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Urban Living Labs and the Role of Users in Co-Creation

Users as co-creators? We examine how urban living labs (ULLs) effectively engage in a participatory methodology that facilitates co-creation with users, and discuss the link between user involvement and the transformative potential of ULLs. User involvement, governance structure, leadership and power distribution are important factors for ULLs to become transformative.

Mascha Menny, Yuliya Voytenko Palgan, Kes McCormick

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Abstract
Urban living labs (ULLs) offer opportunities to foster sustainability in cities. They are sites to design, test and learn from innovation in real time. A key element in the operation and success of ULLs is user involvement. Users are often viewed as co-creators who shape ULL outcomes by contributing with their knowledge and experience. The transformative potential of ULLs for sustainability is often interconnected with user participation. Despite its importance, user involvement in ULLs remains a practical challenge that is also understudied. In this article, we examine how ULLs engage in a participatory methodology that facilitates co-creation with users, and discuss the link between user involvement and the transformative potential of ULLs. While co-creation is a cornerstone of the ULL concept, we also show that a combination of different user participation levels in different stages of the ULL life cycle has a potential to enhance the outcomes and transformative potential of ULLs. User involvement plays a positive role in realising the transformative potential of ULLs for sustainability, but governance structure, leadership and power distribution are also important factors for ULLs to become transformative.

Keywords
co-creation, experimentation, participation, sustainability, urban living lab, user involvement

Delivering sustainable urban transformation demands collaboration across sectors and between organisations as well as engaging users and citizens (Bulkeley et al. 2016, Voytenko et al. 2016, Luederitz et al. 2017). New forms of governance are being developed and tested in cities, such as urban living labs (ULLs) (Voytenko et al. 2016). The *Joint Programming Initiative (JPI) Urban Europe,* which is a prominent funding source for ULLs, defines them as "a forum for innovation, applied to the development of new products, systems, services, and processes, employing working methods to integrate people into the entire development process as users and co-creators, to explore, examine, experiment, test and evaluate new ideas, scenarios, processes, systems, concepts and creative solutions in complex and real contexts" (JPI Urban Europe 2013, p. 29).

ULLs can be included under a broader umbrella of real-world laboratories (RwLs) (Schäpke et al. 2017b) along with other experimental research approaches such as living labs (Almirall et al. 2012), urban labs, change labs, urban (sustainability) transition labs (Nevens et al. 2013, Forrest and Wiek 2015), sustainable living labs, city labs, smart city initiatives, community-based initiatives, niche experiments (Schäpke et al. 2017a) and social innovation labs (Westley et al. 2014, Seyfang and Longhurst 2013). This variety of definitions is accompanied by slightly different characteristics of each approach.[1] However, common themes include the experimental setting, the element of transdisciplinary knowledge co-creation between RwL stakeholders and the transformative potential of RwLs (Schäpke et al. 2017b). Since public participation plays an important role within urban governance (Arnstein 1969, Ebbesson et al. 2014), we focus on ULLs which emphasise the in-

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volvement of citizens as users. The findings are nevertheless relevant for other RwLs and experimentation that includes citizens.

Participation of different stakeholders is viewed as a key ULL characteristic that is critical for ULLs to achieve their goals of addressing urban sustainability challenges (Juujärvi and Pesso 2013, Voytenko et al. 2016). Terms such as co-creation, co-production, participation, involvement, empowerment, quadruple-helix model, and multi-stakeholder or public-private-people partnership are used to describe the collaborative aspects of ULLs (Baccarne et al. 2014, Budweg et al. 2011, Franz 2015, Leminen 2013, Schuurman and De Marez 2012, Westerlund and Leminen 2011). ULLs are thus expected leading to more effective outcomes that enjoy a higher acceptance among different stakeholders (Schäpke et al. 2017b, Salter and White 2013, Voytenko et al. 2016). It is argued that "by producing knowledge 'in the real world' and 'for the real world', urban laboratories can catalyze rapid technical and economic transformation" (Evans and Karvonen 2014, p. 415).

At the same time, the role of stakeholders and particularly citizens, and the desired level of their involvement[2] in ULLs are not fully understood (Franz et al. 2015, Juujärvi and Pesso 2013, Menny 2016). There is some research on user participation in living labs, however, the studies that go beyond highlighting its importance in the broader concept of ULLs are limited. While a high degree of participation is often emphasised as important (Buhr et al. 2016, Schuurman and De Marez 2012), few studies analyse the level of participation and the methods to involve users and citizens in ULLs (Menny 2016). Moreover, there is little understanding on how different levels of user involvement in ULLs connect to their transformative potential for sustainability. Inspired by the transformative science approach (cf. Schneidewind 2015, Schneidewind et al. 2016, Schäpke et al. 2017a), we conceptualise the transformative potential of ULLs for sustainability as their ability to initiate and catalyse change processes by advancing sustainable innovations that help address socio-economic and environmental challenges in cities.

