Paper to be presented at the

DRUID Society Conference 2014, CBS, Copenhagen, June 16-18

Unpacking Stickiness: Categorizing User Inputs and Knowledge for Innovation

Yat Ming Ooi
University of Auckland
Department of Management & International Business
y.ooi@auckland.ac.nz

Kenneth Husted
University of Auckland
Centre for Innovation and Entrepreneurship
k.husted@auckland.ac.nz

Abstract

Firms are increasingly involving their customers in their innovation processes. Customers co-develop products, provide feedback, and provide specific problem- and solution-based customer knowledge. This phenomenon has been extensively studied in the user innovation literature from a user-centric perspective. Less attention is paid to examining the micro-foundations of how firms use user knowledge to generate innovative outcomes. We offer a starting point to addressing this issue, by categorizing user inputs grounded on the knowledge characteristics of embedded user knowledge and innovation dimensions of the outcomes. Categorizing user inputs can provide a clearer indication of the user knowledge that firms can access, transfer, and utilize throughout the user innovation process. We systematically review the user innovation literature and apply a knowledge management and micro-foundations perspectives to propose four categories of user inputs with varying knowledge characteristics. The review enables the identification of a range of practices and issues for transferring user knowledge that forms the micro-foundations of user innovation phenomenon.

Jelcodes:O31,L21

Unpacking Stickiness: Categorizing User Inputs and Knowledge for Innovation

ABSTRACT

Firms are increasingly involving their customers in their innovation processes. Customers co-develop products, provide feedback, and provide specific problem- and solution-based customer knowledge. This phenomenon has been extensively studied in the user innovation literature from a user-centric perspective. Less attention is paid to examining the micro-foundations of how firms use user knowledge to generate innovative outcomes. We offer a starting point to addressing this issue, by categorizing user inputs grounded on the knowledge characteristics of embedded user knowledge and innovation dimensions of the outcomes. Categorizing user inputs can provide a clearer indication of the user knowledge that firms can access, transfer, and utilize throughout the user innovation process. We systematically review the user innovation literature and apply a knowledge management and micro-foundations perspectives to propose four categories of user inputs with varying knowledge characteristics. The review enables the identification of a range of practices and issues for transferring user knowledge that forms the micro-foundations of user innovation phenomenon.

INTRODUCTION

Firms seek to reduce market uncertainty by obtaining inputs and knowledge that are relevant for future innovations from a wide range of users. Users are those who benefit from using a product, and include intermediate user firms and individual end-users (Bogers, Afuah, and Bastian 2010; von Hippel 2010). Firms benefit by working closely with users in the innovation process because users provide insights about unmet needs; in some cases they even develop solutions to their problems when existing products fail to satisfy their needs (Urban and von Hippel 1988; Neale and Corkindale 1998; Lilien et al. 2002).

User innovation literature predominantly suggests tools and methods to facilitate user-driven innovation activities in both firm- and user-initiated contexts, with the goal of generating innovative outcomes (Bogers et al. 2010). While contributions in open source offer some insight into what and how user input and knowledge is shared, transferred, and used to innovate within the open source community (Murray and O'Mahony 2007; Stuermer, Spaeth, and von Krogh 2009); less systematic attention in user innovation literature is given to examine what and how the firm employs internal organizational practices to access, transfer, and utilize specific user inputs. Greer and Lei's (2012) interdisciplinary review of user innovation literature organized the literature based on stages of the collaboration process. According to them, firms need to understand the collaboration process from start to finish. This includes understanding the drivers and barriers to innovative collaboration, considering the feasibility of such collaboration, methods of implementing the collaborative arrangement, further development of the arrangement, and evaluating the arrangement. Bogers et al. (2010) provide a review of studies on reasons why users innovate, with a distinction between user firms and individual users. They conclude that while user innovation is being studied extensively, several key questions pertaining to the user innovation phenomenon such as underlying assumptions, impact of user and tacit knowledge, and appropriation mechanisms,

have yet to be examined. In particular, the existing reviews do not fully engage with issues related to the transfer of user inputs and organizational practices for accessing user innovations.

In this paper, we address issues related to the transfer of user inputs and organizational practices for accessing user innovation through a systematic review of user innovation literature. The aim is to offer clearer suggestions of user inputs grounded on the knowledge characteristics underlying these inputs. This would allow us to explicate related issues of knowledge transfer and sharing in the context of user innovation phenomenon. Specifically, we focus on identifying the micro-foundations of how firms generate innovative outcomes from capturing value from user innovation, namely the user inputs. Transferring user knowledge is neither simple nor straightforward, as user knowledge contains tacit components and is "sticky" (von Hippel 1994; Nonaka et al. 2000) because of the costs of knowledge transfer, characteristics of knowledge, and characteristics of transferor and transferee (von Hippel 1994; Szulanski 1996). The knowledge management literature is vocal about the fact that tacit components of knowledge resides in individuals and demands significant effort from the parties involved to share it (Nonaka, 1994; Szulanski, 1996; Kang, 2007; Foss, Husted, and Michailova 2010).

The ability to systematically identify relevant knowledge amongst users allows firms to employ knowledge accessing and transferring practices to manage better both external user and internal knowledge types (Quintas et al. 1997; Zack 1999; Dahlander and Gann 2010; Lichtenthaler 2011). Organizational practices for accessing and transferring external user knowledge in this context are the internal organizational mechanisms required for firms to access, transfer, and use user inputs. Examples of such practices are organizational structures, employee reward systems, and internal communication practices (Almeida, Phene, and Grant 2006; Foss, Laursen, and Pedersen 2011). Recent contributions offer some insight on user

inputs and internal organizational practices (e.g. Bogers et al. 2010; Foss et al. 2011; Poetz and Schreier 2012), but the role of user inputs and internal organizational practices components in user innovation is still largely under-researched. This inhibits efforts to explain the nature of how firms benefit from user innovation. Understanding the nature or micro-foundations of how firms benefit from user innovation is critical for the quality of the explanations and implications user innovation literature can offer.

Drawing from conversations in micro-foundations (Teece 2007; Foss et al. 2010; Felin, Foss, Heimeriks, and Madsen 2012), the notion of micro-foundations is to explicitly examine and identify the explanatory factors of a phenomena located at lower level of analysis compared to the phenomenon, namely individuals and their actions. Not limited to only individuals as level of analysis, the micro-foundations perspective can also be adapted identify the micro-level mechanisms and understand how they interact to create macro-level phenomenon (Coleman 1990). Innovation phenomena are inherently multi-level occurrences and adopting a micro-foundations perspective provides a clearer analysis on the intricacies of user innovation phenomenon for the firm (Gupta, Tesluk, and Taylor 2007). We use the notion of micro-foundations to identify micro-level user inputs, and offer suggestions on their effects on internal organizational practices to generate innovative outcome for the firm in user innovation context.

The remainder of the paper is organized as follows. First, we present the conceptual framework that informed this review and the approach we adopted. Based on the analysis of the articles we review, we propose user input categories - we inductively group the user innovation outcomes suggested in the literature into clear user input categories relevant to user innovation research. We also present the transfer mechanisms that firms typically use to access and transfer user inputs. Finally, we develop theoretical and practical insights related to accessing, transferring, and managing user inputs.

CONCEPTUAL FRAMEWORK

Users are motivated by pecuniary and non-pecuniary benefits, such as monetary benefits and the satisfaction from addressing an innovation problem or need (Luthje 2004; von Hippel 2005; Jeppesen and Frederiksen 2006; Bogers et al. 2010). Apart from rent-seeking behavior, studies have also found that users innovate when it is costly for them to transfer need-related information to firms. The costliness and difficulty in transferring need-related information (i.e. knowledge stickiness) arises because need-related information contains user knowledge that has tacit characteristics (von Hippel 1994; Ogawa 1998; Lakhani and von Hippel 2003). Innovation researchers acknowledge the importance of user knowledge and its tacitness in providing relevant insights and inputs to generate innovative products and services (Bogers et al. 2010). Knowledge management and related fields use the tacit and explicit knowledge classification to explain the formation of competitive advantages and barriers for technology transfer (Nonaka 1994; Hall and Andriani 2003; Nightingale 2003). When firms engage in user innovation to access and transfer user inputs, they also access the user knowledge embedded in these inputs. User knowledge is likely to possess both tacit and explicit knowledge components which would affect knowledge stickiness in intra-organizational knowledge transfer (Szulanski 1996; Szulanski and Cappetta 2006).

The user innovation literature argues that users provide two types of knowledge to firms: problem- and solution-based knowledge (von Hippel 1986; Bogers et al. 2010; Poetz and Schreier 2012). Problem-based knowledge is information about users' needs evolved out of users' implicit usage experience. Users often share problem-based knowledge with firms to obtain a solution from the producer firm. A firm normally uses problem-based knowledge shared by users to create new products and services, serving as a starting point for new product development. This often results in products or services that meet the users' needs, thus solving users' problems. Solution-based knowledge contains the solution to an existing

user or market need. Von Hippel (1976) reported a shift in the locus of innovation from producer firms to their users, the premise of which is that users have the solution-based knowledge to innovate, one that the firm does not possess. The tacitness of solution-based knowledge inhibits the transfer of solution-based knowledge to firms as argued in both the user innovation and intra-organizational knowledge transfer literature (von Hippel 1994; Szulanski 1996).

Users use the problem- and solution-based knowledge that they possess to generate innovative outcomes. User-created innovations, especially those created by lead-users, are often novel and breakthrough products that tend to be superior to existing products (Luthje and Herstatt 2004). Collaboration between users and firms also generates continuous improvements and changes that enhance prevailing products and services in the market (von Hippel and Katz 2002; Jeppesen and Frederiksen 2006). User innovation literature also suggests various tools and methods to encourage user participation and solicit user inputs, such as the lead-user method, toolkits approach, and user communities (Herstatt and von Hippel 1992; von Hippel and Katz 2002; Bogers et al. 2010).

