

Market Creation for Radically New Technologies: a Literature Review on the Role of Market Niches

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Abstract

The article focuses on the role of niche markets in creating a market for radically new technologies. Managerially, niche strategies are important to build up a market. Scientifically, the information about these strategies is scattered. In a literature review four research questions are addressed: (1) Are different types of niches distinguished? (2) Are specific sequences of niches distinguished? (3) What are the factors that determine the emergence of niches? (4) Are different niche strategies distinguished? We found that articles focusing on technical details or on social aspects alone underestimate the difficulties in building up markets for radically new technologies. Three sequences of market niches are found to build up such markets. Many factors important for the emergence and selection of niches are found but the overview is lacking. We found two generic niche strategies and indicate when these strategies are applicable. The review discovers important gaps in the extant literature.

Keywords

Radically new technologies, Market creation, Niche markets, Niche strategies, Niche management

1 Introduction

Nylon was first applied in tooth brushes in 1937 before it entered a mass market in 1940 in the form of lady stockings. The contraceptive pill was also first introduced in small scale applications from the late 1920s on, as a hormone preparation for complaints such as problem pregnancies, gynaecological cancers, menopausal complaints of woman and hormonal disorders in men, before it became a regular contraceptive that diffused in a mass market from the 1960s on [Junod and Marks, 2002]. Many radically new, and later-on successful, technologies are introduced in niche markets prior to the emergence of a mass market [Levinthal, 1998], [Ortt et al., 2009], [Sood and Tellis, 2005], [Tushman and Rosenkopf, 1992]. These niche markets form a kind of transition path towards mass markets [DeBresson, 1995].

This article focuses on these niche markets and their role in creating a market for radically new technologies. We will present the results of a literature search focusing on niche markets, niche management and niche strategies. This search tries to shed light on questions such as: what types of niches can be distinguished, what are the factors important for the emergence and selection of niches, and what are alternative niche strategies?

Definitions

In the article we focus on radically new technologies. The contraceptive pill and Nylon have in common that, at the time of their introduction, they were radically new in the market and state-of-the-art in their respective disciplines. Radically new in the market means that the functionality was new to the market or the price-performance ratio was much better than contemporary products. State-of-the-art in their respective disciplines means that the products were based on new technical principles (e.g. contraception using hormones) or were based on an existing

principle but with a much better price/performance ratio. Following the typology proposed by [Garcia and Calantone, 2002] we therefore refer to them as radically new.

A niche market refers to a relatively small group of customers with specific wants and demands regarding a product [Dalgic and Leeuw, 1994], [Shani and Chalasani, 1993]. [Parrish et al., 2006] contrast niche and mass markets in terms of the size of the market (small or large) and the product characteristics (specialized or generic functionalities). Niche markets can be further subdivided using the stage of the technology life cycle in which they emerge. We define a “strategic niche” as a niche application that emerges prior to industrial production and large-scale diffusion of a radically new technology in a mass market. A typical strategic niche is the use of digital imaging in satellites for military surveying. This strategic niche appeared prior to the use of digital imaging in ordinary photo cameras. Niches can also emerge later on i.e. during large-scale diffusion of a technology, when the market has matured. In the latter case we refer to these niches as “mature niches”. An example is the segment of consumers that nowadays want a hand-made and unique car.

After defining radically new technologies and different types of niche markets we will also define niche management and niche strategy. Niche strategy refers to a deliberate choice to introduce a radically new high-tech product in particular types of market niches. An example of a niche strategy is to focus on government protected niches first and then, later on when the technology has matured, conquer market niches that face competition from existing technologies. Niche management refers to the organizational and management challenges within a particular niche in order to make products on the basis of the technology successful in that niche and to use the niche as a stepping stone towards a mass market.

Relevance

Niche markets represent a highly relevant topic, both from a scientific and managerial perspective. From a managerial perspective, niche strategies are often described as an important step in commercializing new high-tech products [DeBresson, 1995], [Meldrum, 1995], [Moore, 2002], [Lynn et al., 1996]. [Hultink et al., 1997] show that in a large sample of innovating companies, that the greatest success was enjoyed by a small group of companies categorized as “Niche Innovators”. Their launch strategy involves a niche focus, targeting innovative products into markets with few competitors. [Debruyne et al., 2002] show that competitors fail to respond to niche market introductions for radical innovations. In addition to these survey studies, several studies can be found that describe subsequent niche applications for radically new technologies [e.g. Lynn et al., 1996], [Levinthal, 1998], [Ortt et al., 2007]. So, niche markets play an important role in the commercialization of radically new technologies [Gerlagh et al., 2004].