Therefore, we examine how ULLs engage in a participatory methodology that facilitates co-creation with users, and discuss the link between user involvement and the transformative potential of ULLs. We explore two research questions (RQ):

- ***RQ1:*** Through which means and at which participation level are users involved in design, implementation and evaluation of the studied ULLs?
- ***RQ2:*** What role does the level of user participation in the studied ULLs play for their transformative potential for sustainability?

We apply a multiple case study research design. The four cases were identified using the *European Network of Living Labs (ENoLL)* database, online information on major ULL projects in Europe and recommendations from experts. The primary ULL was to select ULL cases that were diverse in terms of their leadership model after Leminen et al. (2012) to be able to discuss the potential implications of different ULL leadership models and different actor constellations for the user involvement processes. Leading actors include companies (utiliser-driven ULL), public sector organisations and NGOs (enabler-driven ULL), knowledge institutes and consultancies (provider-driven ULL), and user communities (user-driven ULL). Cases were selected following the key ULL characteristics by Voytenko et al. (2016).

The cases represent only mature and finalised ULLs as this allowed collecting data from several stages of the ULL lifetime. It was deemed useful to select cases from different geographical locations (i.e., Sweden and Germany) and of different sizes to be able to map and discuss a range of factors that may affect user involvement. ULL topics vary from lighting, participation in urban development over smart city activities to mobility. An overview of the studied cases – *New Light on Alby Hill (Alby)*, *Nexthamburg*, *T-City Friedrichshafen (T-City)*, and *UbiGo* – is provided in table 1 (p. 70). Data was collected through a literature review, 19 semi-structured interviews with ULL stakeholders and experts, and participation in conferences.

Literature Review and Analytical Framework

In this article, the terms "participation" and "user involvement" are defined as "a process where individuals, groups and organisations choose to take an active role in making decisions that affect them" (Reed 2008, p. 2418). Public participation is a core element of good governance and essential for modern democracies, being closely linked to human rights (Arnstein 1969, Ebbesson et al. 2014). ULL actors are citizens, businesses, public agencies, knowledge institutes, NGOs, special interest groups, small and medium-sized enterprises and municipalities (Franz et al. 2015). User involvement is implied by the experimental setting of ULLs (Voytenko et al. 2016). Users help design and develop innovations (Nyström et al. 2014), and test new ways of addressing sustainability challenges (Bulkeley et al. 2016, Franz 2015). Buhr et al. (2016, p. 27) highlight that ULLs "go beyond engaging urban stakeholders and residents (...) in that various stakeholders are partners throughout the co-creative process".

The active involvement of users from the early stages of the ULL is important to ensure that they can shape the process rather than just respond to it (Bergvall-Kåreborn and Ståhlbröst 2009, JPI Urban Europe 2013). It helps to identify the needs of users and ensures a common vision (Baccarne et al. 2014, Devaney et al. 2014, Salter and White 2013). Users can provide specific knowledge based on their experience, needs, and preferences. User involvement >

1 For example, living labs have a stronger focus on technological innovation, and user-based knowledge is mainly a tool for commercialisation of such innovation (Almirall et al. 2012). ULLs favour user involvement to strengthen democracy and social justice in the city (Voytenko et al. 2016). While in RwLs the city is rather seen as a context for transformative experimentation (Schäpke et al. 2017b), in ULLs city governments act as prominent partners making ULLs a form for experimental urban governance.

2 In this article the terms "involvement", "participation" and at times "engagement" are used as synonyms to describe the integration of users or citizens in the ULL processes.

TABLE 1: Overview of analysed urban living labs.

	NEW LIGHT ON ALBY HILL	NEXTHAMBURG	T-CITY FRIEDRICHSHAFEN	UBIGO
aim	enhancing social and environmental sustainability by experimenting with new LED technology to turn a pathway for pedestrians into a more attractive and secure walkway	to encourage citizens to develop and discuss ideas for the future urban development of Hamburg	to test how innovative information and communication technology (ICT) can contribute to addressing future urban challenges	■ to make travel behaviours of Gothenburg citizens more sustainable ■ to develop and test a business model for a travel broker service
duration	2013 to 2016	2009 to 2011	2006 to 2012	2012 to 2014
location	Alby, Sweden	Hamburg, Germany	Friedrichshafen, Germany	Gothenburg, Sweden
partners	■ Municipality of Botkyrka ■ IVL Swedish Environmental Research Institute ■ Mitt Alby housing company	■ *Urbanista/Nexthamburg* team ■ citizens	■ Deutsche Telekom ■ City of Friedrichshafen	■ Chalmers University of Technology ■ Viktoria Institutet ■ Volvo IT ■ Arby Kommunikation
type by leading actor (Leminen et al. 2012)	enabler-driven	user-driven	utiliser-driven	provider-driven
outcome and its relation to urban sustainability challenges	Testing of new LED lighting technologies and co-design of light installations. Positive effect on the attractiveness of the walkway and some positive effects on the sense of security, mainly among women.	Creating a virtual and physical space to discuss ideas. Co-creation of a citizens' vision for Hamburg with ideas developed by the citizens. *Nexthamburg* is now a registered self-funded association, which sells its expertise and collaborates with city actors.	Building a test bed for smart city technologies and projects Telekom installed the fastest available broadband connection in the city. Citizens could make use of applications on the basis of this new broadband technology. Participants of the Smart Meter project could reduce their electricity consumption.	Piloting of a travel broker service. More than half of the participants reported after the field operational test that their travel behaviour had changed leading to a decrease in a private car use. Almost all the participants liked the travel broker service and did want to continue using it. A relaunch based on the experiences is planned for 2018 in Stockholm.

