

Setting up an ITS innovation environment with many stakeholders

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Abstract

This paper presents a business-oriented multi-stakeholder approach for setting up an open innovation environment combining aspects of different test and experimentation platforms. The resulting platform and innovation environment supports a wider range of testing activities in terms of both focus and maturity of the developed solutions. The approach is described through an example case where the implementation of such environment was started as a public-private partnership after defining a feasible form of co-operation with different types of stakeholders. The specific case is based on using a fleet of electric buses as a concrete platform for testing, validating and promoting new technologies and services as well as involving the end users in the innovation and development process. Setting up such environments as a collaborative effort based on each party's own business development activities has benefits in sharing the risks and focusing on core competences. While potentially reducing the need for public funding, the business-oriented approach consisting of multiple stakeholders also includes specific challenges in identifying and defining the necessary roles and suitable partners to fill in the needed spots without conflicts of interest. The paper identifies such challenges and proposes solutions for mitigating or solving them.

Keywords:

open innovation environment, Living Lab, public-private-people-partnership.

Introduction

The role of innovation and ability to develop new services is increasingly important for businesses to stay ahead of competition [1, 2]. New concepts and ideas are expected to be refined to marketable or usable products and services in a relatively short time [3, 4]. This has brought forth the need to manage innovations rather than just fostering it [5]. Similarly, the public sector needs to find new and more efficient ways of providing the basic services with scarce resources as the customer requirements and expectations have also become more demanding and sophisticated [6, 7].

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Intelligent transport systems and services (ITS) offer alternatives to problems that traditionally would require significant investments in infrastructure and/or would be labour intensive. The use of information and communications technology (ICT) and related concepts, such as Internet of Things (IoT), enable new ways of and tools for improving e.g. traffic flow, traveller experience, sustainability, safety and cost efficiency. With the increasing need for better solutions and the ubiquity of smart devices, the business potential and use of ITS is also growing and enables long-term economic growth [8]. In 2015, Marketsandmarkets [9] projected an expected growth at a compound annual growth rate (CAGR) of 11.6% from 2015 to 2020 for the global ITS system market, reaching \$34 billion in 2020.

ITS solutions are often reliant on contextual and more or less timely data, e.g. navigation information based on congestion and road conditions, traffic light prioritization, or location-based advertisement or tourist information. Collecting data can often have high costs due to needed hardware and software (e.g. distributed sensors, data transfer), often embedded in e.g. vehicles or road-side units. Depending on the intended use case, simulation can be a useful tool to deal with these issues [10]. However, for testing the functionality of new technologies (e.g. novel sensors for collecting different types of data) and for validating the performance in real context and – particularly in the case of business-to-consumer (B2C) services, with actual end users – the availability of suitable test environments is crucial. Furthermore, these environments are logical extensions of the traditional and controlled research environments [11].

Open and participative innovation and co-creation methods such as Living Labs allow businesses to create scalable solutions along with faster and richer innovation cycles, better optimised and personalised services to citizens and new approaches for service providers [12, 13]. The importance of enabling innovation and rapid development and test cycles through suitable test environments is well-recognised on a national level as well. In Finland, for example, the government programme states the introduction of a culture of experimentation aiming at innovative solutions and service improvements as one of the key projects for the government term [14].

Even though modern vehicles are increasingly equipped with various sensors along with the drivers' and passengers' personal mobile devices, use of such data is still at an early stage [15]. Where available, access to the data may be limited to specific parties and the data itself can be limited based on the hardware. While there are test environments that allow testing and implementing different technologies with varying degrees of flexibility and rules, the more complex and dynamic the context (e.g. limitations of the physical environment and number of stakeholders involved), the more difficult it becomes for new actors to implement and try new things. One such context is public transport where bus operators need to maintain normal

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activities and service level and the public transport organisers expect a smooth and uniform user experience. Even though ITS related to public transportation has significant market potential and expected growth for it [16], there is a lack of development environments for it.

For both the private and the public sector, it is important to get experiences from real life environments and actual end users in order to collect user feedback, needs and experiences to understand the applicability of and user acceptance for the new solutions. There are many different ways of organising and structuring test environments depending on the objectives and who the main actors involved are. The approaches range from private companies providing test sites for specific technologies as a commercial service to less to passively operated publically funded tools for offering open data, interfaces or feedback channels. There are limitations and challenges associated with the different approaches such as comparability to real life usage, barriers of entry to new actors, need for significant public funding, or evolution and management of environments [8, 13, 17].

