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Knowledge Characteristics and Organisational Practices in User Innovation

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Abstract

Using insights from the user innovation and knowledge management literature, we develop and empirically illustrate a typology of user inputs for innovation. Based on the knowledge complexity and uncertainty associated with a particular innovation, we propose four user input types and link them with particular organisational practices. We suggest that user inputs have different characteristics and level of stickiness, and firms that wish to access user inputs for innovation would need to develop organisational practices that fit with the type of user inputs they want to access. This paper contributes to the user innovation literature by shifting focus away from the innovative user towards the firm that wishes to utilise user innovation for its own ends.

Keywords: *User innovation, organisational practices, knowledge transfer, stickiness*

INTRODUCTION

In order to reduce market uncertainty and to enhance their innovation efforts and activities, firms obtain inputs and knowledge from users. Users are those who directly benefit from using a product, including both intermediate- and end-users, be it a firm or an individual (Bogers et al., 2010; Franke, 2014). In the innovation process, a firm can benefit from working closely with users because they can provide important insights about unmet needs and opportunities (Foss et al., 2013; Öberg, 2010). In some cases when existing products fail to satisfy users' needs they even develop solutions to their own problems (Lilien et al., 2002; Neale and Corkindale, 1998).

The phenomenon of user contribution to the innovation process has attracted attention from scholars of innovation. Topics have included economic value of user innovation, and the relationship between users and manufacturing (von Hippel, 2005); motivation for users to innovate and to share their innovation with other users (Raasch et al., 2008); characteristics of user innovation and organisation of innovation processes (Kline and Rosenberg, 1986). Other studies have considered how and why innovative outcomes are derived from user-driven innovation processes, in particular: 1) How firms involve users interactively at different stages of the firm's innovation process to improve existing or create new products and services; and 2) How users innovate individually or collectively to

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solve a particular need (Franke, 2014; Greer and Lei, 2012).

Studies of user innovation and the closely related open source literature tend to focus extensively, in both firm- and user-initiated contexts, on examining the antecedents, tools, and methods that can facilitate user innovation and open source activities (Murray and O'Mahony, 2007; Stuermer et al., 2009). The tendency in such studies to focus on innovative users as the unit of analysis has led to an overly one-sided view on user innovation, which largely ignores the role that capabilities grounded in specific organisational practices (West et al., 2014) play in enabling or inhibiting firms to appropriate value from user innovation activities (Foss et al., 2011; Salge et al., 2012). Relatedly, the literature implicitly assumes that freely-revealed user inputs and embedded knowledge to fellow users and producer firms will result in successful utilisation of the knowledge (Harhoff et al., 2003; Levine and Prietula, 2013; West et al., 2014).

However, from the resource-based and knowledge-based views, we know that in order to explore and exploit the various sources of knowledge, firms need specific capabilities in the form of routines, processes, and practices (Barney, 1991; Grant, 1996). But knowledge, especially external knowledge, is not easily shared or transferred to the firm due to the personal and tacit nature (Simonin, 1999). In the context of user innovation, users innovate partly because they find it difficult to transfer tacit innovation-related knowledge to firms (von Hippel, 1994; Poetz and Schreier, 2012). Although firms are able to access various user inputs such as feedback and ideas through user innovations, the underlying tacit user knowledge remains complex and causally ambiguous to firms, thus increasing knowledge stickiness (von Hippel, 1994; Ogawa, 1998; Szulanski, 1996). The impediments that knowledge stickiness creates requires organisational practices that support the management of knowledge, and ease the access and transfer of user knowledge for potential exploitation (Foss et al., 2011; Grant, 1996).

In this paper, we argue that user innovation literature will benefit from a more nuanced treatment of user inputs, which would enable us to examine the role of organisational practices in facilitating or inhibiting exploitation of user innovations. We build on the extant user innovation literature and research on knowledge characteristics, to provide clearer user input categories. The aim is to understand how, in the context of accessing and transferring user knowledge, the underlying knowledge characteristics of user inputs interact with organisational practices.

We seek to unpack the user input construct into different categories, and theorise the relationship between different user inputs and organisational practices. In its current state, user input may mean many different things from novel ideas to feedback (Bogers et al., 2010; Zhu et al., 2014), with unclear characteristics, making it un-measurable. By deriving and justifying different user input categories, we contribute toward the development of measurable user input variables under the user input construct within the user innovation concept. While the typology does not replace theory, it offers a stepping-stone for the development of subsequent theoretical arguments broadly addressing how user input types interact with organisational practices for the exploitation of user innovation (Bacharach, 1989; MacInnis, 2011; Weick, 1995). We also seek to bridge user innovation and industrial organisation literature through the explanatory power of knowledge characteristics. Building on the work of Foss et al. (2011), and Poetz and Schreier (2012), we argue that user inputs may have more refined knowledge characteristics if their conceptualisation is anchored in literature beyond the need-based and solution-based dichotomy common in the user innovation literature. It is problematic to examine the complex interactions between user inputs and organisational practices without clarifying them in literature.