empowers citizens and enhances their feeling of co-owning the decisions strengthening trust and commitment to the ULL goals (Friedrich et al. 2013, Juujärvi and Lund 2016). As such, user involvement is a key element in the operation and success of ULLs but should not be seen as an end in itself.

Participation of users includes giving feedback, answering questions, voting, and contributing to the development processes and decision-making via other means (Friedrich et al. 2013). According to Leminen (2013), a participation approach in ULLs can be inhalation-dominated (i. e., utiliser- and user-driven) where ULLs are more authoritative in serving the needs of their leading actors, and exhalation-dominated (i. e., provider- and enabler-driven) where ULLs seek to fulfil the needs of other stakeholders. The coordination of an innovation mechanism is "top-down" or "bottom-up" with the latter more likely to support higher levels of user involvement.

Studies have examined user roles in living labs and degrees of user involvement. Schuurman and De Marez (2012) categorise modes of user innovation as design for, with and by users. Design *with* users is considered as the most common mode of user innovation while design *by* users is not as dominant. Similarly, Nyström et al. (2014) classify users as informants, testers, contributors and co-creators and pose that more than one role is normally present. While co-creator is a less frequently adopted role, contributor is the most common one, followed by informant and tester.

Meyer-Soylu et al. (2016) analyse an RwL looking at a five-step model of participation (information, consultation, cooperation, collaboration, empowerment). Despite determining that the RwL under analysis has applied all five levels, the presence of so-called participation hybrids has been identified, that is, participation formats that integrate more than one level of participation. Furthermore, their analysis shows a tendency of increasing levels of participation over time. Stauffacher et al. (2008) study the involvement of stakeholders and the public in societal decision processes. Looking at the ladder of participation introduced by Arnstein (1969) with its eight levels of citizen empowerment ranging from no participation to the highest degree of citizen control,[3] they state that the boundaries between the different participation levels are blurry and permeable.

While the metaphor of the ladder suggests that the aim of participation is to strive after its highest level, this view is not unquestioned. It is often highlighted that different contexts may require different levels of participation (Davidson 1998, Fung 2006, Hage et al. 2010). Fung (2006, p. 67) emphasises that in some contexts public empowerment may be strived after, "but there are certain-

3 These include non-participation (manipulation, therapy), degrees of tokenism (informing, consultation, placation) and degrees of citizen power (partnership, delegated power, citizen control).

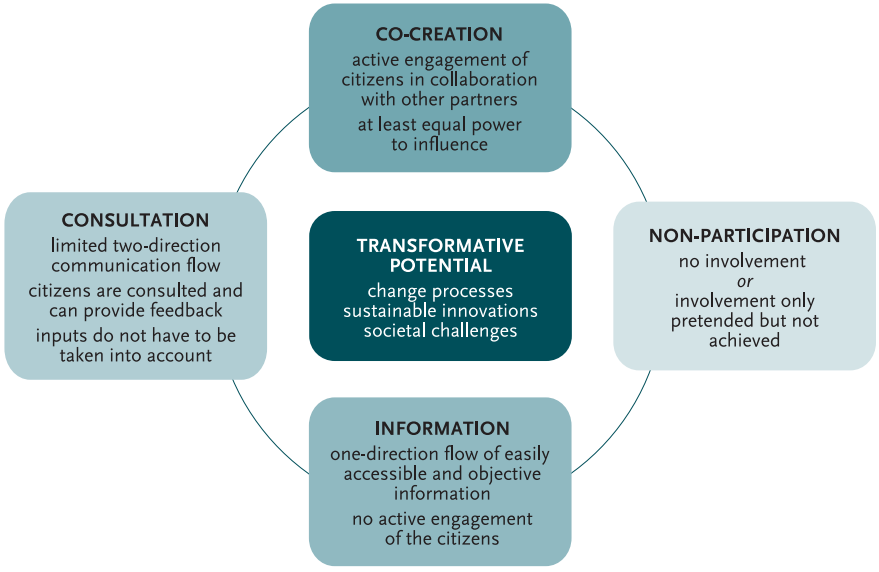

FIGURE 1: Analytical framework: categorisation of user involvement and transformative potential. The four levels of user involvement are on the ring. The centre presents the research themes for the analysis of the transformative potential.

