The Lead User method: an outline of empirical findings and issues for future research

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In order to reduce the risks of failure usually associated with NPD, leading companies such as 3M, HILTI, or Johnson&Johnson are increasingly working with so-called Lead Users. Their identification and involvement is supported by the Lead User method – a multi stage approach aiming to generate innovative new product concepts and to enhance the effectiveness of cross-functional innovation teams. While the Lead User method is frequently cited in the literature, yet, there are only limited attempts to comprehensively discuss how this approach is embedded in theories and empirical findings of innovation and marketing research. Therefore the Lead User method is in the focus of the present paper, both with respect to its theoretical foundation and its implementation into the innovation management system. First, empirical research on user innovations is reviewed to clarify the theoretical foundation of the Lead User method. Second the attention is drawn to the Lead User practice by discussing the various process steps of this specific approach on the basis of two applications of the method. Based on this discussion, we outline open questions related with the practical implementation of the Lead User method in order to start an agenda for future research.

1. Introduction

The creation of innovations leading to corporate growth and profitability is a critical task for managers in nearly all industries. Empirical research, however, shows the high risk which is usually associated with developing new products (Crawford, 1994; Brockhoff, 1999). In order to reduce the risk of failure, researchers and practitioners concordantly recommend to better align key activities within NPD-projects with the needs of actual and potential customers (Jaworski and Kohli, 1993; Atuahene-Gima, 1995). A strong customer orientation encompasses acquiring information about customer needs (intelligence generation), disseminating the information throughout all critical functional areas like marketing, R&D and production (intelligence dissemination), and translating this information into marketable products and services (responsiveness) (Kohli and Jaworski, 1990). A customer focus in this sense seems to foster product advantage in terms of quality, reliability and uniqueness which in turn is positively correlated with product market performance (Li and Calantone, 1998).

Reducing market uncertainty is particularly important in the early stages of innovation projects. By using the customers as an information source in the 'fuzzy front-end', the project teams may receive valuable input for the generation of promising new product ideas (Kim and Wilemon, 2002a). The market compatibility of the selected project idea is an important determinant of the performance in the fuzzy front end. After all, the product idea will influence the definition of the product concept and, at the end, will determine the key attributes of the commercial product (Kim and Wilemon, 2002b).

But does the intensive integration of customers into the fuzzy front-end of innovation processes basically involve the same set of activities, regardless of the specific type of innovation project? We believe the answer to this question is no. Particularly, there is strong evidence that customer integration in the context of incremental innovation projects is very different from the case of radically new products (Lynn *et al.*, 1996; Veryzer, 1998).

For incremental innovations a company can apply a variety of proven market research methods. For example, some well-documented methods for the assessment of current and future customer needs ('need assessment') can be used to generate promising ideas for innovations early in the process (Herstatt and Geschka, 2002; Holt *et al.*, 1984). Subsequently, quantitative user questioning, (virtual) focus group discussions and sophisticated conjoint analysis techniques can be applied to examine whether early product concepts meet general customer needs or not (Dahan and Hauser, 2002; Bristol and Fern, 1996).

But for breakthrough innovations the situation is very different. The results from conventional market research studies continually evoke disappointment. It appears impossible to determine the demands of tomorrow's markets via traditional market research methods (Lynn *et al.*, 1996; O'Connor, 1998). Two limitations seem to be most important. Firstly, most market research approaches work with random samples of customers. Market researchers aim to ensure that findings are representative by integrating a group of 'typical' customers that represents the population of the target customers. The insight of these customers into new product needs and potential solutions is constrained by their own real-world experience. In order to forecast their needs in the future, the customers will have to integrate the potential product into a use context which does not yet exist (Davis, 1993). This is a difficult mental task. Hence, it seems reasonable that the familiarity with existing market offers often inhibits to conceive substantial novel product attributes (von Hippel, 1986). Secondly, most of the market research techniques do not offer appropriate ways to discover new product attributes and ideas outside the well-known solution space (Fornell and Menko, 1981; Schrader, 1995). Survey designs and stimuli (e.g. questionnaires, test products) that researchers present to customers are mostly determined in advance. Customers are confronted with such stimuli and market researchers mainly record the customers' answers and reactions. There are no mechanisms to induce involved customers to formulate emerging needs and to identify new solutions to those needs (von Hippel, 1988).

In light of such difficulties with conventional market research methods, leading companies such as 3M, HILTI, and Johnson&Johnson are increasingly working with so-called Lead Users in the early phases of innovation projects (Herstatt and von Hippel, 1992; von Hippel *et al.*, 1999; Lilien *et al.*, 2001). Lead Users are at the leading-edge and are both, sufficiently well qualified and motivated to make significant contributions to the development of new products or services (von Hippel, 1986, von Hippel, 1988).

Their identification and involvement in the fuzzy front end of innovation is supported by the Lead User method – a multi stage approach aiming to generate innovative new product concepts and to enhance the effectiveness of cross-functional product development teams.

While the Lead User method is frequently cited in the literature, yet, there are only limited attempts to comprehensively discuss how this approach is embedded in theories and empirical findings of innovation and marketing management. Therefore the Lead User method is in the focus of the present paper both, with respect to its theoretical-empirical foundation and its implementation into the innovation and R&D management systems.

In section 2 we review the empirical research on user innovations to point out that the phenomenon of user-initiated product development is anything but rare. In section 3 we outline the characteristics of Lead Users and review theoretical concepts and empirical findings which support the assumptions that underlie these characteristics. This discussion serves to qualify the theoretical-empirical foundation of the Lead User method.

