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Quadruple-Helix and its types as user-driven innovation models

Anita Füzi

Cardiff School of Management, Cardiff Metropolitan University/ Széchenyi István
University

E-mail: anita.fuzi@sze.hu

Anita Füzi is currently a visiting PhD student at Cardiff School of Management, Cardiff Metropolitan University. Originally she is doing her PhD studies at Széchenyi István University (Győr, Hungary) and researching how SMEs can benefit from open innovation ecosystems. She is participating in several research projects such as ‘The Industrial Zone of Győr as a new direction and tool of local economic development’ where her research has been focusing on investigating the effectiveness of Triple/Quadruple Helix and Open City concepts using examples from the European Union URBACT and URBAN programs which enables numerous European cities to work together in projects to share and capitalise on experience.

She has been a Teaching Assistant in Methods of Regional Analyses I-II., Integrated Spatial Development, Regional Economics and Politics, Regional Development and Municipal Management.

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JEL Classifications: O10, O30

1. Introduction

The Quadruple Helix conception is *not yet a very well-established* and widely used concept in innovation research. In the literature we can find many approaches which can be named as Quadruple Helix concepts, some of them are similar to Triple Helix model, some of them are completely different. What is *common* to all Quadruple Helix models is that in all of them a *fourth group* of innovation actors have been added into the Triple Helix model. There are different views of what the fourth helix consist of, so it can range from intermediate innovation organizations to different users/consumers as well.

According to the Quadruple Helix theory, a country's economic structure lies on four pillars/helices which are the *Academia*, *Firms*, the *Government* and a fourth group, which in our research considered as the *talented and productive User Community*. Academia and Firms, together with Technological Infrastructures of Innovation provide the integrated innovation ecosystem where all forms of creativity can rise. Governments provide the financial support and the regulation system for the definition and implementation of innovation activities. The creative User Community demands for ever innovating goods and services.

Considering the fourth group as the *User Community*, we found that the *user-driven Living Lab open innovation ecosystem* is very close to the Quadruple Helix theory. Living Lab concept is a *new way* to sensing, prototyping, validating and refining complex solutions in real-life environment where the user community is strongly integrated in the *co-creation process* in order to facilitate new knowledge and innovation.

The *Living Lab phenomenon* is widely discussed and researched in many academic fields. Mostly shows its benefits in order to create values and opportunities in society, but almost nothing is said about the *drawbacks and bottlenecks*. Thus, there is a need to understand how Living Labs are *practiced* in different places and contexts.

In order to make some interesting dimensions of Quadruple Helix based on Arknil et al. (2011) we have constructed *three different types of Living Lab* collaborations from a Quadruple Helix perspective: 1) the *Firm-driven Living Lab* model, 2) the *Public Sector-driven Living Lab* model, and 3) the *Academia-driven Living Lab* model.

The purpose of this study is to bring some *important characteristics* of the different Living Lab models more clearly, and to provide *good practices* of the Quadruple Helix type of innovation activities.

2. Methodology

This paper provides a *focused literature review* that is not seeking to cover all published research in innovation studies. Rather, the focus is on *defining the concept* and model of Quadruple Helix, and *identifying* different types of Quadruple Helix collaborations.

We evaluated relevant scholarly publications and conference materials using academic archives and Google. The following *keywords* were used: Triple Helix, Quadruple Helix, user innovation, user-driven innovation, user-centric innovation, public-private-partnership, citizen and innovation, civil society and innovation, user involvement, Living Lab, co-creation with users.

The most important finding is that the concept of Living Lab is *very closely related* to the Quadruple Helix concept as to the criteria of four cooperative actors in order to produce new knowledge and innovation. We found that *three types of Living Lab* models can be constructed according to their goals, types of innovation produced and the roles of actors in the co-creation process.

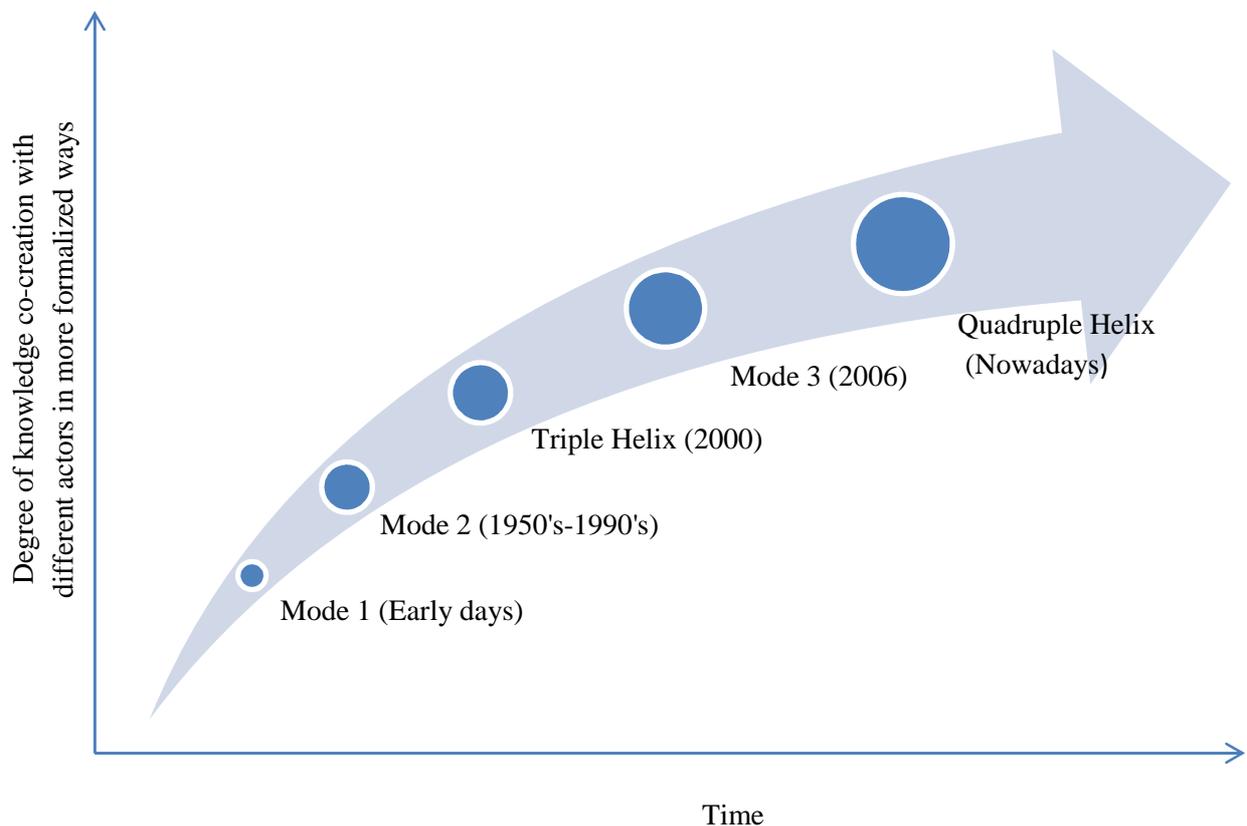
After identifying the *key characteristics* of the three types of Living Lab collaboration, based on case study analyses we have chosen 1-1 *active* Living Lab from ENoLL (European Network of Living Labs) webpage in order to illustrate the application possibilities of Quadruple Helix type of innovation environments.