ly others in which a consultative role is more appropriate for members of the public". Krütli et al. (2010) highlight that appropriate involvement methods depend on the function of participation, the number of people as well as their expertise and the topic itself. The level of participation also has to consider the heterogeneity among and within stakeholder groups (Luyet et al. 2012). Davidson (1998, p. 14) therefore suggests replacing the ladder by a *wheel of participation* as it "promotes the appropriate level of community involvement to achieve clear objectives, without suggesting that the aim is always to climb to the top of the ladder."

Taking up this idea, we analyse the levels of participation in four ULL cases based on the framework developed in figure 1. We define four categories of user involvement: co-creation, consultation, information, non-participation. While the highest level of user involvement can be further specified and subdivided into the levels of collaboration and empowerment (Meyer-Soylu et al. 2016, Stauffacher et al. 2008), it was chosen to use *co-creation* as a broader term that includes both, collaboration and empowerment, to be consistent with the terminology that is typically used to define the concept and characteristics of ULLs. Co-creation refers to the ability of citizens to actively engage in decision-making processes with at least equal power to influence them compared to other decision-making bodies.

ULLs undergo three stages in their development: 1. *design,* when the context is grasped and activities are designed and developed; 2. *implementation,* when the ideas are put into practice; and 3. *evaluation,* when learning is achieved and ULL outcomes are improved (Friedrich et al. 2013). The evaluation often happens throughout the project lifetime so that its results can be directly fed into ULL processes. These stages are thus not clearly distinguishable and often overlap. We analyse to which extent the four studied ULLs involve users in each of the three development stages, and if the level of co-creation is achieved (RQ1).

We also seek to uncover the implications that different levels of user participation have for sustainable urban transformation in the studied ULLs (RQ2). Following the above definition of the transformative potential of ULLs for sustainability, research themes for this analysis include "change processes", "sustainable innovations" and "societal challenges" (see center of figure 1). We argue that a ULL can be considered successful if it has realised its transformative potential for sustainability, that is, initiated and catalysed change processes by advancing sustainable innovations and addressing societal challenges with these innovations. Guiding questions to uncover the mechanisms that link user involvement and transformative potential of ULLs are provided in table 2.

Levels of User Participation in Urban Living Labs and Transformative Potential

Comparing the results from the four ULL cases, we first discuss through which means and at which participation levels the users are involved in the design, implementation and evaluation of each ULL (RQ1). Figure 2 (p. 72) summarises the different participation levels. We then discuss the potential role of the level of user involvement in the four ULLs in relation to their transformative potential for sustainability (RQ2).

Design Stage

User involvement is important in designing an ULL since including users early in the process helps identify their needs (Devaney et al. 2014, Salter and White 2013), and ensures that all stakeholders follow a common vision. In all four ULL cases the users were not actively involved in developing the initial idea but, with the >

TABLE 2: Questions guiding the analysis of links between user participation and the transformative potential of urban living labs for sustainability.

THEMES	GUIDING QUESTIONS
change processes	How is the initiation and catalisation of change processes linked to the level of user participation in each ULL?
sustainable innovations	How is the advancement of sustainable innovations by the ULL linked to the level of user participation in it?
societal challenges	How is the level of user participation linked to how the ULL addresses socio-economic and/or environmental challenges in cities?