The notions of problem-/solution-based knowledge, knowledge tacitness, stickiness, and innovation dimensions form part of our conceptual framework, with which assumptions are drawn to provide direction in the organization, interpretation, syntheses, and analyses of user innovation articles. The transfer mechanisms of different knowledge types in the knowledge management literature provide explanatory power in relation to how and why different methods are more suitable in transferring different user inputs and embedded user knowledge.

REVIEW METHOD

We conducted a systematic review, which entails the use of explicit steps and criteria to search and appraise a body of literature (Tranfield et al. 2003; Petticrew and Roberts 2006; Thorpe et al. 2011; Keupp et al. 2012). A systematic review method is a suitable approach because of the rigorous process that increases the transparency, clarity, and reproducibility of the review (Tranfield et al. 2003; Thorpe et al. 2011) and minimizes researcher bias and random errors (Cooper 1998).

Following the recommendations of Cooper (1998), we started the review by outlining its objective and the selection criteria used to screen user innovation articles. Although systematic reviews rely on specific steps leading from one process to another, conducting them is an iterative process (Tranfield et al. 2003; Petticrew and Roberts 2006). In our case, after identifying the keywords and search strings, we conducted a preliminary search to test the robustness of the search strings. Based on these results, we adjusted the search strings to ensure that we obtain a relevant and robust set of articles.

Searching for articles

We identified keywords that are relevant for the purpose of this review by examining high impact user innovation articles. We identified these articles through citation-based analysis, cross-checking with Harzing's (2012) Journal Quality List and Podsakoff et al.'s (2005) selection of high impact management journals. We formulated keyword strings before searching for relevant articles using ISI Web of Knowledge's Social Sciences Citation Index (SSCI). SSCI database is one of the most comprehensive databases of peer-reviewed journals with a citation counts feature that allowed us to also employ citation-based analysis.

To obtain a pool of relevant articles on user innovation, we used 'User' and 'Innovation' in their derivatives (i.e. TS=User*). This initial search resulted in 2,935 articles.

We then limited the selection to relevant journals in the subject areas of Business, Management, and Economics, which yielded 1,135 articles. The keywords and search strings are summarized in Table 1. We only searched for peer-reviewed scholarly journals, omitting books, book chapters and non-refereed publications to be able to rely on validated knowledge (Podsakoff et al. 2005; Crossan and Apaydin 2010; Keupp et al. 2012). From this, we obtained a final base set of 642 articles. We included both conceptual and empirical studies (Crossan and Apaydin 2010) and among the latter, we found that the user innovation literature is distributed rather evenly between qualitative and quantitative studies. This is not surprising, given the present intermediate state of development of the user innovation concept (Edmondson and McManus 2007).

(INSERT TABLE 1 HERE)

Screening the evidence

Using the final set of 642 articles, we employed a three-step process to screen them (Pittaway et al. 2004). First, we removed articles from unrelated fields of studies (e.g. Computational Economics, Accounting Studies, and Macroeconomic Dynamics) from the base set. When in doubt, we referred to the respective journal's website to determine the relevance of the journal for this review. This resulted in 221 articles being removed. Second, we used citation analysis to screen the remaining 421 articles. To ensure the selected articles are of high impact, we removed articles published before 2012 that attracted less than 2 citations a year and exempted articles published in 2012 and 2013 from this criterion. This step removed additional 172 articles. Though citation analysis is not without its flaws, doing so enabled us to filter high impact articles objectively, using acceptable standards in academia to meet our time constraint (Bartunek et al. 2006; Crossan and Apaydin 2010). In the third step, we conducted title and abstract screening of the remaining 249 articles. Title screening yielded 156 articles. When the title of articles was not indicative of the exclusion

criteria, we included these articles for abstract screening to minimize the possibility of eliminating potentially relevant articles. Through abstract screening, we identified the final set of 109 articles for full-text screening.

We studied the 109 articles and identified those addressing user inputs, user knowledge, transfer modes of user inputs, and practices to transfer user knowledge. Descriptive and thematic information of these articles (e.g. citation information, research aims and questions, methodology, findings) were extracted for further analyses. We removed articles not addressing these topic areas, and thus not relevant for the purpose of this review. The removed articles address 1) extent, antecedents, outcomes, and diffusion of user innovation without addressing user inputs, organizational practices, or knowledge transfer; 2) patterns of innovation systems with minor mention about collaboration; 3) purely open source literature on intellectual property rights, and commercialization of open source software with no explicit linkage to user inputs; 4) networks/communities literature solely addressing network management and positioning from non-user innovation perspective; 5) methods of corporate entrepreneurship; and 6) technology transfer typologies. Removing these articles yielded a final consideration set of 54 articles.

SYNTHESIZING THE ARTICLES

We synthesized the evidence with the purpose of identifying patterns that allow us to categorize user inputs and provide insights on characteristics of the embedded user knowledge. Users play many roles in the user innovation process. Bogers et al. (2010) summarized user innovation research based on the role of users into two streams: user as adapter of firm's products and users as sources of knowledge. We extend this classification by examining the inputs and knowledge that users actually offer to firms. Grounding our

assumption of user inputs on the user innovation literature and guided by our conceptual framework, we examine and analyze the evidence to propose categories of user inputs.

In total, the 54 reviewed articles were published in 21 different journals from fields such as new product development, innovation and technology management practices, economics, organizational management, marketing, and management reviews (see Figure 1). One-sixth of the articles were published in Journal of Product Innovation Management, an interdisciplinary journal devoted to publishing scholarly contribution in the area of new product and service development. Approximately 11% of the articles were published in Research Policy and International Journal of Technology Management.

(INSERT FIGURE 1 HERE)

We found that ideas and prototypes generated by users are often novel and meet specific market need, resulting in new products and services that firms can offer to the market (Prugl and Schreier 2006; Hienerth et al. 2011; Mahr and Lievens 2012). Users also provide input in the form of comments that result from evaluating novel ideas and prototypes. This is commonly seen in user communities where community members evaluate ideas and prototypes submitted by other members (Lettl et al. 2006a; Franke et al. 2008; Hutter et al. 2011). User inputs also take the form of user feedback, which leads to incremental changes on existing products, e.g. improving product performance and increasing functionality (Brockhoff, 2003; Jeppesen & Molin, 2003; Kohler, Matzler, & Füller, 2009; Magnusson, 2009; Mahr & Lievens, 2012). User input also take the form of actual modifications to existing products that are then revealed to firms (Henkel, 2006; Prugl & Schreier, 2006; Füller, Jawecki, & Mühlbacher, 2007). This input is different from prototypes as adjustments are only made to improve existing product performance, not to create radically new products. The last form of input is one that informs firms about unarticulated needs and potential radical innovation. This could take the form of ideas or suggestions that enable firms to

identify and understand latent needs for future market applications (Lilien et al. 2002; Pedrosa 2012).

The user innovation literature also offers indication on the characteristics of user inputs, including whether they are problem-/solution-based and the likely degree of tacitness. First, novel ideas recommend potential market needs that are worth developing - the knowledge in novel ideas offers firms a starting point to designing new products that meet existing or emerging market needs. Second, prototypes offer firms solution-based knowledge and reduce the time needed for firms to research and develop new products. Third, users frequently evaluate ideas and prototypes offered by the firm or other users. Online communities and open source are two examples provided in the literature where users commonly evaluate ideas and prototypes for the purpose of improving the development of the actual product. These evaluative comments and feedback contain knowledge that is relevant to addressing shortcomings of the initial idea or prototype.

Suggestions about existing product performance provide good descriptions of the problems that need to be addressed in a product. However, due to the implicit usage experience that users draw on to generate suggestions, this input is mainly problem-based and lacks solution-based knowledge that firms need to implement the suggestions (Magnusson 2009). Though descriptions provided in suggestions are in explicit written form, their implementability is highly subjective. When users make minor improvements to existing products and reveal the changes freely to firms, the modifications offer firms the needed solution-based knowledge to implement the changes on a larger scale. This is especially relevant when users amend software codes to increase software performance and functionality (Kohler et al. 2009). User input on unarticulated and latent needs contains tacit knowledge on personal usage experience. Though the input is useful and could contribute to radical innovations (Lilien et al. 2002), it is based mainly on describing the needs of

advanced users; the solution of how firms should address the needs is not in focus (Magnusson 2009; Pedrosa 2012). This implies that firms need to unfold the underlying knowledge, thus increasing the time and effort they invest into offering workable solutions to the market.

It is indicated earlier, that different user inputs consist either of mainly problem- or solution-based knowledge. While this distinction is important in relation to the contribution of these inputs to the firm's innovation process, the degree of tacitness is an important dimension in regard to the potential difficulties in transferring the user inputs. There are no concrete categories of user inputs in the user innovation literature; however we are able to deduce from our review that user inputs have a varying degree of tacit and explicit knowledge components. Tacitness is important here because of the difficulties that are associated with transferring tacit knowledge (von Hippel 1994; Szulanski 1996; Nonaka et al. 2000).

The reviewed articles reveal that novel ideas and prototypes have different degree of tacitness. When prototypes are created using explicit solutions, they are more radical and relevant, as solution-based knowledge is clearly presented and integrated in the user input. The explicit nature of solution-based knowledge enables firms to transfer and develop user prototypes with less effort compared to other forms of user inputs. In contrast, novel ideas are commonly derived from the users' implicit usage experiences and contain users' problem-based knowledge. It is because novel ideas are derived, amongst other components, from the implicit usage experience, it contains more tacit knowledge, making it more difficult for firms to comprehend when compared to a functional prototype (Franke & Piller, 2003; Mahr & Lievens, 2012). However, in open source processes (Henkel 2006; Prugl and Schreier 2006), even when users conduct major changes to original software codes, the created input still consists of source codes that are explicit and easily revealed to firms. Similarly, in cases

where firms provide toolkits for users to create and customize products within a range of fixed parameters (Franke et al., 2008), products created by users, though some are novel, are less tacit because they are created using sets of solution-based knowledge offered by firms.