The analysis presented in this paper draw on existing user innovation studies to provide clearer categories of user inputs. Closer examination of the user input construct enables us to explore the relationship between organisational practices used to access and transfer user inputs, and the knowledge characteristics of the different inputs. We believe that applying a knowledge transfer lens to user innovation will offer new insights into our understanding of the role organisational practices play in capturing value from user innovations. Our findings suggest practical implications for the design of internal organisation and the choice of organisational practices needed to facilitate and exploit user-driven innovation processes that are useful for practitioners.

TRANSFERRING USER'S INNOVATION-RELATED KNOWLEDGE

In this paper, we define user innovation as an outcome derived from user involvement in the firm's user innovation process. Users are motivated by pecuniary and non-pecuniary benefits including the satisfaction from addressing an innovation problem or need (Bogers et al., 2010; von Hippel, 2005; Lüthje, 2004). User innovation scholars argue that users provide two types of knowledge to firms: need-based and solution-based knowledge (Bogers et al., 2010; von Hippel, 1986; Poetz and Schreier, 2012). Need-based knowledge is information about users' needs, which have evolved out of their implicit usage experience. Users often share need-based knowledge with producer firms to obtain solutions from them. A firm normally uses need-based knowledge shared by users to create new products and services, with the knowledge serving as a starting point for new product development. Solution-based knowledge contains the solution to an existing user or market need.

Transferring user knowledge is neither simple nor straightforward, as user knowledge is "sticky" (von Hippel, 1994) because of, among other things, characteristics of the knowledge, and characteristics of the transferor and transferee (von Hippel, 1994; Szulanski, 1996). In this paper, knowledge transfer is defined as the process of transferring user knowledge to firms. The knowledge management literature stresses that tacit knowledge resides in individuals and demands significant effort from the parties involved to share it (Foss et al., 2010; Nonaka, 1994). The costs and difficulties in transferring user knowledge (i.e. knowledge stickiness) are caused by its tacit components (von Hippel, 1994; Ogawa, 1998). As argued in the user innovation, and intra- and inter-organisational knowledge transfer literature, the tacitness of need-based and solution-based knowledge inhibits their transfer to firms (von Hippel, 1994; Szulanski, 1996).

While knowledge characteristics, such as tacitness, ambiguity, and complexity affect knowledge transfer (Easterby-Smith et al., 2008), the source and recipient of the knowledge transfer process could inhibit or foster knowledge transfer at both intra- and inter-organisational level (Easterby-Smith et al., 2008; Grant, 1996; Szulanski, 1996). It is assumed here that although user knowledge is not readily transferable, relatively immobile, and context-specific (Kogut and Zander, 1996; Simonin, 1999); however, it is embedded in user inputs and is transferred to firms with relative difficulty (von Hippel, 1994; Ogawa, 1998; Szulanski, 1996). The methods and tools, proposed in user innovation research, to encourage user participation such as the lead-user method, toolkits approach, and user communities (Bogers et al., 2010; Herstatt and von Hippel, 1992; von Hippel and Katz, 2002), act as conduits for access and transfer of 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 (Petticrew and Roberts, 2006; Thorpe et al., 2011; Tranfield et al., 2003). A systematic review method is a suitable approach because of the rigorous process that increases the transparency, clarity, and reproducibility of the review (Thorpe et al., 2011; Tranfield et al., 2003) and minimizes researcher bias and random errors (Cooper, 1998).

Following Cooper's (1998) recommendations, we started the review by outlining its objective and the selection criteria we used to screen user innovation articles. Although systematic reviews rely on specific steps that lead from one process to another, conducting them is an iterative process (Petticrew and Roberts, 2006; Tranfield et al., 2003). 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 (Crossan and Apaydin, 2010; Podsakoff et al., 2005). 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).

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 two citations a year and exempted articles published in 2012 and 2013 from this criterion. This step removed additional 172 articles. Although citation analysis is not without its flaws, relying on it enabled us to filter high impact articles with relative objectivity, using accepted 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 carefully 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.

TYPOLOGY DEVELOPMENT

This section will first argue that the complexity and associated uncertainties of user knowledge are key dimensions for differentiating between the four types of user input. The four types are described in details and are illustrated with examples from a study on the role of user innovation in firms from traditional industries. After the four types have been developed, the paper suggests that firms will need different organisational practices in order to access, transfer, and apply knowledge related to each of the user input types.

Knowledge characteristics and types of user input

In order to provide clearer categories of user inputs, we must first understand how knowledge itself can vary within the context of user innovation. We know from earlier discussion that users offer firms need-based and solution-based knowledge embedded in user inputs (von Hippel, 1986; Poetz and Schreier, 2012). While this distinction is useful to indicate possible functions of user knowledge, it is not particularly helpful in differentiating the inputs. This is because it is often difficult to disentangle need-based from solution-based knowledge in situations where a single input would most likely contain both types of knowledge in various combinations (Lüthje and Herstatt, 2004). Following the recommendation by Hambrick (1984) that classes formed when generating a typology must be mutually exclusive, this intertwined nature of need-based and solution-based knowledge makes them less useful as dimensions in a typology of user inputs. Similarly, the concepts of tacit and explicit knowledge are used widely to indicate whether one can articulate knowledge. Explicit knowledge is codified and can be articulated clearly for knowledge transfer, however, knowledge that is codified still contains some components of tacit knowledge embedded in its explicit form (Nightingale, 2003; Nonaka, 1994). It is the complexity involved in trying to disentangle need-based from solution-based knowledge, and to articulate whether user knowledge is tacit or explicit that makes it difficult for firms to access and transfer user knowledge (von Hippel, 1994; Szulanski, 1996).

