunic and Rodan, 1998). However, they do not identify clearly what the outcome of their innovation process is. We argue here that an innovation is in essence new knowledge, and therefore that it is possible to conceptualize innovation as an outcome from a knowledge-based perspective. Schumpeter (1934) proposes the following characteristic of the creative response (i.e., the innovation outcome):

“from the standpoint of the observer who is in full possession of all relevant facts, [the creative response] can always be understood ex post; but it can practically never be understood ex ante; that is to say, it cannot be predicted by applying the ordinary rules of inference from the pre-existing facts”
(Schumpeter, 1934, p. 150).

This implies that an innovation is a result that cannot be foreseen, but that the process that led to an innovation can be understood once the innovation has been generated. From a knowledge-based perspective, this means that an innovation process (the generation of an innovation) is characterized by the creation of the knowledge needed to understand how the innovation was generated. We can thus infer that an innovation, as an artifact, contains the knowledge needed to understand how it has been created, and how to create it again. In other words, the knowledge that is created during the innovation process and that allows the process to be understood constitutes the essence of the innovation process and it defines the innovation as an outcome.

The main difference between this conceptualization and the existing models of knowledge creation is the emphasis on the creation of knowledge as a process in itself regardless of the form in which the knowledge was created. As such, the process of knowledge creation is defined by its outcome: it is a process that creates new knowledge. In addition, this knowledge cannot have been conceived before having gone through the innovation process. The link between the process of knowledge creation and its outcome thus highlights the need to conceptualize the innovation outcome from a knowledge-based perspective, i.e. as new knowledge. At the same time, we argue that not all new knowledge should be termed an innovation and that specific characteristics should be added to a knowledge-based conceptualization of innovation as an outcome in order to differentiate between new knowledge and new knowledge that is an innovation.

3.2 Innovation Characteristics

Based on the above, we start our knowledge-based reconceptualization of innovation by defining it as *new knowledge*. In the following paragraphs, we will explain the characteristics that we add to this definition to conclude that innovation should be considered as *duplicable knowledge considered new in the context it is introduced to and demonstrated useful in practice*. An innovation, or knowledge creation, process may or may not lead to an innovation, depending on the existence of these characteristics.

Duplicability. Duplicability is an important characteristic that should be considered in the definition of innovation. It is already implicit to our conceptualization of the innovation process as a process leading to the creation of knowledge that allows an understanding of how the innovation has been created. Therefore, it should permit the replication of the result of the innovation process without having to repeat the knowledge generation process itself. For example, once a product has been created, the engineers who created it should have gained the knowledge needed to create a second product very similar to the first one. This knowledge could also be used to replicate the product in another organization or in another situation. The notion that an innovation can to some degree be imitated by others (Nelson and Winter, 1982) implies that it can always be duplicated by at least the innovator. As such, an innovation should consist of new duplicable knowledge that enables a replication of the outcome.

New in the context it is introduced to. We proposed earlier that an innovation process is defined as a knowledge creation process. More specifically, we defined the knowledge creation process as the generation of knowledge that enables the replication of the innovation without having to create this knowledge a second time. Implicit to definitions of innovation in the traditional innovation literature is that the degree of novelty of an innovation is subject to the individuals judging it. Whereas this argument has its merits, it has resulted in the concepts of innovation adoption and innovation creation being used interchangeably in the literature

(e.g., Damanpour, 1991). Conceptualizing innovation as a knowledge-based outcome enables us to provide some clarity to this issue.

We argue that the key element in distinguishing between adoption and creation is not the existence of the knowledge linked to an innovation, but its availability to and use by the unit of analysis. That is, distinguishing between adoption and creation does not necessarily correspond to knowledge that is entirely new to the world. If the knowledge exists but individuals are unaware of it or do not use it (for example if it is very difficult to replicate the knowledge in another context or situation), then these individuals will have to create the knowledge that is needed to replicate this innovation in their specific context. Hence, they will go through the process of knowledge creation and if the outcome corresponds to the criteria defined here, they will have produced an innovation. An example would be a new product that requires extensive adaptation before being usable in a specific context. Therefore, the distinction between the creation of an innovation and its adoption or imitation depends on whether the knowledge needed to replicate the process is available to and used by the group before starting the innovation process. If the knowledge was available beforehand and used, then the group has replicated or adopted an innovation. If the knowledge was not available beforehand or not used, then the group has created an innovation, even if the innovation had been created previously in a different context.

