

Recognising radical innovation: The importance of perspective and level of analysis

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Abstract

Radical innovation is known to differ drastically from incremental innovation, both in terms of process and outcome. This paper discusses how radical innovation can be recognised in a valid way. The presented logic is based on a longitudinal single case research. The research demonstrates that the link between an innovation project's ex ante potential for radical innovation and the radical nature of its actual end result(s) may be too absolute in extant theory. This paper provides at least two important contributions. First, it is explained how ex ante and ex post identification of radical innovation take place according to different criteria. Second, it is argued that one innovation can have an ex post incremental or radical level of innovativeness at the same time in different application industries in an economically viable way. In the latter case, an innovation's actual level of innovativeness is assessed by taking perspective and level of analysis into account.

Introduction

The terms incremental and radical are frequently applied, both by researchers and managers, to denote two different levels of innovativeness. Innovations that offer minor improvements are traditionally called incremental innovations. Radical innovations present a more significant leap forward and provide substantially greater customer value. This paper focuses on radical technological innovations. These are innovations based on familiar or new technological features that offer unprecedented customer value. The aim of the paper is to investigate how radical innovations can be recognised in a valid way.

In research it is relevant to distinguish radical from incremental innovations because of the moderating effect of the level of innovativeness. Consequently, it is essential that researchers define and measure radical innovation in a valid way. Incremental and radical innovations are known to differ in terms of management approach, risk involved, development time and amount of resources needed. Numerous studies investigate the moderating effect of the level of innovativeness on different aspects of the new product development process. Some recent examples include Lee and O'Connor's (2003) research on communication strategies for launching new products. They find that product innovativeness influences the kind of communication strategy needed to promote a successful product launch. Another investigation discusses how customer orientation contributes differently to new product development success, dependent on the degree of product innovativeness (Salomo, Steinhoff and Trommsdorff, 2003). The authors argue that development of highly innovative products requires a stronger customer orientation than more incremental

products do. Increased market research activities and customer integration, with high interaction intensity during the development process, are found to increase performance of radically innovative products. Another research investigates the moderating effect of product innovativeness on the relationship between development speed and new product profitability (Langerak and Hultink, 2006). The development speed that maximises new product profitability is hypothesised to be lower for more innovative new products than for less innovative products. Salomo, Weise and Gemünden (2007) study the moderating effect of level of innovativeness on the relationship between planning and control, and innovation success. Though the results of these studies might be contested, in some cases, or inconclusive, in other, they do provide sufficient justification for the assumption that the level of innovativeness influences practices of developing, producing, marketing and adopting technological innovations.

The empirical part of this paper relates to an innovation project that originates within a large firm. The case was selected based on available definitions of radical innovation. In a longitudinal study of the case the validity of extant definitions is empirically assessed. The definition used implied that the innovation project would naturally lead to radical innovation(s). In this paper the distinction is made between ex ante identification of the potential of an innovation project to lead to radical innovation(s) and the ex post identification of actual radical innovation(s). In addition, the research demonstrates that one innovation can lead to different levels of innovativeness in different application industries and that the innovation can be commercialised in an economically viable way in these different application industries at the same time. The extent to which an innovation is radical is determined by the

solution used by the customer firm before adoption of the innovation as well as by other solutions available in the industry. To date, these considerations are not explicitly taken into account in the identification of radical innovations. This paper aims to explore how radical innovation can be recognised in a valid way.

The paper is structured as follows. The next section describes the research methodology for the empirical part of the paper. A following section discusses the empirical findings. Then, a section concentrates on discussing the focal topic of the paper. It is explained that *ex ante* and *ex post* identification of radical innovation is done according to different criteria and that awareness of perspective and level of analysis can contribute to a more valid assessment of radical innovations. The concluding section summarises the key issues, delineates limitations of the present research and provides some guidelines for future research.