Here, we suggest two key dimensions of knowledge that underpin our typology of user inputs: *Complexity* of knowledge, and *uncertainty* of knowledge. Complexity of knowledge is defined as the number and variety of knowledge components that are present in a type of input (Turner and Makhija, 2006). In this argument, the determinants of complexity are the number and variety of components present in user knowledge, and the relatedness of these components to the firm's knowledge base. These components are drawn from the user's tacit knowledge, and may include skills, need-based and solution-based knowledge, and product usage experiences. The more closely these components relate to the firm's existing knowledge base, the more easily firms will be able to comprehend them, due to the path-dependent nature of knowledge search (Cohen and Levinthal, 1990; Hansen, 1999; Szulanski, 1996). The ability to understand user knowledge is the first step towards evaluating the relevance and usefulness of the knowledge to the firm. It is posited that when user knowledge is highly complex, knowledge stickiness increases, and firms will find it difficult to comprehend and transfer user knowledge.

Complexity is however only one part of the equation that makes user knowledge so valuable yet so difficult for firms to understand, transfer, and use. Added to this issue of complexity is the uncertainty of knowledge being accessed and transferred (Podolny, 1994; Simonin, 2004). Uncertainty of knowledge is defined as the level of ambiguity and completeness of knowledge components that form a type of input (Arrow, 1974; Turner and Makhija, 2006). The notion of ambiguity in the uncertainty argument is related to causal ambiguity, where decision-makers are unclear about what the different knowledge components are and how they interact to achieve organisational outcomes (Lippman and Rumelt, 1982; Szulanski, 1996). In this case, user knowledge is uncertain especially when firms are unclear about the context in which the knowledge is implemented, i.e. user's usage experiences. This is because firms are unable to grasp what and where this need-based and solution-based knowledge would fit in within their innovation process and product offerings (Rundquist, 2012; Zahra and George, 2002).

In determining the overall uncertainty of knowledge, ambiguity is interrelated with *completeness* – the degree to which user knowledge needed for firms to innovate is sufficient and available (Turner and Makhija, 2006). When user knowledge is complete, the components needed for firms to innovate are all available for firms to use. But completeness of user knowledge is useless in mitigating stickiness if the knowledge is ambiguous to the firm because it is unable to comprehend how the knowl-

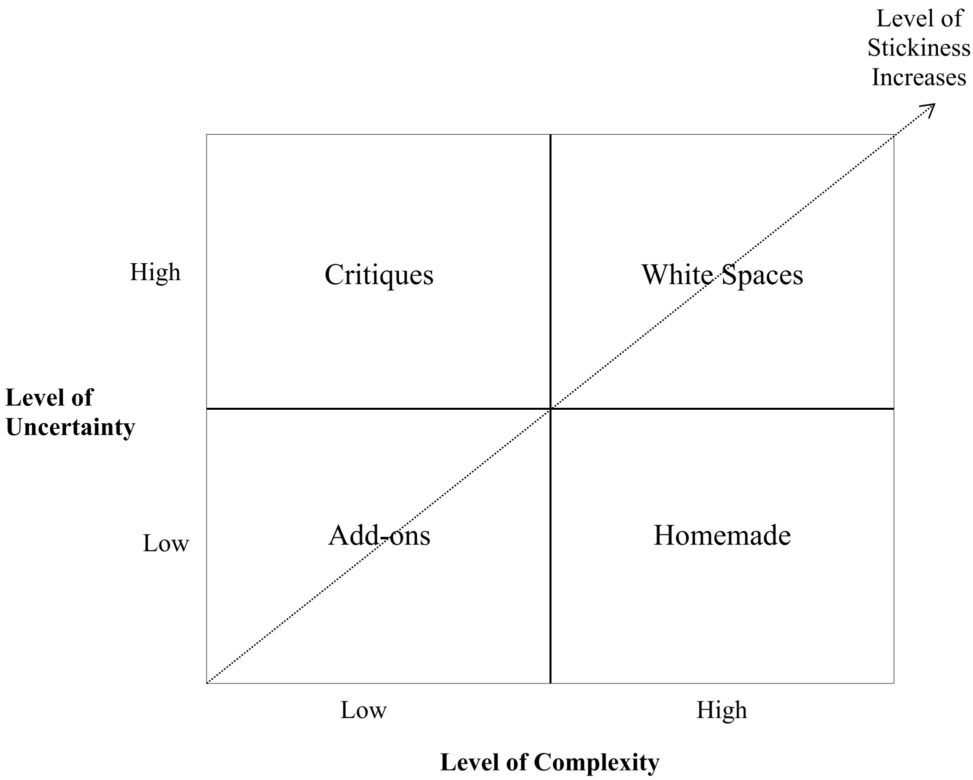

Figure 1: Types of User Input

edge components are interrelated, and fit into the firm's own knowledge and processes (Szulanski, 1996).