3. State of the art

In recent years, a number of concepts have been proposed for modelling the transformations in the knowledge and innovation creation process. To approach Quadruple Helix as an innovation model it is necessary to *locate* it in the context of the *innovation literature*.

Figure 1 shows how *innovation perspectives* have evolved over time, moving from linear to systemic models, and later to new modes of knowledge production. The later innovation theories and approaches stress that knowledge is increasingly created in broader, trans-disciplinary and in, besides economic, also social contexts in which users of innovations have a great role to play.

Figure 1: Evolution of innovation models



Source: own construction

Mode 1 (Gibbons *et al.* 1994) focuses on the traditional role of university research in an elderly ‘*linear model of innovation*’ understanding. The linear model states that first there is *basic research*, which is carried out in a university context. Later on, this basic research is converted into *applied research* and moves from the university to the university-related sectors. Finally, applied research is translated into *experimental development*, carried out by business. The linear model exhibits serious *weaknesses* in communicating user preferences from the market and back to the production of basic research.

Later on, several approaches to *non-linear innovation models* have been made. One of them is the ‘*chain-linked model*’ (Kline and Rosenberg, 1986) which emphasizes the importance of *feedback* between the different R&D stages. The so-called *Mode 2* can be characterized by the following five principles: (1) ‘knowledge produced in the context of application’, (2) ‘transdisciplinarity’, (3) ‘heterogeneity and organizational diversity’, (4) ‘social accountability and reflexivity’, and (5) ‘quality control’ (Gibbons *et al.* 1994, pp. 3–8).

The *Triple Helix* overlay provides a model at the level of social structure for the explanation of *Mode 2* as a historically emerging structure for the production of scientific knowledge, and its relation to *Mode 1*. The Triple Helix innovation process is a model of ‘*trilateral networks and hybrid organizations*’ of ‘*university-industry-government relations*’ (Etzkowitz and Leydesdorff 2000, pp. 118, 111–112).

The concept of *Mode 3* (Carayannis and Campbell 2006) is more inclined to emphasize the *co-existence and co-evolution* of different knowledge and innovation modes. *Mode 3* even accentuates such pluralism and diversity of knowledge and innovation modes as being necessary for advancing societies and economies. This pluralism supports the processes of a mutual cross-learning from the different knowledge modes (Carayannis and Campbell 2006).

Between *Mode 1* and *Mode 2* manifold ‘creative arrangements and configurations are possible, linking together basic research and problem-solving’ (Carayannis and Campbell 2010, p. 57). *Mode 3* ‘encourages interdisciplinary thinking and transdisciplinary application of interdisciplinary knowledge’ as well as

‘allows and emphasizes the co-existence and co-evolution of different knowledge and innovation paradigms’ (Carayannis and Campbell 2010, pp. 51–52).

About these four briefly described models, it can be concluded that in a knowledge society (and knowledge democracy), at the national level, a network-style linkage of knowledge is being processed; each model fulfils a specific contribution for the ‘*creation, diffusion, and use of knowledge*’ (Carayannis and Campbell 2006, 2010). The basic innovation ‘*core model*’ of the *Triple Helix* focuses on the knowledge economy. *Mode 3* already brings in the perspective of the knowledge society (and of knowledge democracy). From the point-of view of the *Mode 3* innovation model, it is evident that there should be a co-evolution of the knowledge economy and of knowledge society (Dubina *et al.* 2012).

2.1 Quadruple Helix model of innovation

A variation of the model would add that the *Triple Helix* is not a sufficient condition for long-term innovative growth, and that a *fourth element* needs to be incorporated in order to play an active role in knowledge creation.

Some researchers argue that the *fourth pillar organizations* that create links between the Triple Helix organizations should be included in the Triple Helix innovation model (Liljemark 2004).

Khan and Al-Ansari (2005) consider the interaction between Firms, Academia, Government and Civil Society as a requirement for sustainable growth.

