

A strategic role for companies in the development of radical innovations: an analytical framework proposed

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Abstract

Radical innovations can bring various opportunities for incumbent companies and start-ups. However, at the start of these innovation's development, the uncertainties regarding the application and the eventual basic configuration are very high. In the cases where the development is still in such an early phase, companies can choose to influence the innovation's development process as to shape its path towards successful diffusion. However currently there does not exist a framework, which captures the process in which a company wants to influence the development of a radical innovation. By means of an extensive literature research, an analytical framework is proposed which focuses on how a company can influence the development through taking-on a strategic role in the business ecosystem. From this framework a step-by-step analysis process is derived which prescribes the steps and analyses needed to gather and analyze data. Further research should be done to refine the framework and a systematic innovation perspective can improve the usability of the framework.

Keywords: analytical framework, business ecosystem, innovation development, radical technical innovation

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1. Introduction

Technological innovations can be divided into radical and incremental innovations. The first type contains a high degree of new knowledge; the latter a low degree of new knowledge (Dewar & Dutton, 1986). Both can bring various opportunities for incumbent companies as start-ups (Teece, 1986). New products and services can be developed or new markets can be entered. Break-through developments in technology or changes in customer demand are often the reason

technological innovations are generated, introduced and diffused. Every day and globally, innovative ideas are generated and introduced by inter alia R&D departments, scientists and entrepreneurs.

In the literature theories on the development of innovations extensively describe how such an innovation is introduced and generated in local niches, loci protected from the normal market selection in the regime (Geels, 2002), and, if successfully, is diffused on a larger scale in the existing environment.

The development path is complex and uncertain (Rotmans, Kemp, & Asselt, 2001); not every idea makes it, due to various reasons. This is especially so for radical innovations. With its development one socio-technical configuration transforms into another. This entails not only the technology changes, but also the other interrelated societal domains, e.g. economics, politics and culture. Thus society changes in a fundamental way if a radical innovation is diffused (Elzen & Wieczorek, 2005; Geels, 2002; Rotmans et al., 2001)

For companies that want to benefit from radical innovations, it is difficult to determine if an innovation is worthwhile to invest their scarce resources at an early stage. At this point much is unknown and its potential success not calculable. Companies could opt for a passive role waiting for the development to go on and to be surer. The risks exist that if the company steps in too late, it will lose a competitive edge. Another option is to assume an active role by influencing its development. This way the company can reduce its lack of knowledge and shape the development process towards a potential successful diffusion.

Take for example the Microgrid. The Microgrid is a small-scale version of the centralized electricity system. In the system integrated energy systems consisting of distributed energy resources (DERs) and multiple energy loads, operate as a single, autonomous grid either in parallel to or islanded from the main energy grid (Galvin Electricity Initiative, 2013; Navigant Research, 2012). It is considered a radical innovation, since the social configuration and the technical control are radically different from the current centralized energy system. In the Netherlands the Microgrid is still in its early stages of its development. There is very much unknown and uncertain about its potential success. However power equipment companies in the Netherlands want to know how they can influence the development, thereby learning more of the issues surrounding the innovation and to take an early competitive advantage in this new system.

Theories on technological transition, strategy formation and design of socio-technical systems have been consulted to find a theory or framework which elaborates on companies influencing the development of radical innovation. However, this type of theory or framework does not yet exist. In this research an attempt is made to fill this gap. The objective of the paper is to propose an analytical framework, which elaborates on how companies can assess the development of a radical innovation and determine a strategy to influence its path. The research question is *"What are the features of an analytical framework, which is able to determine the role of a company to shape the innovation towards successful diffusion?"*

By means of executing a literature research theories have been consulted regarding the development of innovations and strategic roles in business ecosystems. The contribution of this paper is the construction of the new framework, which builds on the previously mentioned theories. The framework conceptualizes the possibility to influence companies in the development of a radical innovation. From the framework a step-by-step approach can be deduced which makes it possible 1) to systematically analyze the development and 2) to identify the issues companies need to tackle or embrace in its diffusion.