In Figure 1, we position user inputs along two dimensions: the level of complexity and level of uncertainty of user knowledge. On this basis, we identify four types of user inputs that we label: *"Add-ons"; "Homemade"; "Critiques"; "White Spaces"*. In the following paragraphs, we analyse how the four types of user input differ along the two dimensions, and we consider the implications for knowledge transfer.

Add-ons: Sprucing-up existing product

Users are always a good source of ideas on how to improve existing products. Users in the fashion, sporting equipment, telecommunications, and consumer goods sectors offer suggestions and feedback to firms with the purpose of improving product performance with tweaks or new features (Di Maria and Finotto, 2008; Franke et al., 2008; Magnusson, 2009; Öberg, 2010). These new features are usually meant to reinforce the existing product rather than alter it.

Compared to the other three types of user inputs, *Add-ons* (low complexity, low uncertainty) are likely to contain fewer and less heterogeneous knowledge components, these being derived from usage patterns and skills known to the firm. Unlike *White Spaces* (high complexity, high uncertainty) they lack the knowledge complexity for firms to make radical changes. Instead, *Add-ons* reinforce and allow firms to leverage existing innovation competency to respond to user needs through incremental changes in the short-term (Tushman and Anderson, 1986).

Add-ons are likely to be transferred by firms with relative ease compared to the other types. The low complexity and low uncertainty of their embedded knowledge will reduce the stickiness effect on knowledge transfer (Szulanski, 1996). The embedded user knowledge here is relatively codifiable, which enables users to transfer their knowledge in more explicit forms such as online discussion threads, feedback forms, surveys, or firm-owned toolkits (Hienerth et al., 2011; Jeppesen and Molin, 2003).

An example of how *Add-ons* contributed and are transferred is illustrated by the case of an Australian rectifier manufacturer. The Australian firm (henceforth AUST) manufactures rectifiers that are purchased by intermediate firms as components for their final product. AUST receives *Add-ons* from its users, normally in the form of an email sent to sales staff. Such emails indicate needs that are met and unmet by the existing rectifiers, often accompanied with suggestions on how AUST should meet the need(s). The Research and Development (R&D) team in AUST is able to translate *Add-ons* rather quickly into actionable tweaks on existing rectifiers, which are then introduced to the market as new features. On some instances further email exchanges are needed between AUST and its users, but these are mainly to clarify the suggestions and comments of the users.

Homemade: User-created working solutions for existing needs

Homemade (high complexity, low uncertainty) are principally, as the label suggests, working solutions created by users to meet existing needs. Users in this case are mainly motivated by their desire to solve their own needs (von Hippel, 2005). A group known as lead-users have advanced needs beyond the existing market, and normally possess advanced knowledge that enables them to create working solutions (von Hippel, 1986; Lüthje and Herstatt, 2004). These lead-users create their own prototypes (such as semiconductor devices, medical devices, consumer goods, and extreme kayaking equipment) to meet their own needs (Adams et al., 2012; Baldwin et al., 2006; Hienerth et al., 2011; Lettl et al., 2006).

As an example, the ZAMMR handle that was created by a New Zealand (NZ) farmer highlights how firms can transfer and utilise *Homemade* successfully. The ZAMMR handle satisfied the farmer's need to have an all-in-one conductive and non-conductive handle for setting up electric fences. A staff from farm management firm Tru-Test saw the handle at a regional agricultural trade-show and instantly recognised the value and potential of the prototype. After some minor product refinements, ZAMMR handle is currently being absorbed by Tru-Test as part of its suite of electric fencing products. While it might have seemed easy for Tru-Test to access and transfer the embedded user knowledge, this is likely due to the explicit form that a prototype takes, and the completeness of the knowledge components. The knowledge underlying the prototype was complex, drawing from a substantial amount and variety of the user's knowledge. However, the lower uncertainty meant that Tru-Test was able to minimise the stickiness associated with complexity, and to understand where and how the knowledge interacted and combined with other knowledge components (Simonin, 2004; Szulanski, 1996).

The key distinction between the knowledge components embedded in *Homemade* compared to *Add-ons* is mainly the level of complexity. *Homemade* have more complex knowledge components, drawn from a wider breadth of the user's knowledge. However, when compared to *White Spaces*, although both inputs have highly complex knowledge, the embedded knowledge in *Homemade* is more comprehensible to firms because of their coherence and completeness in relation to the firm's knowledge base.