Tacitness of user knowledge also tends to vary across other user inputs. When users provide suggestions and feedback on existing products or latent needs, the problem-based knowledge is built on users' existing usage behavior (Cooper et al. 2002; Brockhoff 2003; Di Maria and Finotto 2008; Pedrosa 2012). While users are able to share this input with firms, implying some form of explicit knowledge component, the inherent usage behavior that shapes user suggestions and feedback means that tacit components are also present in the input. This is important because firms need to first comprehend user knowledge before attempting to access and transfer different user inputs (Szulanski 1996; Almeida et al. 2006).

We organize the reviewed articles by grouping the evidence into preliminary categories as presented in Table 2. Despite some limitations, this allows us to provide a clear overview and a foundation for further analysis. In particular, it enables us to clearly identify user inputs, their degree of tacitness, and whether researchers address the problem-based, solution-based, or both types of knowledge in their studies.

(INSERT TABLE 2 HERE)

Grouping is a relevant method because it allows us to explore the relationships between the variables in the next stage of analysis, namely a clearer categorization of user inputs (Popay et al. 2006). Our review suggests that the user innovation literature provides relevant insights on user inputs and the knowledge dimensions of these inputs; however, research seems to fall short of providing clear categories of these inputs or establishing relationships between these inputs, knowledge dimensions, and the firm-level innovative outcomes associated with these inputs. The next section analyses the evidence obtained in this review to derive categories of user inputs.

THE EMERGENCE OF USER INPUT CATEGORIES

As outlined in the preceding section, when users innovate, they generate inputs such as novel ideas, production-ready prototypes, comments or evaluations on prototypes/ideas, feedback or complaints on existing products, software codes, and suggestions for radical products (see Table 2). Developing these different types of inputs require various combinations of knowledge such as users' problem- and solution-based knowledge and usage experience (Luthje and Herstatt 2004; Poetz and Schreier 2012). More importantly, users are able to provide firms with relevant inputs because users possess specific know-how and know-why (Johnson et al. 2002). Without sufficient understanding on the intricacies of why and how things work, users are not able to provide novel ideas or feedback on products.

However, user knowledge has tacit and explicit components that affect the feasibility and difficulty in transferring knowledge from users to firms (Nonaka 1994; von Hippel 1994; Szulanski 1996; Kang 2007). These inputs consist of different combinations of tacit and explicit components that contribute to either incremental or radical innovations. Using the conceptual framework developed earlier, we argue that for firms to access and transfer user knowledge, firms need to access various forms of inputs generated by users. These various inputs are used to generate user-driven innovation that is more incremental, when it enhances the existing product (von Hippel and Katz 2002; Jeppesen and Frederiksen 2006); radical, when it is novel and breakthrough compared to existing product (Luthje and Herstatt 2004). Incremental innovation enhances the firm's existing competencies, resulting in continuous improvements on existing product while radical innovation is discontinuous and disruptive in nature, requiring firms to learn new competencies to create novel products for existing and/or new markets (Tushman and Anderson 1986; Yu and Hang 2010). With this in mind, we propose four categories of user inputs based on the extent the inputs contain problem- and solution-based knowledge components, and the contributions of these inputs to incremental

and radical innovations. The categories make it clearer for firms to identify user inputs that could lead to radical innovative outcomes for the firm. As illustrated in Figure 2, the categories are incremental-demand, game-changing-demand, incremental-fix, and game-changing-fix.

(INSERT FIGURE 2 HERE)

"Game-changing-fix" inputs are prototypes of new products created by users, especially lead-users. The literature talks about user-created designs and prototypes such as semiconductor devices, medical devices, Lego designs, and playboating hardware (Baldwin et al. 2006; Lettl et al. 2006a; Hienerth et al. 2011; Adams et al. 2012). Given the more physical nature of this input, it contains more solution-based knowledge and is likely to be more explicit in nature. We do not claim that "Game-changing-fix" inputs have no tacit knowledge; instead, we suggest that "Game-changing-fix" input contains more explicit knowledge components because firms are able to comprehend and implement this input relatively faster compared to other inputs. When users provide this input to firms in the form of a new product prototype, firms are able to comprehend and transfer this input by examining the prototype. These inputs also contribute to radical innovations in the firm, especially in the case of prototypes created by lead-users. As lead-users have advanced needs and technical know-how, they are prime to create innovations that are more radical in nature (von Hippel 1986).

"Incremental-fix" inputs are actual modifications users make to existing products and evaluative comments users give when assessing the feasibility of an idea or prototype. Users are reported to make modifications to playboating equipment and software (Franke & von Hippel, 2003; Baldwin et al., 2006). This input contains solution-based knowledge as users need to have actual knowledge on fixing the given problem. Users' evaluative comments provide specific goals that allow firms to develop an existing idea or prototype further, such

as evaluation on new consumer goods design and new ski designs in the extreme sports sector (Brockhoff, 2003; Franke et al., 2008). As such, evaluative comments contain more explicit knowledge components. However, when users perform physical modifications in existing products to meet their needs and reveal these modifications to firms, firms are able to learn and adapt these modifications to implement incremental changes to enhance their existing product offerings. Actual modifications contain tacit knowledge components - first, although users reveal the modifications to firms, users are guided by their implicit usage experience, which is unknown to the firm; second, firms are able to learn from the modifications, but most often, the technical know-how or solution-based knowledge are not explicitly revealed to firms (Magnusson 2009). This would require firm to reverse-engineer the modifications to understand the intricacies of such changes. "Incremental-fix" input contributes to incremental innovations because minor modifications and actionable evaluations provided by users serve to increase the firm's existing competence in developing an existing idea, not to equip the firm with an entirely new set of competencies (Tushman and Anderson 1986).

The third user input category is "Incremental-demand" input. "Incremental-demand" inputs are unique and novel ideas for current application in the market, and suggestions given by users on existing product performance. This is evident in the fashion, sporting equipment, telecommunications, and consumer goods sectors (Di Maria and Finotto 2008; Franke et al. 2008; Magnusson 2009; Hutter et al. 2011). "Incremental-demand" input contains essential problem-based knowledge that highlights user needs. This input contributes to incremental innovations that increase the capability of existing products (Henkel 2006; Füller et al. 2007; Kohler et al. 2009; Dahl, Lawrence, and Pierce 2011; Chandra and Leenders 2012). Feedback and complaints provided by users on existing products allow firms to perform incremental changes and increase product performance or refine its features.

"Game-changing-demand" inputs are contributions by users that contain information on radical innovations beyond the needs of the existing market. Such input contains problem-based knowledge and is important to firms as it has the potential not only for radical innovations, but also to open entirely new markets. The evidence suggests that users provide firms with input on latent needs in logistics services, music equipment such as turntables, and industrial products (Lilien et al. 2002; Faulkner and Runde 2009; Pedrosa 2012). Lead-users are main contributors of "Game-changing-demand" input because they have advanced skills and technical know-how that ordinary users lack, and have the knowledge to identify future needs of the market (von Hippel 1986; Lettl et al. 2006a). Users providing "Game-changing-demand" input are guided by implicit usage experiences, which increases the tacitness of the input. While "Game-changing-demand" input is important for radical innovations, it is also tricky if firms are unable to provide the solution to address the emerging need (Magnusson 2009), especially when firms are unable to access users' tacit usage experiences that characterize "Game-changing-demand" input.

Any transfer of knowledge between two different units will be affected by knowledge stickiness. The notion of stickiness implies that the difficulty in knowledge transfer increases if tacit knowledge is the main object of transfer (von Hippel 1994; Szulanski 1996). Applying the knowledge stickiness argument to the four user input categories, we postulate that the level of stickiness increases not only when the inputs have more tacit components, but also when the inputs contribute to more radical innovations. In incremental innovations, firms are more likely to utilize existing competencies to implement the changes, with some changes even enhancing existing competencies. However, in radical innovations, firms need to forgo existing competencies and learn new ones (Abernathy and Clark 1985; Tushman and Anderson 1986), which in turn, requires firms to be able to comprehend the underlying knowledge of radical changes. Given the path dependent nature of knowledge acquisition

(Cohen and Levinthal 1990; Almeida et al. 2006), it is likely that firms will have comprehension difficulties, let alone transfer knowledge of radical changes (Szulanski 1996). This difficulty is thus the basis for our argument that stickiness increases when user inputs contain more tacit components and when the inputs contribute to more radical innovations.

TRANSFER MECHANISMS FOR USER INPUTS

The evidence suggests that firms employ various transfer mechanisms to overcome the stickiness of user knowledge. In Figure 3 we summarize these mechanisms for the four user input categories. Firms utilize workshops and collaborative arrangements to access and transfer all user inputs categories. Interaction activities such as workshops, formal discussion forums, and co-creation activities provide the opportunity for users to share all user input categories (Herstatt and von Hippel 1992; Fuchs and Schreier 2011; Adams et al. 2012; Chatterji and Fabrizio 2012; Wadell et al. 2013).

(INSERT FIGURE 3 HERE)

Apart from workshops and collaborative arrangements, user inputs with solution-based knowledge are transferred through software codes, users freely revealing innovations, and ideas competition. Software codes and files are commonly used to transfer "Incremental-fix" and "Game-changing-fix" inputs. The embedded solution-based knowledge is transferred when user freely reveal the source codes of these software files to firms (Henkel 2006; Prugl and Schreier 2006; Jeppesen and Laursen 2009). Firms can then access these codes to understand the underlying solution-based knowledge of the newly created software files. Users also freely reveal innovations in the form of prototypes and modifications to firms. Similar to software codes and files, when users freely reveal prototypes and modifications, firms are able to access and transfer the solution-based knowledge to either manufacture radically new products or improve on existing offerings (Franke, von Hippel, and Schreier

2006). “Incremental-fix” and “Game-changing-fix” inputs are also transferred through ideas competition. This is where firms define the innovation problems and officially solicit solution-based knowledge from a wide range of users. Solution-based knowledge is normally in written form, where users solve the innovation problems posted by firms. Firms screening user inputs through ideas competition obtain the necessary solution-based knowledge from users’ submissions (Kohler et al. 2009; Dahl et al. 2011; Frey, Luethje, and Haag 2011; Füller, Hutter, and Faullant 2011; Poetz and Schreier 2012).

