

*Anna Góral*

Jagiellonian University

ORCID: 0000-0001-8868-3958

*Sylwia Wrona*

Jagiellonian University

ORCID: 0000-0003-1881-0370

*Beata Jałocha*

Jagiellonian University

ORCID: 0000-0003-2297-563

*Monika Jedynak*

and Social Communication, Jagiellonian University

ORCID: 0000-0002-0167-5013

## University living labs: tools for green transition and sustainable development

---

### ABSTRACT

---

This study delves into the potential of living labs (LLs) as transformative tools for sustainability and green transition within university settings. Through a scoping review analyzing 38 scholarly articles, the research addresses the central question: How can living labs be a tool for transforming universities in the field of sustainability? The analysis reveals that universities frequently use living labs comprehensively in all three dimensions of sustainability. Living labs are identified as multifaceted entities, serving as research methods, stakeholder collaboration platforms, educational tools, and institutional frameworks. Additionally, the research underscores the significant role of living labs across various domains of university management. The findings suggest that living labs may play pivotal roles in nurturing sustainable practices within academic institutions. This study

contributes to the understanding of the dynamic interplay between living labs and sustainability initiatives in higher education contexts.

**Keywords:** University Living Labs; Green Transition; Sustainable Development; scoping review  
**JEL Classification:** I20, I23, Q56

---

## Introduction

The demand to discover innovative approaches to tackle significant societal issues such as climate change and resource depletion has gained increasing attention in both political and academic spheres. However, it is argued that traditional policy interventions may not be adequate to initiate and promote sustainability transitions. There is a call for novel methods of governing transformative change and one specific type of experimental intervention is living labs (LL) [von Wirth, Fuenfschilling, Frantzeskaki, Coenen, 2018]. Living labs are open innovation ecosystems in real-life environments [Hossain, Leminen, Westerlund, 2019]. This concept is based on the quadruple helix model, which recognizes four main actors in the innovation system: science, public sector, industry, and society. It means that participatory engagement including representatives from each of the aforementioned sectors in each phase of the project is essential for creating results. A specific type of LL is the university living lab.

University living labs (ULL) may play a crucial role in the green transition, serving as platforms for experimentation and knowledge generation. These labs, located at universities and their campuses, may be instrumental in driving systemic change through the diffusion of innovations and know-how. Some university-based living labs go beyond testing product innovations. They actively direct their efforts toward supporting changes in public policies, such as education, environmental, or food policies. Hence, through ULL innovations, universities may influence local and national economies for the sustainable development transformation.

In this article, we describe issues related to the utilization of university living labs as catalysts supporting the green transition. The research problem is:

How can living labs be a tool for transforming universities in the field of sustainability?  
The research questions are:

RQ1: In relation to what dimensions of sustainability do universities use living labs?

RQ2: How is a living lab understood in the context of implementing the university's mission?

RQ3: In what areas of university management is a living lab used?

The article begins with a discussion of current challenges in green transition and sustainable development. Then, we present the concept of a living lab and its specific type – university living labs. Subsequently, we provide an analysis of university living lab cases that focus on creating ecological solutions within campus spaces. The article concludes with a discussion and reflection on future research directions in the discussed area.

## Contemporary challenges in green transition and sustainable development

Nowadays, the topic of environmental degradation is intensively discussed both in scientific literature and in political and economic discussions [Kuźniarska et al., 2024]. The factors contributing to this state include economic expansion, industrialization, urbanization, and globalization [Asongu et al., 2020]. These factors lead to increased energy consumption, carbon dioxide emissions, and environmental pollution. The concept of sustainable development meets these problems by introducing responsible thinking about the planet's future.

The idea of sustainable development assumes that thinking about economic and social development is necessary, considering the natural environment in which business is conducted. One of the most famous definitions of sustainable development emphasizes that meeting the needs of the present should take place without compromising the ability of future generations to meet their own needs [Brundtland, 1987].