From a managerial perspective, the niche strategy might be identified as an important strategy, yet the information about these strategies is very generic. “The literature is generally silent when it comes to addressing a number of market conditions and features such as the existence of niche markets that can support the development of new technologies.” [Gerlagh et al., 2004, p. 369]. Most of the information on niche markets and strategies is case-based and, as a result, hardly generalizable. Different types of niche strategies are proposed and different sequences of niches are explored [DeBresson, 1995], [Venkatesh and Vitalari, 1986] but the types and sequences of niches are highly case-specific. Our contribution is to analyse available information from the scientific literature.

Research questions and contents

Articles from a literature search are analysed using the following questions:

1. Are different types of niches distinguished?
2. Are specific sequences of niches distinguished?
3. What are the factors that determine the emergence of (particular types of) niches?
4. Are different niche strategies distinguished?

We will show that articles focusing on niches belong to different sub-disciplines or scientific fields. These disciplines differ in how they see the pattern of development and diffusion of radically new technologies, the role of niches in these patterns and their respective methodologies in empirically assessing the questions.

In the next section the method of the literature search and the analysis of the resulting articles are described. The third section will present the results. The conclusions and discussion are in the fourth section.

2 Method

A literature search was performed in Web of Science. We tracked scientific articles in “Web of Science” having the terms “niche market*” “niche manag*” or “niche strateg*” in the title of the article. The “*” in “market*” means that all articles with market, markets or marketing in their titles were selected. A similar approach was adopted for manag* and strategy* to select articles having terms related to management or strategy in their title. The search results in three subsets of articles (niche market, niche management and niche strategies in title).

Three blocks of results from the literature search will be reported. Firstly, the preliminary results show how articles from the literature search are selected. The preliminary results also indicate to what extent the selected sets of articles overlap. Secondly, we analysed the articles to assess whether specific groups or disciplines can be distinguished. This analysis is based on the references in the article and the contents of the article. The contents refer to the type of product or technology described or the type of approach proposed in the article. The third part of the results forms the core of the article. In this part we present the answers to the research questions after analysing the articles.

To analyse the selected articles systematically, we formed a template that was completed for each article. Using the template the discipline of the article was assessed and information regarding the four research questions was gathered systematically. From these templates an extended table was formed with articles in the rows and issues in the columns to allow a systematic overview of the information in the articles.

3 Results

3.1 Preliminary results

Three separate searches for articles in Web of Science were completed using the following combinations of words in the title: niche market*, niche manag* or niche strateg*. The searches were completed in October 2011. Table 1 shows the number of articles resulting from each search and the number of articles selected for analysis.

Search terms→ ↓ Subsequent selection	Niche market*	Niche manag*	Niche strateg*
Articles with terms in title	143	28	61
Articles selected abstract + intro	75	16	23
Articles completely read + analysed	25	16	22

Table 1: Selection of articles.

Many articles were found with niche and market* in the title (143 in total). In order to select articles we looked at the title. If the title reflected that technology or a high-tech product was described or if the title reflected that a niche was used to build up a market for the case of a particular product, then the article was retained for further analysis. Conceptual and more theoretical articles discussing niches in general were also selected for further analysis. In total 75

articles were selected in the “niche market” category. These articles were further explored by reading the abstract and introduction. In total 25 articles were selected for detailed analysis i.e. the articles were completely read and for each of the articles a template was completed. For articles from the other two categories, with niche manag* and niche strategy* in the title, a similar process was adopted and 16 and 22 articles were finally selected for complete reading and analysis using the template.

Table 2 shows the overlap in the three selected sets of articles. All of the articles had the term “niche” in their title. The first column shows that from the 25 articles with both “niche” and “market” in the title, two had also “management” in the title and another two had also “strategy” in their title. The total number of articles (corrected for overlap) can be found by adding the bold numbers in Table 2. In total, because of the overlap in the selected sets of articles, not 63 articles (See totals per column in Table 1, $25+16+22=63$) but 49 ($21+2+4+2+10+10=49$) articles were analysed.

