II. Conceptual foundations of the embedded lead user phenomenon

1. User innovation and related phenomena

The phenomenon of user innovation and its theoretical underpinnings are closely linked to Eric von Hippel who started his work on this topic in the seventies. He was one of the first scholars who challenged the traditional view of innovation (also called manufacturer-active paradigm) which regarded customers and users as passive consumers of innovation (e.g. new products and services) and manufacturers as only relevant source of innovation (von Hippel 1976; von Hippel 1988). In early research efforts he and others showed that innovation is not always induced by manufacturers and employees of firms, but users both engage in innovating and exploiting innovations (labeled as customer-active paradigm)[4]. As the distinction between users and manufacturers is central to this stream of research I will follow von Hippel in his definitions thereof (von Hippel 2005, p. 3):

> *"Users [...] are firms or individual consumers that expect to benefit from using a product or a service. In contrast, manufacturers expect to benefit from selling a product or a service."*

Thus the definition of users comprises both intermediate users (such as firm employees, scientists, surgeons) and end users (users of consumer goods) (Bogers et al. 2010). With respect to the first group, researchers have presented both evidence of product and process innovation.

Product innovation by intermediate users has been observed in various cases: Evidence includes scientists who invent and prototype new scientific instruments (Riggs and von Hippel 1994; von Hippel 1976), doctors who develop and commercialize own surgical devices (Chatterji and Fabrizio 2011; Lettl 2007; Lettl 2005; Lettl and Gemünden 2005; Lettl et al. 2006a; Lettl et al. 2006b), industrial plumbers who deliver ideas for pipe hanger systems {Herstatt, 1992 #836}, or librarians who design and share their own information systems (Morrison et al. 2004; Morrison et al. 2000). Other than product innovation, scholars have also presented evidence that intermediate users inside firms modify and improve work and production processes (e.g. de Jong and von Hippel 2009; von Hippel and Tyre 1995).

Lately researchers have also taken innovation of end users or consumers into consideration. Product innovation by users has been shown to be especially prolific in the field of sporting devices such as kiteboarding (Franke et al. 2006; Tietz et al. 2005),

[4] The role of the user is one of many which a customer can take (Lengnick-Hall 1996), and user and customer are not always congruent: the buyer (customer) of a product is not necessarily the user. For reasons of simplicity I will neglect these differences in the definition and use user and customer interchangeably.

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technical diving (Schreier et al. 2007; Schreier and Prügl 2008), sailplaning (Franke and Shah 2003; Schreier et al. 2007; Schreier and Prügl 2008), mountain-biking (Lüthje et al. 2005), mountaineering (Fauchart and Gruber 2011; Harrison and Corley 2011; Lüthje 2004), rodeo kayaking (Baldwin et al. 2006; Hienerth 2006; Hyysalo 2009), and sailing (Raasch et al. 2008). Yet there exist also examples from other consumer products fields such as music devices/software (Faulkner and Runde 2009; Jeppesen and Frederiksen 2006), toys (Janzik 2010), and juvenile products (Shah and Tripsas 2007).

Considering the evidence for innovation by users it seems that user innovation is a meaningful alternative to manufacturer innovation. But under which circumstances is user innovation more prolific than manufacturer innovation, and why do users innovate after all?