According to Carayannis and Campbell (2009), the fourth helix is the ‘*public*’, more specifically being defined as the ‘*media-based and culture-based public*’ and civil society. This fourth helix associates with ‘*media*’, ‘*creative industries*’, ‘*culture*’, ‘*values*’, ‘*lifestyles*’, ‘*art*’, and perhaps also the notion of the ‘*creative class*’ (Carayannis and Campbell 2009, pp. 218, 206). This fourth helix is explained by the influence of media to the public reality which influences at the same time national innovation systems. The consequence of the diversity of agents involved in the innovation process within the Quadruple Helix model may result in knowledge- and

innovation based democracy continuously being shaped by the mutually interacting and influencing citizens and the dominant designs of the underlying cultures and technological paradigms (Carayannis and Alexander, 2002, pp. 26-27).

Some authors have called this fourth pillar as '*intermediate organizations*' or '*innovation-enabler organizations*' (Liljemark, 2004). They act as brokers and networkers between the Triple Helix organizations.

Delman and Madsen (2007) also consider one kind of organizations which lead to Quadruple Helix structures. They are '*independent, non-profit, member-based organizations*' which combine funding from government and private sector. They have the important task of translation and coordination, in the emerging fields of knowledge between the four helices. They bring together communities of common interest to focus on important opportunities to stimulate innovation. These kind of fourth pillar organizations are catalysts for strategic government investment in enabling platform technologies and wealth across all industrial sectors.

Other author offers alternative wives. Yawson (2009) argued that the missing fourth helix should be the '*user*'. This choice is supported by the opinions brought forward in recent innovation research and policy, which present *user-driven innovation* as an essential factor of success for both firms and public sector organizations (Eriksson *et al.* 2005, Lundvall *et al.* 2002, Thomke and von Hippel 2002, Schienstock and Hämäläinen 2001). One important reason for this is the changed competition situation of firms. Kostiainen and Sotarauta (2007) argue that today firms have become more aware of the *need of collaboration* in contexts where companies cannot act by themselves because most new products and services that are developed and introduced to market fail commercially. That changed situation caused a shift: a growing number of firms pay close attention to *users as a source of valuable feedback* and use experiences. One of the most important recent trends is integrating users in the innovation process where *value is co-created*. Co-creation with users helps firms' better address their costumers' latent needs and reduce their market risk in the launch of new products and services (von Hippel, 2005).

Furthermore, at EU level, there has been an abundance of open innovation policies and emerging *private-public-partnership*, sometimes referred to Quadruple Helix models, which give attention to user need, various types of networking and interactions with the local environment (Dosi *et al.* 2005). The involvement of users/customers in the product and service development process is added to the Triple Helix model to build a framework where Academia, Government, Firms and Users join forces in order to produce innovation. This is also the approach we have chosen in our research.

While the *Triple Helix* type of innovation activity focuses on producing high-tech innovation based on the *latest technology* and research knowledge, the Quadruple Helix type of innovation activity, instead, can focus on producing other kinds of innovations and applying *existing technology, research and user knowledge* as well. To SMEs, the increase in quadruple and user-driven type of innovation activities could open up new possibilities to participate in innovation activity, as also other types of SMEs could participate than only strongly science-based ones or companies having science-based companies as clients (Arknil *et al.* 2011).

As we could see above, Quadruple Helix is a very wide and multidimensional concept referring to *numerous different activities and actors*. Therefore it could be more reasonable to talk about *Quadruple Helix models* and not just a single Quadruple Helix model of innovation.

2.2. Understanding user involvement and user-driven open innovation

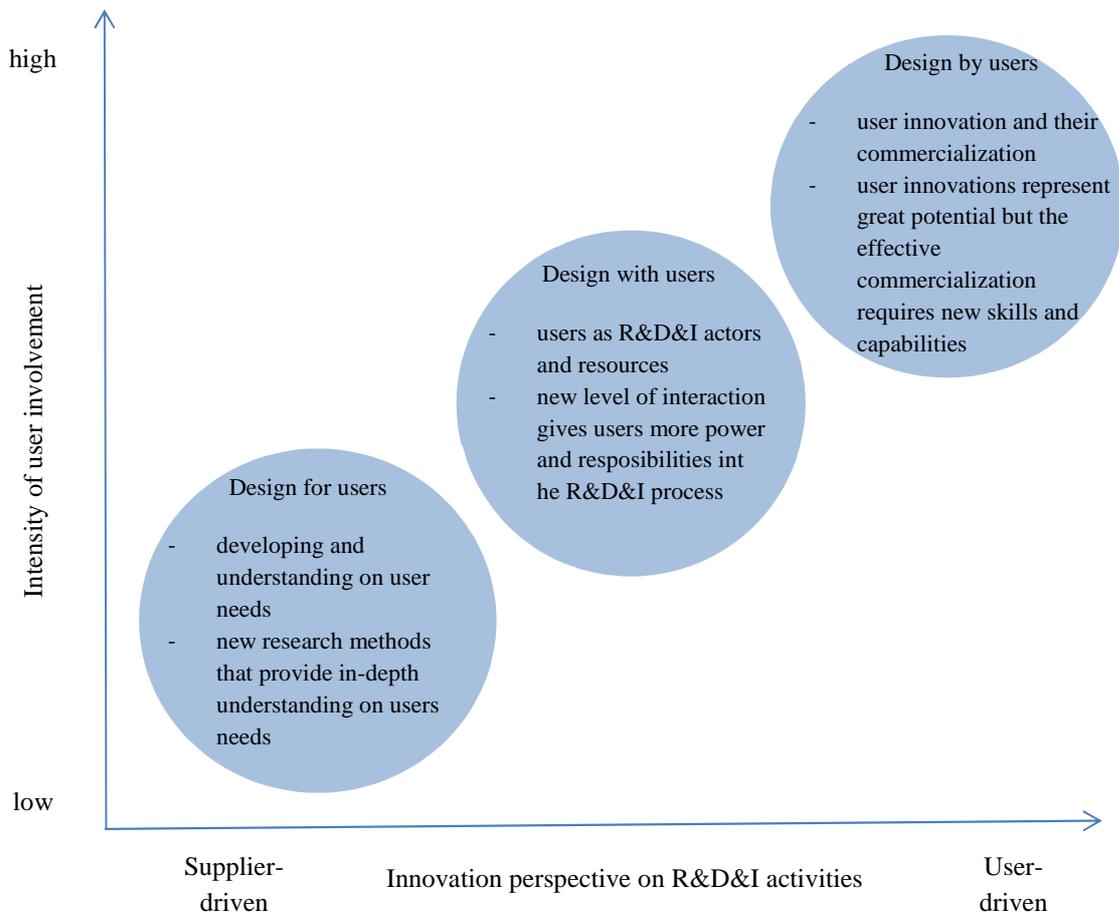
Today's firms that drive innovation have to face *various challenges*. The emergence of the internet and the explosion of data and information exchanged via ICT platforms have dramatically changed the innovation scenery for firms over the past decades. Firms need to *open up* their boundaries and use knowledge from different sources in order to keep up with innovation needs and achieve strong market positions (Chesbrough 2003, Christensen *et al.* 2005, Gassmann 2006).

