How to Co-Create Internet of Things-enabled Services for Smarter Cities

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Abstract — **What is the future of Smart Cities? The San Raffaele Scientific Institute (HSR)'s eServices for Life and Health unit in Milan strives to explore and push the boundaries of the Smart City concept through the ideation and implementation of smart services. Often, these services achieve their highest potential through Internet of Things, which enable the constituents of these services (users, products, environments) to be interconnected. In order to examine the dynamics between users, service touchpoints and Internet of Things, HSR decided to develop a methodology within a Living Lab framework and set up the City of the Future Living Lab. The City of the Future Living Lab is both a virtual and real research environment and community and embodies a Smart City (indeed it contains a university, laboratories, a hospital, offices, shops, a supermarket, post-offices, streets, parks, a light rail train and bus service, numerous ICTs, etc.). It therefore has exposure to all users and consumers of a city. This paper focuses on delivering an overview of the Living Lab methodology and the way it brings together people, environments, ICT and Internet of Things in the creation of e-Services designed by and around the end user. The paper presents the methodology and tools implemented for all the phases of the Living Lab process and presents the case of Living Labs as user-driven open innovation ecosystems for services for future Smarter Cities.**

Keywords - ***Living Lab; Internet of Things; Smart City; Service Design; user-driven open-innovation***

I. INTRODUCTION

The concept of Smart City, and how it could evolve in the future, is a very hot topic. At the same time the advent of IoT (Internet of Things) as amplifier of traditional ICT (Information and Communication Technologies) has been recognized and is expected to greatly contribute to addressing today's societal challenges (from healthcare to energy efficiency, from education to well-being, from mobility to accessibility). In this context, the e-Services for Life and Health unit of San Raffaele Scientific Institute in Milan (http://www.eservices4life.org) explores, analyses, and develops tomorrow's services by fostering the collaboration between a number of different professionals, including doctors, engineers, designers, and psychologists. The aim of this research facility is to explore the ways in which the Smart City concept could evolve by involving users directly in the process for the creation of Internet of Things-enabled services within a real city environment. A user-driven open innovation ecosystem was adopted, successfully bridging the gap between fundamental and applied research. In order to integrate the strengths and engaging the efforts of users, stakeholders, researchers, SMEs (Small and Medium Enterprises) and policy makers, the City of the Future Living Lab was set up as a fruitful breeding ground for Smarter City Services.

The following paper will tackle the topic of the future of Smart Cities by firstly explaining how eServices for Life and Health interprets the concept of Smart City, and how Internet of Things and eService design combined can be considered essential elements for the development of services for Smarter Cities. The paper will then present the Living Lab methodology and process adopted by City of the Future Living Lab through descriptions of both, as well as through the presentation of five eServices that are being developed and implemented by the research unit as substantiation of the integration of Internet of Things and the Living Lab process.

II. SMART CITY & INTELLIGENT CITY

There is an array of terms used to define what is meant by Smart City in contemporary literature. In order to identify an exhaustive definition that successfully encompasses in a single concept all the most important elements, an evaluation of existing texts was made. The research was further broadened by the unit's team to include also definitions concerning Intelligent City in the search for the most successful umbrella term.

The report published by the Centre of Regional Science at Vienna University of Technology in 2007 [1] offers a holistic definition of Smart City, which encompasses a series of very valuable characteristics that the HSR find equally important. For a city to be considered a Smart City, it must call for the cooperation of a multitude of fields of activities including industry, education, community participation, technical infrastructure, and various 'soft factors': "A Smart City is a city well performing in a forward-looking way in six characteristics (Smart Economy, Smart People, Smart Governance, Smart Mobility, Smart Environment, Smart Living), built on the smart combination of endowments and activities of self-decisive, independent and aware citizens."

If analyzed, the above-mentioned definition can be broken down into the following characteristics. A Smart City must have well-developed connectivity obtained through a networked infrastructure [2] [3]. High-tech and creative industries (known as 'soft infrastructure') [4] must emerge from this fertile foundation and over time attract new businesses and investments therefore producing both urban growth and a positive socio-economic performance [5].