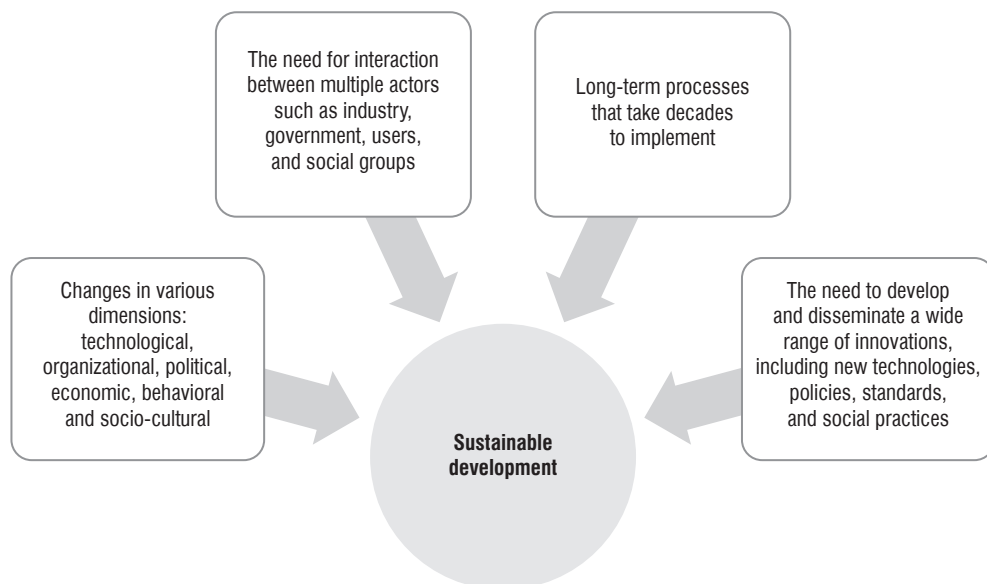
The definition emphasizes that sustainable and stable development requires a balance between resource consumption and the capacity to restore natural systems. Therefore, it is necessary to establish priorities for meeting the basic needs of people with low incomes and to emphasize the need to maintain the environment's ability to meet current and future needs through technology and social organization [WCED, 1987].

Sustainable development has three key components: economic growth, environmental protection, and social justice [Brundtland, 1987]. These three dimensions of sustainable development – social, environmental, and economic – are closely interrelated.

The United Nations committed to implementing the concept of sustainable development by specifying 17 goals and 169 related actions that address a wide range of sustainable development issues and focus on five areas: 1) people, 2) planet, 3) prosperity, 4) peace, 5) partnership [Ede et al., 2016].

Green economy and green growth are crucial elements of sustainable development [Midilli et al., 2006]. A green economy is a system in which environmental sustainability is combined with social well-being [Loiseau et al., 2016]. In turn, green growth refers to economic growth that is both environmentally sustainable and socially inclusive [Braunstein et al., 2019]. These concepts emphasize that it is necessary to move towards more sustainable patterns of production and consumption and to consider social justice and sustainable development [Borel-Saladin, Turok, 2013]. The introduction of the principles of green economy and green growth is intended to contribute to sustainable development while ensuring the improvement of the well-being of society [United Nations Environment Programme, 2018].

Changing the way of thinking and moving towards sustainable development involves long-term, multidimensional, and fundamental transformation processes through which established socio-technical systems shift to more sustainable alternatives [Markard et al., 2012]. The challenges related to the transformation process concern various areas, as presented in Figure 1.

**Figure 1. Challenges related to the transformation towards sustainable development**

Source: own study based on Chang et al., 2017; Geels, 2012; Grin et al., 2010; Markard et al., 2012; Rotmans et al., 2001.

The need to achieve the Sustainable Development Goals and the green transition is widely discussed globally [Mentes, 2023; Söderholm, 2020]. This discussion increasingly concerns individual sectors, organizations, or functional management areas [Kuźniarska et al., 2023]. In the next part, the green transition and sustainable development at universities is presented.