In the second part of the paper (section 4) we draw the attention to the Lead User practice by discussing the various process steps of the Lead User approach. In contrast to the method's theoretical and empirical foundation, little is known about critical success factors of the method's implementation in the fuzzy front-end phases of innovation projects. Although published applications of the method provide first insights with respect to promising actions and decisions when working with Lead Users, empirical findings are scarce. We therefore outline some open questions regarding the successful practical application of this method in order to start an agenda for future research.

2. Empirical evidence of user innovations

Empirical research has shown that users frequently play an important role in the development of new products – particularly for *industrial markets*. Often, a significant fraction of the innovations within a given industry are directly initiated by the needs and specific requests of users (Biemans, 1991; Utterback *et al.*, 1976). Also many ideas and concepts for new products are frequently developed by users (Baker *et al.*, 1986; Voss, 1985). For some industries, it was even shown that the majority of innovations was initially fully developed by product users. In these cases users did not only initiate the process and generated early ideas, but they dominated all subsequent stages of the innovation process including prototyping and building first devices. For example, in semi-conductor and electronic subassembly processes significant advances in technology were made by the semi-conductor manufacturers themselves and not by the developers of the respective process technologies (67% user innovations, von Hippel, 1977). Similar results are reported for the categories of process technologies such as CAD/CAM systems and scientific instruments for which product users developed most innovations (83% user innovation in CAD/CAM systems, Mantel and Meredith, 1986; 77% in scientific instruments, von Hippel, 1976). Innovative product users were likewise found in the medical field. Clinics and doctors in several medical sub-areas are responsible for the majority (53%) of new product developments (Shaw, 1985).

Also in the dynamic IT industry there are numerous examples of innovations that have been developed by Lead Users. The operating system 'Linux' and the server software 'Apache' are two prominent examples of successful 'Open Source' software programs. These projects were initiated by individual software users – Linus Tovalds in the case of Linux or Rob McCool with Apache – and were later accepted by important user groups. These user communities improve and test the programs and decide independently over the recording of new program codes in the software. Even today when the marketing of the products is partly taken over by professional companies (e.g. Red Hat Inc., VA Linux Systems), manufacturers are rarely involved in the development of the software (Franke and von Hippel 2002; von Hippel, 2001).

For *consumer markets*, a number of anecdotal cases of user innovations are documented. One of these well-known examples is 'TipEx', that was invented at the end of the 1950s by a secretary. The athletes' drink 'Gatorade' was developed by the trainer of a college football team. The early versions of protein shampoos go back to recipes of house wifes, the same is true for baking recipes of ready-mixed cakes. In general, the recreation and sport markets are rich in examples for user innovations. However, besides these anecdotal examples, only a few empirical studies are available. One of these investigates the significance of consumer innovations within a single product category over time: Shah (2000) explored the sources of innovation for equipment which is used in specific areas of sports like snowboarding, skateboarding and windsurfing. Her findings reveal that it was always the end users who invented the first versions of the basic equipment in each of these fields. Similarly, 58% of the major improvements to this equipment were developed by Lead Users or so called 'User Manufacturers' which benefited both from the use of the invention and from participation in small firms which produce and sell the innovation to others.

Other empirical studies have not investigated which fraction of all innovations in a particular product field was realized by the users, but focused on the percentage of innovating users among a given (representative) user population (see Table 1).

The findings clearly reveal that innovation activities are not limited to a small group of users in a market. The percentage of users who improve prototypes or develop completely new solutions is not insignificant. The numbers range from 10% to nearly 40% of innovating respondents in different industries (Table 1).

The frequency of user innovations is one issue, their technical and economic potential another. Some specific results with respect to the innovations' potential are provided by Morrison *et al.* (2000) in a survey of Australian users of the library information search system OPAC. They found that about 70% of the provided user improvements are of at least 'medium' importance from the point of view of commercial OPAC-system vendors. In another study of innovation activities in sports communities presented by Franke and Shah the respondents

Table 1. Fraction of users who build solution for own use within different user populations.

Study	Field of innovation	Users sampled (n)	% of users who developed solution for own use
Lüthje (2004)	Equipment for outdoor sports (Germany)	153	10%
Lüthje (2003)	Medical surgery equipment (Germany)	261	22%
Franke and Shah, (2002)	"Extreme" sporting equipment (Germany)	197	38%
Tietz, Morrison, Lüthje and Herstatt (2002)	Kite surfing equipment (Australia)	157	26%
Lüthje, Herstatt and von Hippel, 2002	Mountainbike equipment (USA)	287	19%
Morrison Roberts and von Hippel, 2000	Library information search system OPAC (Australia)	102	18%
Herstatt and von Hippel, 1992	Pipe hangers hardware (Switzerland)	74	36%
Urban and von Hippel, 1988	PC-CAD for the design of printed circuit boards (USA)	136	24%

reported that one in four (23.1%) of the innovations were or would be soon produced for sale by a manufacturer (Franke and Shah, 2002). Finally, Lüthje could show that innovation efforts of surgeons with respect to new medical equipment have an economic impact. One in three of the inventing surgeons indicated that his/her innovative idea had been transferred into a marketable product. A notable fraction of the innovating surgeons had obtained a patent (22% of all innovators) and almost half of the innovations is currently or will be marketed in the foreseeable future by a manufacturer of medical equipment (Lüthje, 2003).

To summarize, innovating users exist and they frequently initiate or even dominate the development of major innovations with considerable market potential. Hence the involvement of innovating customers in the early stages of the innovation process is a promising strategy for manufacturers with a current need for innovations. Considering the strong empirical evidence, an approach that supports the systematic identification of leading-edge users and their integration into NPD projects of manufacturers, seems to be relevant and useful for innovation management.