As any economic actor (Jensen and Meckling 1994; Simon 1991), users (and manufacturers) are likely to act, i.e. innovate, if their benefits from innovating are higher than the costs associated with it (Baldwin et al. 2006; Baldwin and Von Hippel 2011; Lüthje and Herstatt 2004; Raasch 2011). In general, inventions can only emerge, if need and solution knowledge are combined in a new design or product (Alexander 1964; Bogers et al. 2010; Tschirky and Trauffler 2011; von Hippel 1994)[5]. For innovation to happen, need and solution knowledge have to be either both inside the firm, or both with users. The traditional situation is specified by a constellation where users hold need knowledge and firms hold solution knowledge. Thus, either need knowledge has to be transferred into the firm (manufacturer innovation), or solution knowledge has to be acquired by users (user innovation). Scholars have pointed out that two factors are dominant determinants of the benefits and costs associated with either user or manufacturer innovation: heterogeneity of user needs and stickiness of knowledge (Lüthje and Herstatt 2004; Ogawa 1998; Sanchez-Gonzalez et al. 2009). Higher heterogeneity of user needs is likely to facilitate user innovation over manufacturer innovation (von Hippel 1998). As manufacturers have only limited resources, they cannot satisfy the need of every user segment individually, but have to focus on needs from major segments. The share of unsatisfied users will rise with higher heterogeneity of demand, since it becomes more and more costly for firms to offer customized solutions for each customer segment. In these cases, unsatisfied users may take the lead and search for own solutions to their needs, i.e. come up with designs (and even convert these into real products) (Lüthje and Herstatt 2004). Similarly, high stickiness of use-related information will lead to prevalence of user innovation over manufacturer innovation. Stickiness of information is defined as "the incremental expenditure required to transfer that unit of information to a specified locus in a form usable by a given information seeker" (von Hippel 1994, p. 430). If use information is very sticky, it

[5] This is a central theoretical assumption of this thesis and will be more elaborated in part II.3.

becomes very costly for the manufacturer to unstick and transfer this information into the firm. In these cases, it may be less costly for the user to acquire solution information and innovate. This is especially likely to happen, if users have easy access to solution knowledge: They tend to use local information resources which are readily available to them or which the already possess (Lüthje et al. 2005).

Next to the cost advantage users might have over manufacturers in some cases, they are also likely to innovate if they perceive high benefits from innovations. The higher the expected value from an innovation, i.e. the higher the pressure to find a solution to an unsatisfied need, the more likely will an individual user devote resources to finding such a solution (Lüthje and Herstatt 2004). In research, the propensity to innovate has been attributed to a special group of users, so-called lead users. Following von Hippel (1986, p. 796), lead users carry two defining characteristics:

- *"Lead users face needs that will be general in a marketplace - but face them months or years before the bulk of that marketplace encounters them, and*
- *Lead users are positioned to benefit significantly by obtaining a solution to those needs."*

Lead users are more likely to innovate than others, since they expect higher value from innovations. The other dimension of lead userness, being ahead of a trend, will also relate to propensity to innovate: As lead users perceive emerging needs earlier than others in a certain industry (users and manufacturers), there will exist no solutions to the problems they face. Thus, they have to rely on their own initiative to come up with solutions to their needs. The theoretical link between lead userness and innovativeness has also been empirically established in research (e.g. Franke et al. 2006; Jeppesen and Frederiksen 2006; Morrison et al. 2004; Morrison et al. 2000). Ever since its establishment in the seventies, the concept of lead userness has moved beyond the original measure to demarcate non-innovative from innovative users and has been theoretically linked to other characteristics of users. Higher lead userness has been associated with early adoption of innovations (Morrison et al. 2004; Schreier et al. 2007; Schreier and Prügl 2008; Urban and Von Hippel 1988), opinion leadership for other users (Schreier et al. 2007), knowledge provision in communities (Jeppesen and Laursen 2009), and lower perceived complexity of innovations (Schreier et al. 2007). Next to the characteristics associated with lead userness, researchers have also carved out factors which abet lead userness of individuals. Here, both a mix of innate traits (internal locus of control, innovativeness) and domain-specific factors (use experience, consumer knowledge, product involvement) play a role (Lüthje 2004; Schreier and Prügl 2008).

User innovation does not occur in a vacuum, but within socio-technological systems (Geels 2004; Pinch and Bijker 1984; Rosa et al. 1999). I.e. users are influenced by the

technological and societal context in which they are located. Whereas research on the former aspect has pointed out how certain technological conditions like technological complexity and maturity inhibit user innovation (Braun and Herstatt 2009; Raasch et al. 2008), scholars have carved out facilitators of user innovation with respect to the latter, societal aspects. Users are often organized within user networks or communities (Mahr and Lievens 2011; Schweisfurth et al. 2011; von Hippel 2007). In these communities they support each other's innovative activities (Franke and Shah 2003), exchange knowledge and ideas for products (Füller et al. 2007; Janzik 2010; Jeppesen and Laursen 2009), or develop prototypes (Hienerth and Lettl forthcoming). Thus, user communities can be regarded as fruitful grounds for user innovation.

