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INNOVATION DIFFUSION CATEGORIES AND INNOVATION-RELATED NEEDS

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ABSTRACT
This paper proposes a typology of innovation-related needs to explain the innovation diffusion patterns observed in the empirical studies conducted in Architecture Engineering and Construction (AEC) sector. Three types of innovation related needs are identified. The 'need for the innovation' and the 'need to innovate' are directly related to innovation, while the 'need for the diffusion of innovation' is indirectly related to innovation. The three innovation-related needs are used in conjunction with Maslow's hierarchy of needs to explain the individual and organizational response to ICT innovation diffusion efforts. Congruence between Maslow's hierarchy of needs and actor categories in innovation diffusion networks is demonstrated. Findings have implications on how diffusion of systemic innovation should be planned, designed and managed.

Keywords: innovation, design management, requirements, needs, diffusion

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1 INTRODUCTION

Innovators and designers are change agents. Besides their design and creativity skills, they are also expected to be adept at identifying and creating needs, which is a key driver for innovation. Even if the innovator or the designer has created a technically and functionally sound innovation or invention, it may not necessarily succeed or diffuse in the market (Rogers, 1995; Fichman and Kemmer, 1999; Lai et al, 1993; O'Sullivan and Dooley, 2001). Various factors have been posited to explain such failures, including non-existent needs misjudged by the innovators, and innovations that are too early for the market, i.e., a need that is not widely recognized until much later (Sheth, 1981). On the other hand, many innovations and designs are successfully diffused in the market because of their perceived need, irrespective of their technical and functional shortcomings (O'Sullivan and Dooley, 2001). Thus, innovation or change, and its diffusion appear closely coupled with the perceived need for that innovation or change. This apparent coupling suggests that a study of innovation-related needs or perceived needs is important to our understanding of the diffusion of innovation. This paper builds on this premise.

Diffusion of innovation has been studied extensively (Rogers, 1962, 1995; Abrahamson, 1991; Burt, 1987; Damanpour, 1988; Wolfe, 1994; Wejnert, 2002; Greenhalgh et al, 2004). There is a vast range of literature on innovation diffusion across diverse disciplines. Some of the key phenomena and patterns are well established, including the identification of the key actor categories that include innovators, early adopters, the early majority and the late majority and the laggards (Rogers, 1995; Burt, 1987; Greenhalgh et al, 2004; Wolfe, 1994; Wejnert, 2002; Meyers et al, 1999). It is commonly agreed that typically the innovators are risk takers, the early adopters are enthusiasts and opinion leaders, early majority are pragmatists, and the rest are conservatives that are skeptical of the innovation (Rogers, 1995). Accordingly, it can be seen that the diffusion of innovation shows a hierarchical adoption structure. The key drivers of innovation, i.e., the innovators and the early adopters are at the top of the hierarchy, while the laggards and late majority are at the bottom of the adoption pyramid, as represented in Figure 1. The hierarchical structure shown in Figure 1 is a modified re-representation of Roger's (1995) diagram and the percentage values are statistically established. Further, a top-down sequential flow in the diffusion process can be observed in an innovation diffusion process.

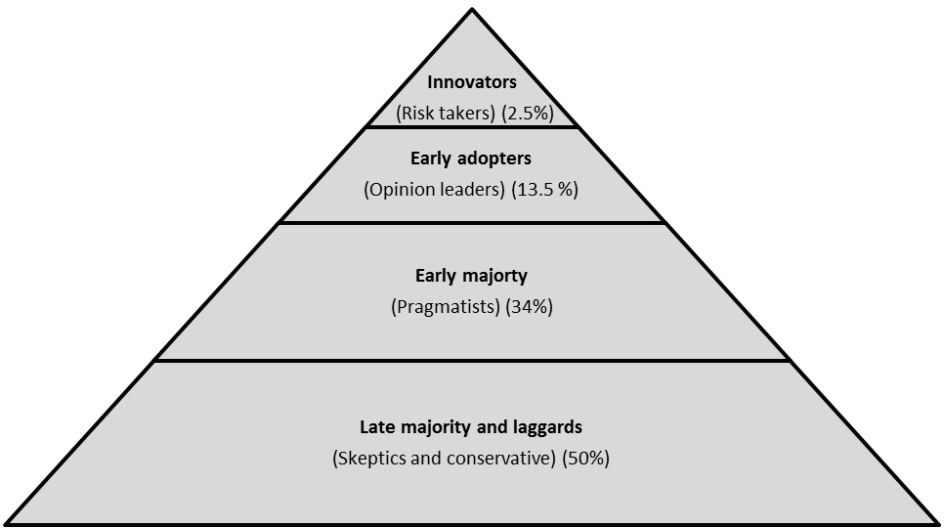

Figure 1. Re-representation of innovation diffusion categories (based on Roger and Kincaid, 1981)