The outline of the article is as follows. In the next section discusses the basis of the analytical framework. In sections 3 and 4 the different theories are discussed. In section 5 the constructed framework is presented. The final section ends with a conclusion and recommendations for further research.

2. Theoretical basis

There does not yet exist an analytical framework, which elaborated on phenomena where companies would influence the development of an innovation. For the creation of an analytical framework, the focus of the literature research has been on finding theories which elaborate on the two aspects separately: the development of a radical innovation and the strategy of companies in the (early) development of an innovation.

The focus of the research determines which concepts or elements of those theories will be used to build the framework from. The focus is on companies influencing the development in order successfully diffuse the innovation. The concepts of interest in the development theories are thus elements or concepts that elaborate on what drives or hinders successful innovations and how to accomplish successful diffusion. With regards to the theory of strategies, elements or concepts of interest are descriptive roles a company can take based on their own strengths and the status of the development process.

3. The development

As is stated earlier, two theories are used to create rich insights into an innovation's development. The first theory is the technological transition theory that focuses on the transformation process of radical technical innovations and its diffusion in its socio-technical environment. The second theory is that of technology adoption, which takes the perspective of the adopter rather than the development itself.

3.1. Technological transition

According to this theory, successful radical innovations go through a development in which they are introduced, generated and diffused into society, thereby transforming one socio-technical configuration into another. This entails that not only the technology changes, but also other interrelated societal domains, e.g. economics, politics and culture. Thus society changes in a fundamental way (Elzen & Wiczorek, 2005; Geels, 2002; Rotmans et al., 2001). The process is extremely complex and involves a multitude of technological and social factors on different aggregation levels - micro, meso and macro (Rotmans et al., 2001).

A transition only occurs when the developments of several of these factors come together and align. However this does not happen simultaneously, but takes a long period of time (Negro, 2007; Rotmans et al., 2001; Suurs, 2009). There are four different transition phases; 1) the predevelopment phase

in which new options and varieties are established by laboratories, universities and between stakeholders, 2) the take-off phase in which the process of change starts to occur, 3) the break-through phase in which visible structural changes take place due to the accumulation and reaction of socio-cultural, economic, ecological and institutional changes, 4) stabilization phase in which a new dynamic equilibrium is reached (**Fout! Verwijzingsbron niet gevonden.**) (Negro, 2007).

In the literature two main views on innovation processes can be found: the innovation system perspective and the multi-level perspective (Markard & Truffer, 2006; Negro, 2007; Suurs, 2009), each having their own framework to analyze innovation processes. However, both focus solely on the first two phases of the transition process, also called the innovation process. The first perspective focuses on the prospects and dynamics of a particular innovation that has the potential to contribute to far reaching changes. It identifies the most important drivers and barriers for a successful diffusion of a particular technology or product. The latter perspective focuses on the broader transition process at a more aggregated level (e.g. energy supply in general). It is concerned with the identification of factors that drive the transformation processes. The one has an emergent technology perspective, while the other has a more transition perspective (Markard & Truffer, 2008). After analyzing both perspectives, Markard & Truffer (2008) concluded that the two perspectives have very similar concepts in their frameworks but also have significant differences. However, according to them these differences can complement each other. Thus they proposed an integrated framework, here called the Markard & Truffer framework, to analyze the innovation process from both perspectives. In this research the Markard & Truffer framework is used for the contribution of theories on technology transition in the proposed framework, which is explained henceforth.

Markard&Truffer framework

The framework of Markard & Truffer is based on “the concept of technological innovation systems (cf. Bo Carlsson & Stankiewicz, 1995; Edquist, 2005; Hekkert, Suurs, Negroa, Kuhlmann, & Smits, 2007) but also draws on the literature on socio-technical regimes and transitions (e.g. Boelie Elzen, Geels, & Green, 2004; Geels, 2002; Rip & Kemp, 1998)” (Markard, 2008).

The central point of this framework is the Technical Innovation System (TIS). The TIS, more elaborately explained hereafter, is a network of institutions and actors in the public and private sectors, whose activities and interactions initiate, import, modify, and diffuse new technologies (Carlsson & Stankiewicz, 1991; Edquist, 2005; Freeman, 1987). It applies a technology specific perspective and restricts the system to actors, institutions and networks that are supportive to the innovation process (Markard & Truffer, 2008). The TIS can interact with its environment, also more elaborately discussed hereafter, consisting of its landscape, socio-technical regimes and/or other TIS.