	Niche Market*	Niche Manag*	Niche Strateg*
Market*	21	2	2
Manag*	2	4	10
Strateg*	2	10	10
	25	16	22

Table 2: Overlap in the articles

3.2 Results regarding categories of articles discussing niches

Many different (sub)disciplines focusing on niches (i.e. niche market, niche management and niche strategies) can be distinguished. In a kind of simplification a tree diagram can be formed with a single disciplinary branch at the bottom (technical and social sciences involved with niche markets, niche management and niche strategy) and a very fine-grained set of branches at the very top. After considering different categorizations and different levels of detail we arrived at a categorization of six groups of articles.

To create these categories we use a continuum from fully technology-oriented articles (with no market, management and strategic considerations) up to fully marketing, management and strategy oriented articles (with no technological considerations). To assess the position of an article on the continuum we looked at the references and the content of the article. Completely technology-oriented articles focus on a particular set of technologies and almost exclusively describe the technical details of these technologies. This is reflected in the list of references. Completely market/management and strategy oriented articles do not specify the particular technologies and do not refer to technical articles. These articles focus on marketing, management and strategy references.

Table 3 shows some data regarding the categories of articles. The first column in Table 3 describes the category of articles, the second column indicates whether or not the category represents a true discipline, meaning that the articles in the category share an approach and conceptual model and refer to each other. The third column indicates what type of pattern of development and diffusion is envisioned for technological product(s) in the article and what the role is of niches in that pattern. The fourth column indicates the types of methodology adopted in each category of articles. The last two columns indicate the number and type of references in each category, respectively.

Description of category of articles	True Discipline	How is pattern of development and diffusion seen? What is the role of niches in that pattern?	Mainstream Method	N	References
1 Articles from Marketing, Strategic management, Economics or Sociology without discussing technical aspects of products or technologies.	Multiple Disciplines	Usually standard diffusion theory is adopted in which a product gradually diffuses directly after introduction. Niches are almost always seen as small market segments next to a mature market.	Survey study; Multiple-case study; Simulation study; Single case study; Conceptual theory.	10	[Basov & Smirnov, 2007] [Bradburd & Ross, 1989] [Brooks, 2003] [Brouthers & Van't Kruis, 1997] [Burt & Talmud, 1993] [Debruyne & Reibstein, 2005] [Ivanov, 2009] [Rhee et al., 2006] [Toften & Hammervoll, 2007] [Wright, 1986]
2 Business press articles: Mostly implicitly based on Marketing, Strategic management or Economics without technical details.	No	Describing niches as new exciting market segments in existing industries but next to a mature market.	Journalism: Opinion, statement backed up with data.	5	[Klebnikov, 1997] [Lenorovitz & Herndon, 1994] [Rose, 1986] [Sparaco, 1994] [Yim, 2010]
3 Strategic Niche Management: articles focusing on sustainable clean and socially-responsible technologies.	Yes	In the beginning of the pattern both development and diffusion is not smooth but irregular and hampered by lock-in effect of existing technologies institutions, and so on. Niches are seen as a step towards building of a new market (regime).	Single case study; Conceptual theory.	14	[Caniels&Romijn, 2008a] [Caniels&Romijn, 2008b] [Eijk & Romijn, 2008] [Hegger et al., 2008] [Kemp, et al., 1998] [Monaghan, 2009] [Raven, 2007] [Raven et al., 2010] [Raven et al., 2011] [Romijn et al., 2010] [Schot & Geels, 2008] [Van der Laak et al, 2007] [Verborg et al, 2010] [Witkamp et al, 2011]
4 Articles focusing on one type of product/technology (often sustainable technologies) combining both technological and social aspects.	No	In the beginning of the pattern both development and diffusion is not smooth but irregular and hampered by lock-in effect of existing technologies institutions, and so on. Niches are seen as a step towards building of a new market (regime).	Case study; Multiple case study; Simulation.	10	[Adamson, 2003] [Andrews & deVault, 2009] [Cai et al., 2008] [Foxon, 2010] [Gerlagh et al., 2004] [Jorgenson, 2007] [King & Tucci, 2002] [Little et al., 2010] [McFadden et al., 2009] [Tso & Chang, 2003]
5 Articles focusing on technical details and mentioning a kind of market (niche) that might have potential for the technology.	No	The pattern is not described explicitly. In many of these articles, price/performance characteristics of the new technology/product are matched with various requirements in separate niches of the market.	Mostly technical conceptual articles;	4	[Andreou, 2008] [Cigolotti et al., 2008] [Mollersten et al., 2003] [Ramirez et al., 2009]