3. Reasoning on lead user characteristics

The strong empirical evidence for the existence of user-dominated innovations gives rise to the question by which factors users are prompted to become the initial developers of new product solutions. Researchers found that innovation by users tend to be concentrated in a progressive segment of the user communities (von Hippel, 1986; von Hippel, 1988). These 'Lead Users' have been shown to be different from ordinary users and can be identified by two characteristics:

1. Lead Users face new needs of the market and do so significantly earlier than the majority of the customers in market segment (capability).
2. Lead Users profit strongly from innovations that provide a solution to those needs (motivation).

The first characteristic specifies that those users who experience new needs are well-prepared to generate innovations that substantially differ from existing market offers. However, not all users facing new needs are Lead Users. If a manufacturer aims to develop profitable products for tomorrow's market, an additional condition has to be met: Lead Users by definition do not just face any new need, but they realize needs that most customers in the market will face in the future.

The second Lead User characteristic reflects the hypothesis that users will initiate the development of new solutions if they expect an innovation-related benefit. The incentive associated with a new solution to their needs can become that strong that the Lead Users are motivated to dominate all stages of the development process, particularly if no manufacturer is able or willing to take on that task.

In the following we will present a synopsis of findings on the innovation-related capabilities and motivations of Lead Users. The research on the antecedents of Lead User innovations provides the theoretical basis for the identification of promising users and their integration into innovation projects of the manufacturers.

3.1. The capability for innovation: being ahead of the market

The first Lead Users characteristic implies the hypothesis that users in fact exist who are ahead of the market with respect to need-related trends. In addition, it is proposed that users who realize new needs earlier than others are better prepared to develop ideas for tomorrow's products.

The first notion is based on the assumption that new needs typically flow slowly across markets and market segments, rather than impact all customers simultaneously (von Hippel, 1988). The idea of the gradual diffusion of needs directly results from the research on the diffusion of innovation. One of the basic elements of diffusion theory is that the dispersion of information, ideas, products, and services always takes time and is therefore never instantaneous (e.g. Mahajan *et al.*, 1990; Dosi, 1991; Rogers, 1995). In several studies on new product adoption, the perceived relative advantage of the innovation as compared to the existing market offers was found to be an important predictor of new product adoption (Tomatzky and Klein, 1982; Gatignon and Robertson, 1985; Davis *et al.*, 1989). These studies also suggest that high profitability of an innovation is not perceived by the customers in a market at the same time. Rather, the perception of a relative advantage emerges in a time sequence which provides support for the first assumption that underlies the Lead User characteristic.

According to the second implicit assumption, users who actually realize new needs are particularly capable of conceiving substantial new product solutions for future markets. It can be plausibly argued that users who face needs that are not met by existing market offers do that because they often operate in use contexts that lie in the future for most users in a market. Take the example of the first cyclists that started riding down steep mountain tracks with standard safety bikes. They developed a novel use for an existing commodity and by this realized their limitations and acquired new product-related needs (e.g. the need for more stable bike components). The significance of this 'real world' experience in a novel use context can be understood by using theories of creative cognition and cognitive learning theories.

From the perspective of creativity research, knowledge about new needs can be interpreted as a precondition for taking the creative step of developing solutions that differ from the existing ones. When individuals and groups have to accommodate creative cognitive tasks, they tend to apply knowledge that is already in their possession (Perkins, 1988; Marsh *et al.*, 1999). For instance, experimental surveys have demonstrated that the behavior of problem-solvers facing new situations tends to be entrained by their previous experiences with similar situations and problems (Lunchins, 1942; Birch and Rabinowitz, 1951; Adamson, 1954). Several empirical studies indicate that individuals will inadvertently use prior knowledge and stored experience in creative problem solving even under specific admonition instructions to avoid doing so (Marsh *et al.*, 1999). These striking findings strongly suggest that exclusively users who are familiar with new needs and already operate in novel use contexts can be expected to generate substantially new product ideas. As opposed to ordinary customers, users at the leading-edge do not have to imagine themselves in a yet non-existing situation. The 'new' is already familiar to them. When developing product solutions that differ from existing market offers they can use knowledge already in their possession. The situation is different for users that are exclusively familiar with existing products and a 'typical' use context. Their prior use-related knowledge will interfere with their ability to conceive novel problem solutions (von Hippel, 1986).

From the perspective of cognitive learning theories, users facing new needs are likely to start a learning process in order to develop new solutions to their needs. Acquisition of new wants and learning how to satisfy them may be therefore interrelated (Witt, 2001; Buenstorf, forthcoming). These dynamics result from the restricted capacity of the human memory and limited resources to process all information in a complex environment (Simon, 1957). Individuals react to this situation by concentrating their attention to selective domains which are strongly connected with the individuals' cognitive base (Dequech, 2001, Selten, 2001). As a consequence, the motivation to acquire knowledge to develop innovations is probably shaped by the existence of new needs and their current state of deprivation (Witt, 2001). Leading-edge users will also have a higher capability to register innovation-related information. Cohen and Levinthal (1990) in their concept of 'absorptive capacity' stress the role of prior knowledge for learning. According to this concept, users facing new needs will find it easier to make sense of innovation-related information because it fits with their cognitive structure (Bower and Hilgard, 1981; Cohen and Levinthal, 1990). These users are therefore more likely to recognize, to memorize and to apply pieces of information that may be relevant for developing solutions to their needs.

3.2. The motivation for innovation: high expected profitability

Industry/product category level. Why in some industries users rather than manufacturers have an incentive to innovate

At first glance, manufacturers, in general, seem to have a higher incentive for innovation than users. After all, they can sell their product developments on the market or capture rents by licensing their patent protected know-how to others. Furthermore, manufacturers, due to their know-how and financial resources, simply seem to be in a better position to generate sophisticated and marketable solutions to a market need.

