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Managing Innovation Uncertainties: a User-Oriented Knowledge Typology

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Abstract:

New product development processes are subject to uncertainties. These uncertainties can and should be managed to prevent innovations from failing. Uncertainties or knowledge deficits are addressed by deploying the right approaches, or *learning activities* to stimulate relevant inflows of knowledge. A typology of user-oriented knowledge types is key to overcome the reluctance of organizations towards multi-actor involvement and user-oriented learning activities. Here, we present a user-oriented knowledge typology departing from the end-user, embedded in a two-states framework (current state opposing future state). We discuss three iterations of the framework, including an expert review and real-world application as part of a workshop with intermediary organizations. When implemented, the framework enabled participants to identify and select learning activities enriching their innovation project. We want to underline our vision to transcend the gut-feeling and experience-driven allocation of learning activities, but instead strive towards optimal activity-selection based on the knowledge deficit at hand.

Keywords: Uncertainties; uncertainty management; open innovation; user innovation; knowledge deficits; knowledge; workshop.

Introduction and problem formulation

Although it is hard to estimate, up to 40% of all product innovations end up as failing innovations (Castellion & Markham, 2013). According to Russo et al. (2013), one of the reasons for such failures is the *mismanagement of uncertainties*. These uncertainties may reflect internal knowledge gaps (Drechsler & Natter, 2012) or internal knowledge deficits (Amara, Landry, Becheikh, & Ouimet, 2008) in the available stocks of knowledge (Lane, Koka, & Pathak, 2006b), the prior knowledge, knowledge corridor (Gruber, MacMillan, & Thompson, 2012) or the knowledge bases (Cohen & Levinthal, 1990), both at the organizational level and at the level of the new product development (NPD) process. Furthermore, these uncertainties may occur through multiple aspects of the NPD-process (Van De Vrande, Lemmens, & Vanhaverbeke, 2006): the product or service, the organization, the technology, the customer, the user and the broader environment. Additionally, in order to successfully address uncertainties, there is a need to find the right approaches to address these distinctive uncertainties with optimal resource allocation (York & Venkataraman, 2010). In other words: uncertainties can, and should be *managed* to prevent innovations from failing.

When it comes to the degree of uncertainty in innovation development, Russo and colleagues stipulate that the higher the degree of *novelty* of the innovation, the greater the level of uncertainty regarding the innovation, and the higher the probability that an unforeseeable uncertainty arises (Russo et al., 2013). Moreover, technological and market uncertainty is said to be the highest in the *earlier stages* of the new product development process (Van De Vrande et al., 2006). During these early stages, there is a degree of freedom. Therefore, the importance of uncertainty management is the highest at the beginning of the NPD process. In practice however, this often leads to wild, or only slightly educated guesses and might consequently cause failure if uncertainties are mismanaged (Courtney, 2006).

However, the knowledge to overcome dominant knowledge deficits is available outside the organization. This insight is not new. In 1945, Friedrich Hayek stated that knowledge is broadly distributed across society (Hayek, 1945), and Bill Joy (Sun Microsystems co-founder) is often quoted: “*No matter who you are, most of the smartest people work for someone else*”. Therefore, organizations are increasingly shifting from a closed to a collaborative innovation development strategy. This is key to one of today’s dominant innovation paradigms, that of Open Innovation (Chesbrough, 2006). One of the central arguments within Open Innovation literature is

that knowledge external to the organization is much larger than knowledge within the organization. The capability to overcome these knowledge deficits has previously been coined as *absorptive capacity* (Cohen & Levinthal, 1990). Besides Open Innovation literature, User Innovation, a second strand of literature originating with Eric Von Hippel in the 1970s (Hippel, 1976; von Hippel, 2005), also promotes the absorption of external knowledge, albeit specifically through a user-oriented reasoning. So, while uncertainties pose challenges for successful innovations, adequate management of external knowledge might be the key to overcome these challenges.