Given the more explicit form that *Homemade* usually take (i.e. physical prototypes), we speculate that user knowledge is transferred through working closely with users and through crowdsourcing. Running lead-user workshops enables firms to have face-to-face interactions with lead-users, and provides an avenue to elucidate user-created working solutions. Lead-user workshops normally have specific activities that encourage users to share their embedded knowledge related to the working solutions (see Herstatt and von Hippel, 1992; Lüthje and Herstatt, 2004). Through crowdsourcing, firms are able to access a wider range of users, even those from other markets. Working solutions here are in the form of detailed, technical specifications (Frey et al., 2011; Füller et al., 2011; Poetz and Schreier, 2012). NASA is rather successful in using crowdsourcing to source working solutions for its complex problems (King and Lakhani, 2013).

Critiques: Nurturing experimental developments

Critiques (low complexity, high uncertainty) tend to be user ideas about new products for existing market needs. For example, users in the consumer goods, software, fashion, extreme sports, and farming sectors offer their critical but developmental evaluation of the firm's early-stage working prototypes (Brockhoff, 2003; Füller et al., 2011; Ogawa and Piller, 2006; Poetz and Schreier, 2012). These evaluations are meant to provide firms with knowledge that could be used to improve the early-stage prototypes at the pre-market launch phase.

Compared to the other three types of user input, *Critiques* are likely to contain fewer and less heterogeneous knowledge components, but these components may be derived from usage patterns and skills unfamiliar to the firm. Compared with *Add-ons*, they have higher levels of uncertainty and user knowledge is less complex. Uncertainty may arise from how users derive those knowledge components and how the knowledge components might be implemented to improve an early-stage prototype. While *Critiques* somewhat reinforce and allow firms to leverage on existing competencies to access and transfer embedded knowledge components, the utilisation of these components may require more effort.

An example of *Critiques* can be seen in the automation unit of a NZ farm management firm (henceforth FARM). FARM often tests its early-stage farm automation prototypes with users. These farm trials are important avenue for FARM to obtain *Critiques*, which are important in providing benchmarks for testing new farm automation systems. In this example, knowledge components are normally accessed and transferred through face-to-face communications and sometimes even on-site demonstrations at the user's farm. Knowledge components are usually less complex and more targeted at the performance and/or features of the trial prototype at hand. However, because of the piecemeal nature of the embedded knowledge components, FARM staff, especially the R&D team, will find some of the inputs difficult to understand. FARM finds the users' knowledge ambiguous in terms of both its origins (the user's context from which the knowledge is drawn) and intricacies amongst the components, increasing the stickiness of the knowledge components and their resistance to transfer.

Critiques are likely to be difficult for firms to transfer than *Add-ons*. While the embedded knowledge is less complex, the higher uncertainty increases its stickiness (Szulanski, 1996). The less complex knowledge is relatively codifiable, enabling users to transfer it in explicit forms such as oral and written evaluation comments, and online discussion threads (Antorini et al., 2012; Füller et al., 2007). The transfer mechanisms also depend on the technological context (Raasch et al., 2008). In the FARM illustration, a more integrated farm technology system means that more face-to-face transfer mechanisms are needed. But in the case of Muji (a Japanese departmental chain), an online, written transfer mechanism is more suitable due to the prototypes being less technology-driven and is more aligned for mainstream users.

White Spaces: The key to uncharted territory

Lead-users have advanced needs and superior knowledge beyond the existing market, and can be seen as innovators (von Hippel, 1986; Lettl et al., 2006; Rogers, 1995). They provide firms with knowledge of latent needs in, for example, logistics services, music equipment such as turntables, and industrial products that are likely to lead to radically new products, or open entirely new markets (Faulkner and Runde, 2009; Lilien et al., 2002; da Mota Pedrosa, 2012).

When compared to the other three types of user inputs, *White Spaces* are likely to contain knowledge components that are highly complex, and with higher levels of uncertainty. Lead-users are usually ahead of the curve in terms of needs (Lüthje and Herstatt, 2004), and the knowledge they draw on to derive *White Spaces* is likely to come from many knowledge components of different varieties and from different contexts. To firms, although lead-users draw from a multitude of knowledge components, the knowledge is uncertain because firms are unable to articulate it effectively based on their current knowledge base. Given the path-dependent nature of knowledge acquisition (Almeida et al., 2006; Cohen and Levinthal, 1990), it is likely that firms will have comprehension difficulties, let alone being able to transfer the knowledge components.

Table 1: Overview of User Input Types

User Input Type	Knowledge Characteristics	Example	Level of Stickiness	Transfer Mechanisms	Industry Sectors
Add-ons	Less complex and uncertain. Contain only small number and variety of unambiguous and complete knowledge components	Ideas to improve performance and features of existing product	Low	Feedback forms, survey, online discussion threads, and toolkits	Fashion, sporting equipment, tele-communications, consumer goods
Homemade	Highly complex but less uncertain. Contain many number and varieties of unambiguous and complete knowledge components	User-created working prototypes (Physical or written technical specifications)	Medium	Face-to-face interactions and crowdsourcing	Semiconductor, medical devices, consumer goods, sporting equipment
Critiques	Less complex but highly uncertain. Contain only small number and variety of ambiguous and incomplete knowledge components	Critical and developmental evaluation of working prototypes	High	Verbal and written evaluation comments, online discussion threads, face-to-face (For technologically complex prototypes)	Consumer goods, software, fashion, extreme sports, farming
White spaces	Highly complex and uncertain. Contain many number and varieties of ambiguous and incomplete knowledge components	Information on latent needs	Very high	Observations and face-to-face interactions	Logistics, music, industrial products

The coalescence of complexity and uncertainty meant that *White Spaces* are likely to have the highest level of stickiness compared to the other three inputs (Szulanski, 1996).