Demonstrated usefulness. Usefulness relates to the capacity of an innovation to improve on an existing situation (Dosi, 1988; West and Farr, 1990). This characteristic can be used to distinguish between an innovation and an invention. An invention can be new, but it will not necessarily improve existing processes or situations. Usefulness is a defining characteristic of innovation because it relates to the implementation decision. Following Machlup (1962), an entrepreneur has to take the decision to invest in an invention to turn it into an innovation; the entrepreneur is therefore expecting a return on his/her investment.

While an innovation is not a guarantee of a successful investment, the implementation decision cannot occur if the invention or idea is not useful or anticipated to be useful. This perspective has been emphasized in the literature, for example in Dougherty and Hardy's (1996, p. 2) definition of sustained product innovation "as the generation of multiple new products, as strategically necessary over time, with a reasonable rate of commercial success", with the latter part explicitly alluding to the notion of usefulness.

In addition, usefulness is not attributed theoretically to a product or an idea. Rather, it is constructed through the application of the invention in practice and it involves a social component because individuals need to be convinced to make a decision to make use of it (Rindova and Petkova, 2007). Schumpeter (1934) explained the difference between an inventor and an entrepreneur in terms of the ability of the entrepreneur to "get things done" (Schumpeter, 1934, p. 152). For Schumpeter, an invention belongs to the realm of ideas and an innovation is a practical implementation of these ideas.

4. CONCLUSION AND DIRECTIONS FOR FUTURE RESEARCH

Adopting a knowledge-based approach to innovation we have proposed an alternative perspective to the organizational innovation process. Specifically, we developed an organizing framework to structure the literature by (1) conceptualizing innovation as process- or outcome-based and (2) differentiating between the traditional innovation and the knowledge-based innovation literatures. With the help of this conceptual lens, we identified a lack of clarity in the measurement and definition of innovation in research that considers innovation as a knowledge-based outcome. Whereas a few empirical studies operationalize innovation as a knowledge-based outcome these studies lack a corresponding theoretical definition. We argue that a knowledge-based, outcome-oriented definition of innovation provides a common theoretical ground for such operationalizations and facilitates comparisons across the wide range of existing knowledge-based measures of innovation. To

that end, we provided an extended definition that understands innovation as the creation of new knowledge that is necessary to replicate the process leading to innovation outcomes. In our conceptualization, this knowledge needs to be duplicable, considered new in the context it is introduced to and demonstrated useful in practice.

Our conceptual results entail several implications for future research. First, the distinction between innovation and new knowledge, and the absence of reference to technology or product in our definition of innovation, should facilitate the study of non-product innovations and open the possibility to analyze innovations generated at any place in an organization. This might also enable the study of innovation in services, currently underrepresented in the innovation literature (Gadrey *et al.*, 1995). Additionally, by giving clear parameters this definition should allow the adoption of alternative and more comprehensive methods of measuring innovation and innovativeness. For example, a measure of innovativeness that could be related to this definition is the literature-based innovation output indicator (Coombs *et al.*, 1996; Walker *et al.*, 2002), which is comparable to the measures used to assess innovativeness in universities (Garfield, 1986; Liebowitz and Palmer, 1988; Stigler and Friedland, 1975).