The question remains however, *how* such knowledge transfers can take place in this context. Uncertainties or knowledge deficits can be addressed by deploying the right approaches, or *learning activities* to stimulate relevant inflows of knowledge. One way to look at such learning activities is an experimental approach: learning by doing (Amara et al., 2008), or learning by experimenting (Chew, Leonard-Barton, & E. Bohn, 1991; Daghfous, 2004). More specifically, Chew and colleagues (1991, p. 10) propose four types of learning by experimenting: (1) vicarious learning (learning from the experience of others); (2) simulation (constructing artificial models of new technology and experimenting with it); (3) prototyping (actually building and operating the new technology on a small scale in a controlled environment); and (4) on-line learning (examining the actual, full-scale technology implementation while it is operating as part of the normal production process).

As we discussed earlier, an important actor and knowledge source in innovation development processes is the *end-user* (von Hippel, 2005). In a closed innovation development process, end-users are only involved at the end of the process (Griffin & Hauser, 1993). However, given the increasing speed at which innovations are launched and the increased competition, end-user involvement has become an increasingly critical factor for successful innovation (Følstad, 2008; Levén & Holmström, 2008). Therefore, learning activities focused at obtaining end-user knowledge has become an important aspect in a wide-variety of applications in various literature streams. However, organizations are often reluctant to apply such user-oriented learning activities to inflow external knowledge (Heiskanen & Repo, 2007) due to reasons of uncertainty and unfamiliarity with appropriate learning activities. Therefore, this article focusses specifically on *end-users* as an external source of knowledge.

But how can we understand knowledge as a concept? While previous academic work acknowledges, and discusses multitudes of *knowledge types*, both of theoretical nature (Bates, 2005; Leonard & Sensiper, 1998; Nonaka & Konno, 1998; Rowley, 2007) and action-oriented (Byström & Järvelin, 1995b; Lane et al., 2006b; Shane, 2000; Von Hippel, 1994), in detail, the interpretation of knowledge is still broad and undefined. This is problematic, since an adequate understanding and delineation of knowledge types in this context is essential to implement in more rigid uncertainty management strategies. Furthermore, a typology of knowledge types is key in understanding the link between uncertainties and learning activities. Hence, a knowledge typology framework can be considered an instrument to manage specific uncertainties though the deployment of specific learning activities, therefore reducing the knowledge deficits of the organization and increasing the chance on success.

Consequently, this paper's objective is to propose a *user-oriented knowledge typology* to better manage the selection and knowledge transfer of user-oriented learning activities. With such a typology, this paper contributes to both open- and user-innovation literature. Given the centrality of the innovation development process, this research will focus on knowledge directly related to the NPD process, rather than broader organizational knowledge.

To achieve this objective, this paper is structured as follows: (1) We first sketch the current understanding on both knowledge management and knowledge typologies; (2) we then work towards a user-oriented knowledge typology; (3) next, we describe and assess the practical validation of the knowledge typology; and (4) finally, we discuss the results, and provide some conclusions and avenues for future research.

Current understanding on managing knowledge through open and user innovation

Open innovation has been defined by Henry Chesbrough as “*the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively*” (H. W. Chesbrough, 2006: 2). One of its key premises is its interaction with external actors (*‘purposive inflows of knowledge’*). These actors can be broadly interpreted as users, customers, organizations, stakeholders, and so forth. We define these interactions to structure inflows of knowledge (executed both internal and external to the organization) with

different actors and with the objective to gather meaningful insights in support of the new product development process, as learning activities. Learning activities have been previously discussed by Dencker, Gruber and Shah (2009). From an end-user involvement perspective, these learning activities can further be subdivided in active versus passive participation (Bogers, Afuah, & Bastian, 2010), or can be distinguished to its level of empowerment (by, with, for actors) (Kaulio, 1998). Such typologies highlight the differences in end-user agency in the NPD process.

