Position Paper

Analyzing co-creation levels of urban living labs in Europe

Kimberly Noble, Elena Marie Enseñado

Received: 25 July 2022 | **Accepted**: 23 September 2022 | **Published**: 5 November 2022

Keywords: living labs; co-creation; urban sustainability.

Abstract. *Which characteristic of urban living labs (ULL) that focus on urban sustainability, including climate change and water issues, can enhance its level of co-creation? The main question raised for this research paper builds on the idea that optimization of characteristics can positively affect co-creation levels, ultimately improving the outcome of the urban living lab. Through data collected from an online survey participated in by 29 urban living labs in Europe which focused on varying issues, such as water and climate change, it became clear that the most important characteristic to enhance co-creation*

levels was to establish very clear ULL aims in the first instance. Without a purposive aim, the successful delivery of co-creation outputs proves difficult.

---

1. Water issues, living labs and co-creation

Water is a key planetary resource and keeping oceans and seas healthy is crucial. However, many factors are increasingly impacting negatively on their health. According to Herbert-Read et al. (2022):

> Currently recognized drivers of declines in marine and coastal ecosystems include overexploitation of resources (for example, fishes, oil and gas), expansion of anthropogenic activities leading to cumulative impacts on the marine and coastal environment (for example, habitat loss, introduction of contaminants and pollution) and effects of climate change (for example, ocean warming, freshening and acidification) (p.1).

At the same time, planetary freshwater is subject to the same negative factors. Only 3% of planetary water is freshwater and only one third of this is accessible for use in human settlements and agriculture. Water-intensive human activities are leading to increasing depletion of global freshwater resources and numerous cities are subject to growing water stress (Spannring and Hawke, 2021).

In this paper we illustrate the aims and roles of Urban living labs (ULLs) in sustainability practice and propose ULLs as a way of addressing many critical climate change issues as well as the wide range of water issues that have been identified. According to the European Network of Living Labs ENoLL (2018):

> Living Labs (LLs) are open innovation ecosystems in real-life environments using iterative feedback processes throughout a lifecycle approach of an innovation to create sustainable impact. [….] They focus on co-creation, rapid prototyping & testing and scaling-up innovations & businesses, providing (different types of) joint-value to the involved stakeholders. [….] In this context, living labs operate as intermediaries/orchestrators among citizens, research organizations, companies and government agencies/levels. [….] Within a wide variety of living labs, they all have common characteristics, but multiple different implementations (para. 2).

ULLs are based on independent rules, norms, procedures, and principles, and have transformed conceptualizations of governance for sustainable urban management and development (ENoLL 2018), including addressing water issues. ULLs serve as an instrument utilized by various actors to guide transformation efforts by directly intervening and altering traditional systems through real-world testing, co-production of knowledge, and co-creation induced innovations (Rosado et al., 2015; Bulkeley et al., 2016).

ULLs are used interchangeably with 'living labbing', 'living laboratories', 'transition labs', 'social innovation labs', "testing grounds', 'hubs', and 'field labs' (McCormick and Kiss, 2015; Steen and van Bueren, 2017). There is no shared definition, having been defined as a site, methodology, system, an organization, arena, and innovation approach (Følstad, 2008; Bergvall-Kåreborn et al., 2009; McCormick and Hartmann, 2017). However, ENoLL has defined urban labs as 'real-life' research environments utilized to confront innovation challenges in various fields (Feurstein et al., 2008; Den Ouden, 2016). They describe the main activities of urban labs to be co-creation, exploration, experimentation, and evaluation.

Co-creation is an activity in which actors work together to create benefits (Nesti, 2018). Co-creation is generally defined as the action of making value with two or more actors. The literature recognizes co-creation as a process that stimulates mutual value creation and enables creativity and innovative solutions by linking multiple streams of knowledge through partnership interactions (Tanev et al., 2011; Veeckman et al., 2013, Puerari et al., 2018). Haukipuro et al. (2018) further elaborate on the concept of co-creation, stating that this process is where the creativity of citizens and that of interdisciplinary experts are conjoined to realize effective and meaningful change processes, such as in addressing climate change and water issues.