Description of category of articles	True Discipline	How is pattern of development and diffusion seen? What is the role of niches in that pattern?	Mainstream Method	N	References
6. Outliers: articles that do not fit in the categories because they focus on complete industries or public policies.	No	No common (implicit) pattern of development and diffusion. Niches are seen as specific segments of users with specific requirements regarding a product category.	Various methodologies (not a homogeneous mix)	6	[Brown, 1995] [Chang & Tsai, 2002] [Chen et al., 2010] [Chibnik, 2000] [Moellenkamp et al., 2010] [Morales, 2008]
				49	

Table 3: Categorization of articles in six groups

We distinguished six categories of articles. The first and second categories comprise ten scientific and five business articles. The first category of articles is based on ideas from the disciplines of marketing, management, economics or sociology, and these disciplines are reflected in the references. These articles do not constitute a sub-discipline but rather come from different disciplines. An example is [Toften and Hammervoll, 2007] who describe how Norwegian fishermen search new market segments abroad to sell their fish specialties. The second category, comprising business press articles, is implicitly based on the same thinking but lacks a list of references. Both categories of articles do not discuss technical aspects. In both categories of articles, market niches are seen as an exciting small segment of users next to a mature market. Implicitly articles in both categories adopt a model in which new products diffuse gradually in the market and thereby adopt a smooth S-shaped pattern of development and diffusion proposed by diffusion researchers [Rogers, 2003].

The third and fourth categories of articles comprise 14 and 10 articles, respectively. The third category is the only true (sub)discipline, referred to as “strategic niche management”. In that category the authors share theoretical notions, practical approaches and they explicitly work together and refer to each other. The basic idea of the sub-discipline is that in the beginning of the pattern, the development and diffusion of radically new technologies is not smooth but irregular and hampered by lock-in effects of existing technologies, institutions, and so on. Market niches are seen as a step towards building of a new market (regime). The sub-discipline focuses on sustainable (clean) or otherwise socially responsible technologies and generally claims that these technologies need a protected niche to mature before they can compete with existing technologies. The authors therefore envision an important government role to stimulate and protect these technologies. Overviews of the discipline can be found in [Kemp et al., 1998] and [Schot and Geels, 2008]. The fourth category of articles shares some of the ideas of “strategic niche management” because it also focuses on sustainable technologies and organic food, but these articles are not written by the same group of scientists. These scientists also claim that socially responsible products can not directly compete with existing products but they describe other mechanisms than government protection to circumvent direct market competition.

The fifth category of articles focuses on technical details, in these articles market niches are just mentioned as a viable type of application for one technology. The pattern of development and diffusion is not described explicitly. In many of these articles, price/performance characteristics of the technology are matched with requirements of niches in the market. An example is the article from [Andreaou, 2008] describing how optical-electronic components can be applied in a particular market niche.

The last category of articles is a set of outliers some of which, however, present very interesting ideas regarding niche markets, niche management and niche strategies. [Chibnik, 2000], for example, describes in detail how the market for woodcarving in Mexico evolved over time. [Chen et al., 2010] describe how Asian countries stimulated medical tourism towards their countries.

We conclude that several categories of articles focusing on niches can be distinguished with only one true (sub)discipline, referred to as “strategic niche management”. The categories are:

1. Articles from a traditional social sciences perspective (economics, sociology, marketing, management) that hardly discuss technical aspects.
2. Business press articles that hardly discuss technical aspects.
3. Strategic niche management articles, representing a discipline focusing on sustainable technologies and discussing both technical and social aspects.
4. Articles describing the market creation of socially responsible technologies such as organic food and clean technologies. These articles describe both technical and social aspects.
5. Technical articles focusing on one particular technology describing its technical details and indicating a potential niche application for that technology without discussing social aspects.
6. Other articles.

Categories of articles can be subdivided or combined. The first category, for example, can be further subdivided by forming groups of articles with an economic, sociological, marketing or management background. The opposite is also possible, category 1 and 2 can be combined because they have in common that they ignore technical aspects. Category 3 and 4 can be combined because they both look at social and technical aspects.