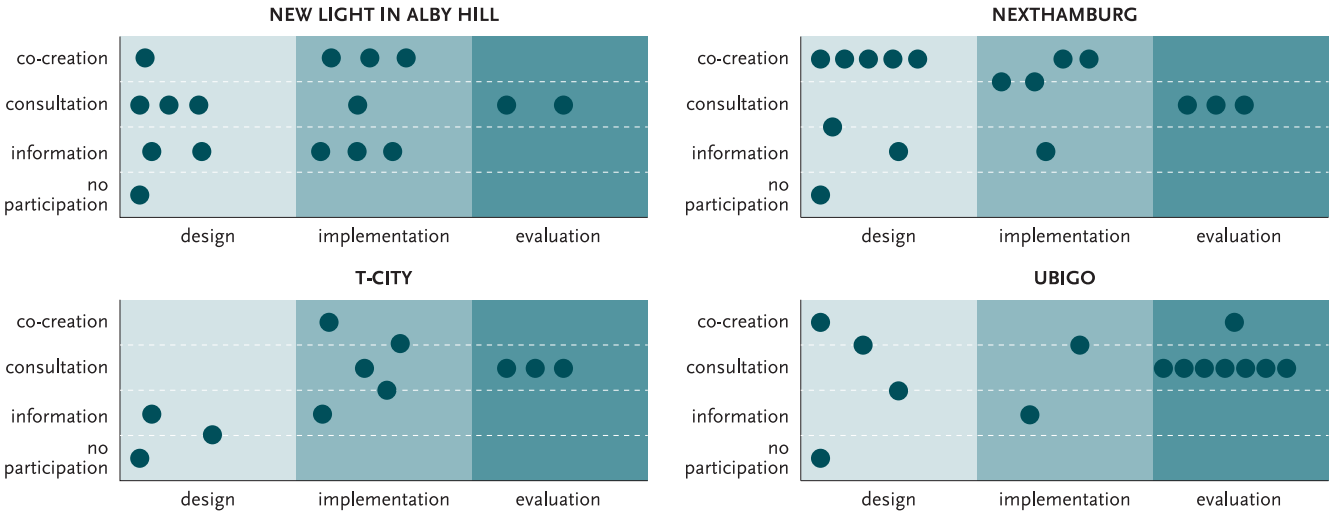

FIGURE 2: Levels of user involvement along the life-cycle phases in the analysed urban living labs. Each circle represents one involvement method and indicates the level of user participation that this involvement method helps to achieve.

exception of *T-City*, were still involved in shaping this idea and the ULL design to varying extents.

In the case of *Alby* the development of the initial idea was based on previous citizen consultation via surveys and safety walks. In the other cases the initial idea was informed by expert knowledge. It was then presented to citizens, who were thus involved on the level of information. The steps after the initial idea development differ between the cases. The subsequent user participation in *T-City* was restricted to making short marketing videos, where citizens could state their interest in *T-City*. Even though the project partners aimed to inform the population to ensure inclusiveness, the methods of involvement partly failed to reach the targeted citizens. In practice, the level of involvement is thus considered as very low (information to partly no participation).

In the design phase, the project partners of *Alby* contacted schools, youth clubs and the resident council for their insights on the ULL design. While the schools and youth clubs were only consulted, the resident council's involvement contained elements of co-creation. Before the final decision, the representatives were invited to comment on the project. The level of consultation was achieved with citizen questionnaires on the perceived sense of security and the people's needs.

The initial idea for *Nexthamburg* was further developed after a public discussion with citizens (consultation). During a one-year pilot, the project idea was specified through citizen workshops, online dialogues, and an ideas contest for citizens. They decided which ideas would be further developed, and the *Nexthamburg* team played a supporting role. Even though *Nexthamburg* was open to all citizens and aimed for a broad participation, only a small portion of the Hamburg population was involved. Certain citizen groups were more difficult to reach than others, and it was challenging to involve a representative group of the city population. However, those citizens who wanted to take part had the possibility to shape and co-create *Nexthamburg*.

To develop the project idea of *UbiGo*, potential users were consulted through information meetings, discussions, interviews and focus groups. The aim of the latter was mainly to get a better understanding of the potential users (consultation). However, the interview findings also intended to shape the service, that is, some co-creative elements are present. Ten people tested the travel broker service during the *UbiGo* pilot and could influence the field operational test by trying out the app and the service and providing feedback. Their involvement is viewed as co-creation, even though the final decision power was with the leading project partners.

To summarise, the user involvement in the design phase of the cases included all four participation levels from no participation to co-creation. However, only in user-driven *Nexthamburg* final decision-making power was transferred to the citizens. In the other cases, final decisions were made by the leading project partners. A common difficulty was to involve a representative citizen group.

Implementation Stage

Reed (2008) argues that public participation typically happens in the implementation phase of a project cycle. The case analysis indicates a similar observation, showing that the overall level of user engagement in the four cases is higher in the implementation than in the design phase. In all cases, there was at least a smaller group of citizens effectively engaged in co-creative activities during implementation. While some methods of involvement were open to every interested citizen (e. g., the ideas competition in *Nexthamburg* or the image competition in *Alby*), others were restricted to a selected citizen group (e. g., the participants of the *UbiGo* field operational test or the "futurists" of *T-City*).

The user involvement in *Alby* during implementation was extended from engaging the resident council to inviting interested residents of *Alby* to be part of the image competition. The information about the possibility to contribute with images and voting

for images was spread via different channels. The citizens were thus empowered to co-create the pathway's appearance (figure 3). Only the test lighting and the selection of an appropriate LED technology were limited to the ULL project partners and the resident council, which allowed for a manageable number of participants to discuss lighting solutions. Presenting the new ambient lighting and the light installations at the official opening ceremony informed the citizens about the co-creation results. The project partners considered this form of feedback important as it made the influence of citizens visible and thus rewarded their participation.