The hierarchical re-representation of innovation diffusion actor categories is conceptually congruent with Maslow's (1943) hierarchy of needs. A preliminary analysis of the identified characteristics of the different actor categories indicates a likely correspondence and dependency between innovation diffusion patterns and individuals' hierarchy of needs. The majority is concerned with their primary needs and security, and hence, they are driven to be conservative and skeptical of change. The early majority feels secure enough to change or adopt new innovation but they need confidence in the innovation. Early adopters or the opinion leaders potentially look for opportunity to gain recognition and respect, while the innovators are driven by creativity and problem solving. This is consistent with

Maslow's needs that progress from security to confidence to self-esteem and finally problem solving and creativity. Therefore, this research adopts Maslow's hierarchy of needs framework as a viewpoint to examine the social patterns in innovation adoption and resistance within organizational networks.
Furthermore, it is equally important to identify the different types of needs related to innovation and innovation diffusion. We need to distinguish between the 'need for the innovation' and the 'need to innovate'. Need for the innovation typically leads to reactive innovation, i.e., an innovation in response to an observed need. The 'need to innovate' typically drives proactive innovation such that innovation is primarily driven by the innovator's or creator's need to innovate. In the latter case, the innovator or the creator searches for a dormant or hidden need, often creating the need for the innovation or converting wants into needs (CBS, 2012). Similarly, there are other actors in the innovation diffusion network who may have an indirect need associated with the innovation. For example, actors such as sellers, innovation champions and drivers, are typically associated with the 'need for the diffusion of the innovation' rather than the use of innovation. This variation in needs associated with the innovation may arise across the actor sub-categories as well, as indicated by Moore (1991). Moore observed that late adopters are fundamentally different than the early adopters because persuading them requires focus on market-centric values rather than the product-centered value.
Hence, in order to understand the diffusion of innovation, we need to consider (1) the dynamics between the 'need to innovate', the 'need for the innovation' and the 'need for the diffusion of the innovation', and (2) how the needs and hierarchy of needs of actors involved in this dynamics are related, if at all. While the empirical study was conducted in construction domain, it is argued that the findings can be generalized to other fields of systemic innovation diffusion.

2 BACKGROUND

The primary research was conducted in the architecture engineering and construction (AEC) sector, and the findings are argued to be applicable to broader context. The AEC sector is one of the oldest, largest, and diverse sectors, employing a wide range of people, processes and technologies (ILO, 2001; Taipale, 2012). This complex organization, along with the fragmented nature of the construction sector and project-based collaboration, poses critical challenge to innovation diffusion and change management across the construction sector (Gu et al, 2010; Peansupap and Walker, 2005; Taylor and Levitt, 2004). As a result, the construction sector is deemed as averse to change. There are significant gaps between the available technology and the technology used in practice (Peansupap and Walker, 2005; Moore and Dainty, 1999). Accordingly, the diffusion of ICT-based tools and applications has been the focus of recent research in construction (CRC, 2009; London et al, 2004; Guillermo and Stewart, 2004).
Findings reported in this paper are based on observations in two research projects. The first project investigated the level of e-business adoption in construction sector, while the second project investigated the adoption of ICT-based collaboration platforms in AEC projects.

3 LITERATURE REVIEW: INNOVATION, NEEDS AND INNOVATION TYPES

According to O'Sullivan and Dooley (2008), the primary difference between innovation and invention is that innovation is closely coupled with needs and exploitation, whereas novelty and need can be decoupled in case of an invention. They suggest that fulfilling customer needs and adding value to customers through new products, processes or services is an important part of the exploitation process. This paper focusses on innovation.
Innovation has been described and classified in different ways (Zaltman et al, 1973). Innovation has been defined in terms of product (goods and services) innovation, process (technical and administrative) innovation, and organizational and social innovation (Boer and During, 2001; Damanpour and Gopalkrishnan, 2001; Damanpour et al, 2009). There is strong evidence that the products, process and social needs are intertwined (Ettlie and Reza, 1992; Fritsch and Meschede, 2001; Kotabe and Murray, 1990; Damanpour and Aravind, 2006). For example, the product cycle model (Abernathy and Utterback, 1978; Utterback and Abernathy, 1975) and the reverse product cycle model (Barras, 1986; Miles, 2001; Uchupalanan, 2000) describe how product and process innovations are linked.
Another classification is 'incremental and radical innovations'. Incremental innovations target needs for constant improvement through progressive changes while radical innovations typically require fundamental shift from the previously existing system(s). Radical innovations often target needs that