We think that the most interesting conclusion from Table 3 is that articles focusing on technical aspects and the articles focusing on social aspects alone have in common that they underestimate how long it takes and how difficult it is to create a market for radically new technologies. These completely different articles have in common that they perceive market niches as small markets in which suppliers can ask a premium price for special products. In contrast, the articles that discuss the combination of social and technical aspects are usually based on historical case-studies and these studies clearly indicate how difficult it is to create a market for radically new technologies. These articles do envision a pattern of development and diffusion in which large-scale diffusion is often preceded by a long period with erratic and small-scale diffusion in niche markets. In these articles, niche markets have an important role in exploring and building up a market.

3.3 Results regarding the research questions

In this literature review four research questions are answered:

1. Are different types of niches distinguished?
2. Are specific sequences of niches distinguished?
3. What are the factors that determine the emergence of (particular types of) niches?
4. Are different niche strategies distinguished?

Ad 1/2 Different types and sequences of niches

After analysing the 49 articles, we found that 12 articles do actually distinguish different types of market niches. After analysing these 12 articles we found that seven articles describe niches prior to the emergence of a mature market, four articles describe niches next to a mature market, and one article describes niches after the emergence of a mature market.

Our attention focuses on the seven articles that describe different types of niches prior to the emergence of a mature market. These niches are important because they indicate how a market for a radically new technology can be created. We found three different sequences of niches during the process of building up of a new market.

- a. [Adamson, 2003] describes that a primary niche for a sustainable technology should focus on a market niche where the technology has a unique functionality. In the primary

niche the technology does not compete with an established technology but may compete with alternative new or emerging technologies. An example is the use of solar panels in places where no electricity networks are available. In the subsequent or secondary niche, the new sustainable technology has matured to a degree that it can compete with contemporary technologies in specific niches favouring the particular characteristics of the innovation. After these niches, the sustainable technology can gradually start competing in a mass market.

- b. [Schot and Geels, 2008], [Tso and Chang, 2003] and [Monaghan, 2009] indicate how a government should create a protected space for a new sustainable technology because the technology cannot survive when directly faced with market forces. [Schot and Geels, 2008] describe how a sustainable technology should first be tested in an experimental or pilot setting, referred to as a technological niche. Then, gradually specific market niches can appear where the technology is applied in competition with other technologies. Finally, when a combination of several market niches enables attaining economies of scale, learning effects regarding the application of the technology and enables the creation of complementary products and services and necessary networks of institutions, companies and other actors, a regime shift can occur. A regime shift means that a radically new technology successfully enters a mass market.
- c. [Jorgensen, 2007], [Little et al., 2010] and [McFadden et al., 2009] focus on the market for organic food. They describe how the market for this radically different type of food started as an act of idealism by a small societal group. This group shared challenging ideas about fundamental changes that were required in society. Organic food was just seen as one important element in their ideal society. Organic food in Denmark, for example, started in a segment of society where economic and competitive mechanisms were circumvented by mechanisms of barter and other alternative systems of payment. [Little et al., 2010] for example describe how societal groups adopted alternative mechanisms of payment for organic food using payment in kind, and how these groups gradually formed a kind of buyers' cooperation that used their home to distribute food from selected farmers. Volunteers organized community activities such as pot luck dinners and were organizing recipe swaps. Later on, in a next step, some of these initiatives could increase their scope and turn into a real market segment when the first chains of alternative food shops emerged. The increase in scope almost inevitably entailed compromising a little on the societal ideals. Finally, organic food was embraced by institutions of research and the mass market was entered when supermarkets started to sell organic food.

We conclude that these three sequences of niches represent completely different ways to build up a market for radically new technologies. [Adamson, 2003] proposes that market mechanisms are important and that a market can be created by carefully entering subsequent market segments with limited competition. In contrast, strategic niche management scholars such as [Schot and Geels, 2008] do believe that a new market for radically new sustainable products can be created only when the first niches are protected from market competition and that this protection requires government intervention. [Jorgensen, 2007], [Little et al., 2010] and [McFadden et al., 2009] agree with the notion that radically new products require some protection but disagree that governments should intervene. These authors describe how alternative economic mechanisms in small groups are used to temporarily shield off market competition.