Methodology

The empirical background of this paper consists of a single case research. The case was selected in 2003 for its potential to lead to radical innovation (see also Vercauteren, 2007). The case was an innovation project within a large firm. The basis of the innovation project is the discovery of a new technological principle according to which a laser additive can be developed that allows for improved laser marking on virtually any plastic. The new technology was viewed, at the time, "... to have the potential to offer unprecedented performance features or embody familiar features that offer the potential for five- to tenfold improvements in performance or at least a 30% reduction in cost" (O'Connor and Veryzer, 2001, p. 233). Longitudinal follow-up

of the case in the period 2003-2007 allowed for a study of whether and how the potential for radical innovation materialises. Semi-structured interviews were an important data collection method. Within the innovating firm interviews took place with managers at various levels in the firm. The corporate innovation manager, the business development manager in charge of the innovation project and the R&D staff involved in inventing and developing the new technology were consulted 8 times in total. Each interview lasted between 2 and 3 hours. The interviews were taped and transcribed. The interview material was complemented with secondary sources of information, such as websites relevant for the laser marking industry and intermediate business plans of the managers involved. In addition, 3 interviews took place with different types of firms that showed particular interest in the new technology. These firms are a laser supplier, a raw material supplier and a user of laser additives.

Empirical findings

Initial discovery of the technological principle for the development of a new laser additive took place in May 2002. The potential for radical innovation lies in the new-found ability to laser mark any kind of plastic. Plastics that would previously not lend themselves to being marked with a laser machine would now be able to receive an accurate and indelible laser mark just underneath their surface. Silicone rubber is an example of a material that becomes laser markable with the new additive. It is used among others in keypads for telephones and computers. Another application in which the new additive entails a radical improvement is the synthetic cork industry. Synthetic corks are plastic alternatives for natural cork stoppers on bottles. They are

currently marked by means of print technology that puts an ink mark on the surface of the corks. It is a cumbersome technology. A switch to laser marking would imply a significant improvement. Industries that already apply laser marking could also benefit from the improved performance of the new laser additive. In the security industry high precision, high contrast laser marking on security passes results in improved security guarantees. Firms that laser mark plastic animal identification tags show interest in the new additive as well. Also in the electrics and electronics industry also many components are laser marked.

In the innovation project, the development team strives to come up with one new additive that can be used in all the different application industries. The technological principle and product concept remain the same across all application industries. If any, the additive shows only minor differences across application industries. For example, in the synthetic corks application an FDA approved version of the additive is used.

Initially the development team explores all of the above mentioned application possibilities. Especially the more radical applications require more significant changes. This slows the commercialisation process down considerably. For some of the applications suitable equipment needs to be developed from scratch. At the end of 2003, pressure from higher management forces the development team to focus on some of the more incremental applications first, to generate base revenues. Efforts to realise the radically innovative applications continue on the side. Some radical application possibilities are abandoned, such as the security application which relies heavily on tendering mechanisms. The development team decides to stop investing in this application because of the unpredictability of sales.

The basic premise of the development team continues to be the creation of one laser additive that can be successfully applied in many industries. The result is that one and the same innovation leads to an incremental improvement in some industries and a truly radical improvement in other industries. In industries, such as the tag industry and the electrics and electronics industry, where laser marking was already being applied, the innovation presents an incremental improvement. In other industries, such as the cork industry, the innovation enables laser marking on materials on which laser marking had been impossible before. Hence, the additive is a radical innovation in these industries. This particular case study was selected because of the radically innovative potential of the new technology involved. However, the case findings indicate that such a definition does not necessarily suffice to describe the level of innovativeness of all the applications of the new technology.

Discussion

The empirical case demonstrates that current definitions may not always identify radical innovations in a valid way. In this section we provide a structured discussion of a more comprehensive way of recognising radical innovations. It is argued that different criteria need to be taken into account for ex ante and ex post identification of radical innovation. The importance of perspective and level of analysis is explained.