The process of user innovation (like innovation in general) is not limited to ideation and invention, but may also include the commercialization or exploitation stage of innovation (Tietz et al. 2005; von Hippel 1976). If users have created a new design or an invention, they have different options to proceed with this knowledge: keeping the innovation secret and using it themselves only, freely revealing and sharing the innovation, or protecting and commercializing the innovation (von Hippel 2007). Especially the first option has been argued to be unrealistic in practice, since keeping an innovation secret may be cost prohibitive (Allen 1983; von Hippel 2007; von Hippel and von Krogh 2006).

Next to keeping designs private, users can also choose to legally protect the design (e.g. patent protection) in order to appropriate innovation rents. Even if scholars have pointed out that the returns on these innovations may be low due to the high costs associated with their protection (Harhoff et al. 2003; von Hippel and von Krogh 2006), there exists also evidence for this scenario, e.g. in the field of user entrepreneurship. Here, users protect their developed innovations in some cases in order to capture the rents if they start up new businesses (Shah and Tripsas 2007).

Scholars have argued that the third option (free revealing of an innovation, i.e. giving "access [to proprietary information] to all interested agents without imposition of any direct payment" (Harhoff et al. 2003, p. 1754)) is the dominant and most viable mode of diffusing user innovations. In this case, the decision to freely reveal the innovation is rather driven by sociopolitical or technological motives than by financial rewards (Schweisfurth et al. 2011). Socially, users profit by higher status or recognition within a community, if they freely reveal their innovation to other users or firms (Jeppesen and Frederiksen 2006; von Hippel 2007). They also comply with norms of reciprocity, because they can use complementary capabilities of other users when sharing innovations (Harhoff et al. 2003; Wiertz and de Ruyter 2007). Technologically, users may profit from free revealing by faster diffusion of their own designs and the increased likelihood to establish them as dominant design or quasi-standard. This way they can

use community resources for building prototypes (Hienerth and Lettl forthcoming), or catch the attention of manufacturers which take over the production of a user's design and produce more stable versions of the product (Baldwin et al. 2006; von Hippel and von Krogh 2006). The likelihood of free revealing is contingent on contextual factors: Scholars have shown that some factors like low transfer costs abet free revealing among users (Baldwin and Von Hippel 2011; von Hippel 2007), whereas other factors like increased competition among users impede sharing of innovations (Franke and Shah 2003; Harhoff et al. 2003; Morrison et al. 2000).

The above paragraphs illustrate that the field of user innovation, lead users, and user entrepreneurship has evolved from its origination and touched upon a variety of different themes like individual characteristics of lead users, contextual inhibitors, facilitators of user innovation, and differences and interplay of user and manufacturer innovation. Yet, to the best of my knowledge, the phenomenon in focus in this dissertation has not been taken into consideration by scholars. In the next chapter I will present a systematic analysis of the existing scholarly knowledge in this field to support my claim with quantitative data and structure the field with respect to its main thematic clusters. I will also offer an explanation why the phenomenon of embedded lead users has not caught scholarly attention yet.

2. Exploring the structure of the user innovation research field

In this chapter a systematic review of literature in form of a co-citation analysis is presented. The aim of this chapter is to depict existing major streams of literature and show that there is hardly any existing research on embedded lead users.

2.1 Research design

In order to analyze the current state of research in the field of user innovation, a co-citation analysis was carried out (similar to Meyer et al. 2009; Raasch et al. forthcoming; Schäffer et al. 2006; Schildt et al. 2006). Co-citation analysis is a bibliographic methodology that measures the interdependency of the entities in focus. Co-citations are a measure of closeness. When two papers (or authors) occur jointly in the list of references of a given paper, they are co-cited. As citations are based on the opinion of experts (scholars) in a given field, a certain connection between the co-cited works can be assumed. Co-citation analysis can be based on authors or publications (Chen et al. 2010). If it is based on authors, co-citation analysis aims at examining social structures in a field of research (Chen et al. 2010; Raasch et al. forthcoming). If co-citation analysis relies on co-cited papers as the unit of analysis, it aims at revealing the intellectual structure of research fields (Chen et al. 2010; Gmür 2003). Theoretical foundations and content clusters ("key ideas" (Small 1973)) can be identified with this approach. As the

goal in this section is to find out which streams of research exist in the field of user innovation and which blank spots remain to be filled, a paper-based co-citation analysis is a suitable research approach.
My co-citation analysis proceeds in 3 steps, which will be described in the course of this chapter (Chen et al. 2010): data collection, data preparation (construction and visualization of matrix), identification and interpretation of clusters.