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Concurrently, strong efforts must go into investing in social and relational capital, with the aim of creating a community that can successfully embrace technology and learn to comprehend, adapt and innovate it [6]. This in turn sets the base for social inclusion of urban residents within public services. Finally, for a city to be considered Smart, efforts must also go into investing in social and environmental sustainability, therefore successfully guaranteeing the safe and renewable use of natural heritage.

In reviewing the literature regarding the concept of Intelligent City, other factors previously not mentioned in the definitions regarding Smart City can be taken into consideration, which give good indications on the technology necessary in building a city environment that is well-connected, can be successfully enjoyed and used by inhabitants, is an inspiration for new business, helps nurture soft infrastructures, and is socially and environmentally sustainable. Intelligent Cities are often associated to the idea of a digital city, which unites a wide range of electronic and digital applications related to digital spaces of communities and cities [7] into an ICT network and uses this "to transform life and work within its region in significant and fundamental, rather than incremental, ways" [8]. These electronic and digital applications are interconnected among themselves via "embedded technology, which provides users with intelligent and contextually relevant support, augmenting our lives and our experience of the physical world in a benign and non-intrusive manner" [9]. The outcome of an Intelligent City, which for HSR is of extreme importance, is an innovation and ICT system that helps to combine the creativity of talented individuals, institutions that enhance learning and innovation, and virtual innovation spaces facilitating innovation and knowledge management [10], thus enabling "superior cognitive capabilities and creativity to be collectively constructed from combinations of individual cognitive skills and information systems that operate in the physical, institutional, and digital spaces of cities" [11].

For HSR, a Smart City is indeed a melting pot of all of the above features: a seamlessly interconnected ecosystem where products and environments interact among themselves across a number of ICT and Internet of Things-enabled services, with the objective of not only empower users, but also catalyzing the innovation process and bringing about positive social, economic and environmental change for governments, industries and citizens.

III. INTERNET OF THINGS AND ESERVICE DESIGN

In order to understand why Internet of Things and Service Design are interconnected, it is useful to identify the features of both elements. The idea at the heart of Internet of Things, which is very similar to the definition of Intelligent City, is that all things and all environments can be improved from a functional point of view via the embedding of technology that remains invisible to the eye of the users, which enables both products and environments to become smart: meaning that they can gather data (or enable someone to gather data via them) from their surroundings, producing what Fleisch calls high-resolution data (or real-time data, essential in management and improvement of systems [12]), as well as communicating amongst themselves as well as with humans. Internet of Things is a strongly evolving field and it is useful to keep in mind that in the future it will be open, scalable, flexible, secure, customizable by its users, profoundly user-centric [13].

Service Design is the activity of arranging and managing both tangible and intangible goods such as people, infrastructures, communication, documents and products, for the attainment of users' goals and the fulfillment of their needs. The aim of this process, as expressed by the Service Design Network Manifesto [14], is to create services that are useful, useable, desirable, efficient and effective, based on a human-centered and holistic approach that focuses on the customer experience whilst integrating team-based interdisciplinary approaches and methods, in ever-learning cycles.

The service economy in developing countries is increasingly accountable for higher percentages of GDP (Gross Domestic Product) and is mostly concentrated in financial services, health, and education. At the same time, products today have a higher service component than in previous decades, replacing the old dichotomy between product and service with a unified service-product continuum. This is leading to greater expectations and more articulated demands both from users (for increasingly smarter and engaging products and environments) as well as by service providers and infrastructures (for more streamlined, real-time and differentiating artifacts). For this reason, the role of Internet of Things is for it to become an integrated element of both services and their design process, for its capability of capturing, communicating and supplying data directly from the users and making it accessible to stakeholders and decision-makers.