From an organizational perspective, on the other hand, an important concept in exploring external knowledge and interacting with external actors is *absorptive capacity* (Lichtenthaler & Lichtenthaler, 2009). It is contrasted to *inventive capacity* which refers to exploring new knowledge inside the organization. Absorptive capacity is to be situated at the organizational level (Cohen & Levinthal, 1990), but von Hippel is explicitly referring to the concept in the context of problem solving for innovation in his discussion on sticky information (Von Hippel, 1994). This context is closer related to the NPD-process level than the organizational level.

Vanhaverbeke and Cloudt (2014) explicitly link the concepts of absorptive capacity and open innovation, stressing that there should be balance between internal and external sources and inflows of knowledge. Absorptive capacity is related to the assimilation and integration of external knowledge and is therefore limited to the outside-in perspective of open innovation. Lichtenthaler & Lichtenthaler (2009) added *connective capacity* (gaining access to external knowledge) and *desorptive capacity* (the organization's capability to generate revenues through external knowledge exploitation) to explain open innovation practice.

Uncertainty management is often mentioned in the context of startup literature (Borseman, Tanev, Weiss, & Rasmussen, 2016). Scholars only provide high-level listings of uncertainty frameworks (Borseman et al., 2016): product, customer, competitive environment, technology/IP, financing, partnership, resources. More practitioner-oriented publications, such as the business-model-canvas, which was first posited at the business model ontology in Osterwalder's doctoral dissertation (Osterwalder, 2004), propose following aspects: capability, value configuration, partnership, value proposition, cost, profit, revenue, actor, relationship, channel, revenue, customer. These frameworks however, remain at the level of the business model and business model innovation, and not necessarily consider the user-oriented aspects.

Previous academic work is thus mainly focusing on the organizational perspective and the way in which organizations transfer knowledge with actors outside the organization. However, given our previous argumentation, a better understanding of knowledge transfers at the level of the NPD process is needed to apply this to uncertainty management and the selection of learning activities. Hence, we need to shift away from the organizational level as a unit of analysis, and look more towards the level of the innovation development process.

More specifically, we focus on user-orientation within the NPD-process. User orientation, which can be defined as the act of involving external actors with user involvement methods, is said to imply a significant inflow of new information into product development (Heiskanen & Repo, 2007). Information that may be difficult to accept, process, or absorb. It may also compete for the already scarce resources (both on the organizational and individual NPD-process) needed for action. It is often assumed that raising companies’ *“awareness of methods and approaches for user involvement will help them to get closer to users, to learn more about them, and hence to produce more successful innovations”* (Heiskanen & Repo, 2007, p. 182).

As briefly touched upon earlier, concepts on knowledge, internal and external knowledge, available stocks of knowledge are discussed in detail in previous academic work. But the question remains: how can we turn it into practice and make it actionable? Understanding the nature of knowledge is required to be able to manage it.

Current understanding of knowledge typologies

The nature of knowledge

Leonard and Sensiper (1998) define knowledge as information that is relevant, actionable and based at least partially on experience. Rowley (2007) is discussing the hierarchy of knowledge related to data, information and wisdom in the wisdom hierarchy. Here, information is conceived as data processed to be meaningful, valuable and appropriate, and knowledge as ‘actionable information’ (Rowley, 2007). She further summarizes knowledge as *“a mix of information, understanding, capability, experience, skills and values”* (Rowley, 2007, p. 174). We follow Bates’ reasoning of knowledge as information given meaning and integrated with other contents

of understanding (Bates, 2005). This interpretation of knowledge is also in line with the summary of Rowley.

