This paper was presented at The ISPIM Innovation Conference – Innovating in Times of Crisis, 7-10 June 2020.
Event Proceedings: LUT Scientific and Expertise Publications: ISBN 978-952-335-466-1

Towards Sustainability in Urban Living Labs: Dynamics of Actor Roles

Anil Engez*

CITER (Center for Innovation and Technology Research), Unit of Industrial Engineering and Management, Tampere University, Finland

E-mail: anil.engez@tuni.fi

Seppo Leminen

University of South-Eastern Norway, Post office box 235, 3603 Kongsberg, Norway
E-mail: seppo.leminen@usn.no
&
Pellervo Economic Research, Eerikinkatu 28 A, FI-00180 Helsinki, Finland
E-mail: seppo.leminen@ptt.fi
&
Aalto University School of Business, Department of Marketing, P.O. Box 21230, FI-00076 Aalto, Finland
E-mail: seppo.leminen@aalto.fi
&
Carleton University, Sprott School of Business, 1125 Colonel By Drive, Ottawa, ON, K1S 5B6, Canada

Leena Aarikka-Stenroos

CITER (Center for Innovation and Technology Research), Unit of Industrial Engineering and Management, Tampere University, Finland

E-mail: leena.aarikka-stenroos@tuni.fi

* Corresponding author

Abstract: Environmental sustainability is an increasingly interesting topic among living labs where diverse actor roles and their dynamic are rooted into new urban living labs. Therefore, this study examines the actor roles and their dynamics in the design, implementation and evaluation phases of the four living lab projects in the Hiedanranta district in Tampere in Finland. The projects focus on nutrient recycling and material circulation, and their outcomes contribute to the circular economy and sustainability of the region to a large extent. We apply a qualitative research design including semi-structured interviews reinforced with the secondary data from the project reports and websites. The findings of the study indicate that the driving actors may change in the project phases in urban living labs depending on the required tasks and the competence level of the actors. The roles may be shared by different actor types and change depending on the project requirements.

Keywords: living lab; urban living lab; actor roles; circular economy; sustainability; resource efficiency; nutrient recycling.

Event Proceedings: LUT Scientific and Expertise Publications: ISBN 978-952-335-466-1

1 Introduction

The interest in environmental sustainability has been growing globally due to the increased awareness of the effects of the climate change on natural habitats. Furthermore, recent studies have proven that animal agriculture and livestock are the leading cause of the greenhouse gas emissions and the deterioration of natural resources (Steinfield et al., 2006). Such negative developments in the world draw attention to the need for more resource-efficient and regenerative systems, which can be experimented and tested in a living lab environment (Voytenko et al., 2016). Living labs scrutinize multiple disciplines and concepts such as the transition to low-carbon economies, experimental governance, and new approaches to sustainable development (Evans & Karvonen, 2014). Living labs are one of the most recent form of open innovation networks providing multiple research opportunities (Hossain et al., 2019). A living lab emphasizes the role of user involvement, prototyping, testing, and validating in the creation of new technologies, services, products, or systems in real-life settings. Living labs adopt an experimentation approach and involve public-private-people partnerships in the co-creation process (Leminen et al., 2012). Living labs are distinguished from other open-innovation approaches by allowing users to improve the technologies that are being co-created and tested with other stakeholders in real-life environments (Nyström et al., 2014). A living lab consists of a physical region or virtual realities where the actual collaboration among stakeholders takes place (Hossain et al., 2019).

The stakeholders that are a part of a living lab may include companies, researchers, authorities, users and other actors who have a goal of developing certain solutions for an existing problem in an urban area. These actors are classified as utilizers, providers, enablers, and users (Leminen et al., 2012), which indicate the roles the actors undertake in the living lab. A living lab that is formed in an urban area has been called “urban living lab” (Voytenko et al., 2016). Using living lab concept for the development of urban areas has been argued to enable rapid social, technical and economic transformation (Evans & Karvonen, 2014). In the context of urban living labs, city districts that are under development can be considered as innovation spaces where new applications can be tested to be implemented on a larger scale in the future (Juujärvi & Pesso, 2013).

Extant studies draw out attention to the effect of actor dynamics on the development of a living lab. For example, Leminen and Westerlund (2019) document the emergence and evolution of the living labs movement, and point out that objectives, power relationships, and control in the agenda-setting shifted between actors in living labs over time, while Leminen et al. (*forthcoming*) focus on change patterns of living labs. As these studies examine long-term development of living labs, the literature is silent on presenting dynamics of newly formed living labs. More specifically, there is a need to understand the actor dynamics beyond the emergence of living labs from a process perspective, and how the living labs can provide value to cities, communities, or ecosystems to achieve sustainability at the time when it’s needed most.

Even though the living lab literature provides studies on diversity of living labs, roles, and role dynamics (Juujärvi & Pesso, 2013; Leminen et al., 2012; Nyström et al., 2014), further understanding on more detailed roles and their classification is needed in urban living labs. The exploration of the actors who drive the innovation activities in different

stages of living labs, and the dynamics of the actor roles have remained limited. Therefore, this study aims to understand the actor roles and their dynamics in urban living labs. Our research questions are threefold:

- What are the actor roles in a newly formed urban living?
- What are the role dynamics in urban living labs?
- How urban living labs support sustainability?

This paper is structured as follows: following this introduction, the actors and actor roles in urban living labs are discussed to elaborate the current understanding. In the third section, the research design of the study is presented. In the fourth section, the results of the study and the identified actor roles in the Hiedanranta urban living lab projects are presented. The fifth section concludes the paper and synthesizes the results. The sixth and seventh sections present the theoretical contribution and practical implications of the study respectively.

2 Actor Roles in Urban Living Labs

Urban living labs comprise various actors that take part in the practice-based innovation activities in an urban area tackling varying urban challenges. These actors are categorized mainly as municipalities, companies, research institutes, and residents (Juujärvi & Pesso, 2013). Another approach to classify the living lab actors points out the actors' roles and goals of participating in the living lab, and uses the following categorization respectively: enablers, utilizers, providers, and users, which is in line with the action-based role theory (Leminen et al., 2012; Nyström et al., 2014). Action-based role theory explains that an actor's role is created through their actions and an actor takes a role to achieve a specific goal. The roles act as a means to organize innovation in networks, and to assess the resource and partner selection when conducting the tasks that are associated with the roles (Nyström et al., 2014). Therefore, to some extent, the roles describe the contribution and commitment of the actors to specific goals in the urban living lab. The enabling characteristic of municipalities describes the supportive nature of the public sector actors and their role in creating a vision and spreading and communicating the vision to other actors in the urban living lab, thus "enabling" the emergence of innovations for urban challenges. The utilizing characteristic of companies refers to an improvement in the knowledge capital of a company through collaborations while continuing the development of its business operations in the area, which indicates the utilization of collaborations for company's benefit. Therefore, one of the motives for a company to participate in an urban living lab can be argued to be gaining competitive advantage through information retrieval from other actors, especially users (Leminen et al., 2012). The providing aspect of research institutes and universities brings up the methods, tools, expertise, and additional resources that they offer for the development. The long-term research projects conducted in the urban living labs make it possible to generate reliable knowledge. Lastly, residents as the essential actors of the urban living labs use and test the solutions that are developed and provide their feedback for further improvements (Juujärvi & Pesso, 2013). Although each actor type is introduced with specific roles, these roles might change over time, they are context-specific and depend on the innovation network's needs and goals (Nyström et al., 2014). The actor roles are further categorized to improve their understanding in urban living labs in more detail.