However, research on the sources of innovation strongly suggests that sometimes the product user expects higher benefits from a given innovation opportunity than the manufacturer of the respective product (e.g. Lionetta, 1977; von Hippel, 1976; Shah, 2000). Von Hippel carefully analyzed the innovation history in several industries and was able to prove that the expected net benefit (benefit-costs) can explain the variation of the functional source of innovation, i.e. why in some industries manufacturers dominate the innovation activities and why in other industries users are responsible for most development efforts (von Hippel, 1988).

The innovation-related *benefit* expectations of users and manufacturers may be linked to the distribution of user needs with respect to a particular product category (see Figure 1). Market studies indicate that in many industries the need heterogeneity is rather high (Franke and Reisinger, 2002). Even after having carefully segmented a market according to various user-types, a high variation of customer needs within the market clusters is still to be found. In such markets, manufacturers are often just not in a

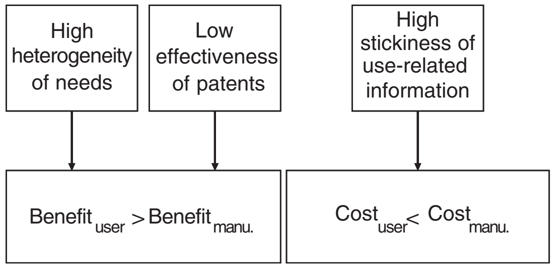

Figure 1. Variables determining innovation-related benefit and cost.

position to offer a tailor-made solution to each customer which would exactly fit his\her individual needs (Franke and Reisinger, 2002). Instead, a manufacturer will try to spread his development costs to as many users as possible. Although the concept of mass customization certainly has helped firms to cope with individualized or heterogeneous demands, in many industries it is economically just not viable to increase the number of product variations in order to better fulfill the needs of all customers (Zipkin, 2001). Consequently, in markets with rather heterogeneous needs, many users may remain dissatisfied with the market offers of the manufactures. In this situation, some users who actively want to improve their situation may take the initiative to improve or develop products themselves. In some cases, such user innovations will become sooner or later attractive to other users. But often manufacturers do not become aware or do not process such weak signals coming from their customers. This is due to the fact that emerging needs are only reflected by a small group of non-representative customers and may therefore not attract the attention of the manufacturers. It may prompt a manufacturer to underestimate an attractive field for innovation.

To exemplify this pattern, please consider again the example of the market for mountain bikes. Mountain biking began in the early seventies when young and progressive cyclist started to use their bicycles off-road (Penning, 1998). It was not earlier than 1982 when established manufacturers of road bikes, after neglecting the trend for more than ten years, started to produce mountain bikes and to sell them at regular bike shops across the USA (Penning, 1998; Berto, 1999).

Higher benefit expectations of users may also be associated with issues of intellectual property (see Figure 1). Users can expect to profit from innovations if they, unlike the manufacturer, are able to establish monopoly control over their innovation. Consider the example of users who improve process machinery in an industry in which product quality and production costs are the most critical drivers for competitive advantage. If the new machinery enables low-cost production, the user may benefit through the exclusive in-house use of the new machinery. The manufacturers of the process machinery, at the same time, may not expect high innovation-related rents if other manufacturers can easily imitate the developments. This is manifest in industries where patents do not provide effective property protection for innovations particularly through 'inventing around' (Cohen *et al.*, 2000). Unlike the manufacturers, the user can protect the process machinery as a trade secret by keeping the innovation hidden in their factory (Mansfield, 1985; von Hippel, 1988).

Also user *innovation costs*, in some industries, can be significantly lower than manufacturer innovation costs. This is the case when the development of new products requires a high amount of 'sticky' information about users' needs (see Figure 1). The stickiness of a given unit of information is defined as the incremental expenditure required to transfer that unit of information from its point of origin to another party (von Hippel, 1998). Information stickiness can be due to attributes of the information itself (Nelson, 1982). User needs often enough are sticky because they are deeply rooted in the personal experience of individuals and can hardly be encoded in explicit terms (tacit knowledge) (Polanyi, 1983; Nonaka, 1994). Consider the example of flavors. It seems quite difficult to transfer the glimpse of a perfect perfume flavor from a user to a manufacturer-based flavor designer. Also users in sports possess sticky information which is difficult to formulate (Shah, 2000; Lüthje *et al.*, 2002). Leading-edge sports enthusiasts usually engage heavily in their sport and, through learning by doing, develop a high level of use experience and skills. It has been shown that experienced users are able to discover problems with existing equipment that only become apparent in a continuous and skillful practice of the sport. They acquire this information during the course of their normal activities and have the possibility to directly test the self-generated solution to their problems. Consequently, users operate in a low-cost-innovation zone (Lüthje *et al.*, 2002). Manufacturers of sport equipment would have to invest to acquire this sticky use-related information.

The impact of sticky information in an industrial context was investigated by Ogawa (1998) in a study of equipment innovations for a major Japanese convenience store chain. His data show that innovations requiring a rich understanding of needs (information local to users) tended to be carried out by the users (the store chain) while innovations involving rich understanding of new technologies (information local to the equipment manufacturer) tended to be carried out by the manufacturers.

To conclude, major innovations developed by users are more likely to occur if, in a given market, the expectations of benefiting from innovation opportunities are usually higher on the user's side than on the manufacturer's side.