Furthermore, Grant (1996) distinguishes between objective versus subjective knowledge and explicit versus tacit knowledge. Explicit knowledge is revealed by communication. By contrast, tacit knowledge is know-how, revealed through its application and acquired through practice. It is slow, costly and uncertain. The work of Nonaka and Konno (1998), is known for the discussion of 'ba' in the context of knowledge creation. 'Ba' is conceived as "*a shared space for emerging relationships: The phenomenal place as the key platform of knowledge creation*". The authors also discuss the distinction between tacit- and explicit knowledge. Tacit knowledge is further divided in the technical dimension of tacit knowledge or know-how and the cognitive dimension of tacit knowledge (beliefs, ideas, value, schemata, mental models). Tacit knowledge is not easy visible, not easy expressible, highly personal and hard to formalize (subjective insights, intuitions, hunches). Technical dimensions (informal personal skills or crafts) and cognitive dimensions (beliefs, ideas, values, schemata, mental models) of tacit knowledge are discussed. Explicit knowledge "*can be expressed in words and numbers and shared in the form of data, scientific formulae, specifications, manuals*". This type of information can be readily transmitted between individuals in contrast to tacit knowledge. Knowledge creation is discussed as the spiraling process of interactions between explicit and tacit knowledge. Interaction then lead to the creation of new knowledge. Foray (2004) states that new knowledge is tacit and sticky. Tacitness indicates that knowledge is neither articulated nor codified. It resides in people, institutions or routines (Foray, 2004). In addition, tacit knowledge is difficult to transfer, and therefore sticky. Here, explicit links are made to the concept of stickiness or '*sticky information*' as proposed by von Hippel (Von Hippel, 1994).

Next to the distinctive explicit, implicit or tacit and objective versus subjective distinction, von Hippel (1994) has proposed the concept of 'sticky information': "*the stickiness of a unit of information is defined as the incremental expenditure required to transfer that unit of information to a specified location in a form usable by a specified information seeker*" (Von Hippel, 1994, p. 430). Von Hippel explicitly links this sticky information to tacitness of information, due to the lack of explicit encoding, and absorptive capacity. Outside technical information is linked to prior related knowledge (Shane, 2000).

Other typologies, such as the one proposed by Byström and Järvelin (1995) state that information can be categorized in (1) problem information, (2) domain information and (3) problem solving information. Problem information indicates the problem characteristics - the structure, properties and requirements of the problem at hand. Domain information relates to known scientific facts - known facts, concepts, laws and theories in the domain of the problem. Problem solving information is then expertise in problem treatment – hereby covering the methods of problem treatment or problem solving. This distinction can be applied on information as a thing, as knowledge and as a process.

Lane, Koka and Pathak (2006a) put forward three primary knowledge characteristics: (1) know-what or knowledge content, (2) tacitness and (3) complexity. Know-what is further divided in common skills, strategy, knowledge bases and similar culture. The tacitness of knowledge is defined as the extent to which the knowledge consists of implicit and non-codifiable skills or know-how. Finally, complexity is described as the number of interdependent technologies, routines, individuals and resources that are linked to a particular knowledge or asset. Hereby, the authors explicitly link to Simonin (1999).

Summarizing the above, several conceptual distinctions are made: know-how versus know-what, objective versus subjective knowledge and explicit versus tacit knowledge. While being part of the discussion related to the nature of knowledge, however, these theoretical contribution refrain from being action-oriented and are not linked (explicitly) to the uncertainties in the different stages of the NPD process.

Action-oriented knowledge types

In addition to the above-mentioned theoretical contributions, multiple scholars have attempted to make more practical and usable knowledge distinctions. Robert Grant, for example, (1996) states that many types of knowledge typologies are available to organizations, hereby explicitly linking to Machlup's 17 subject groups and 115 subgroups of knowledge (Machlup, 1984, p. 313-314). This distinction in subject groups however stays of theoretical nature. The subgroups are limited to a longlist of potential knowledge objects. Table 1 lists different types of common uncertainties or knowledge (to cope with these uncertainties) that can be found in literature.

von Hippel (1986) has been repeatedly introducing need and solution information related to the 'lead user' concept. These types of knowledge have been widely adopted, predominantly in User Innovation literature. Shane (2000) distinguishes three types of prior knowledge: prior knowledge of markets (supplier relationships, sales techniques and capital), prior knowledge on ways to serve markets (how to use, alternatives and business mode) and prior knowledge on customer problems. Amara, Landry, Becheikh and Ouimet (2008) are elaborating on four types of knowledge deficits an organization may experience: technological uncertainty, technical inexperience, business experience and technology costs. Sammarra & Biggiero (2008) complement the technological knowledge with managerial and market knowledge. Lichtenthaler (2009) proposes technological and market knowledge as two critical components of prior knowledge in the organizational learning processes of absorptive capacity. Alasoini (2011) is discussing three types of knowledge as needed in workplace development: design knowledge, process knowledge and dissemination knowledge.