Co-creation contributes to the maintenance of reflexivity and can render opportunities for participants, through ongoing interactions, iterative cycles of implementation, testing, development, and research (Keyson et al., 2016). A study conducted by Puerari et al. (2018) provides a clear overview, derived from a comprehensive literature review, of the five most common elements of co-creation fostered in urban labs: purpose of co-creation, degree of informality, ownership of co-creation process, motivations and incentives for co-creation, and places and spaces for co-creation.

European cities have rapidly taken up urban labs as new collaborative sites to challenge conventional unsustainable trajectories and contribute to urban

sustainability through their outputs derived from co-creation activities. Trencher et al. (2013) present an overview of initiatives that have successfully utilized co-creation for sustainability throughout Europe which have aimed to mobilize and disperse knowledge, transform, and restore natural and built environments, and develop new socio-technical configurations through innovation and multi-actor learning, involving stakeholders from a wide range of areas, including business, academia, government and citizen scientists, as in the Quadruple Helix model proposed by ENoLL (2018).

These urban labs have been employed to inspire the testing, development, and implementation of innovative urban sustainability solutions through the creation of new knowledge, technologies, services and infrastructures. However, there is increased difficulty in determining a full comprehensive understanding of urban lab success factors that could potentially be up scaled or used in different contexts.

This situation necessitates more research regarding co-creation to fulfill desired sustainable outcomes and to bring urban lab initiators in structured knowledge creation as well as build awareness of crucial lessons and issues experienced for the success of each urban lab (Lucassen et al., 2014). Without further research into the conditions necessary for harnessing high co-creation levels, management and performance of urban labs will be averted from their full potential to make significant impacts.

If the characteristics that best optimize conditions for co-creative outputs can be identified, urban labs can foster high co-creation levels to be utilized as an effective and efficient mechanism for sustainable change in urban areas. Hence, assessments must be made on the performance of their characteristics. The influence of these characteristics on cocreation levels must be analyzed to indicate the most important aspect for co-creation optimization to further the understanding of knowledge generation, co-creation outcomes, and the improvement of current and future urban labs for urban sustainability.

This paper presents the results of a survey in which we examined 29 ULLs in Europe that focus on varying issues, including climate change and water issues. These ULLS represent 13 countries, namely Switzerland, Spain, Italy, Sweden, the Netherlands, United Kingdom, Belgium, Turkey, Greece, France, Austria, Slovenia, and Denmark. The main research aim was to explain which characteristics of ULLs can enhance co-creation levels. Specifically, we aimed to answer the following questions: Do self-proclaimed ULLs in Europe have co-creation activities? Do these ULLs have high, medium (upper), medium (lower), or low

co-creation levels? Which characteristics of ULLs can explain the co-creation level?

2. Understanding living lab co-creation activities

All 29 ULLs (100%), who served as respondent in our survey, were found to engage their participants in at least one co-creation activity. These activities consisted of future workshops, prototyping, surveys, testing, evaluation, image boarding, interviews, and brainstorm meetings. Other activities identified were symposia, social safaris, focus groups, and placemaking. Of the 29 ULLs, almost half (44%) utilized an average of four to five co-creation activities. There is no ideal number of co-creation activities for ULLs to utilize, although it is mentioned from literature that high frequency collaboration could contribute to the success of co-creation outcomes.

The most frequently used co-creation activities were those which the literature depicted to have the highest success for co-creation and knowledge generation, such as future workshops, prototyping, brainstorming meetings, interviews, and testing (Eriksson and Svensson, 2009). These are the activities that not only serve as a foundation for the generation of valuable ideas but also make them tangible, leading to new innovative solutions designed to be iterative (Veeckman et al., 2013). Thus, lack of activities can be problematic for innovation and the impact of ULLs on urban sustainability.