Depending on their classification, the actors have different level of impact and contribution to the development and sustainability of the urban living lab.

Municipalities as Enablers

Cities are one type of innovation spaces and areas for urban living labs where various opportunities can emerge that accelerate the sustainability and environmental transitions (Frantzeskaki et al., 2014). The experiments that take place in cities can be scaled up to generate broad systemic change (Geels, 2011), and municipalities as enablers are the prominent actors in the local sustainability governance (Bulkeley et al., 2016). The experimental governance approach is mainly adopted by municipalities in urban living labs, which emphasizes knowledge generation and innovation development through open and engaged learning (Evans & Karvonen, 2014). Regarding the institutional context, there are differences in the ways of working, local independence and the level of autonomy between the municipalities across Europe (Loughlin, 2000). However, what commonly characterizes municipalities is that they are embedded in local networks, partnerships, and collaborations, and seek expertise of public and private actors to implement local policies (Fenwick et al., 2012). In a study that explores the capability and role of municipalities in the development and facilitation of urban living labs, three functional roles are identified: *promoter, enabler, and partner*. The role of a municipality may shift over time depending on the collaborative challenges or access to financial capital. There could be multiple roles at once due to the varying interests of sub-administrations within municipalities. Although the roles might be distinctive only in an analytical sense, they are relevant to understand the experimental governance processes (Kronsell & Mukhtar-Landgren, 2018). Another literature assigns three main roles to municipalities: regulator, provider, enabler (Zvolska et al., 2019). The provider role is examined through the investor and host roles, while the enabler role is further enlarged into matchmaker, partner, and communicator roles. In these two studies that examined the roles of municipalities, the partner role becomes apparent as a conflicting role, as one of the studies analyzes it as a separate role dimension (Kronsell & Mukhtar-Landgren, 2018), whereas the other study considers it as a characteristic of the enabler role (Zvolska et al., 2019). Therefore, these changing and conflicting conceptualizations may create a confusion when defining and understanding the roles of municipalities. Leminen et al. (2017) define the catalyst role of the cities as improving the development and stimulating adoption and creation of new solutions, which resembles the description of the enabler role (Kronsell & Mukhtar-Landgren, 2018; Zvolska et al., 2019). In our study, we investigate the municipality roles through the promoting, catalysing, and partnering aspects.

The *promoter* role of the municipalities is drawn upon the collaborative governance process (Vangen et al., 2015) where the municipality initiates, finances, and implements the urban living lab and calls on other actors to implement policies in a top-down approach. The activities of the municipalities having a promoter role may include urban planning, and advancing urban regeneration processes (Kronsell & Mukhtar-Landgren, 2018). Municipalities can apply for funding to initiate urban living labs, but this does not necessarily make them the main implementor of the living lab, and it is up to a municipality to take an active role in implementation or just influence and govern the implementation, which would represent a catalyst role (Leminen et al., 2017). In

promoter role, the municipality undertakes the leadership tasks and is expected to actively apply strategies in relation to its urban agenda to tackle climate, environment, and sustainability issues (Bulkeley & Betsill, 2013). While being a promoter, a municipality may unintentionally be an inhibitor in some occasions where administrative routines may create obstacles in the development processes (Bulkeley et al., 2016).

The *catalyst* role of municipalities includes encouraging action through partnerships and opening spaces for voluntary organizations and service providers, which brings up the challenge of persuading other actors to participate in partnerships and act (Bulkeley & Kern, 2006). The difference between the promoter and catalyst roles is manifested in the involvement level of municipality in leadership tasks and implementation of the urban living lab (Kronsell & Mukhtar-Landgren, 2018). In this regard, a catalyst municipality do not undertake the leadership tasks, but rather provide access to the resources such as facilities, buildings or expertise and facilitate stakeholders to collaborate (Bulkeley & Kern, 2006). On the other hand, the similarity between the promoter and catalyst roles is the top-down process they adopt (Kronsell & Mukhtar-Landgren, 2018). In a similar approach to the promoter role, the catalyst role requires the decision making by the municipality on selecting the partners that will be involved in the development of the urban areas.

The *partner* role of municipalities encompasses activities where the projects are funded and led by different organizations, leading to a shared leadership. Therefore, municipality is considered on equal terms with other stakeholders. Municipality takes up tasks such as network-centred governance and participate in the projects while not having financial ties to the projects (Kronsell & Mukhtar-Landgren, 2018). For instance, a municipality may be a partner of a project, but the technical aspects would be handled by industrial and academic partners who possess more technical competencies. In such a case, the role of the municipality could be a user or observer.

Residents as Users

As one of the crucial actors of open-innovation in urban contexts, residents as users have potential to influence the decision making in urban governance and positively affect the urban development and their living environments (Menny et al., 2018). Residents can play a role in designing and developing innovations to address sustainability challenges from the first hand (Bulkeley et al., 2016). It is advised to include residents already in the early design stage of the urban living labs to identify the user needs that would shape the development process (Bergvall-Kareborn & Stahlbrost, 2009). Different studies analyzed the role of the users in living labs, and four user roles are identified: informant, tester, contributor, and co-creator (Leminen et al., 2014; Nyström et al., 2014). In this classification, the level of user involvement increases as the user role shifts from informant to co-creator respectively. In a similar approach, the participation levels of user involvement in urban living labs are identified: non-participation, information, consultation, and co-creation (Menny et al., 2018). Although the residents are expected to have an active role in the early design stage, on the contrary, non-participation could only be found in the early design stage. The involvement level of the residents in the studied urban living labs was found to be highest in the implementation stage, which can be attributed to the implementation stage being the core of the projects (Menny et al., 2018).

The residents in urban living labs are not necessarily involved as users. The solutions that are developed might not have a use case by a resident, but instead it may serve the resident, as in the case of nature-based solutions that are developed to manage the stormwater for flood prevention (Chronéer et al., 2019). Considering these categorizations, next we elaborate the resident roles.

The informant acts as a source of information on the preferences, needs and problems of the everyday life. The information can be retrieved from the informant through social media posts, webinars, surveys, observation or simply through interpersonal communication. Testers as the next role of residents are the individuals who are the users of the innovations. The innovations in question may be available to be tested in public places. Another role of residents, contributor, highlights the users with increased innovation-related knowledge or competence compared to the previous two roles of the residents. This characteristic of contributors enables them to participate in the design stage with other actors. Lastly, co-creators having the highest level of user involvement are capable of developing the product, service or process together with the research and development teams (Leminen et al., 2014; Nyström et al., 2014). In order to make the terms for the resident roles clearer and more suitable in urban contexts, we propose the following classification, which will be used in the analysis of the residents in the results part: informant, tester, designer, and developer.