This table presents us with a non-exhaustive list of different types of uncertainties or knowledge. These knowledge types are to be situated at different levels of the NPD-process, both at the core and the perimeter. However, unanimity amongst scholars is lacking. We thus miss a clear categorization of uncertainty and knowledge deficits, and their underlying sub-dimensions, which restricts the actionability and applicability for organizations and entrepreneurs faced with product or service innovation needs. In addition, a process model to link these knowledge deficits with actions to facilitate organizational learning is missing.

uncertainty & knowledge types	<i>von Hippel, 1986, 2005</i>	<i>Simonin, 1999</i>	<i>Shane, 2000</i>	<i>Liithje, 2004</i>	<i>Shah & Tripsas, 2007</i>	<i>Amara et al., 2008</i>	<i>Sammarra & Biggiero, 2008</i>	<i>Lichtenthaler, 2009</i>	<i>Alasoini, 2011</i>
<i>business</i>						x			
<i>context-of-use</i>	x								
<i>demand</i>					x				
<i>design</i>									x
<i>dissemination</i>									x
<i>environmental</i>		x							
<i>managerial</i>							x		
<i>market</i>			x				x	x	
<i>need</i>	x		x		x				
<i>process</i>									x
<i>serve markets</i>			x						
<i>solution</i>	x								
<i>technical</i>				x		x			
<i>technology</i>						x	x	x	
<i>usage</i>				x	x				

Table 1 Different types of common uncertainties or knowledge

The remainder of this paper's overarching objective is to map the types of knowledge within the new product development process, as obtained by different types of learning activities, hereby diminishing levels of uncertainty. This way we want to contribute on two levels:

- By structuring the academic discussion on different knowledge types
- By offering a specific actionable framework to manage knowledge uncertainties, deficits tailored to user-oriented learning activities within the new product development process.

Towards a user-oriented knowledge typology

Two states

A first 'macro' dichotomy in academic literature is the difference between knowledge related to the current environment versus knowledge related to the innovation under development. While the first is closely related to problem and opportunity identification, the second is related to the formulation and evaluation of solutions. In line with design thinking literature and experimental learning, it is possible to learn about both the present, but also to experiment with 'possible futures'.

Before we go deeper in different knowledge types, we propose a first framework that builds upon this idea. This framework is based on the metaphoric use of 'states'. States relate to some kind of reference point, either from the perspective of the organization or the individual (Gourville, 2005). Where the existing, 'current state of being', the 'as-is' or 'status quo' is opposing 'possible future states' (Alasoini, 2011). A distinction should be made depending on the perspective of which the state is perceived. From the perspective of the organization we may speak of a desired future state, from the perspective of the customer we this could be a possible future state. This metaphoric reasoning is also used to stress the need to first map the current state, before exploring possible future states. This is visually presented in figure 1.