Internet of Things can therefore be considered a powerful means through which to improve the value chain between users, products and environments and therefore better services. Providing adaptable, scalable and personalized services based on meaningful data collected via embedded technologies in products and environments pushes the concept of Smart Cities or Intelligent Cities towards a future where Cities are Smarter.

IV. TOWARDS EXPERIENCE DESIGN

Empowering users by delivering services that significantly improve their lives through augmented values and experiences is one of the key features of Intelligent Cities. At the same time, Smart Cities are those that stimulate communities to learn, adapt and innovate ICT and Internet of Things-enabled services, and therefore embrace technology. Thus it is safe to say that in both cases, users play a key role in defining the future of Smart Cities. Users' experiences can therefore constitute the principle driving force behind the development of successful and sustainable services for smarter cities. Disciplines such as Service Design [15], Transformation Design [16], Interaction Design [17] and Experience Design [18], exist and thrive by

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being cross contaminated by their users through a user-driven approach.

For these reasons, eServices for Life and Health, a department within HSR, has decided to adopt a user-driven approach to its innovation processes to produce an ecosystem where ideas are submitted to users' in order to gain their feedback, in a continuous process of open innovation [19]. The unit is specialized in the application of Information Technology to the realm of health and well-being, with the aim of developing and delivering services to the hospital's infrastructure as well as fostering innovation across numerous domains and disciplines. The reason for embracing a bottom-up approach is to have users contaminate the development process of an ICT or Internet of Things-enabled product or service so as to determine successful solutions that truly respond to (or even anticipate) user needs, bridging the gap between fundamental and applied research and diminishing the time and resources to deploy these on the market.

Such a process finds its natural collocation within a Living Lab methodology. In this context, City of the Future was brought to life, as a response to the unit's need to explore new practices to enrich ICT towards further innovation.

V. CITY OF THE FUTURE LIVING LAB

As previously anticipated, San Raffaele Scientific Institute has recently set up the City of the Future Living Lab, both a virtual as well as real research environment and community. The Living Lab follows along the conceptual framework presented by ENoLL (European Network of Living Labs) in which user-driven innovation is fully integrated within the co-creation process of new services, products and societal infrastructures.

The City of the Future Living Lab is an ecosystem where a multitude of stakeholders and partners can work alongside each other sharing knowledge whilst interacting with a wide variety of ICTs, therefore creating a fertile ground for disruptive innovation and cross-disciplinary research and communication.

A. Living Lab Methodology

The research methodology implemented by the City of the Future Living Lab is built on the widely recognized Living Lab process illustrated in Figure 1. The latter is based on four concurrent phases: co-creation, exploration, experimentation, and evaluation. Since this approach is an iterative and reflective one, a starting point is not defined and the LL process can be commenced at any stage of the design activity.

The fundamental concept at the base of the City of the Future Living Lab is to gain direct and unfiltered access to users' ideas, experiences, and knowledge, based on their daily needs and desire of feeling supported by products, services, or applications. Users are directly involved in co-creating, exploring, experimenting and evaluating new ideas, concepts and technological artifacts related to Internet of Things applications and services. The Living Lab methodology an approach that focuses on making stakeholders and users constructive and active participants in the definition and construction of an artifact, be it a product, an interface, a service or an Internet of Things-enabled platform, with the aim of improving and building value into these same artifacts. Users and stakeholders are all involved from the early stage of the LL process and throughout its entirety (therefore, along the Co-creation phase, the Exploration phase, the Experimentation phase, and finally the Evaluation phase as above). Insights are gathered directly from the users in order to define and implement realistic, useful, desirable and effective artifacts.