Companies as Utilizers

Companies in an urban living lab possess the ability of driving the transition to a low-carbon economy and sustainable living by engaging in the development of innovative solutions (Evans & Karvonen, 2014). Some of the solutions that enable sustainable living include renewable energy production; urban farming; the utilization of nutrient, energy and material flows; and the utilization of side streams from the production activities. By undertaking these tasks, companies tackle various urban issues such as poor air and water quality or waste disposal problems. Companies in urban living labs are regarded as utilizers due to their primary goal of economic performance improvement while reducing the environmental impact of their operations (Evans & Karvonen, 2014). Developing and testing products and services with other actors can be considered as additional motives for companies to take part in urban living labs. While performing these activities, companies are able to utilize the data on users that are easily accessible due to the open-innovation approach that the urban living labs adopt, which provides open and engaged learning (Leminen et al., 2012; Evans & Karvonen, 2014). It is argued that companies seek agile actions and rapid results in living labs to apply strategies according to their business goals. Despite the fact that urban living labs mainly serve the objectives of municipalities, it is still beneficial for companies to participate in an urban living lab, in terms of making use of the information and knowledge created in a collaborative setting (Leminen et al., 2012). Moreover, tackling urban challenges with proven innovative products and services might be of use in the value proposition for business prospects.

Research Organizations as Providers

Urban living labs provide the opportunity of conducting cross-disciplinary research to enhance the ties between the creators and users of the generated knowledge (Evans &

Karvonen, 2014). Urban living labs act as a basis for theory development, knowledge creation, and the discovery of new teaching and research methods, which can be argued to be the roles of the research organizations in urban living labs (Leminen et al., 2012). Research organizations are responsible for generating objective knowledge of scientific practice in urban living labs to influence policies. In certain occasions, the outcome of the research activities might have potential to influence urban development policies in areas regarding sustainable infrastructure design or material procurement strategies. The researchers can act as consultants when the opinions are needed on technical decisions such as the selection of a monitoring equipment and its location (Evans & Karvonen, 2014). Commercialization of the solutions as a result of the research projects can be sought to upscale the impact. However, the local knowledge production does not always find its way to create a widespread impact, as there might be misalignment between scientists and policymakers due to the organizational differences (Evans, 2006; Ingstrup et al., 2020). One of the reasons of the misalignment is the lack of an established standard and protocol for data storage and incorporation of this data into decision making processes. This holds important implications as the science and policy are interconnected in urban sustainability (Evans & Karvonen, 2014).

3 Research Design

A single case study on an urban living lab containing three subcases was conducted and qualitative analysis approach was used. In our study, the urban living lab is a work-in-progress city district (Hiedanranta district in Tampere, Finland) that includes various research projects, business activities, and citizen participation in the development of the district, which enables us to study the dynamics of actor roles. The unit of analysis is the projects that aim to improve nutrient recycling and material circulation in the district as the developments in these areas would contribute to the circular economy and sustainability of the region to a large extent. The case study is based on extensive data from multiple sources, including nine interviews in semi-structured form, the websites of the companies and the municipality that provide information about the ongoing research projects in the district, and the project reports. All the interviews were recorded and transcribed. The conducted interviews included managers of the urban living lab firms, city development project managers from the municipality, and researchers who are involved in the projects that take place in the urban living lab. In the analysis part, the design, implementation, and evaluation phases of the projects, the driving actors in each phase, and their activity sets and corresponding roles are identified, which are listed in Table 1 in more detail. The interviews are listed in appendix.

Event Proceedings: LUT Scientific and Expertise Publications: ISBN 978-952-335-466-1

Table 1 Data analysis process

Data analysis phases		*Task*	*Outcome*
1.	Open coding	• Dataset organization • Identifying the urban living lab projects that focus on material circulation and nutrient recycling • Identifying the informants from the projects to be interviewed	Overview of urban living lab projects and the informants that are associated with the projects
2.	Focused coding #1	• Defining the project phases • Identifying the involved actors in the project phases	Overview of project phases and the involved actors in each phase
3.	Focused coding #2	• Identifying the activity sets of the actors in the project phases • Identifying the roles based on the activity sets	Identification of the roles in different project phases
4.	Theorizing the codes	• Synthesizing phases 1 to 3: analyzing the role shifts in project phases • Describing the characteristics of the roles	Conceptualization of the driving actors and their roles in urban living labs

4 Identified Actor Roles in Hiedanranta Urban Living Lab Projects

KIEPPI Project: Partnership model for sustainable neighborhoods

KIEPPI project aims to create a partnership model for sustainable neighborhoods in the three cities in Finland, and Hiedanranta district in the city of Tampere is one of the focus areas in the project where the urban areas are increasingly redesigned according to sustainability and circular economy principles. The project is coordinated by the Tampere municipality and funded by the European Union. The aim of the funding mechanism and the partnership model is to create as many carbon-neutral technologies, services or innovations as possible in cooperation with companies, research organizations and municipalities. Apart from the solutions related to the utilization of waste and side streams, municipality as the driving actor of the project seeks solutions for four identified themes: premises and services for the circular economy, material circulation, urban food production, and the improvement of blue-green infrastructure in the city district to improve the wellbeing of future residents. In our analysis, we focus on the project activities that deal with the Hiedanranta development.

The municipality's inclusive efforts are in line with the experimental governance approach that the urban living labs adopt. Among the three roles that municipalities

undertake in urban living labs, in this project, the City of Tampere's role fits with the definition of the catalyst role, as the municipality encourages action through partnerships and facilitate stakeholders to collaborate. However, being the coordinator of the project also makes the municipality a promoter, thus we argue that both promoter and catalyst roles are present in this project for the municipality. According to the project manager, the municipality has never taken such a huge role in the development of a certain urban area before, which is Hiedanranta area in this case. The city currently faces many new things about urban planning and do not have a recipe yet on the co-creation and cooperation models for planning the Hiedanranta development. In order to accelerate the development and to make it more structured, the municipality has launched a company that works independently and takes care of the urban planning and construction of the infrastructure and park areas in Hiedanranta. The development company is the sole responsible for the whole development of Hiedanranta. One of the reasons why a separate entity is created by the municipality is to allocate more resources to sustainable development of Hiedanranta and to maintain the resources for this specific purpose. Furthermore, currently there is no high-level political decision making to back up the circular economy strategies that are planned to be implemented in the project, which makes the project more experimental for Hiedanranta. Therefore, the innovation activities in the Hiedanranta development highly depends on the external actors, and the city acts as a bureaucratic actor rather than an innovative actor. The project manager highlights that the external actors mainly consist of companies and research institutes, and the citizen involvement in this project is minimal. One reason for this is that the project highly focuses on reducing waste and increasing the resource efficiency in industrial procurement and applications where the citizens do not have a major impact.

The municipality offers Hiedanranta area to companies and research organizations to perform their activities, and they are expected to introduce novel ideas and solutions that would develop Hiedanranta as a self-sufficient city district. The anticipated involvement level is highest for the companies and lowest for the residents. It is underlined by the project manager that incentives such as different types of subsidies or lower rents offered to companies and research organizations might be needed to attract them to take part in Hiedanranta. In the case of infrastructure procurement, the municipality has a huge role in creating sustainable business opportunities, as it is one of the biggest buyers of infrastructure materials. If the municipality starts demanding more sustainable infrastructure services, the whole industry would have to change, which would enable a shift from linear business models to circular business models. Eventually, this might also lead to the emergence of companies that value the use of recycled or reused materials.