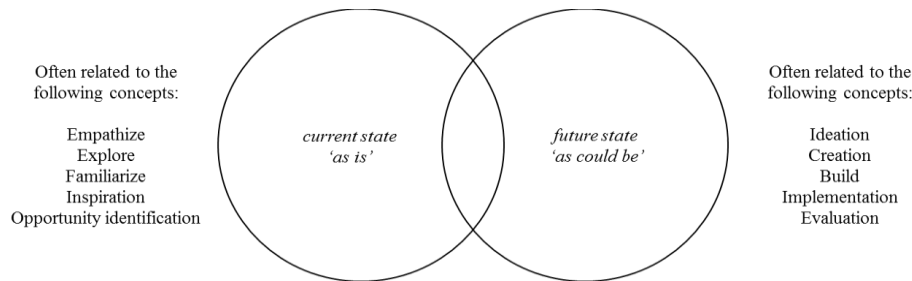


Figure 1 Current versus future state

This dichotomy is in line with the (sometimes implicit) logic of design thinking (Brown, 2008), in which the typical cyclic patterns always start from an exploration of the current state, the ‘*as is*’ state (inspiration, inquiry, empathize, research, observation, etc.) which is followed by the definition and experimentation of future states, the ‘*as could be*’ state (define, ideate, prototype, test, experiment, etc.). It is important to note that experimentation with possible future states might also reveal knowledge of the current state, that both states are partially overlapping, and that this distinction does not pretend to be part of a linear process. It merely highlights the different knowledge domains in innovation development.

A user-oriented knowledge typology

Next, we built upon the ‘action oriented knowledge types’, listed earlier in table 1, which was constructed through a literature review. This non-exhaustive list of knowledge types was the source material which was plotted on the two states as described earlier. Besides the knowledge types that emerged from literature, we retrospectively mapped 125 research questions on these knowledge types as a validation of this typology. These research questions originate from 25 research projects within imec.livinglabs¹, an intermediary organization who supports innovation development through user-oriented research activities. More specifically, the research questions (gauging for knowledge inflow) were extracted from the 25 individual research tenders. The results can be found in table 2.

¹ <http://www.imec-int.com/en/livinglabs>

Knowledge type	Defined in previous work	Author(s)
Need knowledge	<i>“information about the preferences, needs, desires, satisfaction, motives, etc. of the customers and users of a new product or new service offering”</i>	(von Hippel, 1998 in : Piller, Ihl, & Vossen, 2011, p. 2)
	<i>“users possess unique need-related knowledge acquired through their own use”</i>	(Shah & Tripsas, 2007, p. 132)
Environmental knowledge	<i>“knowledge held by consumers as well as firms in the market”</i>	(Simonin, 1999, p. 466)
	<i>“important prior knowledge about markets might include information about supplier relationships, sales techniques, or capital equipment requirement that differ across markets”</i>	(Shane, 2000, p. 452)
Contextual knowledge	Use-context information or context-of-use information. One-on-one with need-information [undefined by author]	(von Hippel, 2005)
	<i>“we use the term context to refer to ‘all factors that influence the experience of a product use’. The way in which a product is used depends on its user and on a variety of factors in the environment”</i>	(Visser, Stappers, van der Lugt, & Sanders, 2005, p. 3)
Usage knowledge	<i>“Emerges via the frequent use of products”</i>	(Lüthje & Herstatt, 2004, p. 560)

	<i>“Not only do users understand their own needs, (what the product is used for), but they also have a distinctive perspective on how it is used. Users have unique knowledge stemming from their system-of-use”</i>	(Shah & Tripsas, 2007, p. 132)
Need-coping knowledge	<i>“Coping, defined as the thoughts and behaviors used to manage the internal and external demands of situations that are appraised as stressful”</i>	(Folkman & Moskowitz, 2004, p. 745)
Solution knowledge	<i>“information about how best to apply a technology to transform customer needs into new products and services”</i>	(Von Hippel, 1994) (von Hippel, 1998 in : Piller, Ihl, & Vossen, 2011, p. 2)
Technical knowledge	Technical knowledge consists of know-how concerning the product architecture, the used materials, and the applied technologies in a product category [Undefined]	(C. Lüthje, 2004)
Demand knowledge	Demand information, estimates in the willingness to pay or value attached. [Undefined]	(Shah & Tripsas, 2007)

Table 2 Knowledge types derived from literature

When applied on our sample set of 125 research questions, however, these knowledge types proved to be incomplete and insufficiently structured. This resulted in a second iteration of the framework, in which the knowledge types were also mapped on the two states of the previous section. The result of this analysis can be found in table 3.