Ex ante versus ex post identification of radical innovation

Scholars have approached the problem of defining radicalness in different ways. Some of the more recent research efforts include Dahlin and Behrens (2005), Garcia and Calantone (2002) and Danneels and Kleinschmidt (2001). An important aspect of the discussion is the perspective taken in the definition. The distinction is made between the perspective of the innovating firm and that of the firm that is adopting the innovation, referred to as the customer or the adopting firm. Danneels and Kleinschmidt (2001) present a literature review (Table 1, p. 359) that shows that extant definitions for radical innovation are formulated from either perspective and that sometimes the definition does not clearly state the perspective taken. However, the problem of ex ante versus ex post identification of radical innovation can not simply be reduced to adopting the innovation firm's versus the customer's perspective. This paper argues that for ex ante identification of radical innovation a process approach to innovation needs to be adopted regardless of the perspective taken. In contrast, ex post identification of radical innovation takes place from the customer's perspective only and is determined by the increase in customer value delivered by the innovation.

For ex ante identification of the potential for radical innovation the theoretical frame of dynamic capabilities (Eisenhardt and Martin, 2000; Teece, Pisano and Shuen, 1997) is adopted. Dynamic capabilities theory derives from the resource-based view of the firm (Barney, 1991; 1999; 2001). It generally states that firm activity is made up of processes that are to a certain extent common across firms, e.g. the innovation process. However, these processes also have a firm-specific component that is idiosyncratic and path-dependent. In a fast changing environment crucial dynamic capabilities are highly experiential and driven by learning. Especially in large

established firms the ability to radically innovate is positively influenced by the capacity to transform capabilities (Herrmann et al., 2007). Aiming for radical innovations entails transforming practices common to incremental innovation, or even common to previous radical innovations. Capabilities in terms of developing, producing, marketing and adopting technological innovations often need to change drastically in order to allow for radical innovation. The assumption is that the more radically innovative the innovation, the more and more significant change it incites in more of the aforementioned business processes. As the innovation process progresses from development to production, marketing and adoption, there is a shift in perspective from the innovating firm in the first processes to the customer firm in the final adoption process. If more of the activities need a different approach, for example because of new technology involved, then this gives an ex ante indication of the potential of the innovation project to lead to radical innovation(s) as end result. Several authors note that novel technology is not a prerequisite, nor a sufficient condition for radical innovation. Radical innovations can entail an unexpected combination of existing performance attributes that delivers unprecedented performance levels (Mascitelli, 2000). Moreover, the truly radical character of innovations is finally determined by value added in the market, rather than by technological novelty (Leifer et al., 2000; Jolly, 1997). Technological novelty is one of the factors that can give an ex ante indication of the potential to radically innovate, but the ex post or actual radical nature of innovations is determined in the customer's usage context. Some authors (e.g. Chandy and Tellis, 1998) choose to regard radical innovations as more radical as they require transformation in more of the capabilities involved in offering – from the innovating firm's perspective - and attempts at adopting – from the customer perspective - them. In this paper we take a process

approach only to recognising the ex ante potential for radical innovation. This means that the changes radical innovations cause in the processes for delivering and adopting them merely give an indication of the believed potential radical improvement in customer value that is justifying these investments in change. But ex post, it is the actual improvement in customer value that determines whether or not the innovation is truly radical. This is the motivation to discuss ex post identification of radical innovation in the next section, from the perspective of the customer only.

Ex post identification of radical innovation

The empirical findings discussed in this paper indicate that for determining the level of innovativeness from the perspective of the customer it is useful to perceive the adopted innovation as being relative to at least two things:

- 1) the solution previously used by the customer, and
- 2) alternative solutions offered in the industry.

The fact that these two aspects refer to different levels of analysis calls for an explanation of how level of analysis is perceived in this paper. The distinction is made between the micro level, which is the level of the individual customer firm, the meso level, which refers to one industry and the macro level which regards the effects of one innovation across industries.

At micro level, previous definitions incorporate the relative notion of a new solution being innovative only to the extent to which it brings about an improvement compared to the previous solution used by the customer. For example, the O'Connor and Veryzer (2001) definition also includes a relative notion. They refer to a radical

innovation offering a five- to tenfold improvement in performance or at least a 30% reduction in cost for the customer. The performance improvement and cost reduction levels are formulated in a relative way to current levels. A logical consequence is that one innovation can signify different levels of innovativeness in different application industries. Hence, for measurement of the radical nature of innovations it seems desirable to consult the customer.