The purpose of co-creation plays a role in the determination of methods and techniques used in the urban lab. Different methods such as prototyping, surveys, future workshops, evaluation, and tests combined with a variety of techniques such as scenarios, interviews, and mock-up serve as a foundation for the generation of ideas and render them tangible in a 'real life' context through usage (Eriksson and Svensson, 2009). Eriksson and Svensson (2009) found that the purpose of co-creation can also be determined by participation, specifically, the degree of user involvement, whether it is decision, information, or creation.

The decision degree of user involvement is easiest to apply to methods and techniques, such as surveys or evaluations, that are less resource dependent, straight forward, and ask questions regarding preferences of designs or use behavior. The information degree requires a higher number of resources, and generates a rich set of data through diaries, observations, and interviews. These two degrees correlate with the intentions to generate knowledge and learn through cocreation processes. The creation degree correlates with the purpose of making something through co-creation processes. It is challenging to incorporate in technique and

methods and usually require resources for prototyping methods or future workshops.

3. Level of co-creation in living labs

Co-creation is the key element of the urban lab process, the development of new products, services, systems, and processes within urban labs are utilized to employ people as cocreators to examine, explore, test, and evaluate novel ideas, systems, scenarios, services, and creative solutions in complex 'real life' contexts. The employment of co-creation in urban labs broadens engagement, empowerment, and collaboration of citizens. Co-creation is significant for the alignment of ideas and definitions, and to facilitate discussions about possible actions in decision making processes.

For our study, co-creation level is high when user feedback is captured iteratively. Users are part of the innovation process and can make changes in the innovation themselves. In terms of medium (upper) co-creation levels, user feedback is also captured iteratively. However, this may lead to some modifications/alterations of the innovations. In medium (lower) co-creation levels, user feedback is captured, but users have no decision-making power in the innovation process. Co-creation level is low when there is rare to no interaction with users.

ULL initiators rated the co-creation level as their perspective would present a most accurate depiction between the target of co-creation focus and the actual reach. Initiators and facilitators were chosen to be surveyed to identify the state of co-creation levels in their urban labs because they constitute the 'core group' of urban labs.

Of the 29 ULLs, 18 (62,1%) reported medium (upper) co-creation levels. Only 7 (24.1%) of the ULLs have reported high co-creation levels. Meanwhile, 3 (10.3%) reported having medium (lower) co-creation levels, while 1 (3.4%) reported low co-creation levels. Projects of the labs ranged from various sustainability initiatives and sectors that involve co-creation activities, such as transitioning towards a circular economy, greening of an urban space, taking up sustainable governance and development, or addressing climate change and water issues[1].

[1] In relation to water issues and climate change the SCORE project has developed a unique system of Coastal City Living Labs (CCLLs) as is also covered in this issue by members of the Piran Coastal City Living Lab (Meulenberg et al., 2022).

4. Influential characteristics of living labs

ULLs have different characteristics. For this study, we grouped these characteristics according to "aims", "activities", "participants", and "context". In order to analyze which characteristics of urban living labs influence co-creation levels, we examined these against two sets of ULLs: (1) the top three ULLS with the highest co-creation levels, and (2) the bottom three ULLs with the lowest co-creation levels. Using ordinal logistic regression analysis, we examined the significance of these characteristics to the level of co-creation. It has been revealed that "aims", followed by "participation", and "context" can influence co-creation level.

4.1 Aims

The ultimate aim of urban labs is to learn, experiment, and innovate for the purpose of increasing urban sustainability. Urban labs can have distinct goals, such as to collectively work towards an innovation output e.g., service, product and to build knowledge, learn, and create networks through collaboration. Determining the aim of the lab sets important conditions for pathways that ensure ambitious innovative solutions developed through co-creation (Steen and van Bueren, 2017).

Also, the processes of learning and innovation derived from experimentation are fundamental to the function of ULLs. Innovation in ULLs refers to the discovery of new solutions for existing problems and the development of new products, such as a service, object, application, technology, or system. Successful learning processes between participants can form a pivotal yield for innovation, but it can be difficult to establish, even in the facilitating conditions of the ULL setting, due to the many conflicts or unmet expectations that can arise from diverging interests (Naumann et al., 2018). These learning processes contribute to the emergent experimental process of responding to sustainability issues and can be realized through forms of ongoing participant engagement and consultation or through data control and management systems and 'smart' applications.