## Green transition and sustainable development at universities

Nowadays, universities play a significant role and bear responsibility for promoting sustainable development and achieving related goals. Sustainable Higher Education Institutions (HEIs) enable stakeholders to understand environmental degradation, inspire them to adopt sustainable behaviors, and increase awareness of social inequalities [Calder, Clugston, 2003]. A sustainable university is one that 1) incorporates this commitment to sustainable development into its mission and academic goals; 2) integrates the concept of sustainability into teaching and research; 3) promotes support services for students; 4) encourages students to think critically about environmental issues; 5) promotes sustainable methods that minimize environmental impact and 6) creates local and international partnerships to enhance sustainability [Calder, Clugston, 2003].

A modern university has three missions, the first is education, the second is scientific and research activities, and the third is the creation of mutual relations with the environment, the effect of which is the dissemination and popularization of research results and their

implementation, including commercialization. All these activities have important implications for sustainable development.

Educational activities are essential for implementing equality and respect, human rights, diversity, and care for the natural environment. It also enables the development of competencies necessary to implement sustainable development. Scientific and research activities involve the identification and assessment of environmental and social challenges facing humanity and the development of solutions and technologies that will help meet them. Building relations with the environment and commercializing research concerns several activities, including cooperation between the university and business and the external environment.

The implementation of all three missions involves taking action in the field of sustainable development [McCowan, 2023]. Universities' sustainability activities include but are not limited to providing sustainability education [Hammer, Lewis, 2023; Leal et al., 2024], promoting competencies relevant to the implementation of sustainable development (Leal et al., 2024), promoting the principles of sustainable development [Pietrzak, 2022], promoting involvement in sustainable activities [Pietrzak, 2022] or integrating sustainable development with various institutional activities [Leal et al., 2024].

## Living lab as an open innovation ecosystems

To create and test innovations, organizations are seeking new organizational and methodological solutions that allow them to dynamically respond to the needs of their environment and test innovations more quickly. One form of collaboration enabling co-creation of innovations within the quadruple helix model is living labs. The key characteristic of living labs is their emphasis on real-world experimentation, stakeholder collaboration, and co-creation of solutions in authentic settings.

Living labs are open innovation ecosystems in real-life environments [Hossain, Leminen, & Westerlund, 2019]. They can be both physical and virtual spaces in which complex problems are addressed. According to the European Network of Living Labs [European Network of Living Labs, 2023], the concept of a living lab should be based on six elements. First, a living lab should actively involve users. Relevant end-users of solutions should be engaged in all activities, from the very beginning of the project. Second, the involvement of multiple stakeholders is necessary. Hence living labs operate within the quadruple helix model, involving stakeholders from the public sector, academia, business and society. Third, the work within the living lab approach is based on co-creation. It means that solutions and values connected with them are co-created by all stakeholders involved. This increases the likelihood of final solutions acceptance. Fourth, living labs should operate in a real-life setting. This means that all innovations are tested in a real environment, not in artificially created labs. Fifth, since living labs activities are directed towards solving a specific problem, a multimethod approach is necessary to achieve desired results and meet the needs of final users and stakeholders. Sixth,

the operating mode of a living lab should be orchestration. Living labs should facilitate the ecosystem connections between relevant stakeholders.

Initially, living labs were predominantly technological in nature, but over the past 20 years, their activities have expanded into many areas [Lupp, Zingraff-Hamed, Huang, Oen, Pauleit, 2021]. Currently, the issues addressed by living labs are highly diverse, ranging from testing technological solutions to developing food policies. They are organized by a wide range of organizations; sometimes the initiative to establish a living lab is taken by a public entity, sometimes by NGOs, businesses, schools, or universities. As a result, we can now observe a wide variety of types of functioning living labs (see Table 1).