In this paper, we address the challenges related to setting up open innovation environments for testing and developing new technologies and services in a context where clear precursors and proven impacts and experiences are lacking. In the background section, different forms of innovation platforms, test sites and living labs are analysed. Then, we describe a novel form for structuring and setting up an open Public-Private-People-Partnership (PPPP) innovation environment that is 1) built around co-operation with different business parties, 2) enabled by the public sector, 3) supported by research partners, and 4) involving users. The approach is based on different interests of the stakeholders and combines benefits of different types of test environments. The stakeholder roles, needs and benefits are considered through a case example of an innovation environment built around a fleet of novel electric buses.

Method and background

This study is conducted through a literature review and interviews with experts on different types of test environments and collaborative service development. In addition, the paper reports on the empirical experiences of setting up an open innovation and development environment in the context of public transportation buses in the organisational structure proposed and described in the paper. The proposed way of setting up an innovation environment is described by analysing the roles and motivations of the different stakeholders.

Hence, this research applies to some extent the method of action research: *"a disciplined process of inquiry conducted by and for those taking the action. The primary reason for engaging in action research is to assist the 'actor' in improving and/or refining his or her actions."* [18] Action research aims to solve a particular problem and to produce guidelines

for best practice [19] by actively participating in a change situation and conducting research at the same time. In sum, the focus is on enhancing strategies, practice, methods, and knowledge of the environments in which the organizations or individuals are working.

Ballon et al., [20] distinguish six different types of test and experimentation platforms. In their classification, test and experimentation platforms have two different dimensions: Focus and technological readiness (maturity). The focus can be design-oriented or testing-oriented. If the maturity is low, the testing is usually done as in-house R&D and when maturity is high, testing is done in a form of pilots. Between these, there are open innovation platforms. When the maturity is low, prototyping is used when the focus is to design, and test beds are used when the focus is testing. Field trials have both testing and design features. If the maturity is high, societal pilots are used when the focus is design and market pilots when the focus is testing. In the classification of Ballon et al. [20], Living Lab concept is a special case of test and experimentation platforms, when there is both need to design and test, and open innovation platforms are used. Figure 1 presents the classification.

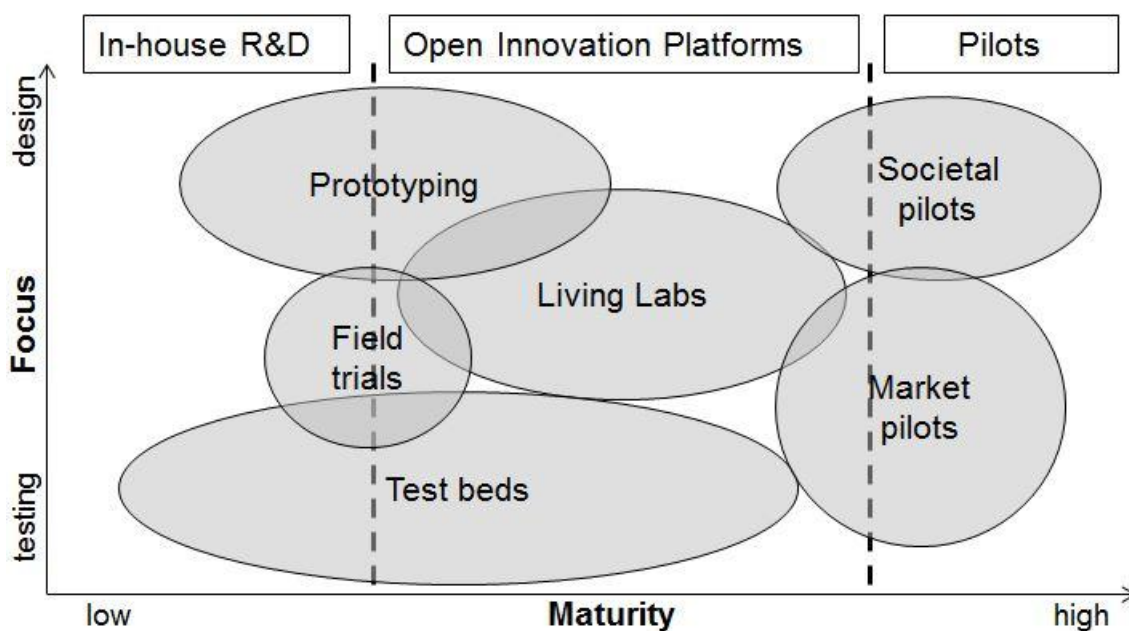


Figure 1 - Classification of Test and Experimentation platforms according to Ballon et al. (2007).