For practicing managers, viewing innovation from a knowledge perspective suggests a greater focus on the knowledge processes and outcomes that allow the creation and replication of an innovation. Incentives for innovation can be adequately designed only if managers can measure innovation. Previous definitions of innovation enable suitable measures for some situations (i.e., when innovation can be measured as patents, or new product introductions). Our definition enables managers to measure a wider range of innovations, including service innovations. This would allow incentive systems to be designed to take into account different types of innovation, and avoids biases towards product innovation only. Clearer specification and measurement of knowledge-based innovation outcomes may also be an initial step to help

managers understand the conditions under which organizations choose to re-innovate rather than engage in a search for existing knowledge. Establishing a clearer link between knowledge and innovation may make it easier for managers to understand the trade-offs between searching and transferring knowledge on the one hand and progressing through the innovation process to recreate an innovation that may exist outside the organization on the other hand. Since innovation is a strong driver of firm competitiveness, an improved ability to measure and understand the key factors in the innovation process should assist managers in improving innovativeness and overall firm success.

NOTES

[1] While patents constitute an output they have been criticized to represent an inventive output rather than an innovative output (Pavitt, 1988). Patents are also highly unrepresentative of economic activity as the majority of patent activity is concentrated in particular industries. Research and development expenditures have also been used as an indicator of innovation, but have been criticized for being only a partial explanation of the innovation process because they only represent a portion of the inputs in this process (Coombs *et al.*, 1996).

[2] Note that this implies that one would need to add an additional characteristic, based on the uniqueness of the knowledge in all possible contexts, if the interest is in examining innovations that are new to the world.

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Table 1. Definitions of Innovation in Different Innovation Literatures

	Innovation as a process	Innovation as an outcome
Traditional innovation literature	<p>“...the development and implementation of new ideas by people who over time engage in transactions with others within an institutional order.” (Van de Ven, 1986, p. 590)</p> <p>“Innovation ecosystems – the collaborative arrangements through which firms combine their individual offerings into a coherent, customer-facing solution.” (Adner, 2006, p. 98)</p> <p>“The invention and implementation of a management practice, process, structure, or technique that is new to the state of the art and is intended to further organizational goals.” (Birkinshaw <i>et al.</i> 2008, 825)</p> <p>“The process of bringing any new problem solving ideas into use.” (Kanter, 1984, p. 20)</p> <p>“Innovation development is a highly uncertain process in which entrepreneurs, with financial support from investors, undertake a sequence of events over an extended period of time to transform a novel idea into an implemented reality.” (Van de Ven and Polley, 1992, p. 92)</p>	<p>“An invention which has reached market introduction in the case of a new product, or first use in a production process, in the case of a process innovation.” (Utterback, 1971, p. 77)</p> <p>Profit-building new and novel products, production processes, and marketing schemes. (Levitt, 1960, p. 2)</p> <p>“The first or early use of an idea by one of a set of organizations with similar goals.” (Becker and Whistler, 1967, p. 463)</p> <p>“For a patent to be granted, the invention must be nontrivial, meaning that it would not appear obvious to a skilled practitioner of the relevant technology, and it must be useful, meaning that it has potential commercial value.” (Jaffe <i>et al.</i>, 1993, p. 580)</p> <p>“Any thought, behaviour or thing that is new because it is qualitatively different from existing forms” (Barnett, 1953, p. 7)</p> <p>Radical change in business processes (Davenport, 1994, p. 137)</p>
Knowledge-based conceptualization of innovation	<p>“The production or emergence of a new idea.” (Gupta <i>et al.</i>, 2007, p. 886)</p> <p>An “innovative solution” to a certain problem involves “discovery” and “creation,” since no general algorithm can be derived from the information about the problem that generates the solution “automatically.” (Dosi, 1988, p. 1126)</p> <p>Innovation as a three-step process: idea development, problem solving, and implementation (Myers and Marquis, 1969)</p> <p>“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.” (West and Farr, 1990, p. 9)</p> <p>“Activities are deemed innovative if they differ significantly from current or recent activities. In organizations, innovations may change the incumbent skills, standard practices, technology, services, and products of the firm.” (Greve and Taylor, 2000, p. 55)</p> <p>“An iterative process initiated by the perception of a new market and/or service opportunity for a technology-based invention which leads to development, production and marketing tasks striving for the commercial success of the invention.”(Garcia and Calantone,2002, p.112)</p> <p>“Organizational innovation is often a process of creating new social connections between people and resources they carry, so as to produce novel combinations.” (Obstfeld, 2005, p.100)</p>	<p><i>Not clearly defined</i></p>