Undoubtedly, the single most important external knowledge source is the knowledge and ideas obtained from *customers and users* (Business Decision Limited 2003).

Obviously, to be successful at markets, firms need to create products and services that are based on customer needs. Towards this end, firms are looking for new ways to make their research and innovation practices more closely linked to customer needs. Some businesses are *developing new processes* that enable deeper understanding of their customers' and users' needs. Many businesses are emphasizing *working together* with their customers on innovation projects to better understand their customers' view and to *co-create* innovations with them (Prahalad and Ramaswamy 2004, Kristensson *et al.* 2008). A different approach is suggested by organizations that identify innovations that users have developed for themselves (user innovations), and then commercialize these to a broader market (von Hippel 1986, 2005)

An important notion to *the user-driven innovation* literature relates to the *broader conception of users*. Users are not only seen as individual persons and costumers, not also users of goods, such as firms, public organizations or civil society associations (von Hippel 2005). This fact that there are *several different kinds of users* makes the concept of user-driven innovation and Quadruple Helix user involvement even more difficult. There are also numerous different ways and degrees of *user involvement*. In order to understand the various ways and degrees of user involvement, we recommend the qualitative research of Kuusisto *et al.* (2010), which presents *different streams of user innovation* in three basic categories, ranging from company centred innovation process to user centred one which also shows the various ways and degrees of user involvement (Figure 2).

Figure 2: Three approaches to user innovation



Source: own construction according to Kuusisto *et al.* (2010)

On the bottom left hand side of Figure 2 is the company centred model, which is arguably closest to conventional R&D activities. This type can be considered also as ‘*design for users*’, which means that the product or service is developed on behalf of users. Research methods (such as interviews, surveys and internet enabled new methods) are used to gain an in depth understanding of users’ needs and as a base for design. In this perspective, many approaches such as ethnographic approach (Hammersley and Atkinson 1983, Korkman 2006), emphatic design (Leonard and Rayport 1997), contextual inquiry (Holtzblatt and Beyer 1993) and contextual

interviewing (Ulwick 2002) state and exemplify that users are involved in the *early stages of new product/service development* in order to better understand their needs.

In the second model, users are seen as *active actors* in the innovation process. Similarly, like in the open innovation approach, external sources are integrated in the innovation process for better results. Using the '*design with users*' model requires a new mindset and methods for the producer, since the *outcomes are co-created* with users (Kuusisto *et al.* 2010). In the context of this model, Kuusisto *et al.* (2010) highlight the role of users as citizens: citizens' engagement and participation are seen to construct an *increasingly important part* in the reform of public services. Still, existing business culture, norms and procedures of traditional organizations can often inhibit the 'orchestration' of a fruitful co-creation setting.

The upper right side of Figure 2 represents the model where *users* themselves are the *producers of innovations* (Kuusisto *et al.* 2010). Users create an innovation with a varying degree of interest in commercializing the innovation: some users innovate just for themselves, where the idea is to create a customized product or service responding to the user needs. Some users can do the same with commercial interests and find new uses for products. The advantage of this model is that the user does not usually face the same barriers, considerations and restrictions (e.g. market-size, production costs) in the innovation process that a firm would face, enabling the creation of unavailable, pioneering solutions and radical innovations (von Hippel 2005).

Firms and universities have used some kind of *user research* as part of their development work for a very long time. Therefore there is arguable that users have been involved also in the Triple Helix types of innovation activities, even though their input is often left without explicit mention in the Triple Helix concept.

Here comes the question of *how can we differentiate user involvement related to Quadruple Helix concept*. Rosted (2005) has argued that we can talk about user-driven innovation in that case, when a firm utilizes in its innovation process knowledge on user needs collected through scientific and systematic surveys and tests. Thus, user involvement in Quadruple Helix innovation model can range from

the systematic collection and utilization of user information to the development of innovative products and services by users themselves.

According to Bergvall et al. (2009) the *user-driven approach* refers those innovation activities when a user or a user community is the true initiator and has a very active and influential role in the innovation process, moreover it participates intensively in all phases of the development process (Eriksson et al. 2005). In terms of the framework of Kuusisto et al. (2010) this means shifting from the model in the bottom left to the model in the centre.

2.3 Living Lab from QH user-driven model of innovation perspective

Pascau and van Lieshout (2009) have named *three concepts* which refer to user involvement: Living Lab, Open Innovation and Social Computing. From the Quadruple Helix perspective, *Living Labs* could be considered to be a *more interesting innovation approach*. The main reason for this is that in Living Labs all *four important actor* groups of Quadruple Helix model are actively present: Academia, Firms, Public Authorities and Users.