Ad 3. Factors important in market niches

After distinguishing different types of niches we will now turn attention to the type of actors and factors that determine whether and how niche markets emerge. After analysing the 49 articles, we found that 16 articles have no specific information on the factors and 12 articles focused on factors important for the emergence of niches next to a mature market. Our analysis focuses on

21 articles that describe factors that played a role in niche markets prior to the emergence of a mature market.

The remaining 21 articles describe actors and factors related to niche markets. In order to analyse these factors we listed them per article. We conclude that many factors are distinguished but an overall categorization or system to classify these factors is completely lacking. In most articles, typical factors in a particular case are described, which means that widely different factor subsets are discussed. In a first effort to make a classification we will distinguish four categories of factors important for niche markets:

- Factors that indicate why a market niche emerges.
- Factors playing a role in the selection of specific market niches.
- Factors and mechanisms important to build up a market niche.
- Factors important for the protection of a market niche.

The first category of factors describes why market niches in general emerge prior to large-scale diffusion. Market needs and problems not covered by existing technologies and products can be a reason why a new market emerges. An example is electricity production from solar photovoltaic cells that proved competitive in some remote areas such as small islands where contemporary technologies cannot work [Gerlagh et al., 2004]. Another reason why market niches emerge has to do with company strategies. [Grübler and Messner, 1998] for example explain the presence of niche markets as a hedging strategy of firms. Firms invest in a diverse technology spectrum to secure their future position in an uncertain future market. The strategy perspective can also hold for governments that consider specific sustainable or responsible technologies as vital for society and therefore deliberately intervene to stimulate the creation of a market for these technologies. [Caniels and Romijn, 2008a] elaborate on this perspective. Both market needs or problems and strategies of companies or governments can explain the emergence of new markets but do not explain why market niches instead of mass markets emerge. To understand the reasons that market niches emerge we will refer to the strategic niche management literature describing why transitions are complex processes often lasting for decades. This literature explains the emergence of niches instead of a mass market in terms of lock-in mechanisms and barriers. The lock-in mechanisms are summarized by [Raven et al., 2010] and comprise rigidity because of the existing institutions, actors and social networks and technological systems. The barriers are described by [Kemp et al., 1998].

When market niches are likely to appear, the second category of factors can be useful to select the best market niches. Many articles describe market selection forces that have to be faced when selecting a market niche for a new technology. These market selection forces are manifold but the ones mentioned most often are:

- a. The competition with new or with existing technologies on price or on performance. Many radically new high-tech technologies initially show weaknesses in performance and still require major investments to adopt and implement.
- b. The long timespan required for radically new technologies to mature and the accompanying investments required.
- c. The huge changes required socially, institutionally or organization-wise to firmly implement the technologies in mass markets.
- d. The uncertainty about the improvement in performance both of the new and the existing technologies, the uncertainty about changes on the demand-side of the market and finally the uncertainty because of random events.

The third category focuses on the mechanism of development within a market niche that are required to create a more large-scale market and These mechanisms are elaborated in the strategic niche management literature and in other categories of literature. We distinguish three of these mechanisms:

- a. Learning (by doing) is required to match a product version and an accompanying market niche and to learn how to implement and use the product in that niche.
- b. Stakeholder management and alignment is required to build social networks that share expectations regarding the technology.
- c. Creating economies of scale and network effects and a system of complementary products and services.

The fourth category of factors indicates how the market niche can be protected so the development process can continue and the technology can become more mature before competition wipes out this technology. Several articles describe how governments can intervene in market mechanisms and thereby promote or protect technologies that they consider to be important for their society. The governments can intervene in different ways. A government can:

- a. Stimulate research and can disseminate information from research.
- b. Support demonstration projects and early commercialization investments.
- c. Facilitate the use of the technology by overcoming institutional and non-market barriers.
- d. Become a lead-user by adopting the technology as a customer and thereby stimulating the emergence of a market for the technology.
- e. Impose taxes on or pricing of existing technologies to favour new technologies.
- f. Adopt a directive, set a standard or make a law to force the market in a direction.
- g. Control the entire process of building up a market.

Several authors describe combinations of government intervention e.g. [Andrews and de Vault, 2009], [Foxon, 2010].