As seen from the classification of Ballon et al. [20], Living Labs are used in a development phase, when there is need to get more user information to complete in-house R&D, but technological readiness is not sufficient for piloting. Therefore, using Living Lab approach requires the involvement of three different stakeholder groups: Researchers, developers, and end-users [21]. Schuurman et al. [22] add one stakeholder group, facilitator, to this list, as they state that there are usually authorities, other public organizations or companies that support or at least subsidize the development efforts.

However, as the Living Lab is a description of a research environment rather than a definition

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of certain research methodology, there are different ways of conducting research based on Living Lab approach. Almirall et al. [23] divide different Living Lab approaches as: 1) User centred, where users are mostly passive subjects of study. 2) Design driven, where designers take the lead. 3) Participatory, where users are considered on equal ground with other partners in a co-creative process. 4) User driven, where user is one who drives the innovation process.

Innovation environment built around business development activities of companies

While the benefits of different kinds of services, and therefore also development environments, are in the end realised by the end users, the direct exploitation of an innovation environment is done by service and technology developers and providers. Next, we describe our approach for setting up an innovation and test environment with the case example of “Living Lab Bus” in the context of public transport. The presented approach is based on identifying and combining the offering and interests of different stakeholders so that each benefit from it without conflicts of interest.

Living Lab Bus – overview, key objectives and approach

The main objective of the Living Lab Bus (LLB) environment (<http://LivingLabBus.fi>) is to enable development, testing and demonstration of various services and technologies by using innovative electric buses as a physical platform in a real use environment. The platform and innovation environment supports a wide range of testing activities in terms of both focus (e.g. from technical performance to design and user experience) and maturity (e.g. from concepts to verifying functionalities) of the developed solutions. Essentially, it potentially covers the range of different experimentation and development environments as shown in Figure 1.

The platform can be used for collecting data, validating solutions and providing an interface for involving end users in the innovation and feedback process, thereby supporting service and technology providers’ business development, innovation, co-development and co-operation activities as well as product marketing. From the public sector point of view, the environment encourages and enables the development of solutions that support common goals such as user-centric services that increase the use of sustainable transport modes.

A core idea in the approach is that rather than just investing in developing a platform to be used once it is ready, the different components the development environment consists of (e.g. sensors, communication channels, and interfaces) are elements which the different parties are developing anyways. Setting up the platform, therefore, should already produce solutions and results that on their own are beneficial in different contexts, and not just the combined whole. The LLB case includes 1) public transport authorities, 2) cities, 3) research organisations, 4)

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technology providers, 5) B2B service providers, 6) B2C service providers, involves 7) users (i.e. passengers, drivers, citizens), and is funded by the Finnish Funding Agency for Innovation. In addition to the companies involved from the beginning, the intention is opening the development environment for third parties to use.

The approach aims to combine push and pull aspects of innovating and testing solutions found in different types of test environments, for both B2B and B2C activities. Here, the “push” approach refers to different actors bringing their ideas and solutions to a real environment to be tested (either in technical terms or from user experience point of view) – similar to test sites. Essentially the environment reduces the barriers of entry (e.g., no need to invest in testing infrastructure) for new service providers by offering suitable facilities so that companies can focus on their core activities.

The “pull” aspect refers to encouraging service developers and providers to find solutions to specific needs and based on provided functionalities and facilities. The needs refer to both the objectives of the relevant stakeholders, such as public transport authorities and cities as well as newly identified user needs – similar to Living Labs. Besides, different parties can either market their offering, such as new sensor data, to illustrate abilities and enable innovation or try to create a market for their offering. This increases the understanding of (local) user needs and market demand as well as offering a network of actors for finding new co-operation and forming new service ecosystems.

There are a few distinctly different types of commercial parties that benefit from the environment. First group are those providing the *enabling technologies* that are a part of the actual platform, second are *utilizing technologies* that benefit from having the platform, third are *utilizing services* that benefit from having the platform through being able to create, deliver and/or evaluate them. In addition to these private sector actors, the innovation environment both benefits and needs *enabling support* from public authorities, research organisations and, last but not least, *end users*. So, before services reach end users, there are preconditions between the stakeholders in order to create the value network of actors, starting from being allowed to utilise the necessary space and facilities in question (Figure 2).