Although Living Lab research is a *quite recent term*, its origins go back to the *non-linear view of innovation* and von Hippel's (1986) work on *led users* as a new source of innovation. Living Lab has been increasingly studied and cited in different disciplines of the academic community (Bergvall-Kareborn et al. 2009, Schuurman et al. 2011, Folstad 2008).

William Mitchell at MIT Boston was arguably the first who use the concept of Living Lab in his studies of a *future/smart home 'living environment'*, where users (in this case residents) were part of the research process (Bergvall-Kareborn et al. 2009, Eriksson et al. 2005). In the MIT context, Living Labs represent a 'user-centric research methodology for sensing, prototyping, validating and refining complex solutions in multiple and evolving real life contexts' (Eriksson et al. 2005).

Svensson et al. (2010) argue that today, especially in Europe, the Living Lab concept is often used to 'enhance innovation, inclusion, usefulness and usability of

ICT and its application society'. Living Labs have already been used in several areas of development including telecommunication, health, housing, tourism, energy and governance.

There are *numerous Living Lab definitions*. We have no place here to go into explanation of all existing definition; therefore we have collected just the most important ones. We think that the following definition is the best: the Living Lab collaboration is an open innovation environment in a real-life setting, in which user-driven innovation is fully integrated within the co-creation process of new services, products and societal infrastructures (EC INFSO (January 2009).

Prior studies describe the phenomenon as a user-centric research methodology (Eriksson *et al.* 2009, Lama and Origin 2006), a user-centred innovation ecosystem (Pallot 2009), a user-cantered real-life approach to services and technology design and development (Ponce de Leon *et al.* 2006), a model for in situ co-design of innovative ICT applications (Marsch 2011), an enabler of assessment of user experience (Vicini *et al.* 2012), an experimental environment, where technology is given in real-life context and where end-user is involved as co-creator (Ballon *et al.* 2005), a co-creating environment for human-centric research and innovation (ENoLL 2009), a system allowing users as co-creators in product/service development process (CoreLabs 2007), an environment in every-day context in which people and technology are gathered (Bergvall-Kareborn *et al.* 2009), a development and testing environment (Stahlbrost 2008), an organization that aims to capture users` insight, prototype and validate solutions in real-life context (Almirall 2008), a system based business-citizens-government partnership (Study on... 2009), a territorial innovation model (Molinari 2011), a type of Quadruple-Helix model (Arnkil *et al.* 2010), a form of open innovation (Westerlund and Leminen 2011), a new focal point for multi-organizational collaboration on innovation (Kviselius 2008), and an extension of test beds for technical testing allowing access to users (Folstand 2008).

The goal of Living Labs is to create '*innovation arenas*' where multiple actors can experiment in an open real life environment. Living Labs could be seen as *development platforms* trying to promote user-centred R&D&I design. This is done

by giving users a possibility to participate in the innovation process as *co-designers and co-producers* (Pascau and van Lieshout 2009), and by studying them how they use certain products and services in real life contexts.

According to Erikssen et al (2005), by integrating costumers into the development process, Living Labs ensure a highly reliable market evaluation, resulting in a significant reduction of technology and business risks.