2.2 Data collection

Two different databases (EBSCO Business Source Premier and ISI Web of Science) were searched for relevant papers in the field of user innovation. I used a keyword search including three strings in all fields ("user innovation", "lead user", "user entrepreneurship"), focusing on publications published up to the end of 2010. This search yielded 155 results in EBSCO and 89 in ISI from which I compiled a database. Only peer-reviewed journal articles were included, as they can be expected to embody high quality and accepted knowledge within the research community (Gmür 2003). I screened my database for non-English articles, duplicates, conference articles, working papers, and accidental search results and excluded these from the database. The final list included 111 papers.

2.3 Data preparation

In the next phase, the co-citation matrix needed to be constructed and visualized. For the construction of the matrix, references were either extracted automatically (ISI) or manually (EBSCO) for each publication included in the analysis. As the entries in the reference lists included different citation styles or misspellings, all references needed to be normalized. I then excluded those references which were not part of the dataset, i.e. those which were not included in the 111 papers. By this procedure many references were excluded from the analysis, but the matrix could be constructed more efficiently. The focus of the citation analysis was rather on the connection of papers within the field of user innovation than on the epistemological foundations thereof (cf. Raasch et al. forthcoming). Thus it was sufficient to include only papers that focus on the topic of user innovation, and not its intellectual ancestry. In the next step I constructed the citation matrix. This 111x111 matrix included all articles and indicated which other publications from the pool were cited. Publications that were not cited at all and did not co-cite others were deleted from the matrix, as they were obsolete for the analysis. This yielded a list of 100 publications. In the last step the co-citation matrix was built. I excluded papers that were not co-cited (46 publications) from the analysis. The closeness measure used in this study (CoCit score) was calculated. The CoCit score of two documents (A and B) ranges from 0 to 1 and can be calculated as follows (Gmür 2003):

$$CoCit_{AB} = \frac{Cocitation_{AB}}{\min(Citation_A, Citation_B) \times (\frac{Citation_A + Citation_B}{2})}$$

The final, symmetric matrix included 54 publications with corresponding CoCit scores. Appendix 1 gives an overview of the papers included in the matrix.

2.4 Identification and interpretation of clusters

For the visualization of the co-citation web, ORA (organizational risk analyzer), developed at Carnegie Mellon University, was used. Figure 2 visualizes the whole network, just to illustrate its complexity.

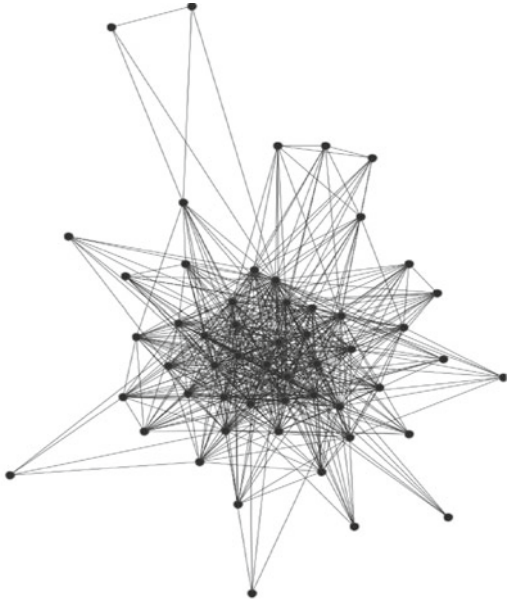

Figure 2: Co-citation network

In order to make clusters of co-cited publications visible, a threshold needs to be chosen. Only nodes with CoCit scores higher than the threshold are shown. The threshold was increased, starting from 0,1, until clusters emerged. At a threshold of 0,3, seven clusters emerge (see Figure 3 and Table 1). These clusters can be regarded as distinct themes in the field of user innovation. To analyze what cluster represented what topic, I read all the papers in each cluster. I then looked out for common thematic grounds and research claims in the papers and labeled the clusters accordingly. In the remainder of this chapter I will describe the contents and themes of each cluster.