Under "aims", based on the survey among the ULLs, the three most significant characteristics are focus, clarity of goal, and goal completion. When goals are clear to all participants, and the goal is to both learn and co-create knowledge and physically make something, it creates conditions that significantly effects co-creation levels. This finding is supported by Veeckman et al. (2013) and Puerari et al. (2018). Interestingly, specific factors, such as lab lifespan, usage context research, frequency of events, and resource availability, did not have a direct correlation to co-creation level variation.

The literature implies that a longer time period will enable participants to interact and generate additional knowledge, expand audience reach, increase networks, trust and develop relationships that will lead to enhanced co-creation levels (Tanev et al., 2011; Luederitz et al., 2017; McCormick and Hartmann 2017). Usage context research before the development of the urban lab process, expressed to be an important factor to influence knowledge production and innovative co-creation outcomes (Veeckman et al., 2013), did not seem to influence co-creation. This claim is underpinned by the depiction of urban labs as specific to each site and heterogeneous, easily altered by particular time and location, contributing to the variations of urban lab co-creation experiences and outputs (Jordan and Lenschow, 2009; Mulder, 2012; Evans and Karvonen 2014).

4.2 Participants

Three specific factors under "participants" were found to have an influence on co-creation levels. These are balanced partnership, power struggles, and predetermined structure. Based on the results, neither the urban labs with the highest or lowest co-creation levels had completely exclusive partnerships. This finding was in accordance with existing literature (McCormick and Hartmann, 2017; Puerari et al., 2018), regarding the value of obtaining a careful balance. As suggested in the literature (Tanev et al., 2011; Veeckman et al., 2013; Puerari et al., 2018), it is also recommended to avoid fully exclusive partnerships, although this will not guarantee high cocreation levels. A lack of completely exclusive partnerships can benefit the co-creation outcomes of urban labs but may not be sufficient to fully impact the outcome of co-creation level.

Further supporting previous studies that emphasize the importance of balance and flexibility in the ownership of urban labs, the findings on power struggles presents a minor correlation between this factor and co-creation level variation. It was determined that poor performance of this indicator can have great influence on co-creation levels due to the higher degree of power struggles with little to no interference from initiators. Thus, it is recommended that there be enough supervision over co-creation activities to ensure there are no power struggles occurring within the urban lab that can hinder co-creation outcomes such as knowledge co-production, learning processes, or innovation ideas.

The results derived from the analysis of the predetermination of urban lab structure also reinforced the consensus in the literature that there is a delicate balance between flexibility and structure that would best enable an urban lab to foster high levels of cocreation (Eriksson and Svensson, 2009; Mattelmäki and Visser, 2011; McCormick and Hartmann, 2017). Participant inclusion was not a

determining indicator for the explanation of co-creation level variation, an important indicator for the enhancement of cocreation levels as suggested by the existing literature (Feurstein et al., 2008; Veeckman et al., 2013; Puerari et al., 2018). Whether collaboration was arranged sporadically or continuously was concluded to not have a direct influence on cocreation level variation. Unlike in Puerari et al. (2018), the coupling of sporadic participant inclusion with short term goals will not have a negative impact on co-creation levels and urban lab success. The finding derived from the analysis of involved sectors infers that the diversity of sectors involved will not ensure high co-creation levels for the urban labs, opposing remarks from the literature declaring sectoral diversity is crucial for co-creation outputs supporting urban sustainability (Tanev et al., 2011; Westley et al. 2011).

All urban labs included at least three sectors throughout the co-creation process, however, no direct correlations were made between the initiating sector, diversity of sectors involved and the variation of co-creation levels. Thus, while diversity of sectors can provide expertise knowledge to forge innovative solutions, it is not a determinant of co-creation level variation. Exposure of intellectual property rights was also not found to directly affect co-creation outcomes that contribute to sustainability (also see research of Veeckman et al., 2013; Luederitz et al., 2017). Counter to Vivek et al. (2012), the study found that co-creation level variation will not necessarily be limited due to the lack or presence of participant motivation.