Firms are likely to transfer knowledge components in *White Spaces* through observations and face-to-face interactions. The lead-user method is a well-matched transfer mechanism because it allows firms to have both face-to-face interactions with users, and also to observe their behaviours and non-verbal cues. An example that illustrates how a firm can benefit from accessing and transferring *White Spaces* is the 3M case (see von Hippel et al., 1999). For the purpose of staying innovative, 3M employed the lead-user method to access *White Spaces*, and was able to tap a wide range of lead-users both within and across the different user markets that 3M serves. The result was the access to latent needs that had applications across different markets. Although user knowledge was highly "sticky", the use of face-to-face interactions and observations following the lead-user method allowed 3M to access, transfer, and utilise the multi-faceted, complex, and uncertain knowledge components.

From our discussions, we can conclude that the four types of user input have different features and require different transfer mechanisms. We summarise the features, examples, and transfer mechanisms of the four user input types in Table 1.

ORGANISATIONAL PRACTICES FOR USER INNOVATION

Even with the appropriate methods and tools as channels for firms to access and transfer user knowledge, firms still need organisational practices and an internal organisation that support such user innovation activities. (Foss et al., 2011, 2013; Teece, 2000; Zack, 1999). Organisational practices as a term, has been used loosely to describe the systematic and functional use of routines and procedures embedded in organisations for the exploration and exploitation of knowledge (Kostova, 1999; March, 1991; Szulanski, 1996). We adapt the definition proposed by Kostova and Roth (2002, p. 216) and build on the work of Foss et al. (2011), to define organisational practices as the firm's routine use of knowledge embedded within the organisation for exploration and exploitation. Organisational practices are essentially centred on how a firm coordinates the various internal functional units to manage, explore, and exploit its resources and capabilities (Grant, 1996; Okhuysen and Bechky, 2009; Turner and Makhija, 2006). This includes practices that encourage staff to access, transfer, and utilise externally-sourced knowledge (Quintas et al., 1997; Zack, 1999; Zahra and George, 2002). Examples of organisational practices relevant to the user innovation context relate to delegation of decisions, communication within the firm, staff incentives, and knowledge governance mechanisms (Foss et al., 2010, 2011; Leonard and Barton, 2014; Salge et al., 2012).

While structure is not explicitly mentioned in our definition of organisational practices or that of Kostova and Roth (2002), we posit, following Foss et al. (2011), that the internal organisation of a firm includes its structure as well as its organisational practices. The organisational design of a firm affects the organisational practices being employed, which then influence the processes, procedures, and routines within the firm to manage, explore, and exploit its resources and capabilities (Bucic and Ngo, 2012; Keinz et al., 2012; Teece, 2000). This is central to the aim of this paper because the discussions around the role of organisational practices in exploiting user knowledge may be affected by the organisational design and structure of the firm.

Differentiating the four types of user input and considering the issues related to managing these inputs adds an antecedent foundation to the user innovation literature. While it is well established that one of the main reasons for firms to collaborate with users is that users are a significant source of innovation-related knowledge, especially tacit knowledge (Greer and Lei, 2012), there is not much clarity and detail in the understanding of the knowledge components underlying user inputs. It is typically assumed that firms, by 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.

Identifying the types of user input offers managers insights into how they can manage user knowledge. Existing user innovation studies enable us to offer advice on how to engage users (e.g. toolkits, user communities) and what types of users are most effective at innovating. The ongoing initiative in open innovation (see Huizingh, 2011; Salge et al., 2012; West et al., 2014) to integrate and develop the open innovation concept in relation to existing management and innovation theories represents important progress that user innovation scholars could follow. The need to develop the foundation for managing user knowledge is important in order to identify relevant practices and governance mechanisms.

Role of organisational practices in user innovation

Firms need to apply certain internal organisational practices to access and transfer user inputs. We have argued that the four types of user input contain knowledge with different levels of complexity and uncertainty. Given these varied levels of complexity and uncertainty, firms require complementary routines, processes, and practices to transfer user knowledge. While firms need absorptive capacity to be able to transfer user knowledge (Lichtenthaler, 2011; Szulanski, 1996), the path-dependent tendencies in knowledge acquisition also affects firms' motivation to transfer, and their ability to comprehend user knowledge (Cohen and Levinthal, 1990). Firms need organisational practices such as better communication channels between departments and balanced incentive systems that encourage staff to search, access, transfer, and share user knowledge, leading to innovative outcomes (Laursen and Foss, 2014; Salge et al., 2012). A lack of such practices will make it difficult for staff to comprehend the tacit components of user knowledge and they may develop the Not-Invented-Here attitude (NIH) and act as a barrier to harnessing external knowledge (Lichtenthaler, 2011). One of the key challenges firms deal with is the friction between the importance of engaging users in their innovation processes, and the transfer and subsequent management of user knowledge. As we summarise in Table 2, each of the four types of user input each has its unique qualities, and organisational practices play a role in the success or failure to access, transfer, and capture value from user