In *Nexthamburg,* interested citizens created their visions and selected the ideas for the final project output – "the citizens' vision" – by participating in workshops and the interactive event *Future Camp*. As in the design phase, the project partners only had a supporting role so that user involvement reached the level of co-creation. However, most of the ULL users used the *Nexthamburg* online platform for information rather than as a possibility to contribute. This resulted in few citizens taking part in co-creative activities.

UbiGo engaged with a smaller group of citizens in its implementation, namely the participants of the field operational test. All interested citizens who fulfilled the project requirements could be part of the field test. In the latter, the business model and the travel service were tested by the participants, who co-created their own mobility service by defining their travel needs and their subscription model. At a larger scale, namely the development of the business model behind *UbiGo,* they tested the service and provided feedback. However, due to the limited time and budget, the suggestions by users were not incorporated in the field operational test. The aim was instead to use this feedback to shape the mobility service before launching the new business.

T-City aimed for a broad user participation in the implementation phase. Public awareness campaigns informed the citizens and invited them to contribute with ideas and to test new products and services. Lessons were learned from the difficulties to involve the citizens, and new forms of communication and engagement were tested. Users could become "ambassadors" and inform other citizens about *T-City* projects. While they mainly served as informants, they also consulted other citizens about their wishes regarding the project and the development of information and communication technologies. Citizens could also become "futurists" testing high-tech equipment in their homes and providing feedback, and in this way could influence further product devel- >

FIGURE 3: Light installation projected on rock wall along the walkway in Alby Hill, Sweden. In the urban living lab *New Light on Alby Hill,* one form of user involvement was an image competition, asking residents to submit and vote for artistic decoration of the walkway.

opment. Even though *T-City* intended to achieve a high and broad level of participation, they partly failed to raise the citizens' interest. One reason was that the smart city topic was not tangible enough. The project experienced a learning curve, and the involvement of citizens increased over time. Co-creation was mainly achieved within certain subprojects but also the framing of the *T-City* project allowed for co-creational elements. Consultation was, however, the most dominant form of user involvement during implementation.

It can be concluded that the level of user involvement during ULL implementation was higher than during the design in all four cases. A possible reason is that all ULLs put an emphasis on a high level of participation in the implementation phase as it constitutes the core of the project. Furthermore, decisions made during the ULL design narrowed down the topics and methods for user involvement during implementation and set a frame. While all cases aimed for co-creation, some were more successful than others. It is found easier to involve a smaller group of citizens in co-creation than actively engaging a broader part of citizens.

Co-creation should not be a single level of user involvement for any RwL to aim. It is rather a combination of different user participation levels, which fits the goals, the vision and other influencing factors of a particular RwL, and thus has a potential to enhance its outcomes and transformative potential.

Evaluation Stage

Evaluation "facilitate(s) explicit learning amongst the participants and allows for the refinement of ULL goals, visions and methods, and their better alignment with user needs" (Voytenko et al. 2016, p. 51). Thus, by evaluating ULLs a feedback loop is introduced. Due to its special role, the evaluation phase cannot be clearly distinguished from the other two phases. While evaluation reports are usually published after the ULL implementation, evaluation processes often happen in parallel with the other phases.

In terms of user involvement in the evaluation, different aspects can be studied. First, the possibility for the users to co-create the evaluation process, that means to determine the subjects and methods of evaluation. Second, the ways of evaluation and the methods to involve citizens during the evaluation phase. Third, the extent to which the evaluation results are fed back into the ULL design and implementation. This third aspect characterises the distinct role of the evaluation phase and makes it difficult to draw a line between evaluation and the two other ULL phases. At the same time, the third aspect is intertwined with the second one as the evaluation methods determine if the user feedback is considered as co-creation or only as consultation.

Apart from *UbiGo*, the citizens in the analysed cases did not have a possibility to influence the evaluation process (aspect 1); rather they served as sources of information during the evaluation. Ten adults who took part in the *UbiGo* pilot provided their feedback on evaluation questionnaires and in this way could influence the evaluation process.

The evaluation methods used in the four ULLs included surveys, interviews, observation and website tracking (aspect 2). Compared to close-ended questionnaires, open-ended interview questions and oral questionnaires allow for more individual answers. Co-creative elements are then more likely to be found. *UbiGo* had the most open evaluation process of the four cases. Combining questionnaires, travel diaries, interviews, and workshops did not only allow reaching different groups of citizens but also yielded both quantitative and qualitative data. The evaluation of *T-City* used interviews, telephone questionnaires and observation. With 1,000 participants for the survey, the evaluation was compared to the other cases most comprehensive in quantitative terms. Reiterating interviews with the same citizens allowed exploring changes over time. *Alby* used questionnaires before and after the lighting project to investigate if the residents' perception of the pathway had changed. However, the oral questionnaires were conducted with random users of the pathway without purposely asking the same people reiteratively. Conclusions about trends that follow from comparing the before and the after questionnaire results therefore need to be dealt with carefully. *Nexthamburg* is the only ULL that did not use interviews as part of the evaluation but based its assessment on surveys and observations. Regarding the second aspect of evaluation, the ways of evaluation, consultation was the predominant level of involvement throughout all ULLs.