are not met or not even recognized within the existing systems. Similarly, innovation can take place as an ongoing effort, typically achieved through R&D teams and innovation cells, or innovation can result from a crisis or 'environmental jolt' (Meyer, 1982). Accordingly, innovations can be classified as proactive innovation or reactive innovation. Proactive innovation is goal-seeking behavior whereas reactive innovation is adaptive response.

3.1 Diffusion of innovation

Diffusion of innovation has been studied extensively (Rogers, 1995; Abrahamson, 1991;, Burt, 1987; Damanpour, 1988; Wolfe, 1994; Wejnert, 2002; Greenhalgh et al, 2004). There is a general consensus that diffusion of innovation is a social phenomenon. Rogers' classical theory explains innovation diffusion in terms of (1) the classic diffusion pattern, known as the S-shaped cumulative adoption curve, (2) adopter categories (i.e., early adopters, early majority, late majority and laggards) and their characteristics, (3) adoption decision stages and influence modes (i.e., word-of-mouth or mass communication), and (4) the role of opinion leaders and change agents. Others (Attewell, 1992; Fichman, 1992; Katz and Shapiro, 1986) have extended the innovation diffusion research to complex technological innovations in organizational settings, introducing the effects of factors such as critical mass, knowledge barriers, and innovation categories. It is agreed that innovation adoption patterns and their needs may exist at various transitional states such that innovation diffusion cannot be described in terms of simple binary states of adoption or non-adoption (Swanson, 1994). Organizational innovation diffusion patterns have also been described in terms of leadership and personal characteristics of the actors such as education level, professionalism, specialization, and attitude towards change (Meyer and Goes, 1988; Ford and Gioia, 1995; Sharma and Rai, 2003).

Fichman (2000) argues that despite the range and breadth of studies on innovation diffusion, the research on innovation diffusion has typically pursued three main questions: (1) what determines the rate and pattern of innovation in a given population, (2) what determines the innovation adoption and assimilation in an organization over time, and (3) what determines the ability of an organization to adopt innovation. Most of these research questions investigate the mechanisms and structural attributes of innovation diffusion in which the actors are involved, but fewer research questions have been directed at the actors themselves (Wejnert, 2002).

Therefore, this research focuses on the actors. Literature indicates that the decision process of actors in innovation diffusion network is influenced by their social interactions (Meyers et al, 1999; Greenhalgh, et al 2004; Kimberly and Evanisko, 1981). Hence, it is important to investigate how the innovation-related needs of the actors evolve as a result of their social interaction.

3.2 Hierarchy of needs

Maslow's theory of hierarchy of needs has been widely researched and debated over the last few decades (Bennis, 1966; Hall and Nougaim, 1968; Hagerty, 1999; Sirgy, 1986; Wicker et al, 1993). Nevertheless, given the simplicity of the theory, it has strong appeal and the following characteristics of his hierarchy of needs theory are commonly accepted (Kenrick et al, 2010):

- Human needs have a hierarchical structure such that there is a preferential order for the needs
- There are distinct basic needs and higher order needs
- Human needs evolve as a result of the fulfillment of lower order needs

While exploring the order of the needs levels and their sequence is not within the scope of this paper, the hierarchical needs structure provides an appropriate framework to investigate the psychological basis to understand the innovation-related needs, as a way to understand the diffusion of innovation.

4 RESEARCH METHODOLOGY AND DATA COLLECTION

This research initially utilized a grounded theory approach (Martin and Turner, 1986) where data was collected from several sources (interviews, focus groups, field observations). Research data was collected with participants from leading organizations in the Australian AEC sector. FGIs included representatives from each tier and discipline of the AEC actor network, including product developers, clients, contractors, consultants, design managers, and government agencies. FGI discussions and interviews revolved around the potential challenges to adopting ICT innovations in construction sector, especially an ICT-enabled collaboration platform, with Building Information Modelling (BIM) (Eastman et al, 2008) at the core of data exchange. The FGI participants and interviewees were encouraged to discuss the challenges to innovation and BIM adoption. The tape-recorded interviews

and FGI discussions were transcribed and analyzed qualitatively. The findings reported in this paper are based on the overarching patterns observed across the different data sets.