Firms also use evaluation and testing sessions with users to transfer “Incremental-fix” input. In these sessions, users evaluate novel ideas and prototypes, sharing their solution-based knowledge with firms via suggestions, comments, and evaluations (Gassmann et al. 2006; Lettl 2007; Desouza et al. 2008; Lettl 2009; Antorini et al. 2012). Firms utilize online discussion threads in relation to both “Incremental-fix” and “Incremental-demand” inputs. Users use discussion threads to share both problem- and solution-based knowledge with firms where users provide novel ideas, and feedback and suggestions on existing products. “Incremental-fix” input, such as evaluations of ideas and prototypes, is also shared through discussion threads (Füller et al. 2007; Mahr and Lievens 2012).

Toolkits and platforms, and written feedback/survey are only used to transfer “Incremental-demand” input. When firms employ toolkits or platforms to capture “Incremental-demand” inputs, problem-based knowledge is transferred to firms through the toolkit itself (Jeppesen and Molin 2003; Hienerth et al. 2011). Problem-based knowledge embedded in “Incremental-demand” input is also transferred through written feedback and survey (Franke, Schreier, and Kaiser 2010; Fuller 2010). The transfer mechanism of observations is used to by firms to obtain “Game-changing-demand” inputs that are largely problem-based knowledge with information about users’ latent needs (Adams et al. 1998; Cooper et al. 2002; Edvardsson et al. 2012; Pedrosa 2012; Wadell et al. 2013).

Our review allows us to argue that the choice of transfer mechanisms not only depends on whether firms transfer problem- or solution-based knowledge, but also whether the four categories of user inputs contain more tacit or explicit knowledge components (see Table 3). For instance, firms use written feedback and survey to transfer "Incremental-demand" input. In other words, "Incremental-demand" input can be documented and written in words, implying that it contains more explicit knowledge components. In contrast, when firms use observation to transfer "Game-changing-demand" input, the objective is to observe users and learn about latent needs that are not easily revealed, thus assuming it comprises more tacit knowledge components. Furthermore, tacit knowledge is difficult to codify and formalize and increases knowledge stickiness – this is why firms need to employ different mechanisms to transfer tacit knowledge as compared to transferring explicit knowledge (Grant 1996; Szulanski 1996; Nonaka et al. 2000; Alavi and Leidner 2001; Kang 2007; Nonaka and von Krogh 2009). When user inputs contain more tacit knowledge components, written or document-based transfer mechanisms would not suffice. Firms need to use other mechanisms such as observations and workshops to elucidate the more subjective tacit knowledge components.

(INSERT TABLE 3 HERE)

DISCUSSION

The user innovation phenomenon has been studied extensively and evolved over the years to offer explanations of the phenomenon and prescriptions of diverse management tools and methods for firms to capture user inputs (Franke 2014). Recent reviews (Bogers et al. 2010; Greer and Lei 2012) extend our understanding and offer insight on managing the phenomenon. However, the subject of user inputs and associated knowledge management difficulties such as knowledge stickiness, have yet to be fully unpacked. Further, the micro-

foundations of user innovation that explain how firms translate the captured value from user innovations to generate firm-level innovative outcomes are still little understood. This makes it difficult for the conceptual development of user innovation phenomena, and limits the advice we can offer to managers on organizational practices to translate the captured user inputs into innovative outcomes.

We addressed these issues by systematically reviewing 54 articles published in 21 journals constitutive of organization studies and innovation fields. We synthesized the articles to propose four categories of user inputs grounded on the knowledge characteristics of the embedded user knowledge and intended innovative outcome for the firm: 1) Incremental-demand; 2) Incremental-fix; 3) Game-changing-demand; 4) Game-changing-fix. Knowledge stickiness increases when user inputs contain more problem-based knowledge and contribute to firm-level radical innovation. Knowledge stickiness associated with user knowledge types (tacit/explicit and problem-based/solution-based) impacts the transfer mechanisms that firms can employ to transfer the four user input categories.

Our paper serves to direct user innovation researchers to further examine the management of user knowledge by firms. Consistent with recent suggestions (Foss et al. 2011), the management of user innovation is focus on managing the engagement part of the process with little in-depth consideration of the internal organization of the firm. This review is the first step to addressing this issue and in doing so we are able to extend Greer and Lei's (2012) review by going beyond discussing issues and practices at different stages of the collaborative engagement, and concentrate on what is being access and transfer and issues related to translating the inputs into innovative outcome for the firm. We offer four clear categories of user inputs that firms can access and lay out the issues firms will face when actually transferring and using these user inputs. This review will spark future streams of user innovation research to address this weakness in the concept. Specifically, how firms transfer

and manage user knowledge with respect to their existing knowledge base, and the effects of these changes in knowledge management on existing firm strategy. Future research could identify the internal organizational practices needed to access and transfer the four categories of user inputs. Research could also examine the role of internal organizational practices in mediating and/or moderating the four user input categories' stickiness effects. Further, research in the areas of capabilities and knowledge-based view indicate that firms need capabilities, processes, and routines to facilitate exploration and exploitation of external knowledge; however, only some studies in user innovation actually examine the effects of internal organization and organizational practices on user involvement in the innovation process (Foss et al. 2011). This lack of studies examining the causal relationship between internal organization and the firm's innovative outcome (Keupp et al. 2012) provides another avenue for future research.

Micro-foundations perspective

Recent calls (Teece 2007; Felin et al. 2012) for examining the micro-foundations of capabilities have extended to other areas of management research such as knowledge governance and open innovation (Foss et al. 2010; Pedrosa, Välling, and Boyd 2013). Micro-foundations perspective is based on the arguments that micro-level mechanisms, such as individuals and interactions between them, are essential to explain the origin of macro-level phenomena. The social interactions at micro-level builds social capital relevant for innovation (Zheng 2010). Issues of trust, norms, and shared culture affect individuals' propensity to interact effectively to build capabilities needed to innovate. But micro-foundations perspective is not limited to only identifying and examining individuals that affect macro-level phenomena, it also manifest in explanatory mechanisms at micro-level that result in the observed phenomena at macro-level (Coleman 1990). This resounds with the purpose of our

paper, which is to address the fundamental issue of managing user knowledge that forms the micro-foundations of how firms use the captured inputs from user innovation activities to create innovative outcomes in a macro-level user innovation context.

Micro-foundations of user innovation

The general premise of user innovation is that users are useful to firms because they possess the required innovation-related knowledge resulting in products that meet market needs and high in user value (von Hippel 1994; Luthje et al. 2005). One can argue that users (whether individuals, firm users, or user communities) are the micro-foundations of the concept and has been researched extensively to identify and examine the motivations and conditions for users to innovate. But the weakness in this perspective is the lack of development on the other end of the equation, the firms that capture and use user inputs. This is unfortunate because firms are increasingly sourcing externally (including users) for innovation and knowledge, and require more micro-level practices that they can apply to manage user knowledge.

By proposing four clear user input categories, we provide the foundations for a multi-level perspective on the role user inputs and embedded user knowledge play in generating firm innovative outcomes. We argued that the success of user innovation for a firm consists of not only macro-level aggregation of user inputs (inventions/innovations) and approaches for firms to access these user inputs (lead-user method, toolkits), but also the complex interactions between micro-level mechanisms such as the four user input categories that forms the innovations and inventions, and the firm's internal mechanisms and structure.

In this paper, we partly addresses the micro-foundations of user innovation from the firm-perspective provide the foundation for future empirical research on micro-level organizational practices required for firms to access and transfer user knowledge. Providing

clear categorization of user inputs is essential to facilitate the identification of specific organizational practices that firms utilize to access user inputs, and also the probability of examining the effectiveness of such organizational practices. The findings in this paper can serve as a foundation for future empirical studies to examine the micro-level organizational practices needed to access and transfer user knowledge embodied in user contributions, and how user inputs interact with organizational practices to create successful macro-level user innovation outcomes.

Managing user knowledge

The four user input categories and the issues related to managing these inputs adds an antecedent foundation to user innovation literature. In Bogers et al. (2010) and Greer and Lei's (2012) reviews, one of the main reasons for firms to collaborate with users is because users are a significant source of innovation-related knowledge, especially the tacit components of knowledge. However, they do not clarify the components of user-generated innovations and the embedded user knowledge in detailed. It is assumed that firms, employing the tools and methods prescribed in user innovation literature, will be able to successfully access, transfer, and use user inputs to generate innovative outcomes. The lack of empirical studies focusing on integrating user innovation with knowledge management assumptions to explain these occurrences inhibit our understanding and development of user innovation beyond a concept for customer engagement. To advance user innovation concept, we need conduct studies beyond reporting the phenomenon, but also to spell out micro-level issues of managing user knowledge. User innovation requires rigorous studies to identify and examine specific knowledge processes that firms employ to transfer and use user inputs. The need such specificity is relevant to the wider purpose of managing the firm's knowledge bases. Without understanding the specific knowledge processes firms use in user innovation,

it is difficult for firms to enforce knowledge governance mechanisms to effectively manage their knowledge to create innovative outcomes (Foss et al. 2010).

But understanding specific knowledge mechanisms to transfer and use user knowledge requires us to first identify what is being transferred and used as knowledge types and characteristics affect the knowledge processes that firms could employ (Szulanski 1996; Kang 2007). Our contribution lies addressing this issue, by providing four actual user input categories and explicating the underlying user knowledge, and offer clearer insight on why users are important sources of knowledge and what inputs are actually provided by users in the user innovation context. Cross-fertilization between user innovation and knowledge management literature is pertinent to the development of user innovation concept because knowledge management studies offer much needed details about the nature, components, and management of diverse sources of knowledge, which is the missing link in many user innovation studies.