In the design phase of the project, three development themes are identified by the municipality. City of Tampere partners with an expert consulting firm to develop the partnership model to identify the methods that will be used to attract companies and research organizations to the area. The expert consulting firm has complete control over designing the partnership model. The model will be jointly used by the three partner cities of the project; thus, the consulting firm needs to consider the needs and goals of each of the three cities. Therefore, the project design tasks are not carried out by only one organization, but it is distributed instead. Recently, the municipality has initiated a tendering process to invite suppliers or contractors to conduct the pilot projects. The tender aims to attract start-ups since the budget for pilots is relatively low for large

companies. However, larger companies might still have an interest in the pilots due to the anticipated growth in the city district area. The city uses the tendering process as a means to test out the companies' motivation to cooperate with the city and participate in the partnership model. One downside of the tendering process is that it only allows the companies that are based in Finland to submit an offer, which restricts the participation of the interested innovators from other countries that might be capable of accomplishing the goal of the development of Hiedanranta. However, as it is pointed out by the project manager, this is not a concern as the main goal of the project is not the pilots, but the creation of the partnership model and the discovery of the innovations and technologies that the companies already have at hand. As the companies are not identified yet and do not have a physical facility to provide for the development, they will act as material suppliers and equipment suppliers. In the evaluation phase of the project, scaling up the results to the city level and exporting the partnership model to other cities as a concept will be sought. The change of the driving actors and their roles in different phases of the project are listed in the Figure 1 below.

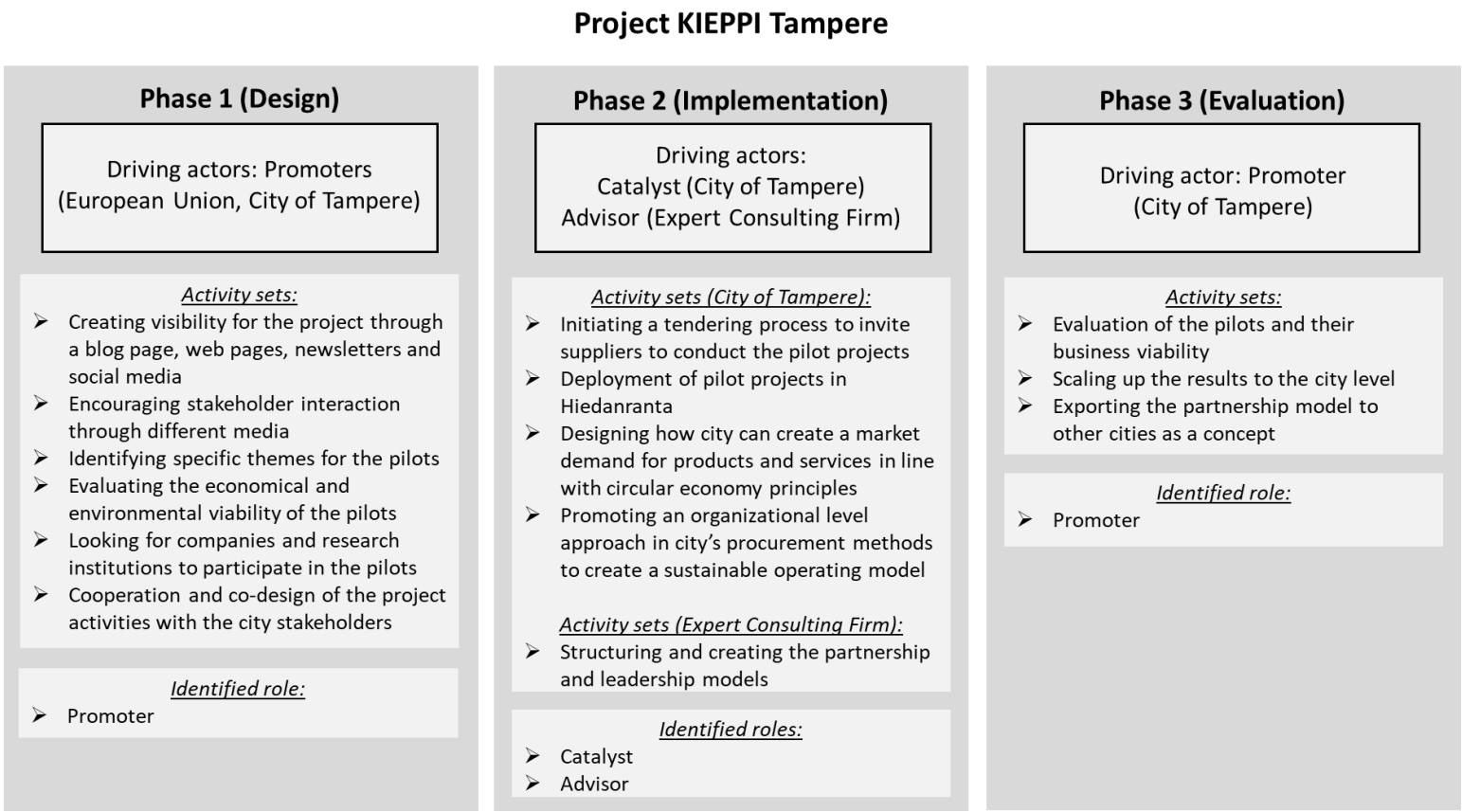

Figure 1 Driving actors and their roles in KIEPPI Tampere project.

Nutrient Recycling Projects in Hiedanranta Urban Living Lab

Nutrient recycling is one of the goals of the City of Tampere in the development of the Hiedanranta district towards making it a carbon-neutral and sustainable urban area. In line with this goal, several projects have been initiated in the area in cooperation with research organizations and companies, which are discussed next. The projects have a top-down approach as there is a push from European Union and the Ministry of the Environment in Finland to enhance nutrient recycling for the improvement of the environment and water bodies.

NutriCity is one of the projects aiming to reduce the amount of nutrient leakage into the Baltic Sea by recycling human waste nutrients through alternative sanitation solutions such as dry and vacuum toilet systems in the urban environment. The project is funded by the Ministry of the Environment of Finland and implemented by the City of Tampere together with Tampere University of Applied Sciences (TAMK) and The Finnish Environment Institute (SYKE). The ultimate goal of the project is to recover nutrients such as phosphorus and nitrogen from the human waste fractions through dehydration and produce fertilizers. Based on the results of the NutriCity project, an operating model for resource and energy-efficient management and utilization of nutrient containing wastewater fractions in cities will be created. The project manager of NutriCity represents the municipality and university and has a dual role in the project as she is part of both organizations, therefore bringing the technical knowledge into the municipality. According to the project manager, in Tampere there is a strong cluster of research in the use of alternative sanitation systems such as dry and vacuum toilets. The same actors from the cluster are usually involved in the projects associated with nutrient recycling. Project manager points out that although there is a pressure from authorities to recycle nutrients for more sustainable food production, major players in the food industry in Finland are unwilling to use grains that are produced with fertilizers made from wastewater sludge due to the risks of contaminants. Therefore, in practice, the low acceptance of the fertilizers made from recycled nutrients is a bottleneck in their market creation. This brings up the question if authorities, companies and researchers should come up with new strategies and solutions that would make such products accepted while ensuring that there are no risks to health and environment. The municipality has a catalyst role in all the nutrient recycling projects by offering the event venue Kuivaamo to be used for research purposes. The dry toilet systems in the event venue that were implemented by the dry toilet company make it possible to collect urine for conducting studies on its properties and suitability for use as fertilizers. The dry toilet company acts as an equipment supplier in the area. In the project, residents have both the roles of informant and tester, as they can test the dry toilets located in Hiedanranta and provide their feedback through an online survey that seeks resident opinions on utilizing alternative toilet solutions for urban nutrient cycles.