5 RESEARCH FINDINGS: OBSERVATIONS AND PROPOSITIONS

Findings indicate that despite the perceived utility and acknowledged need for ICT innovation adoption across individuals and organizations, there is a widespread reluctance in the actor network to adopt innovation because the immediate needs of the ongoing projects take precedence. The primary need to focus on ongoing projects that bring revenue and require risk mitigation, inhibit innovation adoption, which requires time, effort and occasional setbacks in the change management and assimilation process. Thus, the relative advantage (Rogers, 1995) of innovation adoption for the long term benefits are overlooked in favour of short term goals, specific to the projects in progress.

Therefore, the findings raise a fundamental question: if all the actors acknowledge the need for innovation, then why do some take significant steps towards innovation adoption while others find reasons, even excuses, to avoid it? A simpler explanation is that the need for innovation for some actors appears to be greater than that for the others, such that for early adopters the need for innovation is high up their priority while for the others the need for the innovation is dominated by other needs that take priority. To elaborate this further, it is imperative to begin by first reviewing the key adoption patterns observed in this study.

5.1 Innovation, innovation adoption and the innovation drivers

The research participants emphasized the need for process and organizational innovation to support the adoption of technical innovation in AEC. However, technology adoption in AEC is rarely an independent analysis. Discussions indicated that potential adopters need to analyze the status of their project collaborators and partners. Even if the need for innovation is evident to a willing potential adopter, the actual adoption may not be realized. Given this context, the reported early adopters of ICT, especially BIM, in the AEC actor network were found to primarily fall into one of the categories listed in Table 1, driven by one or more of the listed needs.

Table 1. Innovation drivers in AEC actor network and their needs

Organizations	Need	Description
(1) Large corporations with in-house departments and multidisciplinary teams; (2) Large contracting firms that are dominant players in the market and enjoy higher power status in the project network; (3) Influential architects and firms that are established leaders and enjoy opinion leadership.	To retain leadership and competitive advantage	These organizations are driven towards proactive innovation because either they can afford taking risks to try new innovations and stay ahead of the competition. Or, they are threatened by emerging competitors and pushed by 'environmental jolt' towards reactive innovation.
	To improve efficiency and manage complex projects	Complex construction projects with greater regulatory requirements and stringent demands from clients increasingly become difficult to manage effectively without innovation adoption, creating environmental constrain, and forcing firms towards reactive innovation adoption.
Government agencies and departments that are large scale clients or customers	To drive and facilitate change as a social or moral responsibility	Not for profit organizations, government agencies and professional bodies are proactively promoting innovation adoption across the sector as part of their social responsibility (Lorenzen, 2001). However, the innovation adoption drive through such agencies is also, in part, a reactive response as a result of the inability of the industry to move by itself.

Therefore, consistent with Roger's (1962) classical theory, findings suggest that innovation diffusion efforts in AEC sector have greater chance to succeed if there are key drivers or innovation champions. The innovation champions, such as government agencies, non-profit organizations and individuals, do not need the innovation per se, but they find an opportunity in the diffusion of innovation to fulfill other needs that may arise from their economic, social or political objectives. Typically these innovation champions are driven by higher level needs and motivation such as the desire to gain

recognition, demonstrate leadership, and make noticeable contribution to community. The innovation champions play an important role in supporting and creating an environment for greater visibility of the innovation, including measures such as promotional events, training seminars and booklets. Once the willing early adopters get the desired guidance and support to adopt the innovation, and once they commit to adopt the innovation, the innovation diffusion chain is activated. The initial experience and opinion of these early adopters influences the emergent diffusion pattern. These early adopting firms create an environment where individuals at higher levels of need join the innovation bandwagon while a few others are forced to join as they seek job security, a primary need. Thus, it suggests that successful innovation diffusion requires that the innovation network has actors at different levels of hierarchy of needs. This is consistent with Moore's (1991) findings. According to Moore, late adopters are fundamentally different than the early adopters because persuading them requires focus on market-centric values rather than the product-centered value. That is, rather than driven by direct needs for the innovation, the late adopters are driven by the need for support and conformity, which gives them a sense of security.