Ad 4. Different niche strategies to create a market

Two generic types of niche strategies are distinguished to build up a market for a radically new technology: niche accumulation and niche hybridization [Raven, 2007]. A niche accumulation strategy refers to the application of a technology in different niche markets outside the mass market. Outside the mass market the radically new technology can develop without severe competition from mature technologies. In these niches complementary products and services, required institutions and networks among actors required for large-scale diffusion can be developed. In contrast, in a niche hybridization strategy, the radically new technology is combined with an existing technology in a kind of hybrid product design. “The rationale for applying a hybridization strategy is that a technology developer can circumvent harsh competition with the established regime. In particular in cases where a ‘hard’ infrastructure is a crucial aspect of the functioning of the regime, hybridization can be an important strategy, because these are often tightly coupled regimes that create a high threshold for new technologies.” [Raven, 2007, p. 2396].

These generic strategies can be applied in different settings. From the articles we can infer three different settings (see the section on different types and sequences of niches): an alternative market setting without government intervention, a market setting with some government intervention and a fully government controlled setting of market creation.

Setting	When	Accumulation Hybridization	Example
Alternative setting to circumvent market forces without government intervention	Product cannot survive normal competition in a market.	Accumulation is a logical strategy. Alternative economic mechanisms are applied to foster the radically new product in an alternative social group.	Organic food
	Government is not ready or willing to stimulate the product.	Hybridization is less logical in the alternative setting because the radically new product is based on different values and the segment of users usually rejects existing products.	-
Market setting with some government intervention	Product can survive in a market	Accumulation can be a good strategy when specific segments value the product as unique.	Solar cells
	Government can accommodate or facilitate but can leave initiative to the market.	Hybridization can be a good strategy when the radically new product can be combined with the existing products and the existing infrastructure and complementary products and services can be applied. Hybrid combination must be able to compete with existing products.	Hybrid cars
Government controlled market creation	Product cannot survive normal competition in a market	Accumulation: government controlled and protected niches often start outside the mass market if experimentation with the technology is required and combinations of new and old products are not possible.	Jet engine in airplanes
	Government is willing to stimulate the product.	Hybridization is possible when technologies can be combined.	Biofuels

Table 4: Niche strategies in different settings

In general hybridization is the preferred strategy to introduce a new technology because in this strategy the new technology builds on and re-uses important parts of the socio-technical system for the existing technology. This strategy will probably increase the speed of diffusion. An important conclusion from Table 4 is that hybridization is only possible in specific circumstances:

- It should be technically possible to combine old and new technologies and the combination should perform relatively well on an aspect that is considered important by customers or by governments.
- The new technology should be technically mature before it can be combined with existing mature technologies.
- Especially for technologies that require an extensive system of complementary products and services, hybridization is a viable strategy if the old and new technology can share this system.
- The customers should value the combination of old and new technologies in products and the suppliers should be able to benefit from selling the combination.

Hybrid cars incorporate a radically new technology that performs relatively well in terms of fuel efficiency. Electric motors and internal combustion engines are well developed and represent mature technologies. Both the old and the new technology (cars with electric and internal combustion engines) require an extensive system of complementary products and services that can be shared. An advantage of a hybrid car compared to a complete electric car is that a network of electricity provision is not required because the internal combustion engine can load the batteries. Customers value the combination of these technologies. Governments often decide to

subsidize hybrid cars to make them economically competitive and allow suppliers to profit from selling them.

In some cases hybridization is not possible. Experimentation with the first jet-engines in airplanes, for example, was done separately because propellers and jet engines cannot be combined in airplanes. Experimentation with organic food, for example, was done separately from the existing food chain because the first segments of users were opposed to the existing food chain and therefore deliberately refused to make hybrid combinations.

4 Conclusion and discussions

In this article we presented the results from a literature research on niches and their role in creating a market for radically new technologies. The literature search focused on scientific articles describing niche markets, niche management or niche strategies.

Different categories of articles are distinguished by looking at the technical and social aspects covered in these articles. A continuum can be formed from almost completely technical articles to articles only addressing sociological, economic, marketing and management aspects (we will refer to the latter combination of aspects as social aspects). We found that articles focusing on technical details have in common with articles focusing on social aspects that they underestimate or ignore the problems in building up a market for radically new technologies. In these categories of articles, niche markets are seen as small segments of users that require a special product version. In contrast, articles describing the combination of social and technical aspects are often based on in-depth case-analyses and do describe the problems in building up a market. These articles notice a long period of trial and error before large-scale diffusion. Niche markets have an important role in building up the market.

