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# Beyond Open Innovation: the Living Lab Way of ICT Innovation

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## Abstract

Open innovation becomes very popular nowadays. However, how to involve users in open innovation process and unleash the potential of more real life end users is still not easy. Living Lab is the development of open innovation paradigm which combines the advantages of users and their real life contexts and provides a structure and governance for involving users. In this paper, we propose a Living Lab process model and methods taxonomy. We evaluate the proposed Living Lab model and methods taxonomy by a Living Lab elderly caring case. Finally, we discuss the implications for ICT innovation and future work.

## Keywords

Open Innovation, Living Labs, ICT Innovation, User Innovation

## Introduction

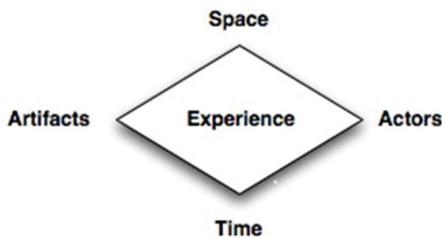
Four innovation paradigms have been identified in the innovation literature, namely the technology push, market pull, the combination of technology push and market pull and open innovation (Ortt & van der Duin, 2008). Open innovation paradigm is characterized by more extensive alliances, partnerships and collaborations between different partners (Chesbrough, 2003).

With the Open Innovation paradigm becoming more and more popular, companies are increasingly interested in involving users in innovation, especially in the ICT innovation and services (Greer & Lei, 2012). For example, effective, agile and trusted digital services Co-creation needs to align the formalized business genuinely on the spot, or ad-hoc, namely understanding the real needs of a customer (Li & Järveläinen, 2013). However, involving users in

the innovation process is still considered to be complex (Cavaye, 1995; Hyysalo, 2003; Maiden & Hare, 1998). Many reasons concerned for this are related with the transformation and expansion of the concepts of context and user in innovation process. For example, traditional IT systems focus on supporting organizational processes and work practices. While the organizational context still prevail for the usage of ICT technologies and systems, with the popularity and pervasion of ICT technologies such as home PCs, Internet and mobile phones, ICT becomes more and more popular in private contexts as well (e.g. for supporting social contacts and interactions in people's everyday lives) (Jain, 2003; Yoo, 2010).

Users usually interact with innovation applications (e.g. products or services) in continuous frames of different contexts such as

space, time, actors and artifacts as shown in Figure 1 (Yoo, 2010). Hence, the process of exploring user requirements and needs related to innovations is a complex technical, social and psychological process that is bounded to the actual contexts (Ståhlbröst, 2008).



**Figure 1.** Schematic framework of user experience (from (Yoo, 2010))

However, many traditional user involvement approaches such as User-Centric Design (UCD) (Gulliksen et al., 2003) and Participatory Design (PD) (Muller, 2003) more come from the background of workplace context (e.g. workshop or laboratory) than users' real life contexts. Therefore, they usually have some limitations in the continuity of the interaction of different contexts (e.g. time, space, actors and events) (Friedrich, 2013). For example, traditional user involvement approaches might ignore how innovations are used with an array of other artifacts (Hasu, 2001) or neglect the collective or social aspect of innovation utilization (Flynn & Jazi, 1998; Hyysalo, 2003) or limit interaction to single events for short-term participation (Klammer, Van Den Anker, & Janneck). Therefore, recent user involvement research in innovation advocates understanding users in more mundane contexts that stretch from workplaces and organizations into everyday life (Bodker, 2009) and public spheres (Bjögvinsson, Ehn, & Hillgren, 2012).

On the other hand, the concept of users is also transformed and expanded in innovation. First, users' role has transformed and expanded during the evolution of innovation paradigm. Users' role has changed from passive content consumers to content producers (e.g. Wikipedia) to active innovation co-creators (e.g. New Product Development) (Hestad, 2009). Second, users' scope is expanded. In early period of user innovation, "Lead users", who are ahead of a

trend and encounter needs, are the main source for user innovation such as open source software enthusiasts (Hippel, 1986, 1988, 2005). Many traditional user innovation examples (e.g. Open source software) stem from professional or hobbyist communities instead of average consumers (Heiskanen, Hyysalo, Kotro, & Repo, 2010). Many traditional user involvement approaches such as UCD and PD limit in involving a small group of users and are more based on the assumption that user needs are something given or pre-existing which can be answered by users or elicited by researchers. However, with the development ICT technologies, more and more ordinary people (e.g. the real end users) are empowered by ICT (e.g. PCs and Smartphones) and have the potential as new innovation source. "Lead users" based user innovation and small group of users oriented traditional user involvement approaches are not capable of addressing the needs and dreams of the majority of "normal" users (Friedrich, 2013). For average users, they articulate their needs only gradually by interacting with the applications in the real life contexts because user needs might not be well known (e.g. implicit needs) or even not yet exist at the time of involving them (e.g. future needs) (Hyysalo, 2003). They often prefer familiar products and incremental improvements (e.g. the common products in their real life contexts) (Duke, 1994; Trott, 2001). For normal users, the "user-developer culture gap" is even bigger than lead users as there are less mutual contexts between ordinary users and developers or designers (e.g. the laboratory context vs. real life social context and the unfamiliar technological solutions and modeling languages vs. familiar daily products and languages) (Vidgen, 2002).