In order not to let the situation-specificity of each individual user context over-determine the radical nature of innovations, available alternatives in the industry also need to be taken into account. This is the meso level of analysis. A new solution is only innovative to the extent that available alternative solutions in the same industry do not offer even better customer value. Though, intuitively, assessing relative improvement of a new solution by comparing it to available solutions seems logical for the identification of truly radical innovations, this reasoning has not been formalised in extant research yet.

The consequence of this reasoning is that for measurement of radical innovations, a method more similar to the lead user technique seems appropriate. The lead user process actually involves four steps (Lilien et al., 2002). One of the initial steps is to identify important technical and market trends in the considered industry in order to, in a next step, correctly assess the extent to which potential lead users are actually 'leading' the industry. Similarly, measurement of radical innovations should take into account the alternatives offered in an industry, in order to, correctly assess the extent to which an innovation actually does bring about a radical improvement compared to current practices. Claims of innovation radicalness need to be confirmed or rejected by consulting industry literature at the time of new product announcement and

launch. Also the opinion of industry experts or other sources of information, possibly related to specialist scientific or trade conferences, can be taken into consideration while measuring the radical nature of innovations. In theory, it suffices that a competitor is first in launching a radical innovation in the same industry to make a firm's new product launch non-radical.

The end result of this reasoning at the macro level is that it allows for the fact that one innovation with the potential to radically innovate can be situated at different levels of innovativeness depending on user context and within-industry available alternatives. The described approach allows for identification of across-industry radically innovative, and less radically innovative, applications of one innovation. The findings in this paper stress that one innovation with radically innovative potential does not necessarily, nor only, lead to applications of a radical nature. It is crucial to assess the level of innovativeness of each application of an innovation separately. For this assessment the context of the user situation and the alternatives available to that user need to be taken into account.

Conclusion

Extant theory presumes a rather absolute link between definitions based on ex ante potential to radically innovate and the ex post identification of actual radical innovations. This may be due to the retrospective nature of much of the research into radical innovation. Nevertheless, the unpredictability of the radical innovation process and its outcomes is well-known. This characteristic is neglected inevitably in retrospective research. This paper discusses a longitudinal research into radical

innovation. An innovation project involving technology with radically innovative potential was followed up from 2003 to 2007. The research provides an occasion to develop an empirically grounded approach to recognising radical innovation. Figure 1 summarises the importance of perspective and level of analysis in the identification of radical innovation.