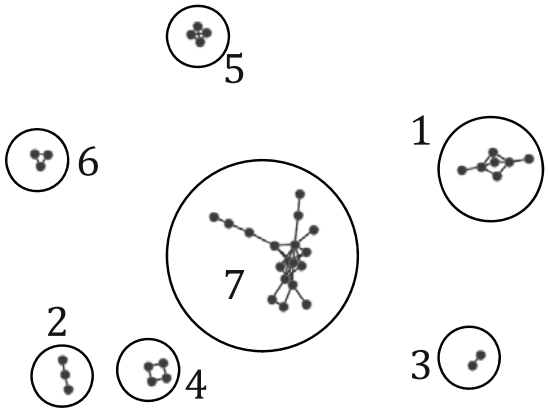

Figure 3: Co-citation network with seven main clusters (threshold 0,3)

Cluster 1	**Cluster 2**	**Cluster 3**	**Cluster 7**
(Franke *et al.*, 2006)	(Franke *et al.*, 2009)	(Enkel *et al.*, 2005)	(Jeppesen *et al.*, 2006)
(Jeppesen *et al.*, 2006)	(Füller *et al.*, 2009)	(Gruner *et al.*, 2000)	(Lakhani *et al.*, 2003)
(Kratzer *et al.*, 2008)	(Prügl *et al.*, 2006)		(Braun *et al.*, 2007)
(Lüthje *et al.*, 2004)			(von Krogh *et al.*, 2006)
(Schreier *et al.*, 2007)			(Franke *et al.*, 2003a)
(Schreier *et al.*, 2008)			(Franke *et al.*, 2003b)
(von Hippel *et al.*, 2009)			(Lüthje, 2004)
			(Morrison *et al.*, 2000)
Cluster 4	**Cluster 5**	**Cluster 6**	(Herstatt *et al.*, 1992)
(Baldwin *et al.*, 2006)	(Hyysalo, 2009)	(Bogers *et al.*, 2010)	(Lilien *et al.*, 2002)
(Douthwaite, 2001)	(Lettl, 2007)	(Gassmann, 2006)	(Urban *et al.*, 1988)
(Raasch *et al.*, 2008)	(Nambisan *et al.*, 1999)	(West *et al.*, 2008)	(von Hippel, 1986)
(Shah *et al.*, 2007)	(Van Oost *et al.*, 2009)		(Von Hippel, 1994)
			(von Hippel *et al.*, 2003)
			(von Hippel *et al.*, 1999)
			(Lüthje *et al.*, 2005)
			(Tietz *et al.*, 2005)
			(Olson *et al.*, 2001)

Table 1: Cluster 1-7 and included publications

2.4.1 Antecedents and consequences of lead userness (Cluster 1)

This cluster consists of seven publications. They are all related to the antecedents and consequences of lead userness which is the central construct in these studies (similarly to cluster 7.2). Lüthje and Herstatt (2004) review the underlying dimensions of lead userness (being ahead of the trend and benefitting from innovation). Other scholars in this cluster find antecedents to lead userness on different levels of personality structure. On an abstract level, personality characteristics like internal locus of control (Schreier and Prügl 2008), innate innovativeness (Schreier and Prügl 2008), and creativity (Kratzer and Lettl 2008) are positively related to lead userness. On domain-specific level, product experience and consumer knowledge foster lead userness (Schreier and

Prügl 2008). Other studies research the consequences of lead userness and find it to be positively related to the propensity to share knowledge (Jeppesen and Laursen 2009), product adoption behavior (Schreier et al. 2007; Schreier and Prügl 2008), opinion leadership (Schreier et al. 2007), likelihood to innovate (Franke et al. 2006), and attractiveness of user generated innovations (Franke et al. 2006). Also structural characteristics like central network position (Kratzer and Lettl 2008) and access to different user networks (Jeppesen and Laursen 2009) positively relate to lead userness. Only two papers take both structural and personal qualities into consideration (Kratzer and Lettl 2008; von Hippel et al. 2009).