## The emergence of Living Lab innovation paradigm

Under the background of open innovation paradigm and the transformation and expansion of user and context in innovation, one emerging Open Innovation approach called "Living Lab" (LL), which employs the advantages of both real users and their real life contexts, has gained increasing interest and momentum in both industry and academic recently (E. Almirall & J. Wareham, 2009). The initial concept of LL was introduced in 1995 by Professor William Mitchell

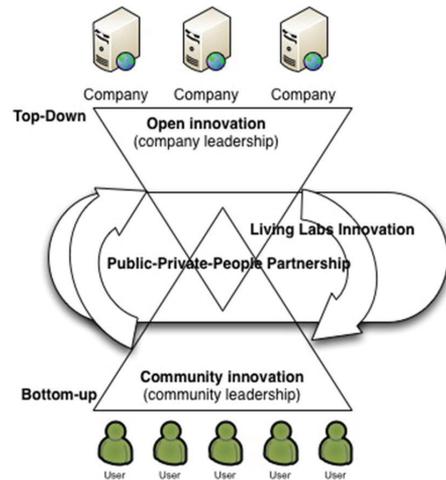
from MIT MediaLab and School of Architecture and city planning (Eriksson, Niitamo, & Kulkki, 2005). The original idea of LL was to construct a home-like living environment by ambient intelligence and ubiquitous computing technologies such as wireless and sensor technologies to sense, prototype and validate complex ICT solutions (Ståhlbröst, 2008). Examples of this kind of LLs include the Aware Home at Georgia Institute of Technology (Kidd et al., 1999) and PlaceLab at MIT (Intille et al., 2005), which simulate users' real contexts (e.g. home) in laboratory. Later, the concept has been extended to more general open innovation environments in real life contexts, in which user-driven innovation is fully integrated within the co-creation process by the close collaboration between users and other stakeholders such as business, research institutes, and government in Public-Private-People Partnerships (PPPP) (Eriksson et al., 2005). Many examples of this kind of LLs are listed in The European Network of Living Labs (ENoLL, [www.openlivinglabs.eu](http://www.openlivinglabs.eu)), which transform users' real life contexts (e.g. community and city) into a big social innovation laboratory.

## Living Lab as a bridge for integrating Open Innovation and Community Innovation

LL has its origin as extension to testbed for ICT technology and services. Currently, LL is also mainly used on ICT development and innovation (Følstad, 2008). The advantages and benefits of LL approach have been recognized by many studies. For example, LL can provide structure and governance for companies to involve users (E. Almirall & Wareham, 2008), understand user needs in the real life contexts (Intille et al., 2005) and reduce market-based risk (Esteve Almirall & Jonathan Wareham, 2009).

LLs have in general an important role as bridges to fill gaps. They bridge the different gaps between technology ideation and development on the one hand, and market entry and fulfillment on the other (European, 2009). LL is also a bridge or intermediary between Open Innovation and community innovation as shown in Figure 2 (Tang, Wu, Hamalainen, & Ji, 2012). On the one hand, LL provides structure and

governance to user participation and other entrepreneurial support for companies (Baltes & Gard, 2010). On the other hand, LL provides company supports such as financial and technical supports to communities (Tang, Wu, Karhu, Hämäläinen, & Ji, 2012). LL functions as a link or glue for connecting different stakeholders or the Public-Private-People Partnerships.



**Figure 2.** Living Lab as an intermediary for Open Innovation and Community innovation (from (Tang, Wu, Hamalainen, et al., 2012))

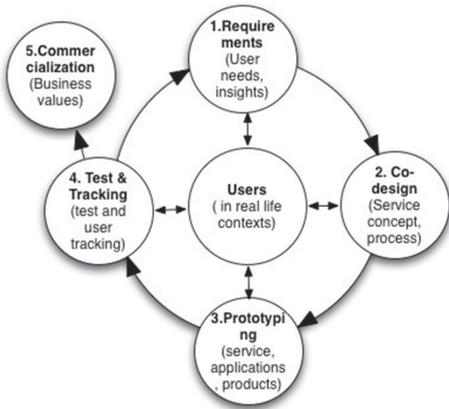
## Living Lab Methodology for ICT innovation

Suitable processes and methods are needed for LL to facilitate user involvement and stakeholder collaboration in the innovation and development. However, there is a remarkable lack of in-depth descriptions and discussions of LL processes and methods in current LL literature (Følstad, 2008), especially the experiences from MacroLevel LLs) e.g. national and international LL activities) (Baltes & Gard, 2010). Therefore, we propose a LL process model and a LL methods taxonomy from many years of Sino-Finnish LL projects practice.