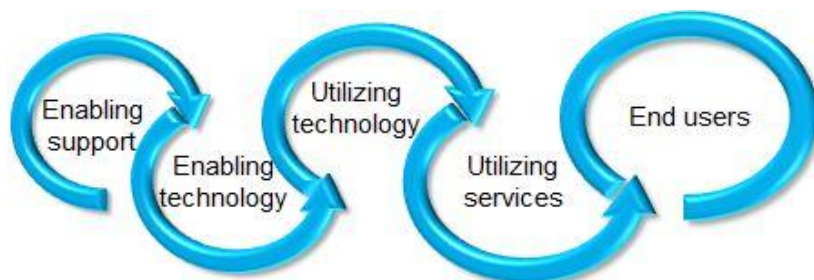


Figure 2 - Required elements and preconditions to reach end users.

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Enabling technologies the platform consists of

In the LLB case, the idea behind the environment structure is such that the components used to implement the development environment – i.e. the *enabling technologies* – themselves are in line with the business development activities of the respective companies. The motivation and benefit of being a part of developing a platform is not only to develop their own technologies and components, but to become an integral part of a networked environment where they can find new synergies (i.e., co-development) and partnerships (i.e., value co-creation) with the other actors that will be utilising their products.

Whether or not the development of the enabling components is funded by the public sector (such as the Finnish Funding Agency for Innovation), it can be argued that those public funds are not used to implement the development environment itself, but indeed the sum of the components generates, as an additional benefit, the development platform as a greater whole that can be utilised by both the already involved parties as well as third parties.

The motivation for setting up the LLB environment as a networked effort of multiple parties was to counter some of the realities and challenges of investing scarce public funding on implementing an innovation environment in a new context. Similarly, if done as a single party effort with the goal of offering the environment/platform as a service, the benefits would only be realized after the concept itself is commercially viable. So, while defining and implementing such development facilities might be easier for a single actor, it would require a much broader scope and larger investment for that actor, whereas a networked solution allows each actor better focus on their core activities.

Utilizing technology benefiting from the platform

For technology providers, a dedicated test environment provides an easier access to the actual use context. When the context is public transportation and the platform a set of operational buses, the need to constantly provide the regular services and service level increases the challenges and need for pre-defined conventions and rules of adding or changing things. Without a dedicated environment with the supporting practices and facilities, implementing new ideas and elements may require lengthy negotiations with multiple stakeholders.

While different technologies such as new sensors or user interfaces require a physical platform to test their capabilities, they are also important in adding value to the whole concept by providing third parties opportunities in developing further services based on the data and possibilities they offer.

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Utilizing services benefiting from the platform

The eventual goal is to provide and validate services for users, whether it's end users (e.g. passengers or drivers) or business users (e.g. fleet operators). As with Living Labs in general, a significant benefit is to be able to speed up development cycles by incorporating the end users from idea generation to testing, further development and validation of services. Being able to test different solutions and get feedback and preliminary market response at an early stage saves time and resources and allows focusing on the most promising ideas. For valid solutions, testing and using them immediately in the proper use context works as promotion and as a reference for scaling up and entering new markets.

In addition to being able to test own innovations and get user feedback, available technologies and community of both business parties and users can help generate completely new ideas and find new ways of co-operation to produce new service concepts.

A significant challenge, and also one of the main reasons new models for setting up innovation environments are needed, is identifying and quantifying the future value of a test platform. For service providers, commitment and investment into developing something can be difficult before anything is realised, particularly if it is unclear what exactly will be available and in what quality. Even if defined in detail, the actual setting up before something can be offered to end users may take a long time.

In a sense, it is a “chicken or the egg” dilemma. Service providers need proven technologies to commit into developing services while technology developers need an environment to test their devices along with a clear demand for the solution. Therefore, to set up the enabling platform itself, there needs to be a demand for not only the enabling platform but also the solutions it enables. In a way, it is about creating a win-win situation between participants and showing that everyone has an essential role in the ecosystem. This kind of setting creates a trust between participants which can be assumed to have a positive impact on the ecosystem.

Enabling support from the public sector

To learn from this case and to achieve wider benefits in line with local and national goals, the test environment itself is supported with a broader research aspect funded by the public sector. While the role of research organisations is significant, the objective is to develop methods and frameworks that support the development environment itself and that can be applied more widely. Therefore, the goals and steering of a different public parties is central.