Another nutrient recycling project, Hierakka (Promoting nutrient cycle and participatory communication in Hiedanranta), was a one-year long project that started in 2017 and ended in 2018. The project was funded by the Ministry of the Environment of Finland and implemented by the City of Tampere together with Tampere University of Applied Sciences. The aim of this study was to determine the properties of separately collected urine, such as nutrient and harmful metal concentrations, drug and contaminant residues,

Event Proceedings: LUT Scientific and Expertise Publications: ISBN 978-952-335-466-1

and microbiological quality, and to investigate the possible effects of urine fertilizer use on the soil's physical properties such as acidity and organic matter content. The results of the study acted as a means to convince authorities, the food industry and farmers of the functionality of urine as a fertilizer and to change the attitude towards the use of urine fertilizers. The project focused on similar issues as NutriCity project does and used the same resources such as dry toilets in Hiedanranta and the funding source. The urine collected from the Hiedanranta dry toilets was tested as fertilizer in agricultural fields and in the vertical farming company located in Hiedanranta. The company acted as catalyst by offering its premises to the researchers for testing the effectiveness of the urine fertilizers on crops. In the project, local farmers had the tester role who tested urine fertilizers and saw their positive effect after harvesting in the late phase of the growing season.

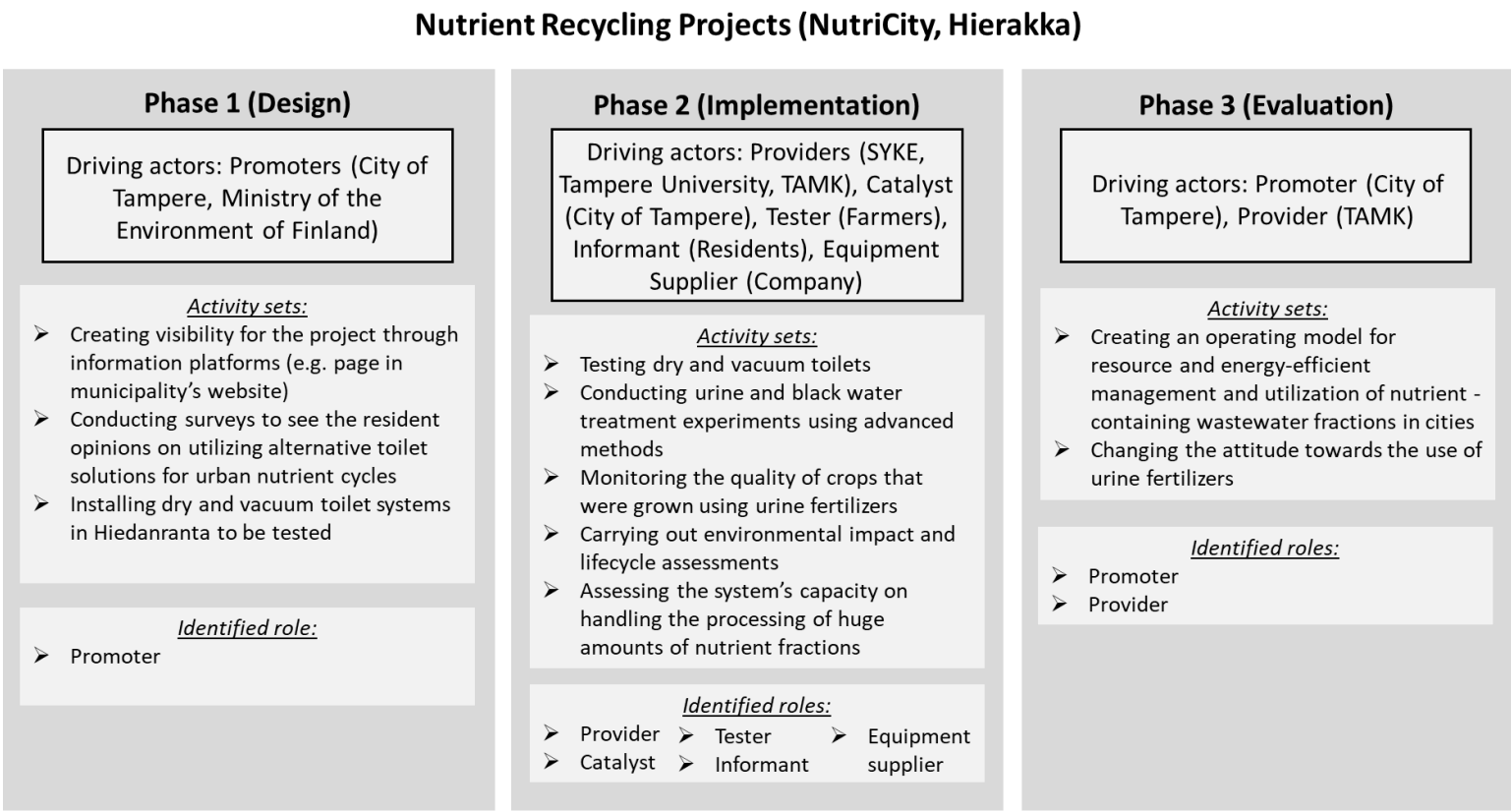

Figure 2 Driving actors and their roles in nutrient recycling projects.

UNaLab Project: Developing nature-based solutions

Climate change will affect Nordics by bringing more rain. Since the greenfield lands in cities are diminishing due to the newly built roads and houses as a result of densifying population, there is a risk of a reduction in the water infiltration capacity and loss of biodiversity. These issues emphasize the importance of nature-based solutions in urban areas. UNaLab is a European Union funded project that aims to implement nature-based solutions to tackle climate and water related challenges in the urban areas of three frontrunner cities, Tampere, Eindhoven and Genoa. Tampere as one of the frontrunner cities in the project has two locations for the implementation of the pilots, which are the city districts of Hiedanranta and Vuores. Objectives of the project are to develop the monitoring and impact of nature-based solutions, to develop business models around the nature-based solutions, and to engage people to co-create multi-functional nature-based solutions that work as parks and recreational areas for the residents. In our analysis, we will investigate the pilots in these two city districts where UnaLab Tampere deals with the water issues as part of the nature-based solutions.