Alby, Nexthamburg and *UbiGo* aimed from the beginning to feed back the evaluation results into the implementation phase (aspect 3). *T-City* is the only example where the purpose of the accompanying research was separated from the ULL implementation. However, as the interim results were presented on a regular basis, a feedback loop was initiated automatically, and thus the implementation phase was influenced.

In conclusion, the analysis of user involvement in the evaluation phase is complex. The main purpose of user involvement during the evaluation of the four cases was to gain information about the citizens' perspectives and insights. An explanation for the dominance of consultation in the evaluation phase is that the evaluations were conducted with a certain aim. Having a pre-defined focus limits the range for co-creation during the evaluation process, and another level of user involvement might enhance that the evaluation results contribute to the aim of the evaluation.

TABLE 3: Transformative potential of urban living labs for sustainability.

TRANSFORMATIVE POTENTIAL	NEW LIGHT ON ALBY HILL	NEXTHAMBURG	T-CITY FRIEDRICHSHAFEN	UBIGO
change processes	***catalysed change*** The initial idea for change, i. e., to transform the pathway, came from the municipality. The decision was informed by citizen consultations; the citizens actively shaped this idea and the change process.	***little change*** The user participation process was exemplary but the catalysation of change was limited as the decision-making power from the City of Hamburg to implement the ULL results was lacking.	***catalysed change*** The main change was the installation of broadband technology in the city, mainly catalysed by Telekom. The initiation of change by citizens was limited due to their low engagement.	***catalysed change*** Participants of the field operational test changed their travel behaviour. This change was directly linked to their ability to co-create their own mobility service.
sustainable innovations	***advanced at a small scale*** The project was small hence its outcomes were limited although the sustainable innovation was successfully implemented. The municipality and the citizens learnt about (active) participation.	***promising at a large scale*** *Nexthamburg* provides a platform for citizens to discuss their ideas for urban development, which have the potential to be more widely accepted than top-down municipal plans. Even though the City did not pursue the future vision, it recognised the *Nexthamburg* concept as a promising approach.	***advanced at a large scale*** The advancement of innovation was mainly triggered by Telekom and other companies. However, the "futurists" were able to shape high-tech products by testing them and giving feedback.	***feasible at a small scale*** The users participated in shaping the innovative business model. Their feedback was considered very valuable by the project team as it was a result of a real-life test.
societal challenges	***addressed*** Social and environmental sustainability were positively affected: the image of the area was enhanced with citizen involvement, and more energy efficient lighting was implemented.	***not addressed*** By contributing with their own ideas, the citizens were able to raise urban challenges that they experienced. These might differ from the challenges perceived by the city. This is unclear as the ULL results were not implemented.	***addressed selectively*** Due to the lower involvement, the citizens had a limited impact on the ULL topics. However, those who engaged in subprojects (e. g., the Smart Meter project) could help address societal challenges.	***not fully addressed*** The socio-economic and environmental impacts were limited since the project is on hold in Gothenburg. Its relaunch is planned in 2018 in Stockholm.

Role of User Participation in Realising Transformative Potentials of Urban Living Labs

Table 3 provides an overview of the transformative potential of the four ULLs following the analytical questions in table 2.

When exploring the user participation role in realising the transformative potential of each ULL for sustainability, it can be concluded that *Alby* has shown a high level of citizen involvement in initiating and catalysing change, advancing sustainable solutions and addressing the challenges of social security and energy efficiency. At the same time, the ULL is a small-scale initiative, and it is unclear whether and how its outcomes could be scaled up or mainstreamed, and by whom. *UbiGo* has been similar in its user participation levels and transformative outcomes to *Alby,* however, its potential in addressing societal challenges has not been realised due to a lack of the project continuity. User involvement has been the highest (co-creation) in *Nexthamburg* but its results have not been implemented due to a low city government engagement in the ULL. *T-City* initiated and catalysed large-scale change and tackled urban sustainability challenges, however, not in a very inclusive manner. Thus, a high degree of user involvement is not a key precondition for ULLs to deliver change processes and implement sustainable solutions. However, we argue that to be considered truly sustainable a transformation needs to build on ethically justified and socially inclusive processes.