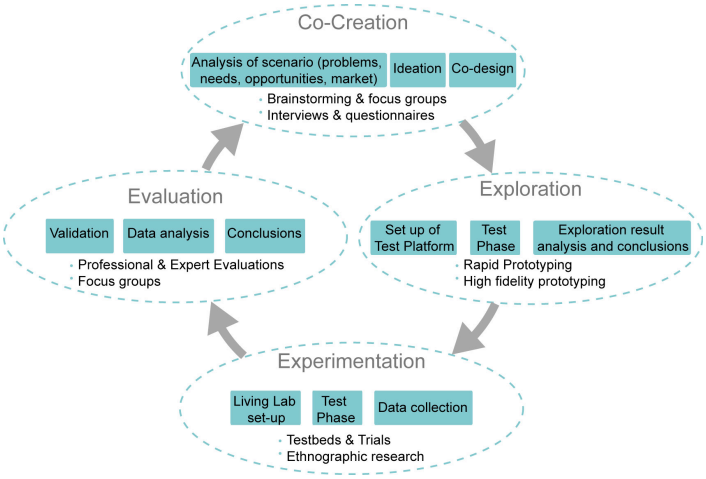

Figure 1: A visual representation of the Living Lab process

B. Methods, Tools and Techniques used in the Living Lab Process

The involvement of users in terms of an active integration of the end-users is a difficult task. One of the problems is that customer orientation is often based on classical market research tools, which puts customers in a passive "speaking only when spoken too" role [20]. City of the Future Living Lab studies, develops and implements a number of different tools throughout each phase of the living Lab process in order to best collect insights from users and use them to develop products and services that truly respond to their needs (both expressed and unexpressed).

The most commonly used tools during the co-creation phase of the Living Lab process are focus groups, interviews, brainstorming sessions and questionnaires. Interviews, questionnaires and focus groups are the most practiced exercises and have been widely discussed throughout academia [21] [22]. Focus groups consist in involving a group of users in a collective activity or discussion around their perceptions, opinions, beliefs and attitudes towards something that could be a product, ad advertisement, a packaging, and so on. This is a useful tool to gain a general overview of a target user as well as of a market. The same can be achieved by using interviews, which generally are one-to-one and involve an interviewer or researcher asking

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open questions to an identified user. Questionnaires are most often composed of closed or semi-open questions though a moderator or researcher is not needed. All these tools are qualitative and can be used concurrently to build a clear picture of wither a market or a targeted user.

Another tool that can be used within the co-creation phase of the Living Lab process is the Lead User Method, developed by Von Hippel et al. [23] in the 1980s. It is a four-stage approach where user needs are explored by involving what Hippel calls "lead users", or expert users with extreme or very evolved requirements. Involving lead users at the birth of an idea allows researchers to delineate the contours of the market in which the idea could grow, benchmark existing solutions and therefore identify new opportunities.

Users can be effectively involved in the innovation process also via co-creation groups and idea competitions. A co-creation group is similar in structure to a focus group, but requires users to actively participate in the creation and development of an idea, be it a product or a service, throughout a group session. An idea competition instead is when users are asked to submit ideas to the research team within a specific time frame, and these ideas are then voted either by peers, stakeholders or a selected jury. In these two ways users are able to express their own creative interpretation regarding a new product or service, providing a fresh and often disruptive approach.

The previously mentioned tools are often used on a one-off basis and help to produce very focused and detailed insights. As users are becoming evermore active, informed and empowered, another tool that is very useful on a more continuous basis is consumer or user partnering. This consists of building a long-lasting relationship with a user who on a regular basis meets up with the research team and discusses his her lifestyle, habits, and behavioral evolutions. Crowd sourcing is another way of gaining insight over time. It can involve a group of users or single users, as well as experts or amateurs. A web-based platform or digital application can be created through which users are able to contribute their views and opinions on a given subject [24]. In this way, researchers and users co-create value through their continuous interaction towards a common goal.

An interesting emerging tool adopted during the co-creation phase is serious gaming. Serious games are indeed games (they can be digitally based or physical) but their aim is not only to entertain, but also to train individuals or investigate an issue. Different topics can be explored via serious games such as behaviors and attitudes in stressful situations, approaches to education, social dynamics, etc. Serious games are a dynamic and effective tool to help users access and use new information in an enjoyable manner, providing an enrichment of skills and living experience to its users. As with regular games, serious games fix a set of rules and each player has a designated role so that everyone is encouraged to participate. They successfully involve users of all social and cultural backgrounds and the "fun" aspect successfully triggers the spontaneous generation of a great number of insights.