4.3 Context

ULLs are commonly bound to specific geographical areas, situated in a "real-life" use context, reducing limitations such as space or time, where co-creation, development, experimentation, and evaluation occurs outside of a laboratory setting (Mulder 2012, Veeckman et al. 2013, Steen and van Bueren 2017). Geographic configurations able to host ULLs consist of either a region, agglomeration, city, district, neighborhood, road, corridor, or building (Voytenko et al., 2016).

The geographic aspect is important for the empowerment of discrete actors to challenge sustainability issues and monitor outcomes and effects of the experimental lab. Local scales, at which ULLs proliferate, territorialize urban innovation at a manageable scale and enhance accountability and trust between participants. Projects, constituting the core of ULLs, are context specific and enable stakeholders to develop local solutions.

The consideration of context research before the development of the ULL can influence its purpose due to the importance of contextual understanding, of the environmental setting, for deep comprehension of the subject to be focused on (Veeckman et al., 2013). Contextual framework factors in a particular location and time contribute to the variations in ULL design, knowledge production, and innovation outcomes (Jordan and Lenschow, 2009; Mulder, 2012; Evans and Karvonen, 2014).

Of the context indicators, visibility was determined to be a significant determinant of cocreation level variation. To optimize co-creation processes and overall co-creation level, the existing literature suggests visibility can attract activities, intensify links and connections, and create support beyond the vision and purpose of the urban lab, catalyzing the uptake of innovative sustainable solutions amongst users (Veeckman et al., 2013; Luederitz et al., 2017; McCormick and Hartmann, 2017). Substantiating the literature on urban lab visibility, this finding revealed that the better the performance score on visibility, the higher the cocreation level fostered by the urban lab. Conversely, the urban labs with poor performance on visibility occupied the lowest co-creation levels. Thus, it is recommended that urban labs focus extra refinement or improvement efforts on urban lab visibility.

High visibility through physical artifacts produced by co-creation activities can help overcome barriers, such as context dependency, to upscale and diffuse cocreation outputs, thereby delivering a well-known symbol of sustainability within the surrounding community to inspire and serve as a demonstration site for initiating further co-creation activities. All urban labs in the study sustained a sense of community ranging from active to passive. While high co-creation levels were not directly correlated with an active sense of community, urban labs that maintained a passive sense of community were associated with low co-creation levels. Although high cocreation levels will not be guaranteed from the successful performance of this one indicator alone, it is recommended to establish an active sense of community, through alignment of shared motivations for collaboration and increased engagement to sustain motivation and encourage valuable interactions, as a foundation to support the performances of the indicators capable of delivering high co-creation levels, such goal clarity (Veeckman et al., 2013).

One of the most prominent features of urban labs is the "real-world" context in which they emerge. Therefore, it was interesting to find that the results of this indicator contradicted studies that communicated high importance of this indicator for generating the necessary urban lab conditions for co-creation success (Veeckman et al., 2013; Steen and van Bueren, 2017). While there may be a need

or desire of participants to experience the "real-world" environment, there is no correlation found between the performance of this indicator and the level of co-creation variation. Possible explanation for this occurrence could be that the "real-world" environment contains many complexities and uncontrolled conditions, not necessarily facilitating the co-creation process, but provides a suitable environment for experiments to take place and valuable knowledge to be generated (Evans and Karvonen, 2014). Valuable knowledge related to water and climate change issues include knowledge on solutions and technologies that are being piloted, tested, and evaluated in living labs[2]. Thus, it can be speculated that real world context does not provide a significant explanation for variation co-creation levels. Indicators that do not significantly influence co-creation levels should not be discredited, as these indicators could play a significant role in the underpinning of impactful indicators.