The socio-technical regimes may represent barriers and drivers for the development and diffusion of the innovation. Depending on the institutional overlap or the shared set of actors of a TIS with a certain regime, resistance will be more or less intensive. Furthermore, the central TIS can interact with other TIS through two basic modes of interaction: competition and complementation. According to Markard & Truffer “If the products or technologies in two TIS serve similar purposes in similar application contexts, the interaction will have a competitive character. If, on the other hand, the innovations support each other, e.g. like network technologies, the interaction is rather complementary.” The landscape level consists of factors on the macro-level that influence or transition processes. However, in contrast to the regimes and other TIS, the landscape is hardly affected by the innovation and transition processes (Markard & Truffer, 2008). Analyzing both the TIS and its environment will result in insights in the introduction, generation and diffusion of an innovation in its socio-technical context. It focuses on both the

innovation process and the factors influencing this process.

3.2. Diffusion of Innovation

The second perspective on the diffusion of innovations is that of technology adoption. While the previous theory focused on how an innovation is generated, introduced and diffused, this theory focuses more on why this is. Rogers, one of the most influential researchers in this field, defines technology adoption as the stage in the innovation-decision process where the choice is made to make full use of the innovation as the best course of action available (Rogers, 1962). Many separate theories exist that explain the adopter's attitude, innovation adoption behavior and various determinants in different context of an innovation adoption, e.g. Diffusion of Innovation (DoI), Technology Adoption Lifecycle (TALC), Bass Model of Diffusion (BMD) and the Technology Acceptance Model (TAM) (Cowan & Daim, 2011; Hameed, Counsell, & Swift, 2012; Jeyaraj & Sabherwal, 2008). When examining the mentioned theories it became apparent that many are focused on the actual adoption process within an organization or individual, while the interest here is creating insight in the diffusion of an innovation on a systematic level. The theory that covers this is the DoI theory, which is introduced by Rogers. It is of origin a communication or social theory used to describe patterns of adoption. In this theory Rogers' explains that the diffusion of an innovation follows a S-shape, which similar to the previous theory. Only here time is put against cumulative number of adopters.

In the S-shaped curve of diffusion Rogers identifies five distinct adopters: innovators, early adopters, early majority, late majority and conservatives. Depending on when they adopt an innovation, they belong in a certain category. According to the theory the rate of adoption of an innovation, the slope of the S-curve, depends on five attributes, or characteristics. These being 1) relative advantage, 2) compatibility, 3) complexity, 4) trialability, 5) observability.

3.3. The elements of a radical innovation's development

The perspectives of both theories describe the same development path. The difference is the angle from which the development is viewed. The Markard&Truffer framework view the development from the external and internal forces that influence the diffusion. Rogers attribute assumes a perspective focused on the innovation itself. The two perspectives can be combined into one.

At the beginning radical innovations originate from developments in the technology rather than developments in the demand. In the predevelopment phase a long process of experimentation in pilot plants ascertain that market and technology can develop in a process of co-evolution (Mourik, R. and Raven, 2006). This happens in so-called niches, loci protected from the normal market selection in the regime (Geels, 2002). After its first successful developments, distinct application domains can be identified and basic configurations can be established (Mourik, R. and Raven, 2006) corresponding to the take-off phases. Assuming the theory of Rogers with regards to technology adoption, in the beginning solely innovators are working on the development of the innovative technology, while in the more advanced phase where distinct application domains can be identified, early adopters, actors who have different preferences than mainstream users, also become active (Rogers, 1962). By developing it even further the radical innovation will take off through the break-through phase in which the early majority of the adopters will become active, thereby becoming established in the meso-level. The late majority adopters will come in at the end of this phase and in the beginning of the stabilization phase. As a last group, the laggards will only become active when the innovation is already far in its development and is used by about 75% of the market (Rogers, 1962).