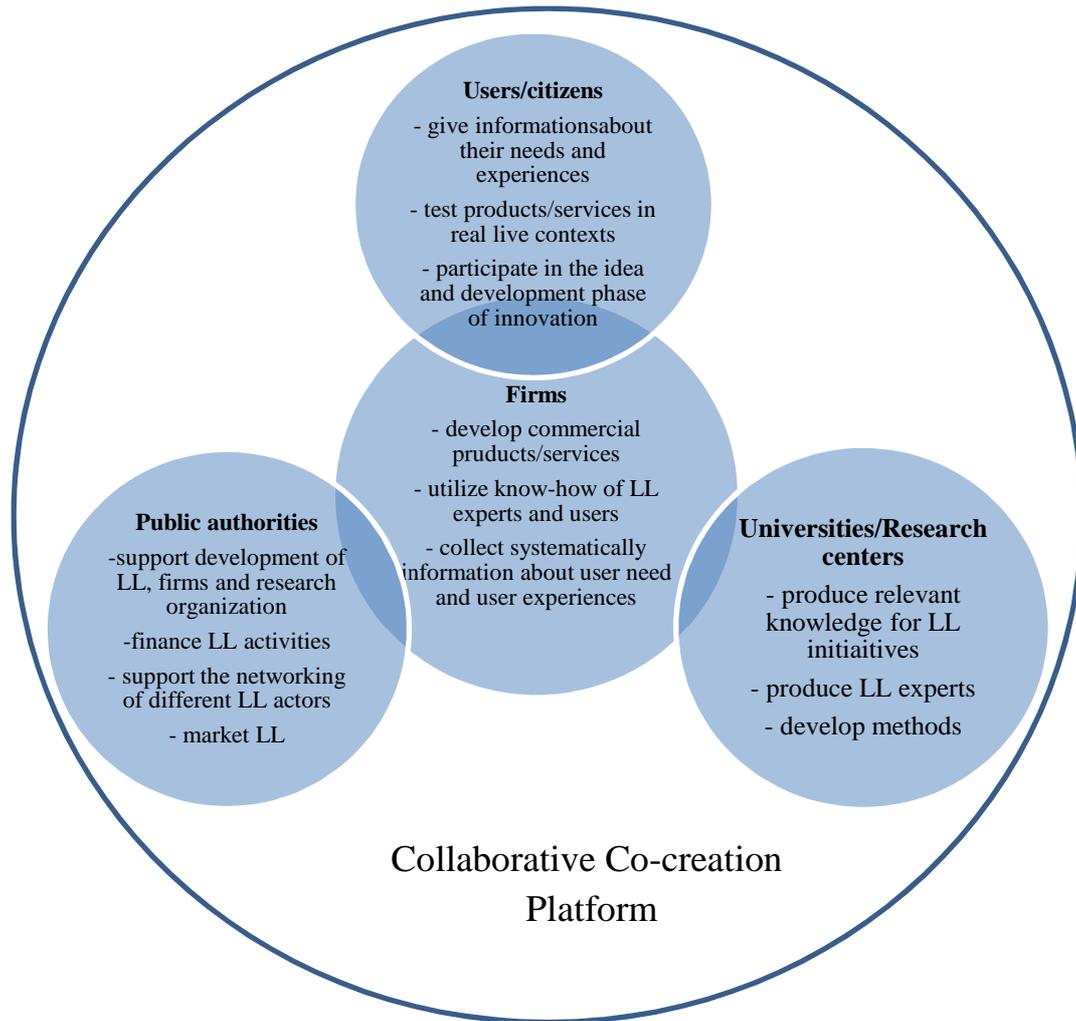
3. Practical Quadruple Helix models

In order to make some interesting dimension of Quadruple Helix based on the user-driven innovation literature and on Arknil et al (2011) empirical study, we have constructed *three different types* of Quadruple Helix models: 1) *Firm-driven Living Lab*, 2) *Public Sector-driven Living Lab*, and 3) *Academia -driven Living Lab*.

The cases studies chosen in our study provide a picture of *Firm,- and Public Sector-driven Living Lab* models in practice as they have very much reality already today in several countries. The *Academia-driven* model also seems to be in use in different projects focuses on internal multidisciplinary research.

In the *Firm-driven Living Lab* model (Figure 3) the focus is on the development of commercially successful innovations. Innovation can be based on the latest research knowledge, and also on new applications or combinations of ‘old’ research knowledge and/or on user knowledge. User knowledge refers to knowledge both about the needs and problems users face in real life contexts and about these contexts of use. The owner of the innovation process is a firm or group of firms. In this model, the degree of user involvement could be characterized as *design with users*. Users are treated both as informants and as developers. This means that they participate also in the *early phases* of an innovation process, for example, in the idea and development phase. In this model, user knowledge can be as important as research knowledge.

Figure 3: Firm-driven Living Lab



Source: own construction according to Arknil et al. (2011)

A good example can be the Botnia Living Lab for the Firm-driven Living Lab collaboration.

Botnia is one of Sweden's first and largest operating open 'test-beds' for mobile services. Geographically Botnia is located in the northern Swedish town of Lulea, but tests are conducted all over Sweden. Today the number of Botnia 'test-pilots' are over 5900, and they aim to have at least 10 000. *Test-pilots* are private persons of all ages that have registered voluntarily. The most important assets of Botnia are the *technical*

platform and the unique evaluation method, developed in cooperation with scientific researchers.

Botnia Living Lab tested the *Skygd mobile security service*. The security service was developed in collaboration with researchers at Lulea University of Technology, and the purpose of this Test Pilot Mission was to examine the usability of the service and how it responds to the need for personal security in a real environment. Test pilots' feedback was also important input for the further development of the service.

The Lulea Sweden based Skygd AB was founded in 2007 to provide mobile security services. The service was originally based on the fact that many of us experience that the level of insecurity is increasing in our society. Security businesses are working hard to develop products and services which offer a feeling of security. As we bring the mobile phone with us everywhere, it has been a matter of time before it would turn into a tool for a security solution.

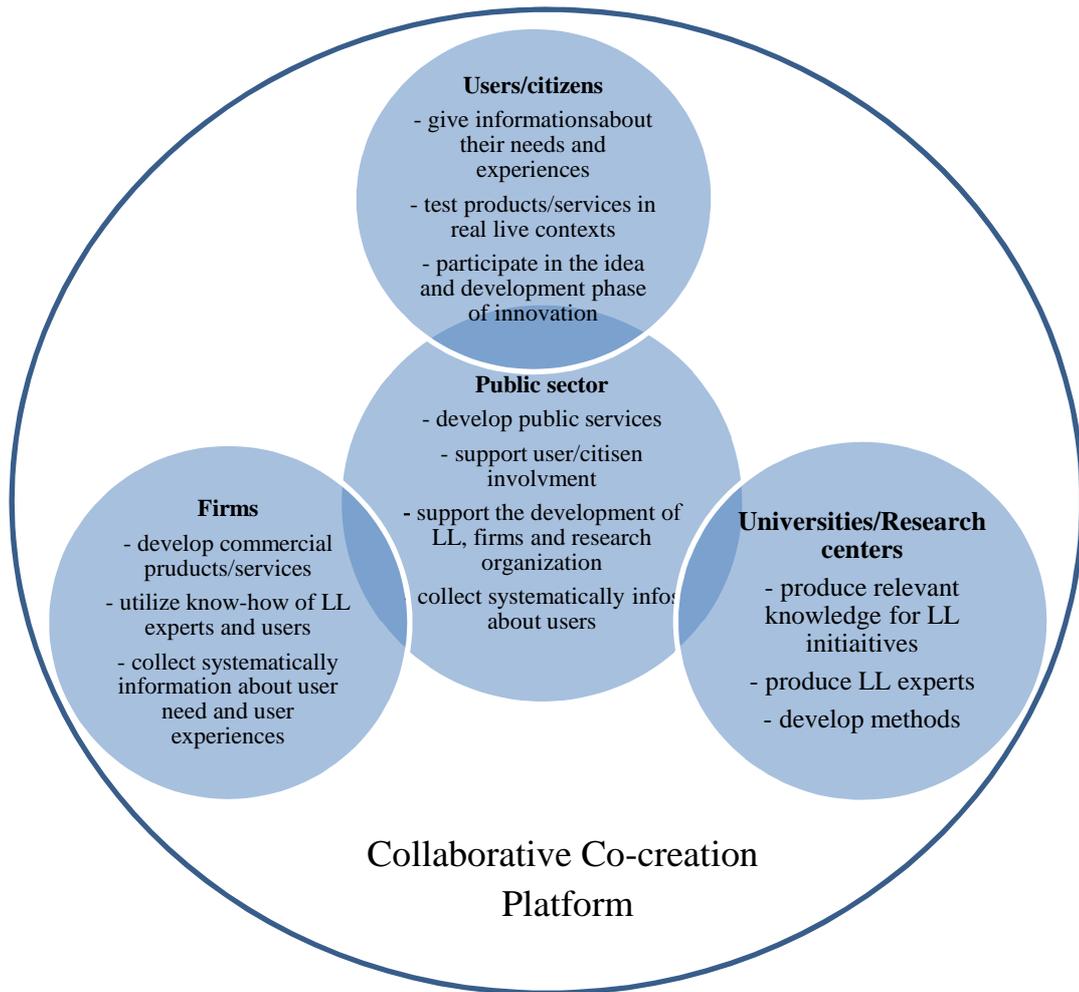
The mobile phone is connected to GPS satellites so your exact position can be shown on a detailed map. Hence, when you send an alarm the receiver can follow your position in real time on a web-based map at the same time as an audio connection is created and pictures from the mobile phone are transferred to the receiver.