Similarly, the different actor categories have different needs associated with the diffusion of innovation. For some actors such as end users the diffusion of innovation is directly related to the use of the innovation while for others the benefit is derived from the diffusion of the innovation, such as sellers and distributors. However, the actors in the innovation networks may play different roles at different times such that under different conditions adopters become innovators, as their needs get transformed. That is, innovation can occur anywhere across the network and accordingly the innovation diffusion structure may get reconfigured. For example, under normal circumstances, the actor network has dedicated firms or dedicated departments and employees within organizations for innovation, research and development. Typically, these actors are expected to push innovation and hence they need to innovate. While the need to innovate, as part of their job description can be considered a primary need for them to ensure job security, these actors are often considered to be driven by higher level needs such as creativity and problem solving. Nonetheless, even within these innovative groups, the outcome of the actors and their ability to innovate may vary as a function of their situation. For example, the principal of an award winning architectural firm reported that newly recruited creative professionals in their firm, who are on probation and uncertain of job security, tend to be conservative or group-think to avoid confrontation, a tendency that reduces innovation opportunity. Once the same individual are assured of job-security, their need for creativity takes over and they tend to challenge existing solutions and practices, opening up innovation opportunities. On the other extreme, individuals who are involved in more routine jobs tend to follow routine activities in normal circumstances. Such individuals are typically considered to be professionally driven by basic needs such as job security, employment and family. However, in situations where these basic needs are under threat such as the threat to job and hence family welfare, the crisis often forces such individuals to take risk and demonstrate creative and innovative instincts at work, which may result in innovation. For example, construction managers reported process innovations created by site superintendents and sub-contractors, which emerged from crisis created by project delays and cost cutting requirements. Thus, environmental conditions can transform the innovation-related needs of the individuals.

6 DISCUSSION

By proposing a typology of innovation-related needs as a way to understand diffusion of innovation, this paper aims to highlight an important gap in the understanding of innovation diffusion. It is argued that even though innovation is always coupled with need creation or need identification, there is evident lack of a theoretical understanding of this coupling and its role in innovation diffusion.

Analysis indicates two primary aspects to consider in investigating innovation-related needs as a way to understand diffusion of innovation. First, congruence between the characteristics of the actor categories in Rogers' classic theory of innovation diffusion and Maslows's hierarchy of needs suggests that hierarchy of needs provides an appropriate framework to study the needs of the different actors in the innovation diffusion network and how they are interrelated. Second, the innovation diffusion network has actors from both supply and demand side of the innovation such that atleast three categories of needs in the innovation diffusion network must be distinguished that include need to innovate, need for the innovation, and need for the diffusion of the innovation.

The indications of congruence between Maslow's hierarchy of needs and Roger's actor categories provide potential opportunities for design management and design research. In particular, the

observations that the change in environmental conditions can trigger a change in the hierarchy of needs of the different actors towards innovation adoption, may provide useful intervention mechanisms for innovation management. First, the design managers intending to introduce innovative tools and methods in their organization can be selective in approaching innovation diffusion at the early stages. That is, they can begin by identifying and targeting actors at higher levels of hierarchy of needs as potential early adopters and innovation champions. The innovation champions need not necessarily be potential users of the innovation but they could be actors that can leverage the innovation diffusion to fulfill some other needs. Second, the design managers and innovation champions need to consider the likelihood that not all actors can be intrinsically motivated to adopt innovation, and hence, they may need contingency plans to consider creating work environments that tie innovation adoption to basic needs of unwilling actors. Third, in order to ensure that the organization avails all the potential opportunities of innovation across its personnel and partners, design managers can apply the hierarchy of needs framework to assess whether the threat to basic needs such as job security is curtailing creativity of potential innovators, and whether, triggering basic needs can foster creativity and innovation from actors otherwise engaged in routine activities. Future research is needed to explore such intervention mechanisms and their potential role in innovation diffusion.

Furthermore, the different levels of hierarchy can be associated with each need category, i.e., need to innovate, need for the innovation, and need for the diffusion of the innovation. For example, need to innovate can be a basic need for people and organizations whose primary job and skill is to innovate; while for many others the need to innovate can be described in terms of passion or the drive to be creative. Similarly, the need for the innovation can be driven by basic need or by the need for belonging and to conform to social norms, as explained by Moore (1991) in terms of product-centric value and market-centric value. The hierarchy of needs for the diffusion of innovation can also vary across actors. For innovation champions the diffusion of innovation might serve higher order needs such as leadership or self-actualization while for suppliers and manufacturers it serves primary need of sustaining a business. A schematic mapping between the innovation-related needs and diffusion of innovation is shown in Figure 2.