The project has the same manager as the NutriCity project who represents the City of Tampere in the activities and events organized by UNaLab consortium. The consortium consists of 28 partners from 10 cities, including municipalities, research organizations, and businesses. One of the solutions implemented in Hiedanranta area is the biofilter for the contaminated waters caused by the nearby old pulp landfill. The system has been designed together with experts and the residents of the surrounding areas. The biochar company in Hiedanranta acted as a material provider by supplying the biochar to be used as biofilter. The projects in Vuores work as benchmark for the Hiedanranta development. In Vuores central, a hybrid stormwater management system, a medium sized retention pond, was built to retain and purify the stormwater. Water quality and flow are monitored through automatic measurements throughout the year. The residents acted as informant, tester, and designer in the project and shared their need of easy accessibility to forests and walk paths. The residents also took part in the design thinking workshops and contributed to the ideation process together with the city officials. Innovation vouchers were used to build horse paddock and community gardens in apartment buildings to attract more people to develop solutions together with the city.

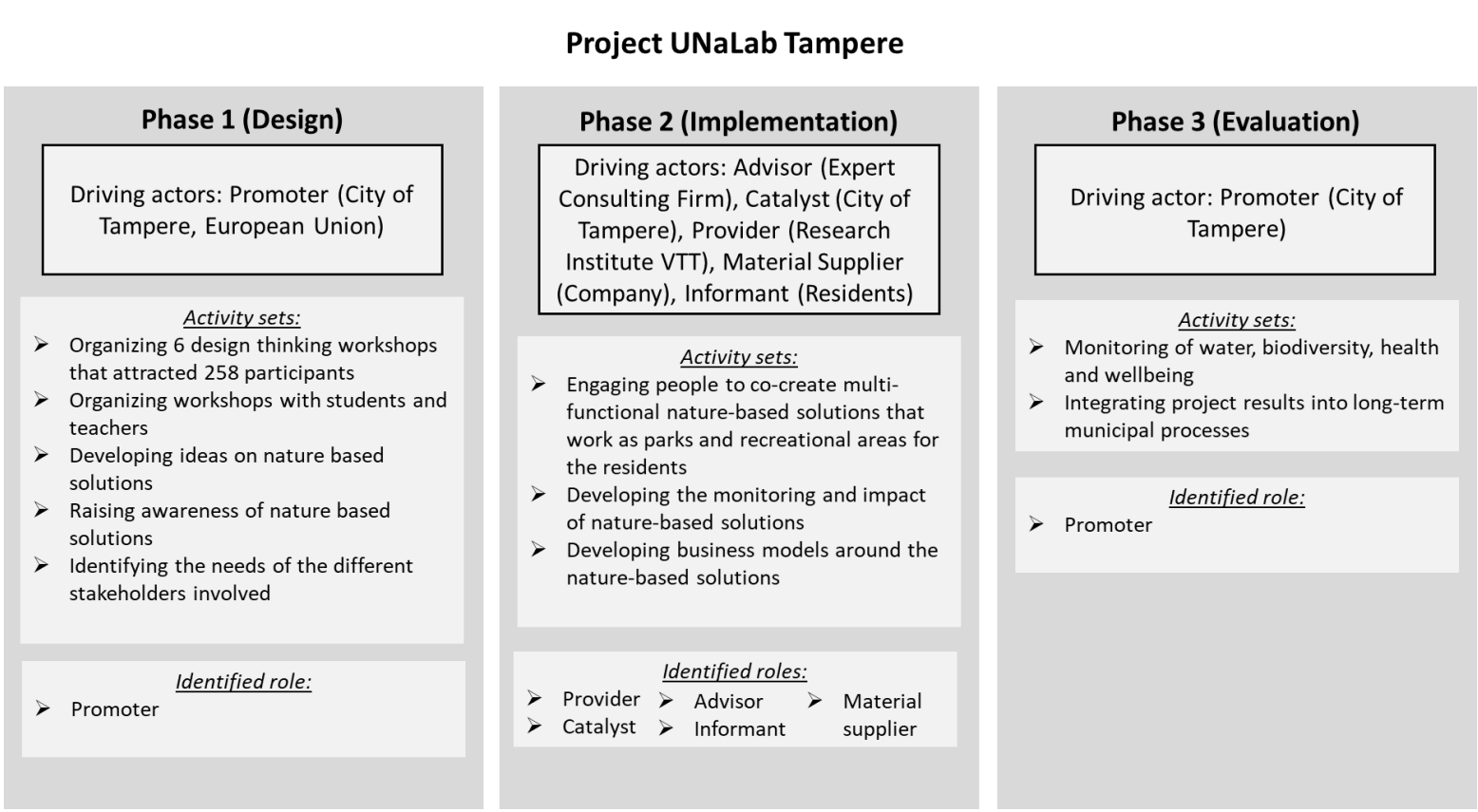

Figure 3 Driving actors and their roles in UNaLab Tampere project.

5 Conclusions

Our results lead to threefold findings. First, the creation of the urban living lab begins with the activities of the municipality and residents in the design phase, whereas in the implementation phase companies and research organizations have more responsibility for developing solutions to improve the infrastructure and technologies as new projects are introduced in the urban living lab. To exemplify the user involvement in the design phase, the designing process of the Hiedanranta urban living lab not only included the city planners but also residents who participated in public workshops and in an idea competition based on which the master plan of the city district was built.

Second, we argue that an urban living lab consists of various projects, and the driving actors may change in the project development phases depending on the required tasks and the competence and expertise level of the set of actors. In all the projects examined in the study, it was found that municipality facilitates the development by engaging other stakeholders such as technical experts, residents, and researchers. In the design phase of the projects, the municipality takes on promoter role, which shifts to a catalyst role in the implementation phase. The literature assigns many roles to municipalities such as regulator, promoter, consumer, sharer, data user, owner, host, investor, data provider, negotiator, partner, matchmaker, and communicator. However, to reduce the complexity, we suggest using two umbrella roles, promoter and catalyst, when further categorizing the other potential roles of the municipality that can be encompassed by the promoter and catalyst roles. Unlike other studies (Kronsell & Mukhtar-Landgren, 2018; Zvolska et al., 2019) our study only revealed the promoter and catalyst role of the municipalities and there was no evidence of the partner role according to its literature definition. This might

be due to the strong involvement of municipalities in the local sustainability governance, as the partner role indicates a weaker involvement in the development compared to other two municipality roles. Our study revealed the roles of the companies in urban living labs, which are catalyst, equipment supplier, material supplier, and advisor roles. The characteristics of the identified actor roles in urban living labs is listed in Table 2 below.