Table 2: User Input Types and Organisational Practices

User Input Type	Overall Challenge to Organisational Design	Role of Organisational Practices			
		Delegation Decisions	Reward System	Intra-Organisational Communication	Knowledge Governance Mechanism
Add-ons	Firms with existing structure that encourages access and transfer need to maintain and update as necessary, which is costly. Firms without such structure might face some initial resistance internally	Delegate some knowledge search and screening decisions to "point-of-contact" staff	Incentivise staff based on product performance. Unlikely to require additional pecuniary incentive	With effective channels, to transfer *Add-ons* between relevant departments with minimum loss of meaning	Search, access, and transfer relevant user knowledge
Homemade	Need to design a structure that minimises the effect of NIH	Delegate knowledge search and assessment decisions to staff. But this could act as a barrier to accessing and transferring user knowledge due to NIH. Need to balance between delegation and control	Incentivise staff for successfully utilising user knowledge will support access and transfer	Provide effective channels to transfer user knowledge. Likely require interdisciplinary collaboration tools	Similar to *Add-ons* but includes learning, and storing user knowledge
Critiques	Need to design a structure that minimise the effect of NIH and also conducive for interdisciplinary collaborations	Delegate knowledge screening decisions to staff on-site. NIH likely to linger in staff attitudes	Incentivise staff based on market performance of products should be sufficient to support access and transfer	Provide effective channels to transfer user knowledge. Likely require interdisciplinary collaboration tools	Access and transfer user knowledge, assess knowledge base for suitable components for implementation, and learning
White Spaces	Requires more overhaul if existing structure don't support access and transfer of *White Spaces*. Match design choice to expected innovation goals and objectives from these inputs	Delegate most of knowledge search decisions to staff involved in searching to maximise knowledge seeking methods. But could promote NIH and path-dependency	Incentivise staff for increasing their search breadth. Without such incentive will hamper the process	Require collaborative tools that facilitates transfer of complex and uncertain user knowledge. Likely to be time-consuming	Increase and maximise knowledge search breadth, and facilitate access and transfer of complex and uncertainty knowledge. Worthwhile to concentrate on accessing without internalising user knowledge

knowledge.

Add-ons are the most closely related to the firm's existing knowledge base as the knowledge components are the least complex and uncertain, with lower level of stickiness. Due to the nature of *Add-ons*, it is likely that the existing organisational practices and structure of the firm play only a peripheral role in encouraging or inhibiting access and transfer of these user inputs. This is not to say that they are unimportant, rather, it is argued that instead, the formal structure already in place at the firm will provide the conditions that encourage staff to access and transfer *Add-ons* (Foss et al., 2010). In the FARM illustration, accessing, transferring, and sharing user knowledge are ingrained in the organisational culture. FARM premises are filled with quotes and vignettes that signals to staff that it is always "part of life" at FARM to always involve users. We could speculate that no additional extrinsic reward systems are needed to encourage staff to access and transfer user inputs. Furthermore, customer-facing staff will be allowed to make decisions on which *Add-ons* to access and transfer, and ultimately share within the firm. Intra-organisational communication channels act as conduit for knowledge transfer between staff from different departments. The main role of knowledge governance mechanisms is to reinforce and maintain the existing knowledge base of the firm (Almeida et al., 2006).

The issues associated with *Homemade* are different to *Add-ons*. With users offering working prototypes, NIH is likely to be prevalent in staff. A reward system that fails to incentivise staff for successfully utilising *Homemade* is likely to inhibit access and transfer of user knowledge. While decision-making authority is required, it could act as inhibitor, where staff reject potentially viable prototypes due to NIH or fear of losing their jobs, especially if they are not incentivised accordingly (Lichtenthaler, 2011). Needing to internalise more complex but less uncertain user knowledge from *Homemade* means that knowledge governance is focusing beyond transferring user knowledge, and including learning and storing the knowledge components in existing knowledge repositories (Almeida et al., 2006; Cohen and Levinthal, 1990). Intra-organisational communication is needed as a conduit for knowledge transfer and organisational learning.

Critiques are inputs with less complex but highly uncertain knowledge components. From the FARM illustration, decision-making authority is normally delegated to staff on-site collecting trial evaluations. These staff, usually a mix of marketing and R&D, will be the first point to screen the inputs. The trial of a prototype is part of the innovation process, and thus is therefore unlikely to be supported by additional rewards to incentivise staff. Market forces when the trial prototype is finally launched to the market serve as conditions governing staff behaviour to access and transfer *Critiques*. Similarly to *Homemade*, mild NIH attitudes might be present, thus intra-organisational communication requires a more collaborative approach that goes beyond merely transferring user knowledge from a source to a recipient in the generic sense (Lichtenthaler, 2011).