Individual level. Why some users within an industry innovate while others remain passive

Even in markets that are characterized by a high level of user innovation, only a fraction of the user population engages in development efforts whereas the majority of users remain passive. Improving existing market offers or conceiving new problem solutions is located outside the range of ordinary customer activities. The initiation of user innovation projects requires a positive outcome of a deliberate decision process by individual customers in the market. Thus, while in the previous section we focused on the link between incentives to innovate and the functional source of innovation at the level of entire product categories, here, we have to discuss the incentive-innovation-link on the individual level. As for the product category level, it is reasonable to assume that also an individual decision to innovate is somehow related to expectations of innovation-related benefits and costs. Is is suggested that individual firms or end users develop specific expectations concerning the positive (benefit) and negative (cost) aspects of their own innovating activities and these believes drive their innovation efforts.

It is important to note, that the individual perspective is relevant for both, users in industrial and consumer settings. Benefit and cost expectations may be developed on the organizational level in case of individual user firms as well as on the personal level in case of individual professionals and end users.

The link between *benefit expectations* and the innovation propensity is well-explored: The greater the benefit a given user expects from a novel product, the greater the willingness to devote resources to obtain a new solution. This has been shown for user firms in industrial markets (von Hippel, 1988), for individual professionals such as scientists, OPAC users, webmasters and surgeons (Riggs and von Hippel, 1994; Morrison *et al.*, 2000; Franke and von Hippel 2002; Lüthje, 2003), and for end users – particularly for users of sports equipment (Shah, 2000; Franke and Shah, 2002; Lüthje, 2004). The type of benefit can differ between different markets and user populations. Industrial user firms usually profit financially via process innovations which, in turn, help to serve their customers in a better way (Mansfield, 1968; von Hippel, 1988). In applying their invention in their internal production process they usually expect to realize competitive advantage (e.g. lower production cost, higher product quality, new product functions). In the case of individual professionals and end users, the incentives to innovate are not necessarily directly associated with economic outcomes. In fact, empirical findings suggest that economical and reputation effects, do not strongly impact the innovation decision of individual professionals and end users. In a study conducted by Lüthje, (2003) in the field of medical equipment, surgeons were found to innovate if they hoped to personally benefit from the use of a new piece of equipment in surgery. The innovators in the surgeon sample, when compared to non-innovating doctors, realized more problems and limitations when working in the operation room. They have a stronger need for performing surgery easier, faster, cheaper, more convenient and less invasive for the patient. Similar results were obtained for innovating users in sports. The innovation-related rewards were typically related to their personal needs and non-financial benefit was derived primarily from in-house use of the inventions (Lüthje, 2004). In the specific case of open source software projects, 59% of contributors sampled by Lakhani and Wolf (2003) report that the use of the output they create is one of the three most important incentives inducing the software users to innovate. Similar results are shown in the survey of webmasters modifying Appache web server software (Franke and von Hippel, 2002). Finally, Henkel and Thies (2003) surveyed users who developed add-ons for game simulator software (train simulator) and found that the enjoyment associated with the creative development activity was the most important motive for innovating.

With respect to *innovation cost*, there is empirical evidence that a high amount of use experience and technical knowledge on the side of the user is positively related with innovation propensity. Or in other words, existing experience and knowledge will reduce the costs of innovation. User experience emerges through the frequent use of products. Like in most creative problem solving processes, this experience is needed to systematically analyse existing problems, to conceive solutions, and to test these solutions in practice (Stein, 1989; Weisberg, 1999). Experienced firms and individuals acquire a vivid and germane knowledge about use problems and promising solutions to those problems (Hoch and Deighton, 1989). This kind of 'learning by acquaintance' or 'learning by doing' can be practiced at low costs. Technical knowledge consists of know-how concerning the product architecture, the used materials, and the applied technologies in a product category. User firms or end users need to have this understanding if they want to translate the wants and needs into specific product specifications and reliable prototypes. The various studies in this field provide strong support for the link between the amount of experience and knowledge on the one side and user innovation efforts on the other side (Franke and Shah, 2002; von Hippel, 1988; Lüthje *et al.*, 2002).

In sum, benefit expectations trigger the motivation to initiate innovation efforts. In addition, expert users in a given product field realize correspondingly lower innovation-related costs and by this are more inclined towards invention. Both core characteristics, innovation-related benefits and costs, can serve as search criteria when a manufacturer aims to identify leading-edge users in a given market. Due to the fact that users tend to use 'local' information (i.e. they develop solutions for those needs they personally experience and apply technical knowledge they already possess) manufacturers should be able to identify specific innovations of potential value to them. They can use the information on users' characteristics to predict the specific application area and innovation solution type the users will probably develop (Lüthje *et al.*, 2002).

4. Research issues regarding the practical implementation of the Lead User method

In the 1980s von Hippel and his scholars developed a methodology to identify Lead Users and to obtain unique data regarding new emerging needs and solutions responsive to those needs. Just as the definition of Lead Users, also the Lead User method directly evolved from the research on innovating users and the functional source of

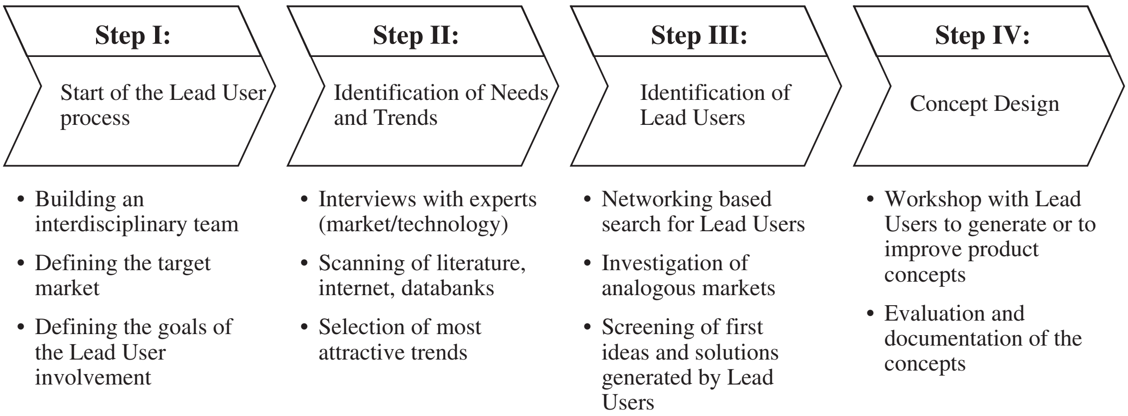

Figure 2. The process of the Lead User method.

innovation. It has since, on the basis of numerous applications, been detailed and developed further.