Table 2. Definitions and Operationalizations of Innovation

Author	Main focus	Definition	Innovation measure
Traditional, process-oriented view			
Armour and Teece (1980)	Vertical integration	Implicit definition: “R&D activities” (p. 471)	R&D expenditure
Terziovski (2010)	SMEs	“the technical, design, manufacturing, management and commercial activities involved in the marketing of a new (or improved) product or the first commercial use of a new (or improved) process or equipment ” (Freeman, 1982 in Bessant and Tidd, 2007, p. 12) (p. 894)	Innovation strategy, formal structure, customer and supplier relationships, innovation culture, technological compatibilities
Van de Ven and Polley (1992)	Learning	“Innovation development is a highly uncertain process in which entrepreneurs, with financial support from investors, undertake a sequence of events over an extended period of time to transform a novel idea into an implemented reality.” (p. 92)	Positive or negative event outcomes (including tangible results and value judgments)
Traditional, outcome-oriented view			
Rothaermel and Hess (2007)	Dynamic capabilities (multilevel)	No definition	Patent counts
Whittington <i>et al.</i> (2009)	Networks	No definition	Patent counts
Tortoriello and Krackhardt (2010)	Networks	Implicit definition: “As Obstfeld (2005) noted, generating new ideas through the availability of heterogeneous perspectives, and coordinating the actions that are necessary to implement those ideas, translating them into innovations, are two distinct aspects of the innovative process.” (p. 168)	Patent applications
Jaffe <i>et al.</i> (1993)	Geographic localization	“For a patent to be granted, the invention must be nontrivial, meaning that it would not appear obvious to a skilled practitioner of the relevant technology, and it must be useful, meaning that it has potential commercial value.” (p. 580)	Number of patent citations
Daft (1978)	Innovation adoption	“The first or early use of an idea by one of a set of organizations with similar goals (Becker and Whisler, 1967, p. 463).” (p. 197)	Adopted technical innovations, adopted administrative innovations
Leiblein and Madsen (2009)	Firm size	“Process technology innovations are defined as significant changes in the tools, devices, and knowledge that mediate between inputs and outputs (Rosenberg, 1972)” (p. 713)	Number of introduced process technology innovations
Bell (2005)	Innovation in networks	“Innovation is the development and implementation of new ideas to solve problems (Dosi, 1988; Van de Ven, 1986)” (p. 288)	This firm leads the industry at introducing new products/introducing new services/adopting new technologies (Likert scale)
Frambach <i>et al.</i> (1998)	Adoption of service innovations	Implicit definition: “Unique and satisfies specific (latent) needs of potential adopters.” (p. 164)	Adoption of electronic banking