In addition to funding, the role of the public sector is essential in allowing the use of public

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spaces of infrastructure (e.g. public transport authority supporting the use of operational buses for development) and increasing visibility and steering the activities towards reaching local goals and objectives (e.g. making public transport easier and a more attractive alternative for private vehicles). For example, based on interviews conducted in the Netherlands [24], public sector has gained a number of benefits, such as influencing social behaviour, raising socially important issues, solving real life problems, new kinds of businesses have been enabled, and those business and other opportunities are being actively promoted both nationally and internationally. On the other hand, public support is often useless if there are no real-life problems for companies to solve, because only these can generate business.

End users and research organisations

In this case, the role of research is to provide some enabling elements to the technical platform as well as facilitating the co-operation and management of the environment. In fact, research organizations or other independent parties, are usually excellent coordinators for ecosystems and collaboration. On a broader scale, however, their main objective is to study and develop methods and frameworks for evaluating different services that can be tested in the environment as well as the organisation and governance models to make the environment scalable, replicable and sustainable in the long run.

In general, the important central role of researchers in any test environments is impartial evaluation and verification of tested services and technologies as well as their impacts. This includes tools for collecting user feedback as well as participatory methods for involving them in the innovation and development processes. In the LLB case, the participants include passengers, drivers and business parties as well as citizens (e.g. students) to bring in ideas.

Conclusions

The presented platform and innovation environment aims to support a wide range of testing activities in terms of both focus and maturity of the developed solutions. The objective is to provide an environment for technology and service providers to test, develop and validate their solutions together with end users and to foster the creation of new partnerships – even long-term – and service concepts with other actors. In brief, the environment aims to provide preconditions for value co-creation and results that could not be achieved alone. Hence, the presented approach for setting up such innovation environments aims to build the platform based on modular business development activities of different actors. Therefore, the participation in the development and implementation of their own solutions provides value for the parties involved and, in addition, the resulting sum of the parts provides an opportunity for those involved as well as third parties to further test new technologies and services.

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By grounding the main offering of the actual platform – i.e. fleet of electric buses with ICT functionalities that facilitate collection and use of data, delivery of services and incorporation of new sensors and components – mainly on strategic development products of different companies rather than building those parts specifically for the environment, the implementation itself already brings value to the parties involved. Often, setting up a test environment, pilot site or a Living Lab only starts to create value after it is available and can be further utilized by its customers (e.g. service providers presenting their services to users).

On one hand, innovation can be sparked by providing content and possibilities in a new context, e.g. by fostering new ideas with new data sources or user interfaces in a test environment. In order to do that, it needs to be decided what should be offered in the first place. On the other hand, innovations can arise from different contexts, but testing the new ideas can be difficult, too costly or too slow if there is no environment facilitating it. This, essentially, is the core reason why open environments are needed. Risk and cost sharing is essential to ensure innovations are taken from ideas to implementation and testing.

Identifying partners and defining their roles so that the underlying basis for implementing and developing further solutions on it is solid, requires many elements. To foster co-operation between the actors, their solutions should be complementary and not competitive. However, for an environment to be “open”, it should also be acknowledged and accepted that other actors may want to develop and test similar solutions as well.

Defining the roles and agreeing on collaboration – or even co-existence – between actors, and identifying new stakeholders or ways of solving conflicts of interest takes time. Particularly for SMEs, delays and prolonged decisions complicates resource planning and commitment.

In addition to the challenges of setting up an innovation environment, the governance and fair “open” use of it during operation pose more interesting challenges and further research topics. Enabling and supporting continued utilization requires a form of organising and managing the partnership and availability of required facilities and functionalities as well as support. This includes aspects such as approval of new ideas to implement, limitations and rules of participation and cost and level of support and evaluation.

In order to benefit all types of actors, to foster co-operation between them and to avoid vendor lock-in, the environment should attract and involve different kinds of new actors (from individual developers and innovators to large companies). For the environment to be sustainable the costs need to be covered one way or another. There are different ways of handling this (e.g. participation fees, covering costs, providing the tested data/services as compensation etc.). Besides, finding a balance that enables fair and open use is important. In

addition to identifying sustainable models for a specific case, a greater value comes from providing guidelines and frameworks for organisation and business models of sustainable, scalable and replicable innovation environments.

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