State(s)	Knowledge type	Definition	Examples
Current & Future	Environmental	Knowledge related to broader contextual dimensions	ecosystem, organization, market, domain, society
Current & Future	Contextual	Knowledge related to the use-context	Temporal, physical, social, task, technical
Current & Future	Usage	Knowledge related to the usage-patterns or habits	Habits, patterns, behavior, experience
Current	Need	Knowledge related to user needs and frustrations in the current state	Needs, frustrations, wants, problems, barriers
Future	Implementation	Knowledge related to the market implementation of the solution	Value promise, pricing, touchpoints, team composition, partnerships
Future	Need	Knowledge related to the needs and frustrations in the future state	Churn, attitudinal, solution, adapted-use

Table 3 Knowledge types after validation with sample set of RQs

This framework actively bridges theory and practice. Previous theory provided us with a good starting point, but also proved to be ambiguous at times. As table 2 shows, some concepts are used without a clear definition, while others are used (or misused) with different conceptualizations in different contexts. This ambiguity is confusing and hinders both theoretical development and practical applications. By validating these theoretical

knowledge types through a data source that reflects actual research questions, a proxy for knowledge sought by organizations to reduce uncertainty, this paper proposes a coherent, action- and user-oriented framework to structure both academic discussion and practical application in the context of targeted learning activities. A conceptual model of this framework is presented in figure 2.

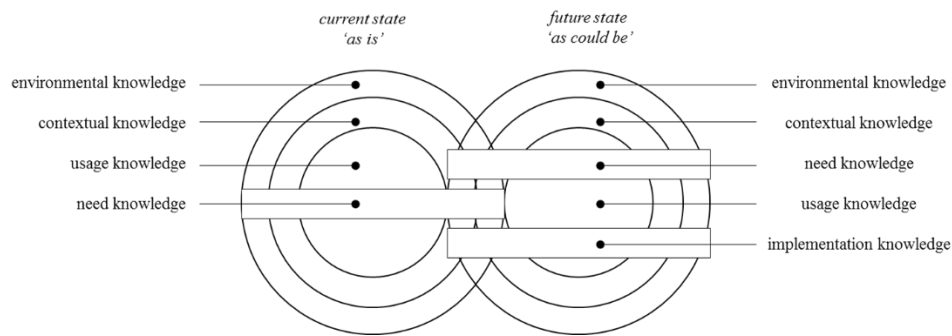


Figure 2 Theoretical framework of knowledge types

Practical validation

To further evaluate and optimize this framework, this model went through three extra validation stages which provided input for subsequent iterations. To achieve this, the framework was implemented in a workshop format aimed at structuring fuzzy input at the beginning of an innovation development process towards a well-planned set of learning activities that could address key uncertainties regarding the innovation development process. Hence, the workshop's main objective was to define appropriate learning activities, hereby taking into consideration the limited number of resources the workshop-participant is confronted with. The workshop was aimed at practitioners and has multiple target users: intermediary organizations; entrepreneurs and intrapreneurs; product managers, etcetera.

The author team was involved as a participant-observant, following a canonical action research approach (Davison, Martinsons, & Kock, 2004). This approach allowed us to have direct access and control over the projects, the implementation of the research protocol, as well giving us access to a multitude sources of evidence, including: field notes, in-depth interviews with relevant stakeholders, meeting minutes, deliverables, project methodologies and so forth.

Iteration 1: mapping learning activities

The first iteration tested the applicability of this framework for the selection of targeted learning activities. The data source for this exercise was the user innovation toolbox¹. This is a set of methods and tools to be consulted when looking for an appropriate and inspiring way of doing user-centric innovation research. It is a collection of over 80 user-centric innovation research methods (which we conceptualize as ‘learning activities’ in this paper) developed by imec-MICT-UGent². The author team mapped the individual tools and methods on the knowledge typology framework. This allowed for a validation of the inclusiveness of the framework, but also resulted in a first step towards the usage of the framework to actively link key uncertainties to learning activities, which is a crucial aspect of uncertainty management. The result of this exercise can be found in the addendum of this paper.