Better understanding of the user knowledge embedded in user-generated innovations allow us to also make a contribution in unpacking the knowledge stickiness argument in user innovation concept. We know that firms use various methods to collaborate with users, such as lead-user method, online communities, and co-creation (Herstatt and von Hippel 1992; Bogers et al. 2010; Greer and Lei 2012). But the choice of transfer mechanisms and knowledge processes that could be applied largely depends on the user inputs because of the tacit components embedded in them. Coping with the issues of modularity, user interaction, costs, and partner selection (Greer and Lei 2012) is insufficient to understand the micro-foundations of user innovation. We need to unravel matters arising from knowledge characteristics of the four user input categories.

Practical implications for accessing and transferring user inputs

Understanding the micro-foundations of user innovation, specifically the user knowledge types and knowledge processes will offer managers insight on how to manage user knowledge. However, existing user innovation enable us to offer advice on how to engage users (e.g. toolkits, user communities) and what type of users are most effective at innovating. The ongoing initiative in open innovation (see Huizingh 2011) to integrate and develop the open innovation concept in relation to existing management and innovation theories is an important progress that user innovation scholars could follow. The need to develop the management of user knowledge aspect is important for us to identify relevant practices for managers to use user inputs and transform them into innovative outcomes. Our review is a start in this direction and we discuss three main implications for managers.

Internal organizational practices

First, firms need to apply certain internal organizational practices to access and transfer user inputs. We argued that the four user input categories contain knowledge with different levels of tacitness. Such differences can be seen where "Game-changing-demand" inputs derived from implied usage experience are more tacit compared to "Game-changing-fix" inputs generated through explicit solution-based knowledge (Mahr and Lievens 2012). Tacit component of user knowledge inhibits knowledge transfers and implies that firms require complementary routines, processes, and internal practices. Firms need absorptive capacity to be able to transfer user knowledge (Szulanski 1996). Although absorptive capacity increases firms' ability to absorb and utilize external knowledge, the path-dependent tendencies in knowledge acquisition also affects firms' motivation to transfer, and ability to comprehend user knowledge (Cohen and Levinthal 1990). Firms need internal practices such as communication channels between departments and balanced reward systems that

encourage staff to search, access, transfer, and share user knowledge. Lack of such practices will make it difficult for staff to comprehend the tacit components of user knowledge and it will likely bear the Not-Invented-Here attitude and act as a barrier to harnessing external knowledge.

Knowledge acquisition practices

Second, different user inputs mean that firms need to re-examine existing external knowledge acquisition practices. The different knowledge components embedded in the four user input categories mean that firms will find it easier to transfer and internalize user inputs that are in a more production-ready state (e.g. production-ready prototypes and features), while focusing on accessing user inputs that contain more tacit components (e.g. information on radical innovations). Knowledge management literature on networks indicates that firms participate in collaborative arrangements to generate new products through learning and acquiring new knowledge from partners or to access knowledge residing in collaboration partners (Grant and Baden-Fuller 2004). For firms employing user innovation practices, knowledge stickiness will impact on the firm's decision whether to internalize tacit components of user inputs in the onset, or start by accessing user knowledge and gradually transfer embedded user knowledge when it evolves to a more explicit and codifiable state. We see a trend where firms tend to access user knowledge when it has highly tacit components. Firms access the know-how and know-why of a new prototype or how to improve the prototype for the intended market, by inviting users to submit evaluations (Franke et al. 2008; Hutter et al. 2011). This eliminates the need for firms to internalize tacit user knowledge at this stage due to the stickiness of such user knowledge. Although firms utilize various methods to access user inputs, they do not necessarily internalize the embedded user knowledge.

Managing intellectual property rights

Third, user inputs also bring with them the issue of intellectual property (IP) ownership and protection. User innovators are able to protect their IP through patents and copyrights (Luthje et al. 2005). When a user has existing IP protection on an input, firms need to manage the IP protection and transfer the IP ownership of that user input to the firm. In this case, the firm's task is to transfer the ownership of the IP through formal channels, such as negotiating with the user owning the patent to the input (Alexy et al. 2012). Major complications arise when firms utilize inputs that have yet to be protected. Firms face the arduous task of ensuring that the input matches the requirements for future IP protection while also ensuring that users forego claims of ownership on the input. User inputs that contain more tacit components increase the complexity of IP protection. Firms need to invest resources into learning and understanding tacit components before the input can be turned into an appropriable IP for the firm.

CONCLUSION

Our review addresses the fundamental issue of user knowledge management that is largely neglected by user innovation literature. By combining multiple theoretical assumptions when analyzing the reviewed articles, we group user input into four categories. These four categories consist of problem- and solution-based knowledge and varied levels of tacit and explicit knowledge components. They form part of the micro-foundations examining how firms create value from these user inputs, remedying the lack of coherent categories available in user innovation concept. Our analysis has also established that user inputs contributing to radical innovation increase the stickiness of user inputs because firms, guided by their path-dependent tendencies, find it difficult to understand the new competencies and

knowledge needed to implement these radical inputs. Specifically, this paper links the research streams of user innovation, micro-foundations, and knowledge sharing and transfer to offer insight on the challenges firms are facing when accessing and transferring the four user input categories.

We note that some user innovation studies could be omitted in our review process, an issue that is common in any literature review (Cooper 1998) or due to the citation-based screening method we applied. We minimized the effects of retrieval bias by employing several screening steps, as suggested by Pittaway et al. (2004). The citation-based screening, exclusion and inclusion criteria, all serve as a stage-gate process to screen and select only the most impactful and highly relevant articles for the purpose of our review. In our final set, the high impact articles could be deemed as representative of the user innovation literature and potential omissions are not likely to affect our analyses and conclusion.

REFERENCES

Abernathy, W. J., & Clark, K. B. (1985). Innovation: Mapping the Winds of Creative Destruction. Research Policy, 14, 3–22.

Adams, M. E., Day, G. S., & Dougherty, D. (1998). Enhancing new product development performance: An organizational learning perspective. Journal of Product Innovation Management, 15, 403–422.

Adams, P., Fontana, R., & Malerba, F. (2012). User knowledge in innovation in high technologies: an empirical analysis of semiconductors. International Journal of Technology Management, 58, 284–299.

Alavi, M., & Leidner, D. E. (2001). Review: Knowledge Management and Knowledge Management Systems: Conceptual Foundations and Research Issues. MIS Quarterly, 25, 107–136.

Alexy, O., Criscuolo, P., & Salter, A. (2012). Managing Unsolicited Ideas for R&D. California Management Review, 54, 116–139.

Almeida, P., Phene, A., & Grant, R. (2006). Innovation and Knowledge Management: Scanning, Sourcing, and Integration. In M. Easterby-Smith & M. A. Lyles (Eds.), Handbook of Organizational Learning and Knowledge Management (pp. 356–371). Blackwell Publishing.

Antorini, Y. M., Muniz, A. M., & Askildsen, T. (2012). Collaborating With Customer Communities: Lessons From the Lego Group. Mit Sloan Management Review, 53, 73–79.

Baldwin, C., Hienerth, C., & von Hippel, E. (2006). How user innovations become commercial products: A theoretical investigation and case study. Research Policy, 35, 1291–1313.

Baldwin, C., & von Hippel, E. (2011). Modeling a Paradigm Shift: From Producer Innovation to User and Open Collaborative Innovation. Organization Science, 22, 1399–1417.

Bartunek, J. M., Rynes, S. L., & Ireland, R. D. (2006). What Makes Management Research Interesting, and Why Does it Matter? Academy of Management Journal, 49, 9–15.

Bogers, M., Afuah, A., & Bastian, B. (2010). Users as Innovators: A Review, Critique, and Future Research Directions. Journal of Management, 36, 857–875.

Bogers, M., & West, J. (2012). Managing Distributed Innovation: Strategic Utilization of Open and User Innovation. Creativity and Innovation Management, 21, 61–75.

Brockhoff, K. (2003). Customers' perspectives of involvement in new product development. International Journal of Technology Management, 26, 464–481.

Chandra, Y., & Leenders, M. A. A. M. (2012). User innovation and entrepreneurship in the virtual world: A study of Second Life residents. Technovation, 32, 464–476.

Chatterji, A. K., & Fabrizio, K. (2012). How Do Product Users Influence Corporate Invention? Organization Science, 23, 971–987.

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive Capacity: A New Perspective on Learning and Innovation. Administrative Science Quarterly, 35, 128–152.

Coleman, J. S. (1990). Foundations of Social Theory. Cambridge, Mass.: Belknap Press of Harvard University Press.

Cooper, H. M. (1998). Synthesizing Research: A Guide for Literature Reviews (3rd ed.). Thousand Oaks, California: Sage Publications. Retrieved from http://ezproxy.auckland.ac.nz/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=63276&site=ehost-live&scope=site

Cooper, R. G., Edgett, S. J., & Kleinschmidt, E. J. (2002). Optimizing the stage-gate process: What best-practice companies do - I. Research-Technology Management, 45, 21–27.

Crossan, M. M., & Apaydin, M. (2010). A Multi-Dimensional Framework of Organizational Innovation: A Systematic Review of the Literature. Journal of Management Studies, 47, 1154–1191.

Dahl, A., Lawrence, J., & Pierce, J. (2011). Building an Innovation Community. Research-Technology Management, 54, 19–27.

Dahlander, L., & Gann, D. M. (2010). How Open is Innovation? Research Policy, 39, 699–709.

Desouza, K. C., Awazu, Y., Jha, S., Dombrowski, C., Papagari, S., Baloh, P., & Kim, J. Y. (2008). Customer-driven innovation. Research-Technology Management, 51, 35–44.

Di Maria, E., & Finotto, V. (2008). Communities of Consumption and Made in Italy. Industry and Innovation, 15, 179–197.

Ebner, W., Leimeister, J. M., & Krcmar, H. (2009). Community engineering for innovations: the ideas competition as a method to nurture a virtual community for innovations. R & D Management, 39, 342–356.

Edmondson, A. C., & McManus, S. E. (2007). Methodological Fit in Management Field Research. Academy of Management Review, 32, 1155–1179.