In the exploration phase of the Living Lab process, the main tool used is prototyping. Prototypes can be made in two different manners: in a rough form (called low fidelity prototypes) and in a more finished yet not definite form (called high fidelity). Rough prototyping consists of making quick mock ups, and this exercise is used to simulate products and service components of an idea in order to better explain them to other members of the research team and stakeholders. High fidelity prototypes on the other hand consist of simulating a service's experience by setting up a representation of the service in mind via all its elements in a more finished form. Both ways are very pragmatic: the first approach allows to de-contextualize problems and issues and confront them with a blank or white slate manner, the second allows for the demonstration and testing of a solution and the drawing up of a set of requirements which will form the basis of the service which will be deployed in the experimentation phase.

Ethnography is a practice adopted from socio cultural anthropology and is based on a qualitative method where researchers examine the shared and learned patterns of values, behaviors, customers and beliefs in a group of users [25]. Researchers can observe users in their natural environment or in an artificially recreated one, though the prior is preferred because it allows users to feel at ease and therefore manifest more spontaneous attitudes. There are many techniques available, for instance, video ethnography, shadowing, disposable camera studies, day in the life studies, and so forth.

Ethnography is a very useful and commonly used tool during the experimentation of the Living Lab process. Through the study of users interacting with a product, service or environment in the process of being developed, the research team aims to understand the nature of behaviors between these elements. The insight gathered is fed back into the Living Lab process, forming the base for the evaluation phase, and allows the product, service or environment to be improved and therefore to respond more successfully to their users, often generating insight beyond the subject researchers initially intend to study.

The evaluation phase is the most critical step in the Living Lab process because it must identify the service's ability to permeate across users and their environment. The evaluation of a service can be viewed through different lenses – for example a business focus aims at understanding whether a service has the capacity of generating revenue over time or if it is sustainable. HSR's interest lies in understanding to what extent the services developed satisfy users' expectations and contribute in producing positive experiences. For this reason, the City of the Future Living Lab alongside a number of partners have recently implemented an experiential analysis platform as an outcome of an EU-funded project entitled ELLIOT (Experiential Living Labs for the Internet Of Things - http://www.elliot-project.eu/). Within this platform data are collected via the Internet of Things embedded in the products, services and environments around users (such as cameras, sensors, microphones, etc.), and provide a clear overview of their interactions and attitudes, thus providing researchers the opportunity to further optimize prototypes.

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The Living Lab Process is explored and validated by applying a set of KSB (Knowledge-Social-Business) Experience Models to each service and correlated products developed. Such Models, specifically designed at the onset of each design process and based upon users' and stakeholders' objectives and expectations, evaluates whether the user and stakeholder objectives and expectations are met or not.

VI. EXAMPLES OF IOT SERVICES TESTED IN CITY OF THE FUTURE LIVING LAB

A. *Interactive Totem Service*

The Interactive Totem Service is based on a totem equipped with a touch screen monitor and an easy-to-use interface suitable for children as shown in Figure 2. It is placed in the pediatric department of HSR and allows hospitalized children to interact with a number of games that allow them to learn whilst playing. A reward system stimulates children to order their own meals and learn about nutrition as well as understand better how to manage their condition during hospitalization.

Figure 2: The Interactive TV Service within the hospital's pediatric ward.

B. *Nutritionally Aware Vending Service*

The vending service developed by HSR [26] offers a service for the promotion of healthy lifestyles, which stimulates users to reflect upon the benefits related to healthy living through a new concept of vending machines via an interactive touchscreen. The Vending Machine depicted in Figure 3 not only provides healthy foods, literature and music, as well as useful information regarding mobility and physical activity but also personalized information on how to adopt healthy lifestyle choices.