Lessons learned & iterations: the framework as presented in figure 2 was found to be well-suited to plot different research methods. However, the research methods could be plotted on different knowledge types, underpinning the need for sub-knowledge types. As preliminary sub-knowledge types we opted for the ‘examples’ as provided in table 3.

Iteration 2: expert review

A second iteration took place through three expert evaluations. Different perspectives were considered when reviewing the validity and the applicability of the proposed framework. More specifically, the review included the perspective of (1) a product designer, (2) a methodology expert and (3) an entrepreneur. The object under review was not only the theoretical framework itself, but also the workshop that put it into practice, which allowed to contextualize the evaluation. For each expert review, the workshop was applied on a realistic or sample innovation development process.

Lessons learned & iterations: The expert reviews acted as a prime test for the workshop format. The practical applicability of certain conceptual descriptions required some more refinement and examples to support a

¹ <https://www.iminds.be/en/userinnovation>

² <http://www.mict.be>

layman to complete the workshop. It was found that a more structured process of the workshop was required. This is presented in iteration 3.

Iteration 3: workshops

A final validation of the framework took place by applying the framework workshop in a real-world context. More specifically, three workshops were organized in the context of an innovation intermediary-support event in the domain of digital healthcare (February 16th 2017, duration: 2 hours). The workshop started with a theoretical framing, and then proceeded by (1) evaluating the degree of uncertainty for each of the knowledge types in the framework, (2) selecting the most appropriate learning activities, (3) formulating adequate research questions, and (4) organizing these learning activities in a research design.

Lessons learned/iterations: Notwithstanding the fact that the workshop was still under development at that date, it enabled the participants to transcend their own (rather limited) set of learning activities and selected other (external) activities to strengthen their research design. In addition, it helped the participants to explore otherwise hidden aspects (e.g. contextual limitations, future-state needs) of the innovation. Our main lesson learned of this workshop was the practical translation of the more theoretical shaped concepts. This will continuously be a challenging endeavor, as we want to ground this workshop in theory but make it relevant to practitioners.

Discussion and conclusion

In this article, we present an actionable, user-oriented knowledge typology to manage learning activities. Hereby taking into consideration the perspective of the end-user, by relating to the existing user innovation literature. Our rationale for this typology is the need to reduce uncertainties-facing organizations during the early phases of the new product development (NPD) process. The typology is further presented through a ‘*two-states*’ framework, taking both the current state (as-is) and the future state (as-could-be) in consideration.

The paper’s main contributions are threefold: (1) we provide conceptual clarity by structuring the academic discussion on the different, existing, action-oriented knowledge types, (2) we made the theoretical concept actionable, by offering a specific actionable framework to manage knowledge uncertainties, tailored to user-oriented learning activities within the new product development process, and finally (3) the democratization

and promotion of learning activities that further help to transcend the notion of '*get out of the building*'.

By presenting this user-oriented knowledge typology, and thereby ideally adjunct learning activities, we hope to meet and diminish the reluctance of organizations to actively involve end-users and by extension all relevant actors to the new product development at hand. Our final vision is to transcend the gut-feeling and experience-driven selection of learning activities, but instead select appropriate learning activities defined by the existing knowledge deficits.

With this paper, we further contribute to the innovation management literature by offering an instrument to assess uncertainties with regards to an entrepreneur's product or service innovation. Scholars in innovation management gain from the conceptual contributions regarding the offered knowledge typology, as to date there is no such typology available. Innovation intermediary organizations have benefit from the typology and the process model as it helps in shaping and choosing the intermediary activities carried out with entrepreneurs. For entrepreneurs and innovation managers, this knowledge is also of interest as it provides a framework to steer different actions and activities during the innovation process.

While implemented in a real-world setting, our typology and therefrom derived framework lacks formal evaluation. This should be tackled in future research. In addition, short term research steps will initially focus on the mapping of relevant learning activities (within for example user-centered design literature) to the user-oriented learning activities and further iterations of the workshop-format. More long term research will focus on the appropriate selection of learning activities, relevant actors – with specific innovation-relevant characteristics – depending on the uncertainty knowledge deficit at hand.

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