Further research focused on four research questions:

1. Are different types of niches distinguished?
2. Are specific sequences of niches distinguished?
3. What are the factors that determine the emergence of (particular types of) niches?
4. Are different niche strategies distinguished?

Regarding the first and second research question, we found three sequences of niches to build up a market. The first sequence of niches to build up a market for radically new technologies suggests introducing these technologies in a market environment with mild competition rather than a fully protected environment. A careful selection of subsequent niches referred to as primary and secondary niches is required therefore. In the first type of niches the products' functionality is unique and the competition is limited, in the second type of niches the product is competing with existing products but on utility rather than price. Subsequently, the products can enter a mass market. The second sequence that we found indicates how a government should create a protected space for a new technology if the technology cannot survive when directly faced with market forces. In a so-called technological niche the technology can mature and in subsequent market niches economies of scale can be attained, complementary products and services and necessary networks of institutions and companies can be built up before the technology has to face competition with existing technologies. The third sequence to build up a market for a radically new product illustrates how alternative economic mechanisms in small groups are used to temporarily shield off market competition.

These three sequences have in common that they envision market niches where the technology can build up momentum and mature without the severe competition with existing technologies in a mass market. These sequences differ in how these niches are shielded off from severe competition. In the first type of sequence, market niches are selected where the new technology is unique and existing technologies can not be applied. In the second type of sequence, government protects particular market niches and in the third sequence small and relatively closed social groups apply the new technology and circumvent normal market mechanisms.

Regarding the third research question (What are the factors that determine the emergence of niches?) we found a large number of factors in the articles. Some of these factors indicate that niches will emerge in general when a radically new technology is introduced, other factors indicate which particular niches will emerge, and some factors refer to the activities to build up a new market.

Regarding the fourth research question (Are different niche strategies distinguished?) we found two generic niche strategies to build up a market for a radically new product, the accumulation and the hybridization niche strategy. We indicated when these strategies can be applied. A hybridization strategy is generally preferable because this strategies forms combinations of new and old technologies that enable the use of existing systems of complementary products and services as well as institutions and networks of companies. This strategy, however, requires that old and new technologies can be combined in a way that performs better in some important aspect. This strategy also requires maturity of both the old and the new technology, it requires the possibility to re-use existing systems of complementary products and services and finally it requires customers who value the combination of technologies and suppliers who benefit from the combination. In the cases where these requirements are not met, an accumulation strategy can be adopted where the technology is building up momentum outside the mass market.

After our review we can see that those scientific approaches that study the combination of social and technical aspects during the development and diffusion of radically new technologies have found important results regarding market niches for emerging technologies. Management of technology, as a discipline, has an important contribution because of the focus on both social and technical aspects.

Our review also indicates important gaps in the literature. Case-studies have reported in some detail how the combination of social and technical aspects shaped patterns of development and diffusion for radically new technologies. A first gap is that multiple case studies are required across industries and across types of technologies, to generalize the findings from the case studies. Most articles describe one particular case. In strategic niche management, several cases are investigated but these cases are limited to socially responsible and sustainable technologies. We need results from different types of technologies to advance our knowledge of building a market for radically new technologies. A second gap is that systematic models that link market or other factors with the emergence of niches are almost completely lacking. Many factors are discussed in the articles yet a systematic model that indicates the importance of these factors, their interrelationships and their combined effect on market formation is missing. Strategic niche management as a sub-discipline has important contributions in this respect but their focus on government intervention to promote sustainable and socially responsible technologies means that economic mechanisms have been ignored to some extent. Managerially relevant findings should include economic mechanisms and focus on questions such as: (1) When (for what technologies and in what market context) are niche strategies required to build up a market and when can direct mass market strategies be adopted to build up a market? (2) How to select the best niches to start the process of building up a market? (3) How to manage the processes of building up within these niches so a mass market will emerge?

We feel that knowledge about niche markets, niche strategies and niche management are vital when commercializing radically new technologies. This is an interesting “management of technology” topic with important gaps that need to be filled if we want to advise companies how to introduce their radically new technology.

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