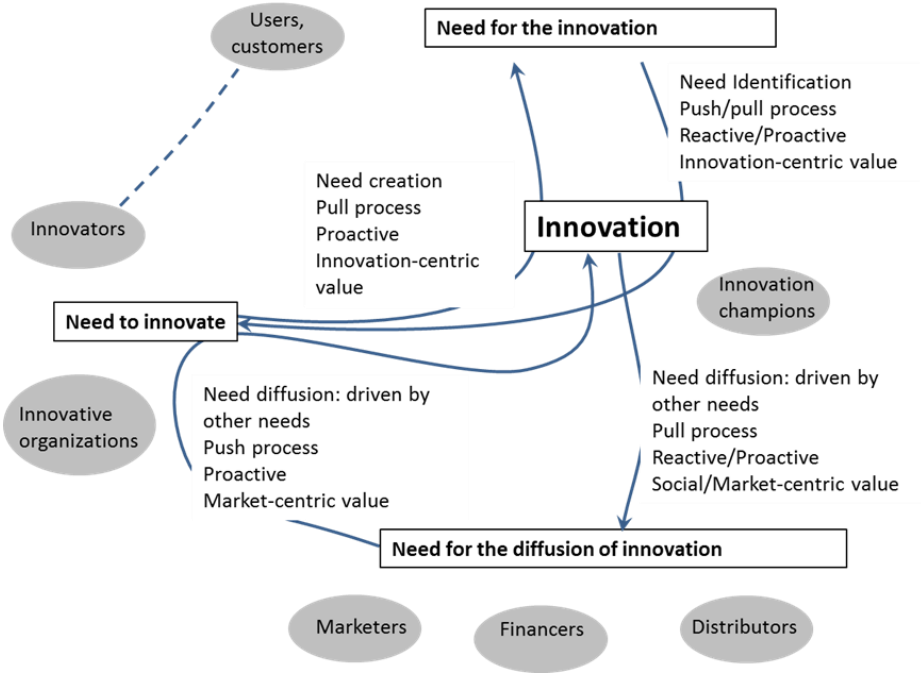

Figure 2. Innovation-diffusion actors and innovation-related needs

As shown in Figure 2, the three types of the innovation-related needs are linked. The need to innovate might result from a push by the need for the innovation, creating a reactive innovation. Such innovations are usually achieved through professional innovators or users themselves. Alternatively, innovators who are proactively looking for innovation opportunities may identify implicit need for the innovation that may have remained dormant otherwise. This second case is typically a pull process, whereby innovation is achieved because of the need to innovate, resulting in need creation. Need creation and need identification focus on innovation-centric value.

Innovation is important for growth of business and organizations. Accordingly, the supply chain of innovation diffusion has many actors from the supply side who need new innovations to sustain their business. Their needs are associated with the market-centric value of the innovation. On the other hand, innovation champions can come from both or either one of the focus areas. That is, the needs of the innovation champions may align with need for the innovation or the need for the diffusion of innovation or both.

Therefore, how the innovation-related needs are linked, and how the different actors in the supply chain are connected through these needs, is likely to determine the innovation diffusion pattern. Hence, designers and design managers engaged in new product development and product planning need to assess the potential innovation-related needs of the different actors for a given case, in order to develop case-based innovation diffusion strategy. It is likely that such assessments conducted at the product development and product planning stages may provide insights into potential challenges and roadblocks to the diffusion of the planned innovation. Future research is needed to understand the implications for design management.

7 CONCLUSION

This research proposes a typology of innovation-related needs as a way to understand the diffusion of innovation. Three types of innovation-related needs, namely, 'need to innovate', 'need for the innovation' and 'need for the diffusion of the innovation' are differentiated, and their dependencies in an innovation diffusion network are explained through the viewpoint of hierarchical structure of needs. The theory is built on findings from study of the challenges to adoption of ICT enabled technologies in the AEC sector. The paper shows that the diffusion of ICT and supporting process and organizational innovations in organizational networks can be explained through the hierarchy of innovation-related needs of the different actors. Findings have implications on how systemic innovation diffusion is planned, designed and managed.

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