It appears that *White Spaces*, compared to the other types of user inputs, are the most challenging for firms to manage. The highly complex and uncertain nature of the embedded knowledge components means that organisational practices need to be adapted more significantly and supported by a more open organisational design. Using the 3M case for illustration (von Hippel et al., 1999), Marketing and R&D needed to be given more freedom and authority to search for *White Spaces*. It is likely that staff will use formal and informal networks to search for these inputs, and will make decisions on the initial screening of inputs before the shortlisted inputs are put forth to Management. There will be a need to incentivise staff for knowledge searches of such breadth, because without this, staff are unlikely to search, access, and transfer these inputs (Salge et al., 2012). Intra-organisational communication will be challenging: *White Spaces* contain piecemeal knowledge components derived from sources unknown to the firm, thus stickiness will inhibit knowledge transfer (Szulanski, 1996). Collaborative tools such as technology road mapping might be required to facilitate intra-organisational knowledge transfer. The knowledge governance objective here is likely to be to increase the existing knowledge base through deliberate path-breaking knowledge search, access, and transfer mechanisms. In the case of 3M (von Hippel et al., 1999), the firm deliberately promote inter-organisational collaboration with the explicit intention of maximising search breadth by involving staff from diverse business markets and functions to maximise search breadth.

CONCLUSION

Our paper addresses a fundamental issue of user knowledge management that is largely (and unjustifiably) neglected in the user innovation literature. Consistent with recent observations (Foss et al., 2011; Laursen and Foss, 2014), the user innovation literature is focused on managing the engagement part of the process but gives little in-depth consideration of the internal organisation of the firm for capturing value from user knowledge. We link the research streams of user innovation, knowledge transfer, and knowledge characteristics to propose four types of user input based on their knowledge characteristics of complexity and uncertainty: *1) Add-ons; 2) Homemade; 3) Critiques; 4) White Spaces*. We also offer insights on the possible interactions between user input types and organisational practices to encourage or inhibit access and transfer of user knowledge. Our analyses have also established that user inputs with highly complex and uncertain knowledge components tend to increase knowledge stickiness for firms.

We contribute to the user innovation literature by building on Foss et al. (2011), and Poetz and Schreier (2012), providing a user input typology that extends beyond the need-based and solution-based knowledge dichotomy (Poetz and Schreier, 2012); and offer insights on managing the user knowledge embedded in the user input types through organisational practices (Foss et al., 2011). The development of theoretically grounded and differentiating categories is itself an important form of conceptual contribution to literature (Bailey, 1994; MacInnis, 2011). We posit that categorising user input types in the context of the user innovation concept increases the construct clarity of user input (Bacharach, 1989; Suddaby, 2010). The user input typology forms the foundation for future work on further unpacking the user input construct.

A prerequisite before a firm can access and transfer user input, leading to its subsequent use, is to have managers who are open and able to operationalise externally sourced knowledge in the firm's innovation process (Leonard and Barton, 2014). Successful firms usually have existing knowledge bases that have proven effective for generating innovation in the past. When managers draw from these knowledge bases, they form core assumptions about the technology they work with and the markets they operate in. It is these core assumptions that form barriers inhibiting managers to search, access, transfer, and use external knowledge (Leonard-Barton, 1992). This is because managers tend to only look for external knowledge that is familiar to them, and so, they may exhibit not-invented-here syndrome to knowledge that is unfamiliar and novel (Alexy and Dahlander, 2014; Berg, 2014). It is when the firm is ready and able to use user input in its innovation process that organisational practices could support the firm's effort to access and transfer user inputs.

As with any research, this paper has its limitations. Firstly, the uncertainty and complexity dimensions of user inputs are limited to describing the firm's ability to translate and comprehend knowledge components present in user inputs. We note that when innovation outcome attributes of magnitude and speed are taken into account, an innovative outcome derived from *Add-ons* could lead to complex changes to the firm's innovation, manufacturing, and distribution processes (Crossan and Apaydin, 2010). However, the focus of this paper is on categorising user inputs based on their knowledge components, not predicting complexity of innovative outcomes. Secondly, we have not delved into discussions about the role of creativity in idea development. This is a related theme, yet it remains outside of the specific focus of our analysis. We note that both limitations constitute fertile directions for future research that can deepen and enhance the understanding of user involvement in innovation.

The user input typology we develop enables managers working closely with users in their firms' innovation processes to better understand the characteristics, and the most relevant transfer mechanisms for each user input type. This allows managers to make better decisions with their limited resources, and capture value from user input types that fit the purpose of their firms' innovation goals. Furthermore, the discussion of potential interactions between user input types, and organisational practices offers managers some useful ideas for reflecting how their firms' organisational practices might inhibit or facilitate the access and transfer of user knowledge. We urge managers to use our discussions in this paper as a starting point to think about how best to design their organisations to capture value from those of the four types of user input that are most relevant to them.

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