Table 2 Characteristics of identified actor roles in urban living labs (Adapted from Nyström et al., 2014)

Actor Role	*Characteristics*	*Examples from urban living lab projects*
Promoter (Similar to facilitator, coordinator, orchestrator)	Initiates, finances, and implements the urban living lab and calls on other actors to implement projects	Funding the projects and integrating project results into long-term municipal processes
Catalyst	Encourages action through partnerships and provides access to the resources such as facilities, buildings or expertise	Initiating a tendering process to invite suppliers to conduct the pilot projects
Equipment supplier	Supplies the required equipment for the development work	Supplying the dry toilet systems in the event venue for studying the properties of urine
Material supplier	Supplies required materials for the development work	Supplying the biochar material to be used as biofilter in the project
Advisor	Guides, supports and designs the development work due to its expertise	Structuring and creating the partnership and leadership models
Provider	Generates reliable knowledge through research	Developing the monitoring and impact of nature-based solutions
Informant	Provides information on the preferences, needs and problems of the everyday life	Providing feedback through online surveys
Tester	Uses and tests the developed or work-in-progress product, service or process	Testing urine fertilizers in local farms
Designer (Similar to co-creator)	Participates in the designing of a product, service or process with other actors	Taking part in the design workshops and contributing to the ideation process together with the city officials

The utilizer role of the companies was not evident in our analysis. This might be due to the fact that companies utilize the user data to develop and provide products and services that create value, which leads us to argue that being a utilizer do not directly contribute to the urban living lab goals, but rather indirectly influences and contributes to the main role of the companies in the urban living lab. Similarly, developer role of residents in urban living labs is also missing in the projects we analyzed, which is the role that has the highest level of user involvement. The study verified that roles may be shared by different actor types and change depending on the project requirements. As a summary, we conclude that a municipality can take on promoter and catalyst roles; companies can take on equipment supplier, material supplier, advisor, and catalyst roles; research organizations can take on provider role; and residents can take on informant, tester, and designer roles in urban living labs, which are visualized in Figure 4.

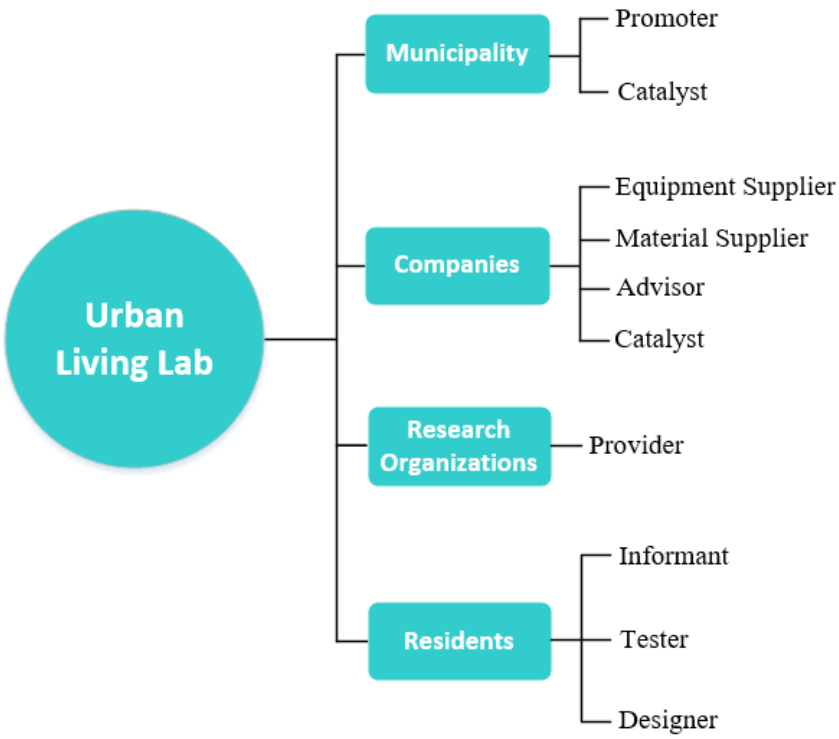

Figure 4 Driving actors and their roles in urban living labs.

Third, the ultimate goal of urban living labs is to introduce sustainable practices in the city district and this goal is shared among all the actors and visible in the projects. Companies perform carbon-neutral business activities that result in sustainable products. The project that deals with creating a partnership model for sustainable neighborhoods aims to provide resources for companies that have material circulation and sharing practices for waste reduction. The nutrient recycling projects inherently aim to recover nutrients from waste fractions that have potential to be utilized as fertilizers. Lastly, the project dealing with developing nature-based solutions aims to preserve the nature by purifying the stormwater that might otherwise contaminate the water bodies, thus contributing to the environmental sustainability of the region while benefiting from resident participation. The municipality coordinates the living lab actors and promotes the sustainability mentality in all activities regardless of the actor type.

6 Theoretical Contribution

Prior literature had documented the role of living lab actors, their role patterns (Nyström et al., 2014), and driving actors (Leminen et al., 2012), whereas this study contributes to the urban living lab literature by discussing and analyzing the actor roles in urban living labs (Juujärvi & Pesso, 2013), and their dynamics in the development of a city district that is considered an urban living lab. Our findings uncover three theoretical contributions. First, the study proposes that a driving party (or parties) may change in

different phases in the urban living lab projects as the activities evolve. The urban living labs are created engaging the municipality and residents in the beginning and in the later stages companies and research organizations are involved due to their higher skill levels regarding the implementation of the projects. Second, the study reveals the newly identified roles that the actors undertake in urban living labs on top of the already identified roles in the previous living lab literature (Leminen et al., 2012; Nyström et al., 2014). The newly identified roles are especially related to the tasks that concern municipalities and companies in urban living labs. Third, the number of research projects, the number of active companies in the living lab, their size and scope, and municipality's open mindset to try out novel applications in the city district play a major role when determining the impact and level of contribution of a certain actor type to the development and sustainability of an urban living lab.

7 Practical Implications

This study highlights several practical implications. First, to achieve favorable results in the city development projects, the dwellers of a city district who practice sustainable living, businesses that contribute to circular economy, research organizations, and municipalities as governing bodies are suggested to collaborate and cooperate. As the initiator of the urban living lab, municipalities should attract businesses and create new jobs based on the ideology of circular economy. Second, the needs of the inhabitants of the district should be considered while testing and co-creating with them and the sustainability aspect should be emphasized. For a city district that is planned to be carbon-neutral, it is crucial to note that in the process of urban growth, the flow of materials should circulate as closed and resource-efficient as possible. Third, a living lab platform provides the opportunity of small-scale testing of the circulation of the nutrients with the cooperation of municipalities, researchers, users, and companies. In order to increase the sustainability of a living lab, pilots can be run where one company's side stream can be the raw material of another.

Acknowledgements

This work was supported by Strategic Research Council, Academy of Finland, through the project entitled "Circular Economy Catalysts: From Innovation to Business Ecosystems" (CICAT2025) (grant ID 320194); the Academy of Finland, through the project entitled "Profi4 - Urban Platform for the Circular Economy" (UPCE) (grant ID 318940); and the research grant that is awarded to Anil Engez by the Jenny and Antti Wihuri Foundation.