The beta testing of the software was carried out in frame of the mobile living lab operations by the *involvement of 20 young girls* (target group) who used the service in their real life and were asked to share their experiences afterwards. The real life test was used to fine tune the service before launch to open market. In addition to the end user involvement, experts of the living lab aided the software company to prepare for the test scenario. During and after the test period, interviews and questionnaires were used as follow up and evaluation methods. After this test the service has been launched on the open market (Rasztovics and Vasvári 2012)

In the *Public Sector-driven Living Lab* model (Figure 4), the focus is on the development of public organizations and services. Innovation can be based on the *latest research knowledge*, also on *new applications* or combinations of 'old' research knowledge and/or on user knowledge. The owner of the innovation process is a public

organization or a group of public organizations. The goal of innovation activity is to develop public organizations so that they can function better and offer new and better products and services to their clients, to citizens. In addition to firms, also public organizations gather systematically information and feedback from the clients of their services, i.e. from citizens. This can be realized by means of more traditional information gathering methods (e.g. surveys, interviews), or by organizing dialogue forums (virtual and real) for citizens. Also in this model the degree of user involvement could be characterized as *design with users*, so users/citizens participate in the development work of public services together with R&D experts.

Figure 4: Public Sector-driven Living Lab



Source: own construction according to Arknil et al. (2011)

Manchester EastServe can be a good example case for the Public Sector-driven Living Lab collaboration.

Manchester City Council has responded to the challenge of the high levels of unemployment, poverty and social exclusion by identifying information and communication technologies (ICTs) and digital media as an important cross-cutting theme within its City-Region Economic Development Strategy and Plan. The aim is that digital technologies should be used to *increase citizens' access* to skills, jobs and

services, and support greater participation in civic life, including in the regeneration process itself (Carter 2007). EastServe, as an online community network run in partnership with local citizens, organizations and representatives, was established in Manchester in 2001. In an environment which was characterized by high crime levels, low educational attainment, poor health condition and a general lack of local facilities, a Living Lab was seen as a *catalyst* for regenerating the area, motivating local government, residents, and local organizations to collaborate actively and continuously.

Over the years EastServe has become one of Europe's largest *community based* all-wireless broadband networks and the largest community regeneration initiative using digital technologies in the UK. EastServe plays an important role by acting as an online community website where users can easily access information such as events, training, courses and workshops, conferences, community services, as well as job and volunteering opportunities.

During 2001 and 2005, broadband access grew from 2% in 2001 to 25% in 2005 and overall 75% of residents had internet access. PC ownership increased from 19% in 2001 to 52% in 2005%. 57% of residents identified access to online services through EastServe as beneficial, highlighting improved communication with family and their community (Wu 2012). Crucially unemployment in East Manchester is now a third of what it was in 1999 and below the national average (EastServe 2010).