4. The strategy

The premise is that a single company should influence the development of an innovation. However a company is part of a bigger

network in which actors interact in the development of an innovation. A stand-alone strategy of one company may not have the desired effect due to the strategic actions of others. It is therefore required to understand the network, or ecosystem, and the company's role in it (Iansiti & Levien, 2004), before deciding on actions regarding the development of an innovation. The theory on business ecosystems focuses on the business ecosystem and the respective roles and strategies of a company within the system.

4.1. Business ecosystems

Networks are large coalitions of firms around a common technological platform. These networks are very similar to biological ecosystems where different species, or firms, work together and interact by performing their own functions (Gawer & Cusumano, 2008; Iansiti & Levien, 2004). Such networks are also called business ecosystems (Iansiti & Levien, 2004). The term business ecosystems is defined as "the term circumscribes the microeconomics of intense coevolution coalescing around innovative ideas"(Moore, 1996). Thus a network consists of several companies, suppliers and customers, around a specific technology that depend on each other for their success en survival. Each of the companies execute its own functions, have its own needs and contributes to the survival and growth of the business ecosystem (Hartigh & Asseldonk, 2004). Determining the boundaries is challenging. Hartigh proposes to determine which company is part of the ecosystem by the degree of compatibility and complementarity of the products or technologies the actor offers or adopts. An ecosystem evolves over time affecting the size and composition of the ecosystem. The ecosystem has four life cycle phases: birth, expansion, leadership and self renewal or death. The ecosystems in this research are often still in its first phase, in which radical (or cumulative incremental) innovations invent a new technology. The ecosystem is small and is populated by small pioneering companies. The relations are volatile and manifold (Hartigh & Tol, 2008). The health of an ecosystem is important since it represents the longevity and propensity for

growth (Hartigh & Tol, 2008). Its health is measured on two levels, partner and network, by means of three critical measures. The first measure is productivity, which is the ability to consistently transform technology and other raw materials of innovation into lower costs and new products. The second measure is robustness, which is the ability to survive disruptions such as unforeseen technological change. The last measure is niche creation, which is the ability to increase meaningful diversity through the creation of valuable new functions, or niches (Iansiti & Levien, 2004).

4.2. Strategic roles

Companies can influence the ecosystem in such a way that the development of innovations serves the strategic interest of the company (Hartigh & Asseldonk, 2004). There are different strategies in an ecosystem based on type of company it is or aims to be. Different researchers have their own classifications, but many overlap. In this research the classification identified by Iansiti&Levien (2004) is a value dominator (keystone), physical dominator or a niche player.

5. Proposed framework

As is discussed earlier, the objective of the analytical framework is to give an perspective on the strategic role of a company in the development of a radical innovation. The framework builds on three theories: the technology transition, technology adoption and business ecosystems. The objective was to find that elaborate on what drives or hinders successful innovations and how to accomplish successful diffusion. Three elements that do this from each a different perspective are: the innovation system (TIS), the 5 attributes of the innovation and the innovation's environment. Based on the business ecosystem four types of strategic roles can be identified that give possible strategic roles in the business ecosystem of an innovation. These are descriptive roles a company can take based on their own strengths and the status of the development process

These four elements must be coupled together to make a complete framework. Thus a jump has to be made between the development and the strategic role. The development alone of the innovation is not of interest for determining a strategic role. Rather the way it can develop over the years is more important to, since then the development is actually shaped. Thus the construction of a development path or paths is used to link the development concepts of an innovation to the strategic role in its business ecosystem. The analytical framework can be seen in Figure 1.

5.1. Analyses steps

From the analytical framework a step-by-step analyses process can be derived. The analyses provide guidelines to systematically gather and analyze data as to form a recommendation of a strategic role. An important aspect of these analyses is iteration. By analyzing and reflecting new insights are created and new aspects are discovered. Going back and forth will ensure that all relevant aspects are covered and the most valuable insights are gathered and concluded.

Step 1: identification of existing issues in the current development stage

Development paths can be established by using important environmental factors to map scenarios and internal variables or factors that can either mitigate or support the development. These factors or variables can be derived by analyzing the three elements of a development, since the current development stage gives insight in how an innovation is being established and why. Thus for step 1 three analyses must be conducted: analyses of the environment, the innovation system and the environment.