In the following section we will describe the four steps of the Lead User method. This discussion is informed by illustrating two applications of the Lead User method at HILIT and Johnson&Johnson Medical (J&J). HILTI, the leading manufacturer of fastening systems for the construction industry, began working with Lead Users as far back as the 1980's. The application described here was carried out in the search field of pipe hangers (water, air conditioning, sanitary) and air duct in buildings (Herstatt and von Hippel, 1992). The application of the Lead User method at J&J was located in the division of surgical hygiene products. The responsible people at J&J chose the patient coverings and the protective clothing of operation personnel as the search field for which innovative ideas should be sought (Herstatt *et al.*, 2002).

Enriched by the experience collected in these two cases we will outline the critical tasks that are to be performed in each of the four steps. From this we will derive a number of key questions with respect to the practical implementation of the Lead User approach to develop an agenda for future research.

The methodology involves four major steps, beginning with the delineation of a search field and ending with the development of a product concept (see Figure 2).

Step I: Starting the Lead User process

The innovation project team usually begins with an accurate definition of the search field (e.g. a market, product field or service area) for which innovative concepts are to be developed. Goal formulation then follows with the determination of the requirements directed towards the outcome of the process (e.g. desired degree of innovation, contribution of the project concerning growth or profitability targets). Both internal and external influences on the application of the Lead User method, such as time restrictions, internal resources, and competition, should be considered at this stage (von Hippel *et al.*, 1999). Most important when specifying the search field, the team has to evaluate the adequateness and usefulness of the Lead User approach for the search field under consideration. As noted in section 3, Lead Users probably exist if users in general perceive high incentives for innovation and are able to innovate in a 'low cost corridor'. The decision to start an innovation project relying on the Lead User approach should therefore depend on the outcome of this evaluation. Hence, project managers have to deal with the challenge of predicting the probability that users are an important source of innovation for a given search field.

The two companies, although aware of the determinants of user innovations, showed the tendency to exclusively select the search field according to general strategic considerations. HILTI defined the installation systems for pipes as the search field because HILTI had no own market offer in this product category and because they forecasted high growth rates in this market. The representatives at J&J selected a mature product category that was characterized by a severe competition on price. It was hoped that the application of the Lead User methodology allowed the generation of substantially new ideas to escape from price competition. While these selection decisions are comprehensible and plausible, the general suitability of the Lead User approach for the particular search field was not extensively and systematically taken into consideration. The team members found it difficult to evaluate variables such as the stickiness of use-related information. From a practical perspective, the following question should therefore be addressed by future research:

- *How can managers in innovation projects carefully estimate how expectations of innovation costs and benefits are distributed among the user population? Can manufacturers actively change the users' cost and benefit expectations with respect to innovation?*

The application of the Lead User approach is too demanding for it to run alongside routine duties in the companies' functional areas. The creation of a dedicated, interdisciplinary team consisting of people from marketing, sales, R&D and production is therefore required. Managers of the innovation projects are well-advised to consider the implications of team composition in the fuzzy front end of the innovation process for the subsequent development phase, when it comes to transfering the ideas and concepts to a 'standard' NPD project within the organization (Kim and Wilemon, 2002a). Experience from the two cases shows that this event is rather critical and is complicated by the reluctance of technical personnel to accept concepts that are developed by inventors outside the organization ('not invented here'; Katz and Allen, 1982). In the HILTI case particularly engineers from corporate R&D had difficulties to imagine that users in the investigated field (e.g. fitters or plumbers) were able to design a pipe fastening system superior to existing products. Representatives at Johnson&Johnson Medical believed the norms for hospital hygiene and the regulations of the German medical product law to inhibit users to develop promising ideas for surgical hygiene products. However, pessimistic professionals usually changed their attitude towards user input through the experience of cooperating with Lead Users. The commitment to the Lead User ideas and concepts was sustained during the subsequent development phases. Most of the people involved in the application of the Lead User method were the most active and persevering promoters of the user generated ideas and concepts. On the contrary, in both companies, technical professionals were more pessimistic if they had not been a member of the team. The general doubt regarding the ability of users to provide valuable input influenced the evaluation of the ideas and concepts that had been developed in the Lead User process (self-fulfilling prophecy). This experience indicates that team composition plays an important role with respect to the successful transfer of the Lead User ideas to the development phase when a firm decides to invest in the ideas. This leads to the following question:

- *Which functions and types of personnel are needed in the team for an undisturbed execution of the project and successful transfer of the results to in-house R&D management?*

Step II: Identification of needs and trends

Theoretical considerations and empirical evidence strongly suggest that average users are heavily restricted by the familiarity with actual products and use contexts (see section 3). The situation is different if users are leading trends with respect to important dimensions of the market which are changing over time. These progressive users are probably familiar with needs that will become general in the future market. Forecasting critical trends is therefore essential for the subsequent identification of Lead Users (Herstatt and von Hippel, 1992; von Hippel *et al.*, 1999). These trends can involve technology and market changes relating to the given search field as well as more general economic, legal and social developments that will probably impact the market. Manufactures usually have access to different sources of information for trend forecasting. In addition to the analysis of secondary source information (e.g. academic publications, data banks, internet), interviews with experts have proven to be especially valuable. The search process should include a wide variety of fields of expertise to ensure that important developments are not missed (e.g. concurrent technologies, newly created markets).