### Living Lab process

Several LL process models on LL activities processes have been proposed in the LL literature such as FormIT model (Ståhlbröst, 2008), iLabo model, Helsinki LL model and

Catalan LL model (Esteve Almirall, Lee, & Wareham, 2012). By synthesizing the existing LL models and many years of international LL practices, we propose a LL process model as shown in Figure 3.



**Figure 3.** Living Lab process model

In this model, users and their real life contexts are in the centric positions. The model has four iterative phases: Requirements, Co-design, Prototyping and Test & Tracking plus an iteration exit phase: Commercialization.

The first phase is requirements in which the real life contexts, users (groups) and issues to be solved are preliminarily identified. For the features of LL, the issues are usually closely related with users' real life requirements and needs such as healthcare and traffic.

The second phase is co-design. Based on the input from requirement analysis phase, designers (e.g. service designers) involve users and other stakeholders to co-design some LL products or services to solve users' requirements and needs. The co-design in LL do not only deal with designers and their design processes in traditional workshop or laboratory, but also deal with how both the things undergoing design and the design process itself are simultaneously embedded in existing real life contexts and everyday life arrangements (Botero, Kommonen, & Marttila, 2010).

The third phase is prototyping. Developers co-develop LL innovation prototypes with users. The

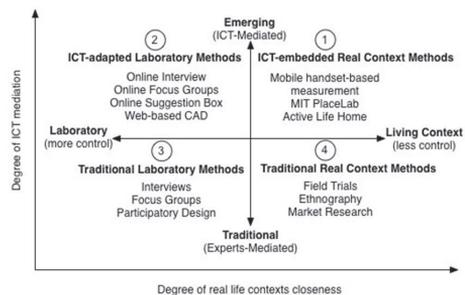
co-creation of ICT solutions is one of core advantages of LL over traditional user-centric methodologies (Mulder & Stappers, 2009).

The fourth phase is test & tracking in which the prototypes are tested (e.g. functions and usability) and users' interactions with prototypes are tracked in real life contexts (e.g. mobile handset-based user behavior monitoring). Users' feedback is collected.

All the aforementioned four phases are closely linked with users and their real life contexts. The iterative phases are not in linear sequence but can take place concurrently. Users have different roles in different phases such as co-designers and co-developers. With the innovation vortex of the iteration, some innovation outcomes might be commercialized.

## Living Lab methods

LL is a mixed or multidisciplinary approach, which combines the traditional research methods and the emerging ICT-enabled research methods as shown in Figure 4. The horizontal axis is the two components of LL, namely the laboratory part (more control) and the living part (less control). The vertical axis is the mediation, by ICT or by researchers. There are four quadrants in the Figure 4, namely the ICT-embedded real context methods, ICT-adapted laboratory methods, traditional laboratory methods and traditional real context methods (Tang & Hämmäläinen, 2012).



**Figure 4.** Living Lab methods (adapted from (Tang & Hämmäläinen, 2012))

The first quadrant is the ICT-embedded real context methods. These methods are the core or essence of LL approach, which manifest the

advantages and innovativeness of LL approach. Examples include the smart homes and mobile handset-based measurement. In these methods, the ICT is embedded in users' real life contexts. The advantages of the methods in this quadrant are that they are non or less obtrusive (embedded in the real life contexts) and suitable for collecting big data from large user bases continuously with less human efforts. The disadvantages include unfamiliarity to researchers and user privacy issues.

The second quadrant is the ICT-adapted laboratory methods, which are the adapted version (by ICT technologies) of traditional laboratory methods (in the third quadrant). Examples include online interview and online focus group. Compared with the methods in the first quadrant, they are more familiar to researchers.

The third and fourth quadrants are the traditional laboratory methods (e.g. interview and survey) and traditional real context methods (e.g. field trials and ethnography) respectively. They are the well-established methods and very familiar to researchers.

Different methods have their own advantages and disadvantages in different aspects such as familiarity to researchers, obtrusiveness, data collection means, data richness and application. Depending on different LL case situations, different combinations of methods in different quadrants can be used. However, by statistics, currently a predominant use of traditional methods was observed in contrast to a rather limited usage of emerging ICT-mediated methods (Schumacher & Feurstein, 2007). The traditional methods may be well suited for some LL studies, but does not represent important methodological advances (Følstad, 2008). With the development of ICT technologies such as sensors, embedded computing and mobile computing, users' daily life activities and experiences are increasingly digitalized. There is an emerging trend for ICT-mediated methods, especially the ICT-embedded real context methods such as the smart-home type of environments like MIT PlaceLab (Intille et al., 2005) and mobile handset-based sensing and measurement methods (Verkasalo, 2009).