Knowledge, process-oriented view			
Hoffman and Roman (1984)	Organizational emphasis on innovation	“Any thought, behaviour or thing that is new because it is qualitatively different from existing forms (Barnett, 1953, p. 7)” (p. 278)	Measure diffusion of administrative policy, not innovation
Subramaniam and Youndt (2005)	Innovative capabilities	Innovation: “...identifying and using opportunities to create new products, services, or work practices (Van de Ven, 1986)” (p. 451); Incremental innovative capability: “...the capability to generate innovations that refine and reinforce existing products and services.” Radical innovative capability: “...the capability to generate innovations that significantly transform existing products and services.” (p. 452)	Incremental and radical innovative capability based on 3-item Likert scales
Sammarra and Biggiro (2008)	Innovation in networks	Implicit definition: “...combine and mutually adapt technological knowledge to anticipated visions of use.” (p. 804)	Collaborative ties through innovation projects
Anand <i>et al.</i> (2007)	Knowledge structures	Implicit definition: “...generate and exploit new forms of knowledge...” (p. 406)	Innovative knowledge-based structures: Practice areas in consulting firms
Obstfeld (2005)	Innovation in networks	“Organizational innovation is often a process of creating new social connections between people and resources they carry, so as to produce novel combinations.” (p. 100)	Involvement in innovation. (Self-reported based on a scale of involvement by Ibarra (1993))
Herrera <i>et al.</i> (2010)	Researcher mobility	“The innovation process in firms is a process of accumulating and creating new knowledge (Nonaka and Takeuchi, 1995; Zahra and George, 2002).” (p. 510)	R&D expenditures, degree of organization of R&D activities, patent propensity
Knowledge, outcome-oriented view			
Schilling and Phelps (2007)	Networks	“A problem solving process in which solutions to problems are discovered via search (Dosi 1988).” (p. 1114)	Patent counts
Makri <i>et al.</i> (2010)	Mergers and acquisitions	“An iterative process initiated by the perception of a new market and/or service opportunity for a technology-based invention which leads to development, production and marketing tasks striving for the commercial success of the invention (Garcia and Calantone, 2002, p. 112)	Innovation quantity: Patent counts. Innovation quality: Patent citations
Benner and Tushman (2002)	Process management	“Innovation is increasingly exploratory the more it departs from knowledge used in prior innovation efforts and, conversely, increasingly exploitative the more deeply anchored it is in existing firm knowledge.” (p. 679)	Patent counts classified by the nature of patent citations
George <i>et al.</i> (2008)	Technological capabilities	“Our premise is that innovation can be viewed as recombination of existing knowledge (Basalla, 1988; Schumpeter, 1939).” (p. 1450)	Patent counts and patent citations classified by technological domain
Chatterji (2009)	Entrepreneurs	No definition	Patent citations
Katila and Chen (2008)	Search timing	“[...]innovation as search – that is, as the problem-solving process in which organizations manipulate knowledge to create new products[...]” (p. 594)	Product innovativeness: Improvements in product design characteristics important to users. Innovation search: Patent counts and citations

Jansen <i>et al.</i> (2006)	Exploitation and exploration	”Exploratory innovations are radical innovations and are designed to meet the needs of emerging customers of markets.[...] Conversely, exploitative innovations are incremental innovations and are designed to meet the needs of existing customers of markets (Benner and Tushman, 2003, p. 243; Danneels, 2002).” (p. 1662)	Exploratory/Exploitative innovation: The extent to which units depart from/build on existing knowledge and pursue innovations for emerging/existing customers (Likert scale)
Mors (2010)	Networks	“This work has built on the notion that innovations are novel combinations of existing information and work practices and assumes these to be disparate (Burt, 2004; Obstfeld, 2005).” (p. 842)	Innovation performance: Contribution to the firm in terms of new knowledge, ability to create new knowledge and expertise (Likert scales)
Dougherty (1992b)	Organizational routines	Product innovation is implicitly defined as technology-market linking: “On the process side, linking involves the construction of new knowledge about the product and the market. On the content side, linking means that a complex array of specific insights must be gathered and brought together.” (p. 181)	Successful innovation: Introduced product meeting/ exceeding expectations Failed innovation: Introduced and later cancelled innovation
Leiponen (2008)	Intellectual assets	No definition	Introduction of improved or new services
Leiponen and Helfat (2010)	Knowledge sources	No definition	Innovation success: Introduction of, and sales revenues from, technological innovations
Tushman (1977)	Communication	Innovation as a three-step process: idea development, problem solving, and implementation (Myers and Marquis, 1969) (p. 588)	R&D project performance as rated by 9 managers (Likert scale)
Greve and Taylor (2000)	Cognition	“Activities are deemed innovative if they differ significantly from current or recent activities. In organizations, innovations may change the incumbent skills, standard practices, technology, services, and products of the firm.” (p. 55)	Format changes of radio programs
Taylor and Greve (2006)	Innovative teams	“Innovation is both the creative development of novelty and its application to generation of a new product (Amabile, 1996; West, 2002).” (p. 724)	Market value of comic books