However, the broad range of information sources and the vast amount of accessible pieces of information created a situation of information overload in both Lead User applications presented here. The team members found it difficult to gauge in advance whether the use of a particular information source will lead to promising results. Furthermore it was challenging to prioritize the pieces information and to decide which trend information should be further investigated. The HILTI team reacted to this uncertainty by focusing on trends that were closely connected to the product category in question. Consequently, the trend analysis relied on interviews with a rather small community of experts within the product field (primarily planning engineers). These experts indicated that the users' need for flexible systems and the need to reduce assembling time of the pipe hangers were the most significant market trends. This narrow focus helped to speed up the process. However, the team risked to not become aware of important trends in related or analogous fields. In the J&J case, the project members decided to start a broad trend search and to consider several fields of expertise in parallel. In addition to different technology and need-related trends in the target market (e.g. robotic surgery) the team also interviewed hygiene experts, microbiologist, and virologists. The broad search reduced the danger to ignore important trends. However the team realized a trade-off between a proper search and the efficiency of this process phase. Some trends, at the end, turned out to be insignificant for the subsequent search for Lead Users.

As a result of this discussion, the following question should be addressed by future research:

- *How can managers of innovation projects assess the richness and relevance of several data sources useful for the detection of trends?*

Not only the large number of different trend areas and fields of expertise challenged the teams, also the number of experts needed to get a comprehensive overview of a given trend area was difficult to determine in advance. The number of expert interviews in a given trend area should depend on whether knowledge is distributed rather homogeneously or heterogeneously among a pool of experts. In the J&J application of the Lead User method we carefully investigated the results of the expert interviews and found a rather high heterogeneity of expert knowledge (Lüthje *et al.*, 2003). Thus, at first sight, it seems risky to restrict trend forecasting to only a small group of experts. However, we also found that the knowledge focus of a given expert is closely linked to his/her (professional) background and largely depends on the specific experiences that the expert has made in the product area of surgical hygiene products. Thus, the number of interviews could possibly be reduced by gathering information about relevant experts prior to starting the interview process. This information opens a way to efficiently screen expert groups with respect to the specific knowledge they would be able to provide if interviewed. We suggest the following research question:

- *Which screening methods can be applied to test the value of experts as information source before conducting interviews?*

Step III: Identification of Lead Users

In order to ascertain who the Lead Users are, the project team must first determine the indicators that will allow for their correct identification. Amongst other considerations, it is important that the users actually do lead the trends that were chosen as being important in the previous step. A second indicator that is suggested by empirical research and practical experience is the dissatisfaction of the users with the current market offerings (indicator of high benefit expectations). If a user perceives a mismatch between his needs and the functions or performance of existing products, this kind of dissatisfaction is likely to emerge. High levels of user dissatisfaction were also observed in the two cases presented here. In the HILTI case we found users who often had expressed their ideas how to improve installation products towards the company's sales representatives. But this information rarely ever reached the R&D department. As a consequence, some users had already developed product solutions for their own use. In the case of J&J we observed that the probability to find user innovations was associated with the severity of the problems that the users faced. To give an example, the burn surgeons have to use the hygiene products in difficult conditions (long operations with large, moist wounds) and had therefore developed interesting ideas to cope with these extreme challenges. The question arises how unsatisfied users and customer complaints can be identified (Brockhoff, 2003):

- *How can internal information sources, such as customer complaint management and reports of sales representatives, be used to efficiently identify Lead Users? Do external sources (e.g. internet user forums) offer possibilities to search for unsatisfied customers?*

The process of searching for Lead Users is a creative one that must be tailored to the specific conditions of the relevant search field. It is possible to follow two basic process types for this search – the first a rather quantitative, standardized screening approach the latter a qualitative, non-standardized networking search process.

Screening approach. This approach is based on a screening of a large number of product users in order to test whether they show previously identified Lead User indicators. The data for contacting users is usually freely available from customer databases which enable manufacturers to conduct quantitative surveys based on telephone interviews or written questionnaires. This approach is suitable if the number of customers in the market is manageable and a more or less complete screening of all users seems to be possible. A screening was therefore used by the team at HILTI. As mentioned before, the search in this case focused on existing product users in the market. This group represented a manageable number of respondents.

Networking approach. This approach starts with a small number of interviews with relevant users in the target market. During the interviews the experts are asked ('by the way') if they would know of any other users who have either new needs or have been active in the development of their own solutions. Such informal references help the teams to identify Lead Users. A significant advantage of this approach lies in the chance that the team is guided to analogous fields in which similar challenges are present as in the search field under consideration. The team at J&J primarily used the networking approach. By this, the team was referred to experts in analogous fields, primarily in the field of semi-conductor production. It was noted by some surgeons and hygiene experts in the target market that problem solutions suitable to ensure particle-free air in the chip factories may be transferable to the operation room in order to reduce the amount of infectious germs.