## Case study

In this section, we present a case study in elderly caring to evaluate the proposed LL process model and methods taxonomy. The case under study is the Active Aging project, a Sino-Finnish LL collaboration project on ICT enabled aging care research.

Aging is one of the serious problems the world current faces. Smart aging is also one of the focal domains of smart city and LL research (Nam & Pardo, 2011).

In the requirements phase, different elderly user communities and contexts are selected such as the Beijing Yangfang dian senior community and Beijing Zhanlan Road senior apartments. The requirements and needs (e.g. healthcare, emotion, travel, eating and housing) of elderly people are identified by both traditional laboratory methods such as interview and focus group in the workshops and traditional real context methods such as field trials in which researchers visit the elderly people's homes and other daily life contexts (e.g. video recording the everyday life contexts and activities of elderly people). Different types of elderly people personas are generalized for common requirements and needs.

In the co-design phase, the design processes and spaces are not only involving elderly people in the traditional workshop and laboratory but also embedded in the everyday life contexts and arrangements of elderly people. Designers co-design different services and products for solving the requirements and needs of elderly people.

In the prototyping phase, different elderly caring products (e.g. smart healthcare devices) and services (e.g. mobile applications and services) prototypes are co-created with elderly people and other stakeholders such as manufacturers and service providers.

In the test & tracking phase, the elderly caring innovation prototypes are deployed in the real life contexts of elderly people such as senior homes and used by elderly people in their daily life activities. The test and tracking are performed not only by traditional laboratory

methods (e.g. usability test) but also the ICT-embedded real context methods (e.g. smart home sensors and mobile handset-based measurement). For example, user interaction behaviors are tracked by smart watch and mobile sensing. Aalto University has developed a mobile sensing application called "ContextLogger" (<https://github.com/apps8os/contextlogger3>), which is based on the MIT open sensing framework Funf ([www.funf.org](http://www.funf.org)). The ContextLogger not only has all the Funf built-in sensing capabilities such as location and application usage, but also provides an interface to let users to mark or log an event such as shopping and eating. It also has the NFC (Near Field Communication) capability in which users can swipe their smartphones near the different NFC tags to log their different activities. The context-trigger questionnaire function and the integration with Smart watch will be added to ContextLogger in the near future. In this way, researchers can collect real time users' feedback in specific contexts and interpret user behaviors more easily.

During the Active Aging project, many elderly caring products and services have been commercialized and adapted and improved for different contexts and users (e.g. Finland and China).

## Discussions and Conclusions

In this paper, we introduce the development of open innovation paradigm, namely the LL approach in ICT innovation. LL is a user and context driven open innovation. It's also a bridge between open innovation and community innovation, which combines the top-down and bottom-up innovation modes. LL is an innovation link for different stakeholders, namely the Public Private and People Partnerships. LL is an innovation paradigm to unleash the potential of more large scale real users in their real life contexts instead of lead users and small group of users in traditional innovation paradigms. We propose a LL process model and a LL methods taxonomy. Finally, we evaluate the proposed LL process model and methods taxonomy by a LL elderly caring case study. The key points of the

proposed LL process model and methods taxonomy are as follows:

- Users and their real life contexts are in the centric positions in different phases such as user requirements and co-design. For example, in the elderly caring case, the design processes and spaces are not only involving elderly people in the traditional workshop and laboratory but also embedded in the everyday life contexts and arrangements of elderly people.
- Users take active and different roles in different phases such as co-designers and co-creators.
- LL is an umbrella concept and methodology, which combines different types of research methods such as traditional methods and ICT-enabled methods. Different methods have their own advantages and disadvantages. Different methods should be combined for better understanding user behaviors from different data sources. The ICT-embedded real context methods are the core and future trends of LL development.
- In order to unleash the innovation potential of large-scale real life users, it's important to lower the innovation participation thresholds for users (e.g. technology threshold and financial threshold). As users often prefer familiar products and incremental improvements (e.g. the common products in their real life contexts), it's important to digitalize and intelligentalize common entities in their everyday life interactions (e.g. artifacts, actors and space) by existing technologies. For example, the mobile handset-based sensing is less obtrusive for collecting user behavior data.

The proposed LL process model and methods and tools (e.g. ContextLogger) have been used in other LL domains such as smart city traffic and environment monitoring and measurement. In the future, we will improve the ContextLogger functionalities (e.g. the context-trigger questionnaire and integration with other smart sensors and devices such as Arduio-based smart devices).

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