5. Conclusions

With the European urban population expected to rise to 80% by 2020 (Voytenko et al., 2016), it is imperative that cities take collaborative action to subdue current sustainability challenges and prevent their exacerbation. Co-creation is a key component to the transformative changes that are necessary to sustain technological and societal transformations for urban sustainability. Collaborative planning initiatives that form enabling conditions and incentives, developed by formal and informal actors, stimulate co-creation processes that reconnect society to the biosphere.

Often framed differently, urban labs generate a range of sustainability solutions through participation, experimentation, collaboration, and learning-by-doing in a 'real-life' context (Höflehner et al., 2016). This approach holds great potential for catalyzing sustainable transitions by fostering co-creation dynamics that contribute to the continuous evaluation for the improvement and refinement of an initiative (Mulder, 2012). The development of a meta-analysis of urban labs across Europe can enable more in-depth comparative studies to refine and realize any generalizations or improvements that can be applicable to any urban lab context.

Underpinned by theoretical knowledge of co-creation dynamics and their interrelationships to urban lab characteristics, the primary objective of this study was to gain new insights on the most valuable urban lab characteristics in forging high

[2] For additional reference, see Atlas of the EU Water Oriented Living Labs which identified 105 living labs in Europe.

levels of co-creation. Overall, the findings suggest that the predominant characteristic of the "aims" of ULLs is to promote co-creation level enhancement. Important specific factors encompassed within this characteristic are lab focus, goal clarity, and goal completion. Hence, a distinct focus on the shaping and planning of the "aims" aspect in urban lab processes can provide benefits that will enhance co-creation experiences, outputs, and overall levels.

This analysis verifies the research by Voytenko et al. (2015), where the capacity of co-created sustainable contribution by urban labs largely depends on practice design and execution. "Aims" is the characteristic in which participants learn to interact with others in collaborative processes and understand how to cater to the concerns of others (Mudler, 2012; Hakkarainen and Hyysalo 2013). It can determine the extent of learning, success of learning processes that form a pivotal yield for co-creation outcomes (Naumann et al., 2018). The processes of learning and innovation derived from experimentation are fundamental to the function of urban labs.

Therefore, the urban lab planning process should assess the quality of the "aims" aspect when creating or optimizing urban lab processes, paying considerable attention to its goalsand briefing all participants on the focus of the urban lab. Through the organizational planning of the lab, the "aims" characteristic sets the stage for the structure of the urban lab, determining the lab focus, goals, frequency of open events, methods, techniques, and infrastructure (Eriksson and Svensson, 2009; Juujärvi and Pesso, 2013; Den Ouden et al., 2016, Steen and van Bueren, 2017). Without organizational clarity, the successful delivery of co-creation outputs will prove to be difficult.

Linked to other transdisciplinary knowledge, the empirical data deduced from this research can potentially provide enhancement in co-creation levels of urban labs in various contexts, along with an overview of necessary improvements for a successful urban lab initiative, and the critical issues that can influence success outcomes. A greater capacity to foster co-creation can facilitate discussions and the alignment of actions in decision making processes through strengthening engagement, collaboration, and empowerment of participants. It can yield information to enhance the relationship between institutions that produce knowledge and users of that knowledge, facilitating urban lab objectives carried out through the stimulation of cross-disciplinary research. Therefore, co-creation enhancement can further support the desired sustainability transitions and projects of urban labs (Puerari et al., 2018).

Apart from contributing to the literature and knowledge on co-creation in urban labs in Europe, this study also provides a new analytical framework for the evaluation of characteristic performance. This strategy can be used to evaluate and measure the levels of co-creation within labs, contributing to refinement and improvement of urban lab processes. However, due to a small sample size and diverse context of urban labs, these demographic observations cannot be confirmed as the general averages of all urban labs throughout Europe.

References

Bergvall-Kåreborn, B., Ihlström Eriksson, C., Ståhlbröst, A. and Svensson, J., (2009). *A milieu for innovation: defining living labs*. New York City, USA: ISPIM.