Step 2: establishment of various development paths

The second step in the analyses steps is to establish the development path(s). From the previous analyses important environmental factors and important internal factors can be identified. The first are factors that cannot be

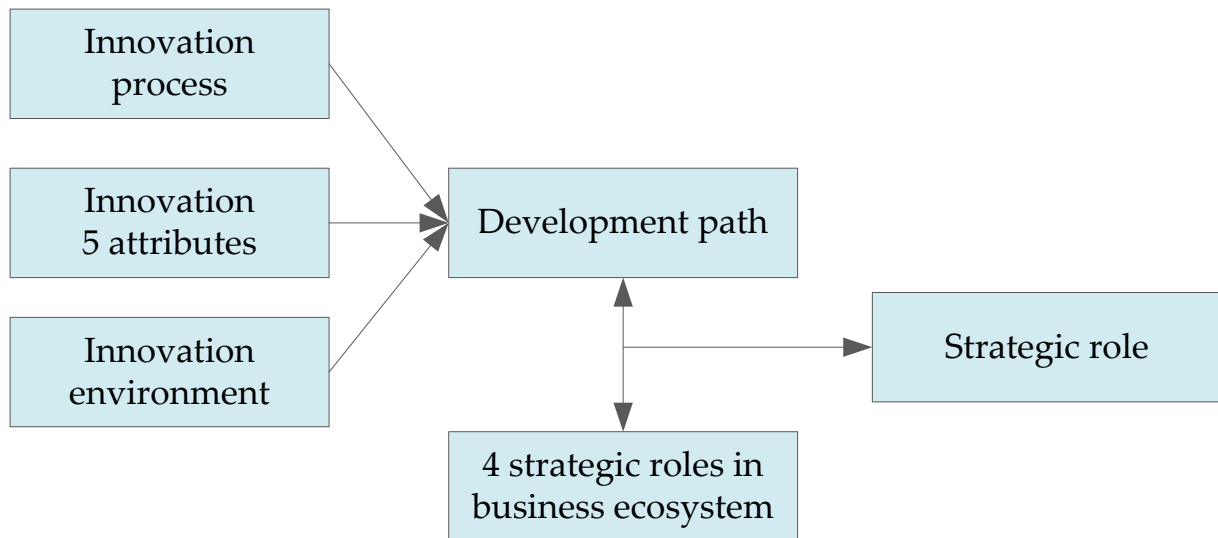


Figure 1: the proposed analytical framework

influenced directly by actors, while the latter are the factors that can be considered actions. These factors can be combined in development paths which describe a scenario and possible actions. It is not prescribed how this should be done scientifically, since it is dependent on the research and the factors in play. It is a result of a creative session in which the factors are put together to make likely predictions of the future development path.

Step 3: analyses of the business ecosystem

With this third step the focus shifts towards the finalization of determining the strategic role. This step entails analyzing the business ecosystem, which surrounds the innovation. This is done via an actor analyses. The objective is to create insight in the actors and their visions present in the business ecosystem.

Step 4: determining the strategic role

The strategy can be formed by taking into account the development paths of the innovation, the business ecosystem and the vision and strategy of the company in the analyses. By combining these three elements, different alternatives can be identified on how a company should establish itself or act in its business ecosystem

6. Conclusions and further research

In this article an analytical framework is constructed which conceptualizes the formation of a company's strategy to influence

the development of a radical innovation towards successful diffusion. The framework builds on extensive literature on the development of innovations and strategic roles in business ecosystems. The framework and derived analyses can be applied to any innovation (system or technology) and any company (e.g. customer, supplier).

In further research several subjects can be tackled in order to improve the proposed framework. As a first step different empirical researches should be conducted with this framework. This way it can be analyzed if the framework should be refined. Second, the theories used discuss stand-alone technologies. In some cases radical innovative systems are the focus point. The framework developed in this research, while promising in its set-up, requires further elaboration to handle the complexity of the systematic aspect.

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