Figure 3: The Nutritionally Conscious Vending Service being developed within the Feed For Good project.

C. *Bicycle Activity Monitoring and Tourism Service*

This service is based on the Vainbici.it Web Portal and its aim is to promote initiatives for healthier and environmentally friendly lifestyles whilst providing new services for pedestrian-cycle mobility. It involves a digital platform (Figure 4) designed for exchanging and sharing information and digital content related to the world of bike and cycling and now includes a wearable monitoring system, which collects biological data from users as they cycles.

Figure 4: The Bicycle Activity Monitoring and Tourism Service involves a web platform that users can through different digital touchpoints.

D. *Infomobility Service*

The Infomobility Service proposed has the aim of improving the mobility of patients, visitors, staff and students in their travel to and from San Raffaele Hospital by offering a platform through which the latter can access a vast number of information including the timetable of the shuttle line, information about the condition of the automatic line and the next connections from and towards San Raffaele Hospital (Figure 5).

Figure 5: The app designed for the Infomobility Service involving the hospital's light rail shuttle line.

E. *Energy Management Service*

The Energy Management Service illustrated in Figure 6 has been developed as part of the eCube project, co-funded by the Italian Ministry of Economic Development and helps users monitor and improve their energy efficiency. Two pilots are being developed: an office pilot and a hospital pilot (which includes patients' rooms, corridors and nurses' room). Smart Appliances and Smart Plugs provided by project partners are being positioned in real work and hospital contexts and used by the users of these spaces.

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Figure 6: The energy consumption of an environment can be managed by the user in our Energy Management Service.

VII. CONCLUSIONS AND FUTURE WORKS

City of the Future Living Lab is a powerful representation of how user-driven open innovation ecosystems can contribute towards the evolution of the Smart City concept and the validation of Internet of Things-enabled services. In this real research environment and community that embodies an evolved vision of Smart City, a number of services have been co-created and will continue to be designed and offered across different scenarios, with the objective of studying and measuring the interactions between users and services as well as the potential of Internet of Things technologies and their impact on creating Smarter Cities.

The Living Lab process is actively and continuously contaminated by the user experience via a set of ever-evolving tools and techniques: during the co-creation phase, users can contribute to the ideation of services by suggesting their own ideas and experiences; user inspiration is explored by the research team through the development of prototypes; refined versions of the proposed services are then opened to users so that they can experiment with them and provide their very personal feedback; insights subsequently are used to evaluate the tested service and improve it.

HSR believes that this effective, user-driven process of innovation will play a vital role also in shaping the implementation of Future Internet technologies. As Smart Cities will embrace IoC-K (Internet of Content and Knowledge), IoP (Internet of People) and IoS (Internet of Services), Living Labs adopting a concurrently bottom-up and top-down approach achieved via a process of what we call co-creation, will become an evermore-important breeding ground for both incremental and especially disruptive innovation. This in turn will lead to the successful deployment of business, societal, economic and environmental change, which will provide the grounds upon which to build Smarter Cities.

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REFERENCES

[1] Giffinger, R., Fertner, C., Kramar, H., Kalasek, R., Pichler-Milanovic, N., and Meijers. E., "Smart cities – Ranking of European medium-sized cities", Centre of Regional Science, Vienna (2007): http://www.smart-cities.eu/download/smart_cities_final_report.pdf (retrieved in January 2012)

[2] Hollands, R. G., "Will the real smart city please stand up?" City, Vol. 12, No. 3, pp. 303 - 320 (2008)

[3] Florida, R. L. "The rise of the creative class: and how it's transforming work, leisure, community and everyday life", Basic Books, New York (2002)

[4] Domingue, J., Schaffers1, H., Komninos, N., Pallot, M., Trousse, B., Nilsson, M., and Oliveira, A., "Smart Cities and the Future Internet: Towards Cooperation Frameworks for Open Innovation", Lecture Notes in Computer Science, Volume 6656, The Future Internet, pp. 431–446 (2011): http://www.springerlink.com/content/h6v7x10n5w7hkj23/ (retrieved in Decembre 2011)