2.4.2 Virtual co-creation (Cluster 2)

This cluster of literature explores the application of toolkits and mass customization to handle demand heterogeneity and offer individualized products to customers. It includes three studies. Franke et al. (2009) show how the ability of customers to make their preferences and need knowledge explicit impacts the perceived value of customized products. They also find product involvement of consumers to be an antecedent to customer satisfaction with customized products. This finding is shared by Füller et al. (2009), who focus on how users perceive the process of co-creation. Lead userness, creativity, and involvement are influence factors on enjoyment and customer empowerment. Prügl and Schreier (2006) extend these findings by showing that lead users' customized designs are also attractive to other users.

2.4.3 Customer integration into new product development (Cluster 3)

This cluster includes two publications. Both of them focus on the integration of different types of customers into the traditional innovation processes. Gruner and Homburg (2000) find that the inclusion of lead users and technically savvy users has especially high impact on product success. Enkel et al. (2005) report similar requirements for user integration to minimize market risks. They claim that customer integration into NPD is especially demanding, if technical innovations are in focus, which require customer integration during the engineering phases of the innovation process.

2.4.4 Dynamics of user innovation (Cluster 4)

The four papers in this cluster explore the dynamic interplay between users and producers during innovation. The Shah and Tripsas paper (2007) was the first publication which dealt explicitly with the emergent process from being a user to becoming a manufacturer. They derive propositions about the contextual factors, which abet user entrepreneurship over traditional entrepreneurship. Baldwin et al. (2006) model the transition from user activity, emergence of user entrepreneurs, and manufacturer entry in an analytic setup. They predict a shared market equilibrium, in

which both user entrepreneurs (high quality products) and traditional manufacturers (low quality mass market products) coexist. Raasch et al. (2008) extend this model and show that user innovation can survive the prevalence of profit driven firms (user entrepreneurs and manufacturers), if certain conditions exist (low customer satisfaction, low technological complexity and maturity, low market concentration, low barriers to innovation). Douthwaite et al. (2001) find that if either technology or system complexity is high, firms should interact with users during the time of early adoption in order to tap their use knowledge. The inclusion can help to improve the technology and make it more attractive to other users who adopt later.

2.4.5 Different types of users (Cluster 5)

The papers in this cluster focus on different types of users and user roles. Nambisan et al. (1999) center on different types of knowledge needed and organizational mechanisms employed to foster information technology process innovation inside organizations. Lettl (2007) draws on case studies to adapt the concept of lead users for radical innovation projects in firms. He claims that next to the motivation to innovate and use expertise, radical lead users also need technological expertise in a certain field. Van Oost et al. (2009) point out that user innovation does not only occur in technological fields, but also in social innovation, like building a community. They also derive different types of users (organizational user, volunteer user, end user, maintenance user). Hyysalo (2009) echoes this view as he points out the importance of socio-cultural innovation by users, e.g. with respect to norms and settings. In his conceptual paper, he also draws attention to the notion that the view of lead user vs. manufacturer innovation is too narrow and many hybrid forms between the two exist. He is one of the first authors who points at the possibility to have product users inside the firm.

2.4.6 Conceptual and review papers (Cluster 6)

Review papers are an important means to summarize and categorize empirical findings and existing knowledge about a scientific field. Bogers et al.'s (2010) review on user innovation delineates main findings in this field. The other two papers are located at the interface of open and user innovation and contrast different forms of open innovation (Gassmann 2006; West and Lakhani 2008) and community involvement (West and Lakhani 2008).

2.4.7 Lead users and innovation (Cluster 7)

The last cluster consists of 18 publications, which are thematically involved with the theme of lead users and innovative users. When the threshold for this cluster is increased to 0,4, two main subclusters with four papers each emerge, which will be explained as follows.

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