Bulkeley, H., Coenen, L., Frantzeskaki, N., Hartmann, C., Kronsell, A., Mai, L., Marvin, S., McCormick, K., van Steenbergen, F. and Voytenko Palgan, Y., (2016). Urban Living Labs: governing urban sustainability transitions. *Current opinion in environmental sustainability*, 22, pp. 13-17.

Den Ouden, P.H., Valkenburg, A.C. and Blok, S. (2016). *Exploring the future of living labs*. Eindhoven, Netherlands: Technische Universiteit Eindhoven.

ENoLL, (2018). European Network of Living Labs. [online] Available at: https://enoll.org/about-us/ [Accessed 14 August 2018].

Eriksson, C.I. and Svensson, J. (2009). Co-creation in Living Labs - Experiences from Halmstad Living Lab. Uppsala, Sweden, August 2009, Uppsala, Sweden: INTERACT.

Evans, J., and 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), pp. 413-430.

Feurstein, K. (2008). Living Labs: A New Development Strategy, in *European Living Labs - A New Approach for Human Centric Regional Innovation*. Berlin: Wissenschaftlicher Verlag.

Følstad, A., (2008). Living labs for innovation and development of information and communication technology: a literature review. *The Electronic Journal for Virtual Organizations and Networks*, 10, pp. 99-131.

Hakkarainen, L. and Hyysalo, S., (2013). How do we keep the living laboratory alive? Learning and conflicts in living lab collaboration. *Technology Innovation Management Review*, 3(12), pp. 16 - 22.

Haukipuro, L., Väinämö, S. and Hyrkäs, P., (2018). Innovation Instruments to Co-Create Needs-Based Solutions in a Living Lab. *Technology Innovation Management Review*, 8(5), pp. 22-35.

Herbert-Read, J.E., Thornton, A., Amon, D.J., Birchenough, S.N.R., Côté, I.M., Dias, M.P., Godley, B.J., Keith, S.A., McKinley, M., Peck, L.S., Calado, R., Defeo, O., Degraer, S., Johnston, E.L., Kaartokallio, H., Macreadie, P.I., Metaxas, A., Muthumbi, A.W.N., Obura, D.O., Paterson, D.M., Piola, A.R., Richardson, A.J., Schloss, I.R., Snelgrove, P.V.R., Stewart, B.D., Thompson, P.M., Watson, G.J., Worthington, T.A., Yasuhara, M., Sutherland, W.J. (2022). A global horizon scan of issues impacting marine and coastal biodiversity conservation. *Nature ecology and evolution*, 6, 1262-1270. https://doi.org/10.1038/s41559-022-01812-0

Jordan, A. and Lenschow, A., (2009). *Innovation in environmental policy? Integrating the environment for sustainability*. Northampton, MA, USA: Edward Elgar Publishing.

Keyson, D., Morrison, G., Baedeker, C., and Liedtke, C. (2016). Living labs to accelerate innovation. In: *Living Labs: Design and Assessment of Sustainable Living*. Switzerland: Springer, pp. 55-61.

Lucassen, I., Klievink, A. J. and Tavasszy, L. A., (2014). *A Living Lab Framework: facilitating the adoption of innovations in international information infrastructures*. Paris, France: Springer.

Luederitz, C., Schäpke, N., Wiek, A., Lang, D. J., Bergmann, M., Bos, J. J., Burch, S., Davies, A., Evans, J., König, A., Farrelly, M.A., Forrest, N., Frantzeskaki, N., Gibson, R.B., Kay, B., Loorbachl, D., McCormick, K., Parodio, O., Rauschmayer, F., Schneidewind, U., Stauffacher, M., Stelzer, F., Trencher., G., Vergragt, J.J., Wehrden, U., Westleyv, F.R. (2017). Learning through evaluation–A tentative evaluative scheme for sustainability transition experiments. *Journal of Cleaner Production*, 169, 61-76.

Mattelmäki, T., and Visser, S.F. (2011). Lost in Co-X: Interpretations of Co-design and Cocreation. In: IASDR, *Proceedings of the 4th Conference on Design Research*. Delft, The Netherlands, October 2011, Delft, The Netherlands: Print Best Printing House.