Edvardsson, B., Kristensson, P., Magnusson, P., & Sundstrom, E. (2012). Customer integration within service development-A review of methods and an analysis of insitu and exsitu contributions. Technovation, 32, 419–429.

Faulkner, P., & Runde, J. (2009). On the Identity of Technological Objects and User Innovations in Function. Academy of Management Review, 34, 442–462.

Felin, T., Foss, N. J., Heimeriks, K. H., & Madsen, T. L. (2012). Microfoundations of Routines and Capabilities: Individuals, Processes, and Structure. Journal of Management Studies, 49, 1351–1374.

Foss, N. J., Husted, K., & Michailova, S. (2010). Governing Knowledge Sharing in Organizations: Levels of Analysis, Governance Mechanisms, and Research Directions. Journal of Management Studies, 47, 455–482.

Foss, N. J., Laursen, K., & Pedersen, T. (2011). Linking Customer Interaction and Innovation: The Mediating Role of New Organizational Practices. Organization Science, 22, 980–999.

Franke, N. (2014). User-driven Innovation. In The Oxford Handbook of Innovation Management (p. 700). Oxford: Oxford University Press.

Franke, N., Keinz, P., & Schreier, M. (2008). Complementing mass customization toolkits with user communities: How peer input improves customer self-design. Journal of Product Innovation Management, 25, 546–559.

Franke, N., & Piller, F. (2003). Key research issues in user interaction with user toolkits in a mass customisation system. International Journal of Technology Management, 26, 578–599.

Franke, N., & Piller, F. (2004). Value creation by toolkits for user innovation and design: The case of the watch market. Journal of Product Innovation Management, 21, 401–415.

Franke, N., Schreier, M., & Kaiser, U. (2010). The "I Designed It Myself" Effect in Mass Customization. Management Science, 56, 125–140.

Franke, N., & von Hippel, E. (2003). Satisfying heterogeneous user needs via innovation toolkits: the case of Apache security software. Research Policy, 32, 1199–1215.

Franke, N., von Hippel, E., & Schreier, M. (2006). Finding commercially attractive user innovations: A test of lead-user theory. Journal of Product Innovation Management, 23, 301–315.

Frey, K., Luethje, C., & Haag, S. (2011). Whom Should Firms Attract to Open Innovation Platforms? The Role of Knowledge Diversity and Motivation. Long Range Planning, 44, 397–420.

Fuchs, C., & Schreier, M. (2011). Customer Empowerment in New Product Development. Journal of Product Innovation Management, 28, 17–32.

Fuller, J. (2010). Refining Virtual Co-Creation from a Consumer Perspective. California Management Review, 52, 98–122.

Füller, J., Hutter, K., & Faullant, R. (2011). Why co-creation experience matters? Creative experience and its impact on the quantity and quality of creative contributions. R & D Management, 41, 259–273.

Füller, J., Jawecki, G., & Mühlbacher, H. (2007). Innovation creation by online basketball communities. Journal of Business Research, 60, 60–71.

Füller, J., Matzler, K., Hutter, K., & Hautz, J. (2012). Consumers' Creative Talent: Which Characteristics Qualify Consumers for Open Innovation Projects? An Exploration of Asymmetrical Effects. Creativity and Innovation Management, 21, 247–262.

Gassmann, O., Enkel, E., & Chesbrough, H. (2010). The future of open innovation. R & D Management, 40, 213–221.

Gassmann, O., Sandmeier, P., & Wecht, C. H. (2006). Extreme customer innovation in the front-end: learning from a new software paradigm. International Journal of Technology Management, 33, 46–66.

Grant, R. M. (1996). Toward a Knowledge-Based Theory of the Firm. Strategic Management Journal, 17, 109–122.

Grant, R. M., & Baden-Fuller, C. (2004). A Knowledge Accessing Theory of Strategic Alliances. Journal of Management Studies, 41, 61–84.

Greer, C. R., & Lei, D. (2012). Collaborative Innovation with Customers: A Review of the Literature and Suggestions for Future Research. International Journal of Management Reviews, 14, 63–84.

Gupta, A. K., Tesluk, P. E., & Taylor, M. S. (2007). Innovation At and Across Multiple Levels of Analysis. Organization Science, 18, 885–897.

Hall, R., & Andriani, P. (2003). Managing Knowledge Associated With Innovation. Journal of Business Research, 56, 145–152.

Henkel, J. (2006). Selective revealing in open innovation processes: The case of embedded Linux. Research Policy, 35, 953–969.

Herstatt, C., & von Hippel, E. (1992). From Experience - Developing New Product Concepts Via the Lead User Method - a Case-Study in a Low-Tech Field. Journal of Product Innovation Management, 9, 213–221.

Hienerth, C., Keinz, P., & Lettl, C. (2011). Exploring the Nature and Implementation Process of User-Centric Business Models. Long Range Planning, 44, 344–374.

Huizingh, E. K. R. E. (2011). Open Innovation: State of the Art and Future Perspectives. Technovation, 31, 2–9.

Hutter, K., Hautz, J., Füller, J., Mueller, J., & Matzler, K. (2011). Communitition: The Tension between Competition and Collaboration in Community-Based Design Contests. Creativity and Innovation Management, 20, 3–21.

Jeppesen, L. B., & Frederiksen, L. (2006). Why do users contribute to firm-hosted user communities? The case of computer-controlled music instruments. Organization Science, 17, 45–63.

Jeppesen, L. B., & Laursen, K. (2009). The role of lead users in knowledge sharing. Research Policy, 38, 1582–1589.

Jeppesen, L. B., & Molin, M. J. (2003). Consumers as co-developers: Learning and innovation outside the firm. Technology Analysis & Strategic Management, 15, 363–383.

Johnson, B., Lorenz, E., & Lundvall, B. (2002). Why All This Fuss About Codified and Tacit Knowledge? Industrial and Corporate Change, 11, 245–262.

Kang, J. (2007). Testing Impact of Knowledge Characteristics and Relationship Ties on Project Performance. Journal of Knowledge Management, 11, 126–144.

Keupp, M. M., Palmié, M., & Gassmann, O. (2012). The Strategic Management of Innovation: A Systematic Review and Paths for Future Research. International Journal of Management Reviews, 14, 367–390.

Kohler, T., Matzler, K., & Füller, J. (2009). Avatar-based innovation: Using virtual worlds for real-world innovation. Technovation, 29, 395–407.

Kristensson, P., Gustafsson, A., & Archer, T. (2004). Harnessing the creative potential among users. Journal of Product Innovation Management, 21, 4–14.

Lakhani, K. R., & von Hippel, E. (2003). How open source software works: "free" user-to-user assistance. Research Policy, 32, 923–943.

Lettl, C. (2007). User involvement competence for radical innovation. Journal of Engineering and Technology Management, 24, 53–75.

Lettl, C., Herstatt, C., & Gemuenden, H. G. (2006a). Learning from users for radical innovation. International Journal of Technology Management, 33, 25–45.

Lettl, C., Herstatt, C., & Gemuenden, H. G. (2006b). Users' contributions to radical innovation: evidence from four cases in the field of medical equipment technology. R & D Management, 36, 251–272.

Lettl, C., Hienerth, C., & Gemuenden, H. G. (2008). Exploring how lead users develop radical innovation: Opportunity recognition and exploitation in the field of medical equipment technology. Ieee Transactions on Engineering Management, 55, 219–233.

Lettl, C., Rost, K., & von Wartburg, I. (2009). Why are some independent inventors "heroes" and others "hobbyists"? The moderating role of technological diversity and specialization. Research Policy, 38, 243–254.

Lichtenthaler, U. (2011). Open Innovation: Past Research, Current Debates, and Future Directions. Academy of Management Perspectives, 25, 75–93.

Lilien, G. L., Morrison, P. D., Searls, K., Sonnack, M., & von Hippel, E. (2002). Performance assessment of the lead user idea-generation process for new product development. Management Science, 48, 1042–1059.

Luthje, C. (2004). Characteristics of innovating users in a consumer goods field - An empirical study of sport-related product consumers. Technovation, 24, 683–695.

Luthje, C., & Herstatt, C. (2004). The Lead User method: an outline of empirical findings and issues for future research. R & D Management, 34, 553–568.

Luthje, C., Herstatt, C., & von Hippel, E. (2005). User-innovators and "local" information: The case of mountain biking. Research Policy, 34, 951–965.

Magnusson, P. R. (2009). Exploring the Contributions of Involving Ordinary Users in Ideation of Technology-Based Services. Journal of Product Innovation Management, 26, 578–593.

Mahr, D., & Lievens, A. (2012). Virtual lead user communities: Drivers of knowledge creation for innovation. Research Policy, 41, 167–177.

Murray, F., & O'Mahony, S. (2007). Exploring the Foundations of Cumulative Innovation: Implications for Organization Science. Organization Science, 18, 1006–1021.

Neale, M. R., & Corkindale, D. R. (1998). Co-developing products: Involving customers earlier and more deeply. Long Range Planning, 31, 418–425.

Nightingale, P. (2003). If Nelson and Winter Are Only Half Right About Tacit Knowledge, Which Half? A Searlean Critique of "Codification." Industrial and Corporate Change, 12, 149–183.

Nonaka, I. (1994). A Dynamic Theory of Organizational Knowledge Creation. Organization Science, 5, 14–37.

Nonaka, I., Toyama, R., & Nagata, A. (2000). A firm as a knowledge-creating entity: a new perspective on the theory of the firm. Industrial and Corporate Change, 9, 1–20.

Nonaka, I., & von Krogh, G. (2009). Tacit Knowledge and Knowledge Conversion: Controversy and Advancement in Organizational Knowledge Creation Theory. Organization Science, 20, 635–652.

Ogawa, S. (1998). Does sticky information affect the locus of innovation? Evidence from the Japanese convenience-store industry. Research Policy, 26, 777–790.

Pedrosa, A. D. (2012). Customer Integration during Innovation Development: An Exploratory Study in the Logistics Service Industry. Creativity and Innovation Management, 21, 263–276.