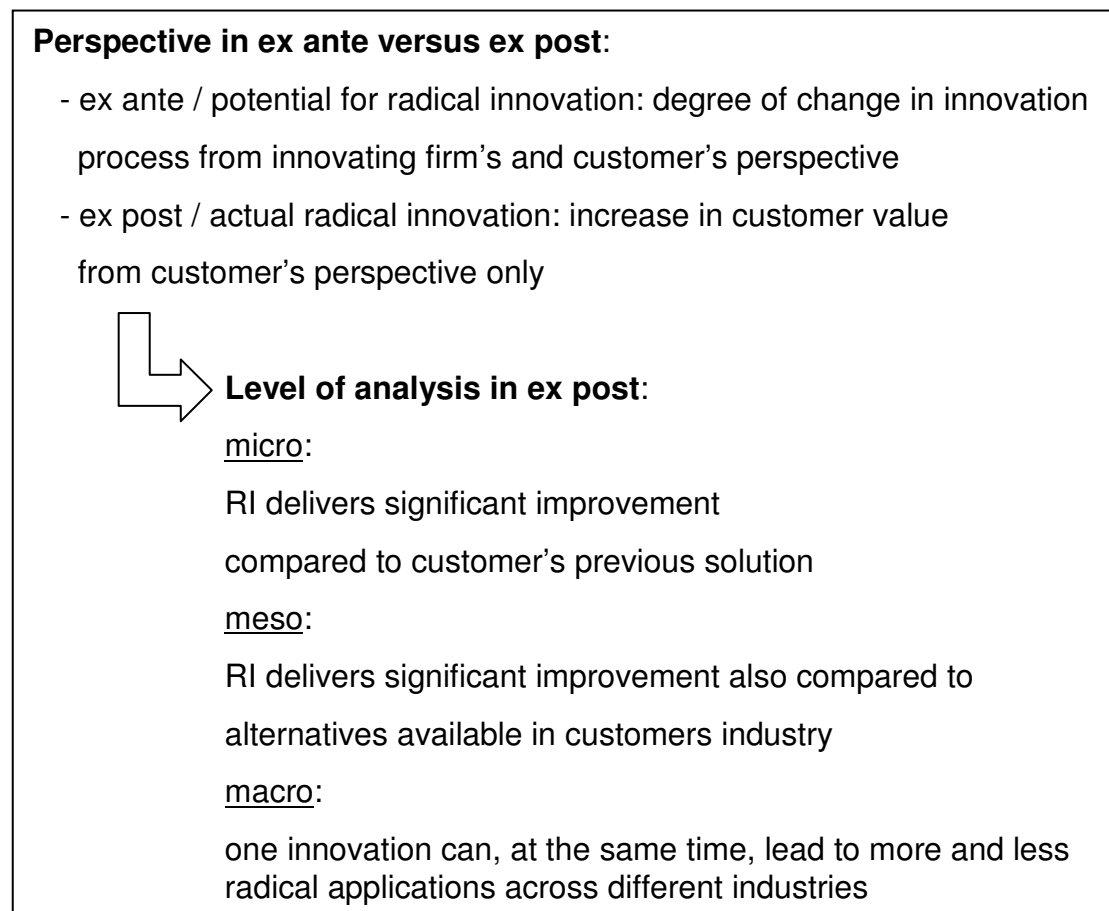


Figure 1: Recognising radical innovation (RI): an overview

An ex ante indication of an innovation project's potential for radical improvement can be generated by adopting a process approach to innovation from both the innovating firm's and the customer's perspective. It is stressed that this ex ante indication does not imply that actual radical innovation will naturally follow or that the innovation will

be radically innovative in all of its application industries. The actual ex post radical nature of an innovation can be assessed only from the customer's perspective. It is important to take different levels of analysis into account. At the micro level, an innovation is radical to the extent that it offers a drastic improvement compared to the previous solution used by the customer. Next, at the meso level, the innovation should also provide a significant improvement compared to the alternatives available in one industry. At the macro level, this paper demonstrates that one innovation can actually lead to incremental and radical improvements in different application industries at the same time. Taking customer and industry related factors into account allows for valid ex post assessment of the radical nature of each individual application of the innovation.

For research practice these findings indicate a need for a more elaborate assessment of radical innovations in order to guarantee the validity of their identification. Awareness of the importance of perspective and level of analysis, as summarised in Figure 1, can contribute to this. A weakness in the demonstrated reasoning is that a cut-off value from which innovations can be considered radical remains open to discussion. The O' Connor and Veryzer (2001) definition, that is also applied for the empirical research in this paper, mentions values of five- to tenfold improvements in performance or at least a 30% reduction in cost. Though O'Connor and Veryzer have not explicitly motivated these values, the interviewees in the empirical part of this research seemed to agree that such levels denote radical improvements. Another limitation of the present research is that it approaches innovation as a dichotomous phenomenon that is either incremental or radical. Logically, innovations are distributed along a continuum between these two

extremes. It can be considered a limitation that this paper does not discuss the full continuum of possible levels of innovativeness. Instead, focus lies on distinguishing truly radical innovations from other levels of innovativeness.

Extant research predominantly focuses on studying singular events of radical innovation. The empirical case in this paper demonstrates that applications of varying degrees of innovativeness can co-exist and, furthermore, may need to be studied as a whole. Even though these applications are situated in different industries, they do originate from one innovation. It may even be necessary to take related, less radical technological applications of an innovation with radically innovative potential into account, in order to understand how the more radical applications of the same innovation could be realised.

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