Reflections on User Co-Creation in Urban Living Labs

This article provides four main conclusions on the role of user involvement in ULLs. We hope these are helpful for other RwLs that seek to address sustainability challenges in a more socially inclusive manner. First, the level of co-creation is not always achieved and it is mainly present in the implementation phase. Second, the degree of user involvement depends on the leading actors of the ULL and its aim. Third, while there is a hierarchy between the different levels, it is not always the aim to climb the ladder. It is important to use a variety of methods, to include different stakeholders but also to combine different levels of involvement. Finally, user involvement plays a positive role in realising the transformative potential of ULLs for sustainability but it is not the only precondition for ULLs to catalyse change processes and successfully implement sustainable solutions.

Understanding the Role of Co-Creation in Urban Living Labs

Our analysis shows that the level of user involvement varies between and within ULLs (RQ 1). Elements of co-creation were present in all cases and most dominant in user-driven *Nexthamburg,* which is not surprising as the ULL had an aim of broad citizen involvement. However, the level of co-creation was only prevalent >

during the implementation and was less common during the ULL design and evaluation. Apart from co-creation, other levels of user involvement, especially information and consultation, were present in all stages of the ULLs. Indicators for no participation could only be found during the (early) design phase (figure 2) and were most dominant in *T-City,* which had a utilitarian aim of commercialising new technology.

These findings are in line with the literature, which argues that co-creation is often less common than other user participation levels in ULLs. One reason for the varying levels of user involvement could be that allowing for co-creation is easier in certain ULLs than in others. An ideas contest for city development *(Nexthamburg)* or an image competition *(Alby)* might be more tangible and thus easier to get involved in for citizens than a travel broker service *(UbiGo)* or smart city technologies *(T-City)*.

Effect of Leading Actors on User Involvement

Different user involvement levels are also determined by the type of leading actor behind the ULL (table 1) (RQ1). As such, user-driven *Nexthamburg* achieved a high level of user involvement throughout its life cycle while utiliser-driven *T-City* failed to successfully engage citizens in co-creation. Both ULLs are inhalation-dominated (Leminen et al. 2012), which primarily serve the needs of their leaders: Hamburg citizens and Deutsche Telekom respectively. The other two ULLs – provider-driven *UbiGo and* enabler-driven *Alby* – are exhalation-dominated ULLs. They seek to fulfil the interests of many engaged stakeholders apart from the users. These ULLs are therefore located somewhat in the middle on the user involvement scale (figure 2).

Combining Different Levels of User Participation

Following the discussion above, it can be questioned that co-creation is the single level of user involvement that ULLs should aim for to achieve successful and transformative ULLs. The "the more participation, the better" principle (Hage et al. 2010, p. 262) does not always hold true (Davidson 1998, Fung 2006, Hage et al. 2010, Krütli et al. 2010). Instead, it is important to consider the right form and the right time. A combination of different participation methods may be required in one situation whereas a consecutive set of techniques might be more suitable for other circumstances (Krütli et al. 2010). Friedrich et al. (2013) therefore recommend to not only define the effort to communicate in relation to the importance of the questions but also to the scope of the issue discussed. While a broader issue calls for a smaller group to be involved, a more focused issue allows for a larger number of engaged participants. Taken together, an analytic, systematic and dynamic approach to participation is important (Stauffacher et al. 2008).

Compared to Arnstein's (1969) ladder, a wheel of participation (Davidson 1998) is put forward as a more appropriate metaphor to deal with different levels of user involvement. Similarly, Juujärvi and Lund (2016) suggest a mix of bottom-up and top-down approaches for ULLs as this combination allows for identifying needs and ideas on the one hand and a validation of the needs and the provision of a formal structure on the other hand. The importance of a mix of different participation levels is also supported by the cases. *Nexthamburg, Alby* and *UbiGo,* which successfully engaged users in different ways, all positively affected sustainability outcomes. Therefore, co-creation should not be a single level of user involvement for any RwL to aim. It is rather a combination of different user participation levels, which fits the goals, the vision and other influencing factors of a particular RwL, and thus has a potential to enhance its outcomes and transformative potential.

User Involvement and Transformative Potential of Urban Living Labs for Sustainability

Two cases have shown a positive role of user involvement in realising the transformative potential of ULLs for sustainability *(Alby, UbiGo)*(RQ2). However, a high degree of user involvement is not a key precondition for ULLs to deliver change processes and successfully implement sustainable solutions. The transformative potential of an ULL with high level of user involvement can be hindered when the users lack decision-making power *(Nexthamburg)*. Therefore, the ULL governance structure, leadership and power distribution are other important factors in addition to citizen involvement for ULLs to become transformative. The transformative potential of an ULL can also be realised with a low level of user involvement *(T-City)*. However, to be truly sustainable a transformation needs to build on ethically justified and socially inclusive processes. Even though a low level of user involvement can realise a sustainable transformation, a higher level of involvement is more likely to be more widely accepted and thus more intrinsically motivated.

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