Pedrosa, A. D., Välling, M., & Boyd, B. (2013). Knowledge related activities in open innovation: managers' characteristics and practices. International Journal of Technology Management, 61, 254–273.

Petticrew, M., & Roberts, H. (2006). Systematic Reviews in the Social Sciences: A Practical Guide. Malden, MA; Oxford: Blackwell Publishing. Retrieved from http://ezproxy.auckland.ac.nz/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=141287&site=ehost-live&scope=site

Pittaway, L., Robertson, M., Munir, K., Denyer, D., & Neely, A. (2004). Networking and innovation: A systematic review of the evidence. International Journal of Management Reviews, 5, 137–168.

Podsakoff, P. M., MacKenzie, S. B., Bachrach, D. G., & Podsakoff, N. P. (2005). The influence of management journals in the 1980s and 1990s. Strategic Management Journal, 26, 473–488.

Poetz, M. K., & Schreier, M. (2012). The Value of Crowdsourcing: Can Users Really Compete with Professionals in Generating New Product Ideas? Journal of Product Innovation Management, 29, 245–256.

Popay, J., Roberts, H., Sowden, A., Petticrew, M., Arai, L., Rodgers, M., … Duffy, S. (2006). Guidance on the Conduct of Narrative Synthesis in Systematic Reviews. ESRC Methods Programme.

Prugl, R., & Schreier, M. (2006). Learning from leading-edge customers at The Sims: opening up the innovation process using toolkits. R & D Management, 36, 237–250.

Quintas, P., Lefrere, P., & Jones, G. (1997). Knowledge Management: A Strategic Agenda. Long Range Planning, 30, 385–391.

Stuermer, M., Spaeth, S., & von Krogh, G. (2009). Extending private-collective innovation: a case study. R&D Management, 39, 170–191.

Szulanski, G. (1996). Exploring Internal Stickiness: Impediments to the Transfer of Best Practice Within the Firm. Strategic Management Journal, 17, 27–43.

Szulanski, G., & Cappetta, R. (2006). Stickiness: Conceptualizing, Measuring, and Predicting Difficulties in the Transfer of Knowledge within Organizations. In M. Easterby-Smith & M. A. Lyles (Eds.), Handbook of Organizational Learning and Knowledge Management (pp. 513–534). Blackwell Publishing.

Teece, D. J. (2007). Explicating Dynamic Capabilities: The Nature and Microfoundations of (Sustainable) Enterprise Performance. Strategic Management Journal, 28, 1319–1350.

Thorpe, R., Eden, C., Bessant, J., & Ellwood, P. (2011). Rigour, Relevance and Reward: Introducing the Knowledge Translation Value-chain. British Journal of Management, 22, 420–431.

Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a Methodology for Developing Evidence-Informed Management Knowledge by Means of Systematic Review. British Journal of Management, 14, 207–222.

Tushman, M. L., & Anderson, P. (1986). Technological Discontinuities and Organizational Environments. Administrative Science Quarterly, 31, 439–465.

Urban, G. L., & von Hippel, E. (1988). Lead User Analyses for the Development of New Industrial Products. Management Science, 34, 569–582.

Von Hippel, E. (1976). The dominant role of users in the scientific instrument innovation process. Research Policy, 5, 212–239.

Von Hippel, E. (1986). Lead Users: A Source of Novel Product Concepts. Management Science, 32, 791–805.

Von Hippel, E. (1994). "Sticky Information" and the Locus of Problem Solving: Implications for Innovation. Management Science, 40, 429–439.

Von Hippel, E. (2005). Democratizing Innovation. Cambridge: MIT Press.

Von Hippel, E. (2010). Chapter 9 - Open User Innovation. In B. Hall & N. Rosenberg (Eds.), Handbook of the Economics of Innovation (Vol. Volume 1, pp. 411–427). North-Holland Publishing Company.

Von Hippel, E., & Katz, R. (2002). Shifting innovation to users via toolkits. Management Science, 48, 821–833.

Wadell, C., Sandstrom, G. O., Bjork, J., & Magnusson, M. (2013). Exploring the incorporation of users in an innovating business unit. International Journal of Technology Management, 61, 293–308.

Yu, D., & Hang, C. C. (2010). A Reflective Review of Disruptive Innovation Theory. International Journal of Management Reviews, 12, 435–452.

Zack, M. H. (1999). Developing a Knowledge Strategy. California Management Review, 41, 125–145.

Zheng, W. (2010). A Social Capital Perspective of Innovation from Individuals to Nations: Where is Empirical Literature Directing Us? International Journal of Management Reviews, 12, 151–183.