References

Bergvall-Kareborn, B., & Stahlbrost, A. (2009). Living Lab: an open and citizen-centric approach for innovation. *International Journal of Innovation and Regional Development*, *1*(4), 356–370. https://doi.org/10.1504/ijird.2009.022727

Bulkeley, H., & Betsill, M. M. (2013). Revisiting the urban politics of climate change. *Environmental Politics*, *22*(1), 136–154. https://doi.org/10.1080/09644016.2013.755797

Bulkeley, H., Coenen, L., Frantzeskaki, N., Hartmann, C., Kronsell, A., Mai, L., Marvin, S., McCormick, K., van Steenbergen, F., Voytenko Palgan, Y. (2016). Urban living

labs: governing urban sustainability transitions. *Current Opinion in Environmental Sustainability*, *22*, 13–17. https://doi.org/10.1016/j.cosust.2017.02.003

Bulkeley, H., & Kern, K. (2006). Local Government and the Governing of Climate Change in Germany and the UK. *Urban Studies*, *43*(12), 2237–2259. https://doi.org/10.1080/00420980600936491

Chronéer, D., Ståhlbröst, A., & Habibipour, A. (2019). Urban Living Labs: Towards an Integrated Understanding of their Key Components. *Technology Innovation Management Review*, *9*(3), 50–62. https://doi.org/10.22215/timreview/1224

Evans, J. (2006). Lost in translation? Exploring the interface between local environmental research and policymaking. *Environment and Planning A*, *38*(3), 517–531. https://doi.org/10.1068/a37393

Evans, J., & Karvonen, A. (2014). "Give Me a Laboratory and I Will Lower Your Carbon Footprint!" - Urban Laboratories and the Governance of Low-Carbon Futures. *International Journal of Urban and Regional Research*, *38*(2), 413–430. https://doi.org/10.1111/1468-2427.12077

Fenwick, J., Johnston Miller, K., & McTavish, D. (2012). Co-governance or meta-bureaucracy? Perspectives of local governance 'partnership' in England and Scotland. *Policy and Politics, 40(3),* 405–422. doi:10.1332/147084411X581907

Frantzeskaki, N., Wittmayer, J., & Loorbach, D. (2014). The role of partnerships in "realising" urban sustainability in Rotterdam's City Ports Area, the Netherlands. *Journal of Cleaner Production*, *65*, 406–417. https://doi.org/10.1016/j.jclepro.2013.09.023

Geels, F. (2011). The role of cities in technological transitions: Analytical clarifications and historical examples. In H. Bulkeley, V. Castán Broto, M. Hodson, & S. Marvel (Eds.), Cities and low carbon transitions (pp. 13–18). London: Routledge.

Hossain, M., Leminen, S., & Westerlund, M. (2019). A systematic review of living lab literature. *Journal of Cleaner Production*, *213*, 976–988. https://doi.org/10.1016/j.jclepro.2018.12.257

Ingstrup, M. B., Aarikka-Stenroos, L., & Adlin, N. (2020). When institutional logics meet: Alignment and misalignment in collaboration between academia and practitioners. *Industrial Marketing Management*, (December 2019), 1–10. https://doi.org/10.1016/j.indmarman.2020.01.004

Juujärvi, S., & Pesso, K. (2013). Actor Roles in an Urban Living Lab: What can we learn from Suurpelto, Finland? *Technology Innovation Management Review*, *3*(11), 22–27. Retrieved from http://timreview.ca/article/742

Kronsell, A., & Mukhtar-Landgren, D. (2018). Experimental governance: the role of municipalities in urban living labs. *European Planning Studies*, *26*(5), 988–1007. https://doi.org/10.1080/09654313.2018.1435631

Leminen, S., Nyström, A.-G., & Westerlund, M. (forthcoming). Change processes in open innovation networks – exploring living labs. *Industrial Marketing Management*.

Leminen, S., & Westerlund, M. (2019). Living labs: From scattered initiatives to a global movement. *Creativity and Innovation Management*, *28*(2), 250–264. https://doi.org/10.1111/caim.12310

Leminen, S., Rajahonka, M., & Westerlund, M. (2017). Towards Third-Generation Living Lab Networks in Cities. *Technology Innovation Management Review*, 7(11), 21–35. https://doi.org/10.22215/timreview/1118

Leminen, S., Westerlund, M., & Nyström, A. G. (2014). On Becoming Creative Consumers – User Roles in Living Labs Networks. *International Journal of Technology Marketing*, *9(1),* 33-52. https://www.inderscienceonline.com/doi/abs/10.1504/IJTMKT.2014.058082

Leminen, S., Westerlund, M., & Nyström, A. (2012). Living Labs as Open-Innovation

Networks. *Technology Innovation Management Review*, *2*(9), 6–11. https://doi.org/10.13140/RG.2.1.2423.5281
Loughlin, J. (2000). Introduction: The transformation ofthe democratic state in Western Europe. In J. Loughlin (Ed.), Subnational democracy in the European Union: Challenges and opportunities (pp. 1–33). Oxford: Oxford University Press.
Menny, M., Voytenko Palgan, Y., & McCormick, K. (2018). Urban living labs and the role of users in co-creation. *GAIA - Ecological Perspectives for Science and Society*, *27*(1), 68–77. https://doi.org/10.14512/gaia.27.S1.14
Nyström, A. G., Leminen, S., Westerlund, M., & Kortelainen, M. (2014). Actor roles and role patterns influencing innovation in living labs. *Industrial Marketing Management*, *43*(3), 483–495. https://doi.org/10.1016/j.indmarman.2013.12.016
Steinfeld, H., Gerber, P., Wassenaar, T., Castel, V., Rosales, M., de Haan, C. (2006). Livestock's Long Shadow: Environmental Issues And Options. Rome, Food and Agriculture Organization of the United Nations.
Vangen, S., Hayes, J. P., & Cornforth, C. (2015). Governing Cross-Sector, Inter-Organizational Collaborations. *Public Management Review*, *17*(9), 1237–1260. https://doi.org/10.1080/14719037.2014.903658
Voytenko, Y., McCormick, K., Evans, J., & Schliwa, G. (2016). Urban living labs for sustainability and low carbon cities in Europe: Towards a research agenda. *Journal of Cleaner Production*, *123*, 45–54. https://doi.org/10.1016/j.jclepro.2015.08.053
Zvolska, L., Lehner, M., Voytenko Palgan, Y., Mont, O., & Plepys, A. (2019). Urban sharing in smart cities: the cases of Berlin and London. *Local Environment*, *24*(7), 628–645. https://doi.org/10.1080/13549839.2018.1463978

Appendix

Table 3 Interviews

Actor type	*Role*	*Theme*
Municipality/ Researcher	Project Manager (Urban planning/ Nutrient recycling)	Ongoing nutrient recycling projects in the city associated with the development of the region
Municipality	Project Manager (Urban planning)	Stakeholder engagement in the city development
Municipality	Project Manager (Urban planning)	Ongoing development on the partnership model for sustainable neighborhoods
Researcher	Project Manager (Nutrient recycling)	Research on dry toilets and utilization of nutrients from urine
Researcher	Project Manager (Nutrient recycling)	Research in microalgae plant and using nutrients for microalgae growth
Company	General Manager	Nutrient recycling activities in the vertical farming facility in the area
Company	General Manager	Information about the biochar company and its operations
Company	General Manager	Information about the dry toilet company and its operations
Association	Project Manager	Benefits of dry toilet on nutrient recycling

This paper was presented at The ISPIM Innovation Conference – Innovating in Times of Crisis, 7-10 June 2020.
Event Proceedings: LUT Scientific and Expertise Publications: ISBN 978-952-335-466-1

and required policy and infrastructure changes for its adoption