[5] Caragliu, A., Del Bo, C., and Nijkamp, P., "Smart cities in Europe". Serie Research Memoranda 0048, VU University Amsterdam, Faculty of Economics, Business Administration and Econometrics, pp. 131– 143 (2009)

[6] Coe, A., Paquet, G., and Roy, J. "E-governance and smart communities: a social learning challenge", Social Science Computer Review, 19 (1), pp. 80-93 (2001)

[7] Droege, P., "Intelligent Environments - Spatial Aspect of the Information Revolution", Elsevier, Oxford (1997)

[8] California Institute for Smart Communities, "Ten Steps to Becoming a Smart Community" (2001): http://www.smartcommunities.org/library_10steps.htm (retrieved in January 2012)

[9] Steventon, A. and Wright, S., "Intelligent spaces: The application of pervasive ICT", Springer, London (2006)

[10] Komninos, N., "The Architecture of Intelligent Cities", conference Proceedings from the 2nd IET International Conference on Intelligent Environments, Athens, pp. 13-20 (2006)

[11] Komninos, N., "Intelligent Cities: Innovation, knowledge systems and digital spaces", London and New York, Taylor and Francis, Spon Press (2002)

[12] Fleisch, E., "What is the Internet of Things? An Economic Perspective", ITEM-HSG, Auto-ID Lab St. Gallen. (2006): http://www.autoidlabs.org/uploads/media/AUTOIDLABS-WP-BIZAPP-53.pdf (retrieved in November 2011)

[13] Uckelmann, D., Harrison, M., and Michahelles. F., "Architecting the Internet of Things", Berlin, Germany: Springer. ISBN 978-3-642-19156-5 (2011)

[14] Service Design Manifesto: http://www.service-design-network.org/system/files/media/sdn%20Manifesto.pdf (retrieved in November 2011)

[15] Parker, S. and Heapy, J., "The Journey to the Interface - How public service design can connect users to reform'. Demos, London (2006)

[16] Burns. C., Cottam, H., Vanstone, C., and Winhall, J., "RED PAPER 02 Transformation Design", (2006): http://www.designcouncil.info/mt/RED/transformationdesign/TransformationDesignFinalDraft.pdf (retrieved in November 2011)

[17] Morridge, B., "Designing Interactions", The MIT Press, Cambridge (2007)

[18] Norman, D.. "The Design of Everyday Things", Basic Books, New York (1988)

[19] Chesbrough, H., "Open Innovation: The New Imperative for Creating and Profiting from Technology", Harvard Business School Press (2003)

[20] von Hippel, E., "Successful Industrial Products from Customer Ideas", Journal of Marketing, 42(1), pp. 39-49 (1978)

 ISBN: 978-1-61208-225-7

[21] Mariampolski,. H., "Qualitative Market Research: A Comprehensive Guide", Sage Publications, Thousand Oaks (2001)

[22] Kuniavsky, M., "Observing the User Experience: A Practitioner's Guide to User Research", Morgan Kaufmann (2003)

[23] von Hippel, E., "Lead Users: A Source of Novel Product Concepts", Management Science, Vol. 32, No. 7. July, pp. 791-805 (1986)

[24] Howe, J. "The Rise of Crowsourcing", Wired magazine, June edition (2006): http://www.wired.com/wired/archive/14.06/crowds.html (retrived in Januray 2012)

[25] Angrosino, M., "Doing Ethnographic and Observational Research", Sage Publications, London (2007)

[26] Vicini, S., Sanna, A., and Bellini, S., "A Living Lab for Internet of Things Vending Machines", Communications in Computer and Information Science, Volume 282, The Impact of Virtual, Remote, and Real Logistics Labs, Part 2, pp. 35-43 (2012): http://www.springerlink.com/content/j2t467q358l07

 ISBN: 978-1-61208-225-7