FIGURES AND TABLES

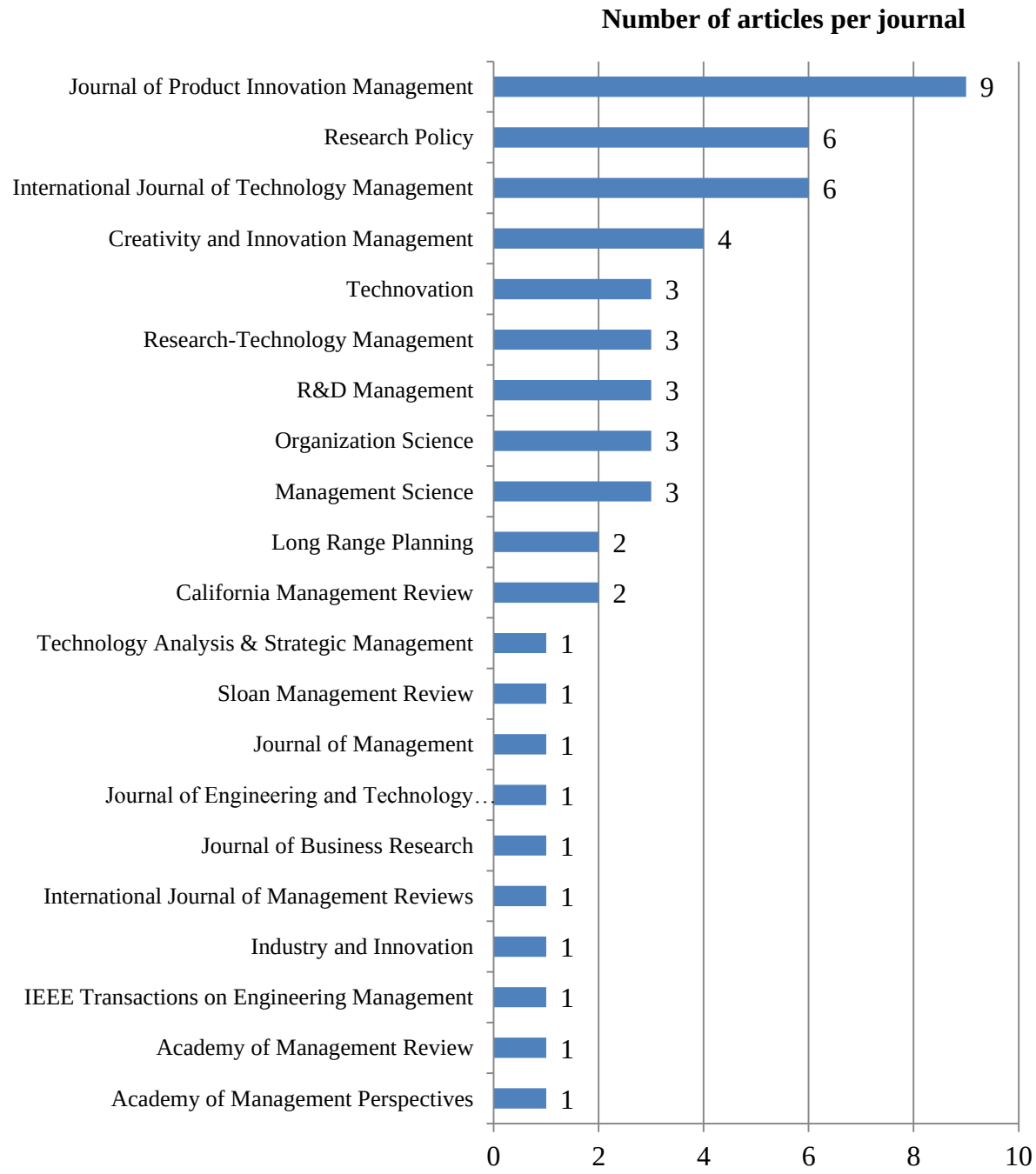

Figure 1: Distribution of Articles Under Review

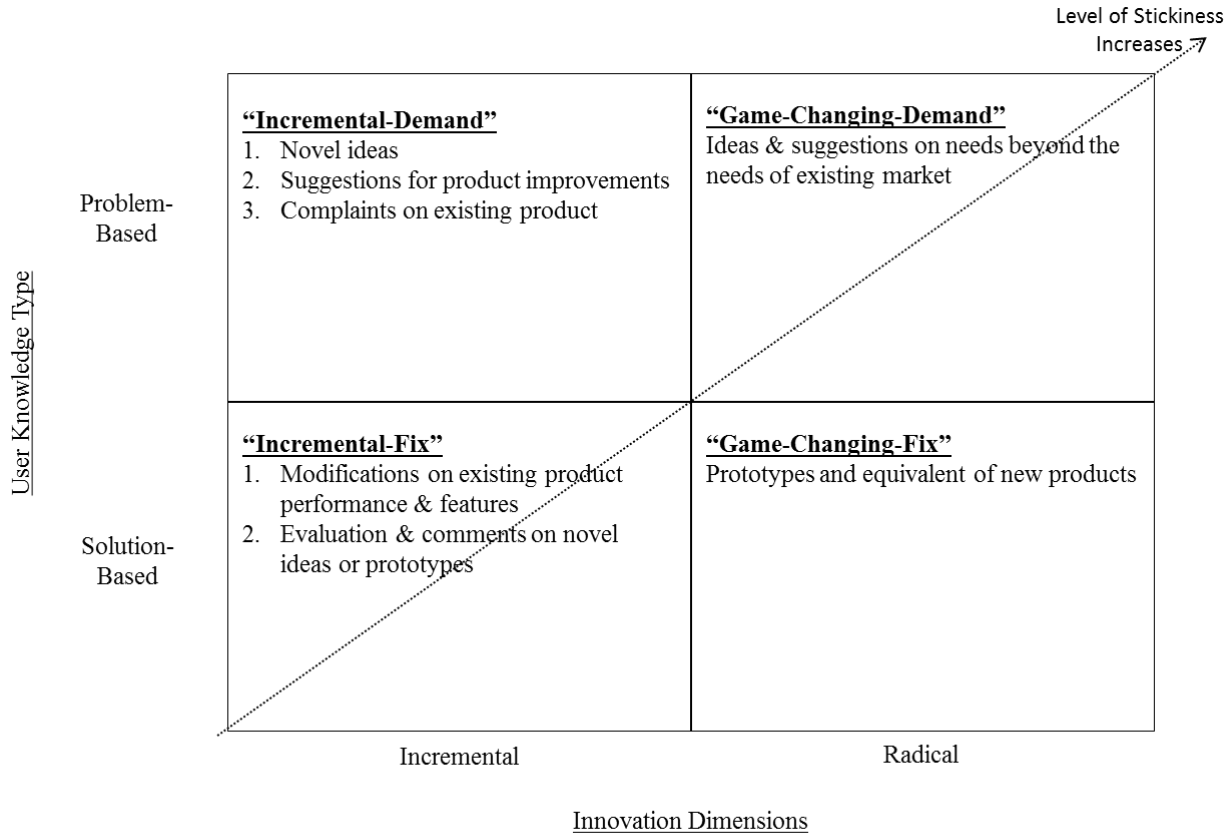

Figure 2: User Input Categories

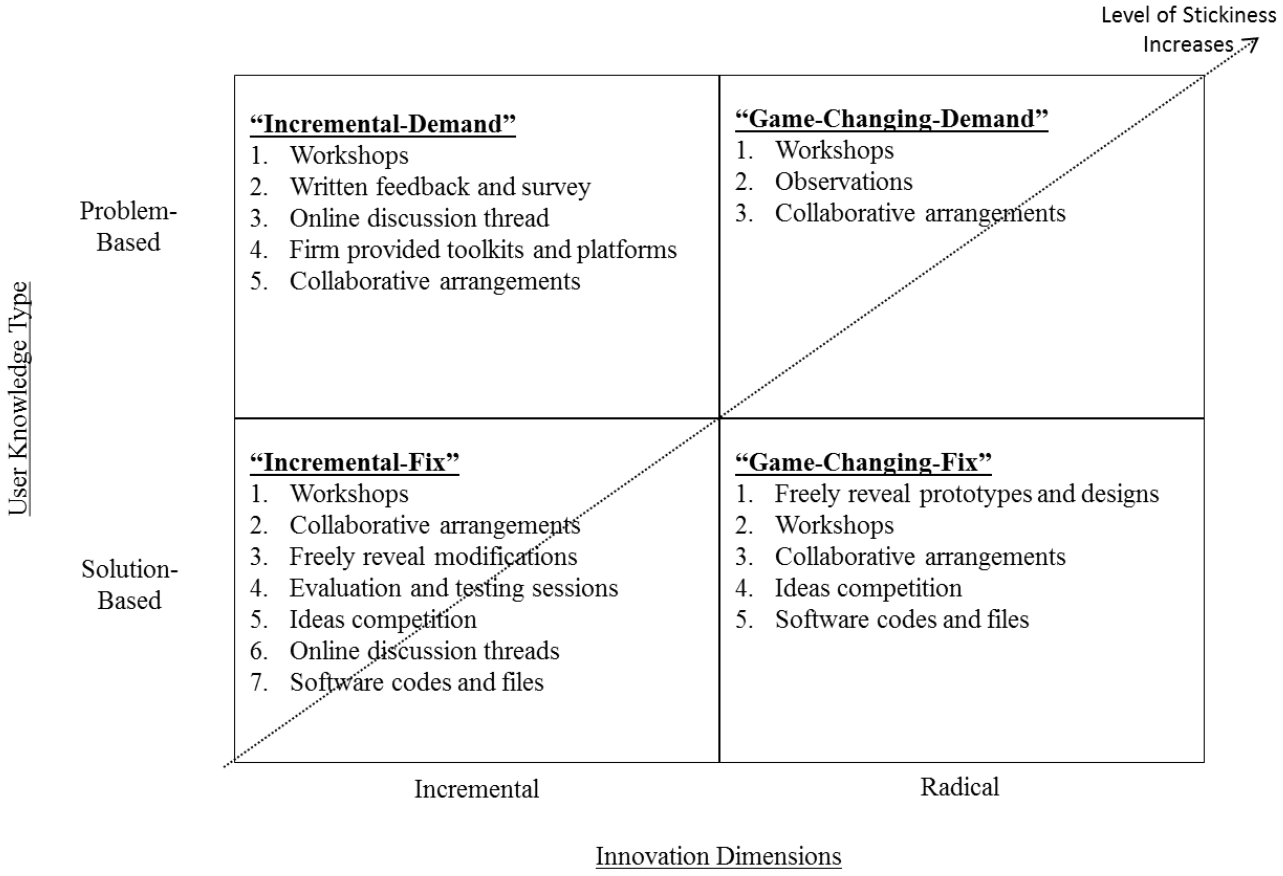

Figure 3: Transfer Mechanisms for User Input

Table 1: Keywords and Search Strings

User		**Innovation**		**Adoption**		**Information Systems**
User*		Innovat*		Adopt*		"Information System*"
Lead-user*	AND	Improve*	NOT	Diffus*	NOT	
Co-creat*		Contribut*				
Collabora*		Knowledge				AND
Distributed		Input*				
Open		Open-source				WC=Computer Science
Customer*		Communit*				WC=Software Engineering
Consumer*						
OR		OR		OR		

WC = Web of Science Categories

Table 2: Framework for Organizing the Evidence

Knowledge types provided by users	As Suggested in the Evidence		
	Articles	**Inputs**	**Degree of tacitness**
Problem-Based Knowledge	Adams et al. 1998; Cooper et al. 2002; von Hippel and Katz 2002; Franke and Piller 2003; Kristensson et al. 2004; Gassmann et al. 2006; Faulkner and Runde 2009; Foss et al. 2011; Hienerth et al. 2011; Hutter et al. 2011; Bogers and West 2012; Chandra and Leenders 2012; Pedrosa 2012; Poetz and Schreier 2012; Wadell et al. 2013	Suggestions & complaints about user needs Ideas about latent needs beyond existing market User description of a need	Input that indicates user problems and needs normally consists a combination of descriptions and implicit usage experience, while high in value, it lacks solution-based knowledge to implement the input. Input provides knowledge on latent needs that are based on implicit usage experience, more difficult for firms to implement solutions to address the need Input created using implicit usage experiences contains more tacit components
Solution-Based Knowledge	Herstatt and von Hippel 1992; Jeppesen and Molin 2003; Baldwin et al. 2006; Henkel 2006; Jeppesen and Laursen 2009; Lettl et al. 2009; Baldwin and von Hippel 2011; Frey et al. 2011; Füller et al. 2011; Greer and Lei 2012	User generated prototypes or equivalent Evaluative comments on existing idea and/or prototype Modifications on existing product	While firms are able to access and transfer user generated prototypes and its equivalent, prototypes are created using both tacit components (e.g. users' usage experience) and explicit solution components In software and gaming cases, while users contribute radical solutions (e.g. software codes), the explicit written form of codes make it more explicit for firms.
Problem- & Solution-Based Knowledge	Lilien et al. 2002; Brockhoff 2003; Franke and von Hippel 2003; Franke and Piller 2004; Franke et al. 2006; Lettl et al. 2006a; Lettl et al. 2006b; Prügl and Schreier 2006; Füller et al. 2007; Lettl 2007; Desouza et al. 2008; Di Maria and Finotto 2008; Franke et al. 2008; Lettl et al. 2008; Kohler et al. 2009; Magnusson 2009; Bogers et al. 2010;Franke et al. 2010; Füller 2010; Dahl et al. 2011; Fuchs and Schreier 2011; Lichtenthaler 2011; Adams et al. 2012; Alexy et al. 2012; Antorini et al. 2012; Chatterji and Fabrizio 2012; Edvardsson et al. 2012; Füller et al. 2012; Mahr and Lievens 2012	Suggestions & complaints about user needs Comments and suggestions about probable solution addressing user needs User generated prototypes or equivalent Evaluative comments on existing idea and/or prototype Modifications of existing product	Innovation-related knowledge, technical knowledge, and domain-specific skills are complex and likely to have both tacit and explicit components. Complexity of user knowledge would also mean more tacit in nature Input created using explicit user knowledge is more novel and relevant because it is less tacit and easier for firms to comprehend

Table 3: Transfer Mechanisms and Tacit/Explicit Knowledge

Transfer mechanism	Feature of the mechanism	Types of Knowledge
Workshops	Face-to-face interaction activities that includes both written and non-written (e.g. discussions) knowledge transfer	Tacit and Explicit
Collaborative arrangements	Co-create with user that includes both formalized and informal knowledge transfer	Tacit and Explicit
Freely reveal prototypes and modifications	Users transfer new product/designs with explicit information to firms but modifications would contain implicit usage experience	Tacit and Explicit
Observation	Observe users in their natural environment (e.g. at work, using the product) to explicate non-verbal and non-written knowledge	Tacit
Firm provided toolkits and platforms	Users create/design products within the parameters set by the firm	Explicit
Written feedback and survey	Users formally write comments or take survey to provide firms suggestions, feedback, or complaints	Explicit
Ideas competition	Users provide explicit solutions to innovation problems	Explicit
Evaluation and testing sessions	Formal activities to evaluate and test product design and prototypes	Explicit
Software codes and files	Users' solution-based knowledge are codified in source codes	Explicit
Online discussion threads	Form of written feedback that is used in online communities	Explicit