Although both approaches (screening and networking) have proven to be useful in the two Lead User cases, the theoretical foundation of the Lead User identification process itself is still rather weak. Primarily, there is a lack of understanding if the assumed advantages of the networking approach can be linked with insights of existing research. In addition, we have to state that there is almost no empirical evidence on the performance of both search approaches (Lüthje *et al.*, 2003). Thus research is needed to tackle the following question:

- *If both approaches (screening vs. networking) are explored in comparative studies: What approach has higher performance in terms of efficiency (search time, search cost) and effectiveness (identification of leading-edge users)?*

Step IV: Development of product concepts

After their identification, the project team has to involve the identified Lead Users in the innovation activities of the manufacturers. Depending on the search field, the issue of Intellectual Property Rights needs to be addressed before involvement. The users might not be willing to openly reveal their innovations to the manufacturers. This is particularly true for industrial users. On the one hand, conventional wisdom would suggest that they should seek to keep their innovation secret to prevent the transfer of their inventions to other (rival) users without an adequate compensation. On the other hand, it seems reasonable that users are probably more inclined towards co-operation with manufacturers if they expect to set their solution as a standard in the market or if they hope to get valuable help in return (Harhoff *et al.*, 2003).

In addition, even if users are in principle willing to share their ideas, they might not see any benefit in getting involved in the manufacturers' innovation projects. From the users' perspective, the involvement may be associated with several cost and benefit items that determine the utility of cooperating with manufacturers. On the one hand, customers might be afraid of investing time and financial resources. On the other hand, they might feel honored to participate or will simply enjoy the creative task. They can also expect to benefit via rewards like the access to exclusive information or the chance to obtain the ready developed product earlier than others (Brockhoff, 2003).

In the HILTI case the Lead Users were willing to cooperate with the manufacturer, partially because they did not intend to either patent or manufacture a pipe installation system. In the J&J case, however, a small group of potential Lead Users declined to cooperate and to freely reveal their know how in the workshop, because they either hold patents or were already cooperating with other manufacturers and therefore felt legally bonded.

Managers of innovation projects need to understand the variables determining both, the willingness to freely reveal their ideas and the perceived utility of an involvement in the manufacturers' innovation projects. Unfortunately, empirical research about factors that motivate or discourage users to openly reveal their leading-edge information and to participate in innovation projects is just beginning to evolve (Harhoff *et al.*, 2003; Brockhoff, 2003). This leads to the following question as a starting point for future empirical research:

- *How can managers assess and influence the willingness of innovating users to freely reveal* *their inventions and to cooperate with the manufacturer?*

In the two applications of the Lead User method presented here, the users were brought together in a workshop that lasted two to three days in order to develop the ideas further and to combine them with promising NPD concepts. In both cases the workshop served as a fruitful discussion platform for the development of innovative product ideas and concepts. At HILTI an innovative concept for a fastening system was generated and was patented shortly after the workshop. The products developed on the basis of this concept created a new business unit 'technical assembly' and are today a key area of the HILTI product portfolio. The Lead User workshops at J&J helped to formulate four complete and detailed concepts. One encompassed the development of a new type of foil to cover surgical robots used in the operation room that could remove the current sterility and handling problems. A second solution, for instance, consisted of a new, integrated system for the sterile storage of the patient's leg during a hip replacement surgery. All four of the concepts could lead to products that at that time were not in the J&J product program. Some of the product ideas are still not available from any manufacturer in the market, making them world firsts.

Despite the promising results of these two applications of the Lead User approach, we cannot be sure whether workshops, when compared to an individual integration of single users, lead to better ideas and concepts for innovations. It is important to note that the project teams had already collected a substantial amount of ideas for innovations in the course of the Lead User search. Taking into account that organizing a workshop and bringing together all participants at one place is associated with a considerable investment of human and financial resources, the need for a workshop has to be discussed. After all, several studies on idea generation in groups indicate that real groups, under specific conditions, do not outperform non-sharing or nominal groups (Fern, 1982; McGlynn *et al.*, 2004). From a practical as well as a research perspective, the following question seems to be relevant:

- *Under what conditions is a Lead User workshop (face-to-face groups), in fact, more promising than the integration of individual Lead Users or nominal groups of Lead Users?*

5. Conclusions

To combine deliberate customer orientation with the objective to create breakthrough innovations constitutes a major challenge of today's innovation management. Companies that cope with this challenge increase the probability that their new products will perform successfully in the market. As shown here, leading companies like HILTI and Johnson&Johnson rely upon the intensive cooperation with Lead Users who are ahead of the market with respect to their needs and therefore benefit from innovations that provide a solution to those needs.

We have shown that the two Lead User characteristics suggested by von Hippel to identify leading-edge customers are supported by theoretical work and empirical research findings. The existence of users that face new emerging needs earlier than others is supported by diffusion theory and empirical findings on new product adoption. The critical role of the experience of new needs for the capability to innovate is embedded in concepts of creativity research and cognitive learning theories. The motivation for innovation can be understood by taking a cost-benefit perspective. It has been shown, that the propensity for user innovations, both on the industry and on the individual level, is determined by innovation-related cost and benefit expectations.

Based on the illustration of two applications we have illustrated the various process steps of the Lead User method. The outcome of the two applications offered the chance for the expansion of the product programs as well as the development of completely new product lines. The effectiveness of the Lead User methodology has been further proven by a new investigation within 3M, a company with great experience in the involvement of Lead Users in innovation projects. In a comparison between innovation projects based on the Lead User approach and traditional (non Lead User) projects, the newness of innovation, the expected turnover, the market share, and the strategic importance all were measured as being significantly higher in the first type of projects (Lilien *et al.* 2001).

Despite this empirical evidence regarding the effectiveness of the Lead User method, little is known about critical success factors of its implementation in the context of the fuzzy front-end phase of innovation projects. Although published applications of the method provide a first insight with respect to promising actions and decisions when working with Lead Users, empirical findings are scarce. We therefore developed some key issues for research on the successful practical application of this method in order to start an agenda for future research. Empirical studies on the basis of this agenda might help to answer the open questions.

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