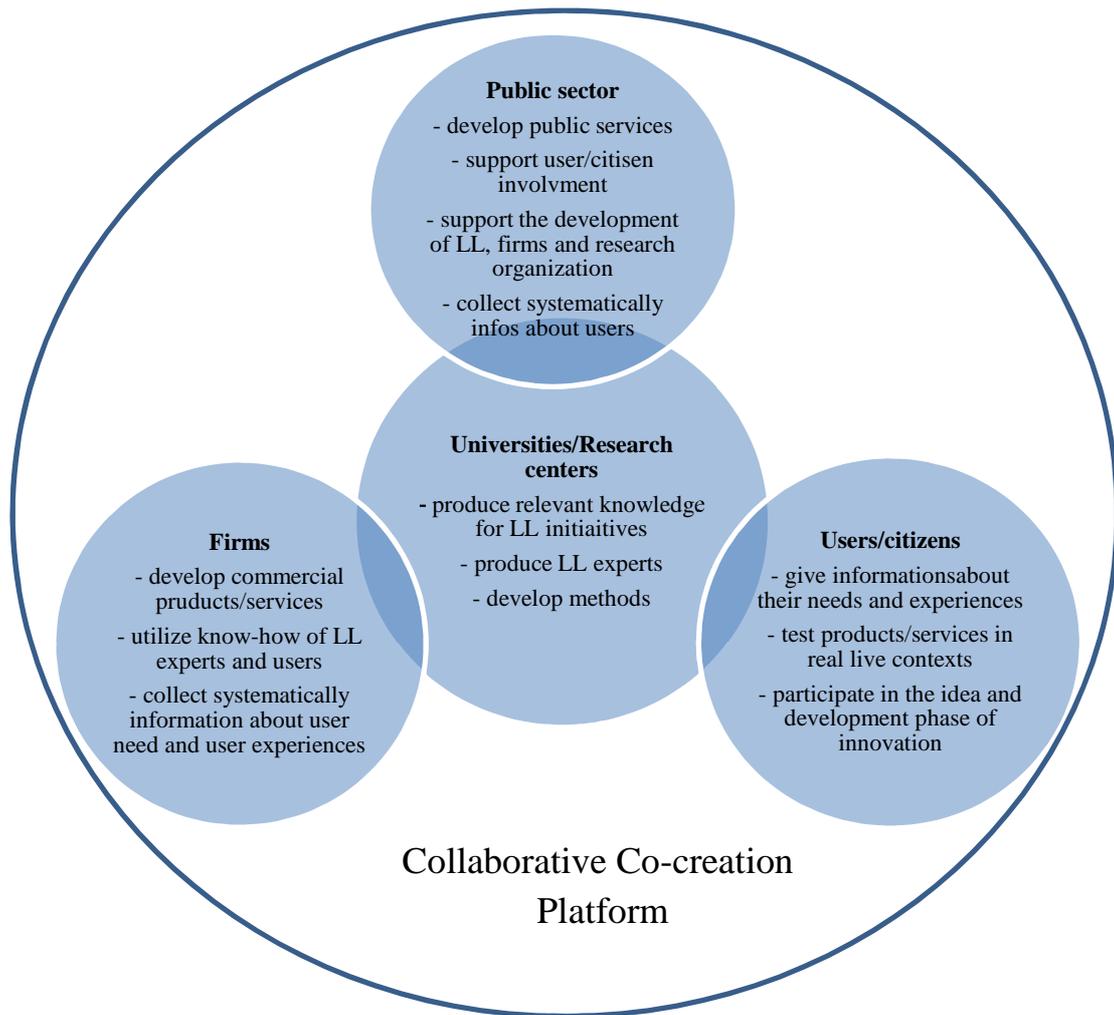
The Eastserve project has many implications for the way that public and community services are delivered, including *eGovernment solutions*, not only in local authorities but also in other areas, e.g. in East Manchester the *Police and health services* are also now implementing changes to the way they deliver services because of the experience of the EastServe project.

There are a number of specific lessons that has been learnt from the EastServe experience. Firstly, the need to develop e-services that are based on the social, cultural and economic needs of the neighbourhoods. This requires a combination of detailed local research and real efforts to consult with and *engage local people* as an essential prerequisite for capturing user needs and involving users in the design and

delivery of the new services. Secondly, that the stakeholders in the project, especially the *public sector*, need to *demonstrate* a long term commitment to community engagement and capacity building and invest as much in the development of people's skills and confidence as in the technology being deployed. Thirdly, the need to have an ongoing evaluation strategy that not only has the ability to identify weaknesses, and even failures, but also has the role of communicating these results directly into the strategic decision making process so that the project can adapt and evolve as quickly and effectively as possible, backed up by effective project management resources (Carter 2007).

In *Academia-driven model*, based on university resources, the focus is on providing facilities and consulting spaces for both researchers and firms. The owner of the Living Lab environment is the university where the co-creation with different stakeholders takes place. As in the above mentioned models, in this model the degree of user involvement could be characterized as '*design with users*' as well.

Figure 5: Academia-driven Living Lab



Source: own construction according to Arknil et al. (2011)

Giving an example, the *Digital Lifestyle Centre* at University of Essex was established in 2006 in order to manage *emerging multidisciplinary research*. It aims to bridge the gap between social and technological sciences by focusing on the *development of innovative applications and technologies* through using new ‘people inspired’ methods and tools.

In University-driven Living Labs such as in DLC Essex, the lack of funding can cause difficulties: although individual researchers have strong personal links to

industry, the funding of this kind of Living Labs is ‘ad-hoc’, which means they face ongoing difficulties in maintaining their organization and facilities.

4. Conclusion

The Quadruple Helix theory exists, but as a concept it is *not very well-established* and widely used in innovation research and in innovation policy. Quadruple Helix is an *innovation cooperation model* or innovation environment in which users, firms, universities and public authorities cooperate in order to produce innovations. There are several different Quadruple Helix model, and what is *common* to all the Quadruple Helix type of innovation conceptions is they all have included some *fourth group* of innovation actors into the Triple Helix model. Based on the innovation research literature we decided to choose the *User Community* as the fourth helix of Quadruple Helix. Depending on the context, the user can be understood very *broadly*: businesses, organizations, civil society associations, lead users, professional users, consumers, employees, residents, citizens and hobbyists.

According to the analytical review of innovation literature of Kuusisto et al. (2010), we have learnt the *key approaches* to costumers’ and users’ roles in innovation. There are *three perspectives* from which to look at user involvement in the development process. In the first approach, users remain an external source of information and new insights. Data about users are used as a base of the design. Secondly, users are involved actively in the development process. The third approach puts the users in the front seat of the car and lets them drive it in order to facilitate new products and services.

As a main result, *three different* types of QH models have been constructed 1) the *Academia-driven Living Lab* model, 2) the *Firm-driven Living Lab* model, and 3) the *Public Sector-drive Living Lab* model. The purpose of these models was to provide examples of the potential application possibilities of the Quadruple Helix type of innovation cooperation.

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