McCormick, K., and Hartmann, C., (2017). *The Emerging Landscape of Urban Living Labs: Characteristics, Practices and Examples*. Lund, Sweden: Lund University.

Meulenberg, C.J.W. Hawke, S.M., Cavaion, I., Kumer, P., and Lenarčič, B. (2022). Understanding interdisciplinarity through Adriatic maricultures and climate change adaptation. *Visions for Sustainability*, 18, 6945, 11-36. https://doi.org/10.13135/2384-8677/6945

Mulder, I., (2012). Living labbing the Rotterdam way: Co-creation as an enabler for urban innovation. *Technology Innovation Management Review*, 2(9), pp. 39-43.

Naumann, S., Davis, M., Moore, M. L. and McCormick, K., (2018). Utilizing Urban Living Laboratories for Social Innovation. In: T. Elmqvist, eds. 2018. *The Urban Planet: Knowledge Towards Sustainable Cities*. Cambridge: Cambridge University Press, pp. 197 - 217.

Nesti, G. (2018). Co-production for innovation: the urban living lab experience. *Policy and Society*, 37(3), pp. 1-16.

Puerari, E., de Koning, J. I., von Wirth, T., Karré, P. M., Mulder, I. J., and Loorbach, D. A., (2018). Co-Creation Dynamics in Urban Living Labs. *Sustainability*, 10(6), pp. 1-18.

Rosado, L., Hagy, S., Kalmykova, Y., Morrison, G. and Ostermeyer, Y., (2015). A living lab co-creation environment exemplifying Factor 10 improvements in a city district. *Journal of Urban Regeneration & Renewal*, 8(2), pp. 171-185.

Spannring, R. and Hawke, S. (2021) *Aqua MOOC - Participatory Engagement with Water* https://imoox.at/course/AquaMOOC?lang=en

Steen, K. and van Bueren, E., (2017). The defining characteristics of urban living labs. *Technology Innovation Management Review*, 7(7), pp. 21-32.

Tanev, S., Knudsen, M.P., Bisgaard, T. and Thomsen, M.S. (2011). Innovation Policy Development and the Emergence of New Innovation Paradigms. *Technology Innovation Management Review*, 1(2), 14-19.

Veeckman, C., Schuurman, D., Leminen, S. and Westerlund, M., (2013). Linking living lab characteristics and their outcomes: Towards a conceptual framework. *Technology Innovation Management Review*, 3, pp. 6-15.

Vivek, S.D., Beatty, S.E., and Morgan, R.M., 2012. Customer engagement: Exploring customer relationships beyond purchase. *Journal of marketing theory and practice*, 20(2),. 122-146.

Voytenko, Y., McCormick, K., Evans, J., and Schliwa, G., (2016). Urban living labs for sustainability and low carbon cities in Europe: towards a research agenda. *Journal of Cleaner Production*, 123, pp. 45-54.

Westley, F., Olsson, P., Folke, C., Homer-Dixon, T., Vredenburg, H., Loorbach, D. et al., Thompson., J., Nilsson, M., Lambin, E., Sendzimir, J., Banerjee, B., Galaz, V., and van der Leeuw, S. (2011). Tipping toward sustainability: emerging pathways of transformation. *AMBIO: A Journal of the Human Environment*, 40(7), 762-780.

Authors

Kimberly Noble, Institute for Housing and Urban Development Studies, Erasmus University Rotterdam, the Netherlands. knoble140@gmail.com

Elena Marie Enseñado, Institute for Housing and Urban Development Studies, Erasmus University Rotterdam, the Netherlands**.** ensenado@ihs.nl ***Corresponding author***

Funds

This research received no specific grant from any funding agency in the public, commercial, or no-profit sectors.

Competing Interests

The authors have declared that no competing interests exist.

Citation

Noble, K., Enseñado, E.M. (2022). Analyzing co-creation levels of urban living labs in Europe. *Visions for Sustainability*, 18, 7060, 37-52. http://dx.doi.org/10.13135/2384-8677/7060