**Table 1. Typology of living labs**

| Living lab type                                     | Scope of activities                                                                                                                                                                                                                                                                                                           |
|-----------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Urban living labs                                   | Operate within specific urban or regional contexts and aim to address challenges related to urbanization, sustainable development, transportation, urban planning and other important urban-related issues.                                                                                                                   |
| Social Innovation living labs                       | Focused on addressing societal challenges and fostering social innovation. Community engagement and participatory processes are key elements of their activities. They collaborate with various stakeholders to develop products and solutions addressing social problems.                                                    |
| Healthcare and Well-being living labs               | Focused on developing and testing innovations in healthcare delivery, medical technologies, patient care, and well-being activities. Their stakeholders may involve healthcare professionals, patients, caregivers, public bodies and businesses.                                                                             |
| Higher Education, University and Campus living labs | Located near universities or within their campuses. They utilize university spaces and the expertise of academic staff to test various types of innovations. They can focus on various areas – urban, social, technological, or related to sustainable development.                                                           |
| Education living labs                               | Concentrated on the exploration of innovative approaches to education and lifelong learning. These labs experiment with new teaching methods, educational technologies or curriculum design. Schools become agents of community well-being, they create new partnerships with local actors and address relevant local issues. |
| Sustainability living labs                          | Focused on developing and testing solutions for environmental sustainability, renewable energy, waste management, resource conservation and green transition.                                                                                                                                                                 |

**Source:** own study based on Archibald et al., 2021; Chronéer, Ståhlbröst, Habibipour, 2018; Marone, Onofrio, Masella, 2020; Romero Herrera, 2017; SALL, 2022.

The selected types of living labs mentioned above do not represent a comprehensive list of various forms of living labs. The scope of living lab activities is much more complex, and the methodology is used to address a wide range of social and technological issues. Additionally, there can be overlap between different types of living labs. Not all living labs are focused on one type of issue; they can address multiple fields simultaneously. Also, the results they yield range from tangible designs, products, prototypes, and systems to scenarios, processes, concepts, and ideas. Living labs utilize a diverse array of methodologies including behavioral data analysis, ethnographic research, and focus groups [Nyborg et al., 2023].

## Higher education, university and campus living labs

In a rapidly changing world, the role of universities is also evolving. They are becoming more like regional engines of innovation, rather than just centers for education and research. Until recently, universities have typically taken a rather passive approach to engaging users in the solutions they create. Scientists, confined to laboratories or conducting research where society was the object rather than the subject of study, did not employ tools that would enable them to engage in a deep dialogue about stakeholders' needs. This trend is changing, and universities, are getting closer to the real needs of the socio-economic environment as they pursue their third mission. Initiating collaborations to establish living laboratories with external entities such as local government or businesses can expand a university's engagement to a broader range of stakeholders [Purcell, Henriksen, Spengler, 2019]. This partnership has the potential to stimulate local innovation and facilitate the development of community-based projects. Moreover, through methodologies such as action research or living labs, the three missions of universities (education, research and engagement with society) can be merged.

Various types of living labs can be located within university spaces, including those focusing on technological advancements (mostly found in technical universities), social issues, urban planning, healthcare, nutrition, or related to sustainability and green transition. In the literature on living labs associated with higher education, several types are distinguished. However, as Evans, Jones, Karvonen, Millard, and Wendler [2015] describe their experience in implementing university-based living labs at the University of Manchester, they also state that focusing on specific issues or infrastructure is effective because it allows for the creation of a community centered around particular topics. Regardless of the area that university living labs focus on, their common feature is a strong organizational connection with universities, which often initiates work within the living lab methodology.

Living labs at universities began to emerge around 2010 [van Geenhuizen, 2018]. A special type of HEI living labs are those located on campuses, where the campus is used as a testing ground for new solutions and products. In this case, the campus environment serves as a miniature representation of the broader society, offering an opportunity to explore and experiment with innovations [Martek, Hosseini, Durdyev, Arashpour, Edwards, 2022]. Initially, universities used single laboratories or units as living labs. Currently, we observe a trend showing that entire campuses can be perceived as living labs. Illustrating the broader application of the living lab principle, engagement now encompasses not only the laboratory and individual buildings but also extends to the entire campus environment. Nyborg et al. [2023] investigate the emerging concept of University Campus Living Labs (UCLL), which entails universities utilizing their own buildings, streets, or energy infrastructure as experimental environments to facilitate applied teaching, research, and collaborative innovation with society.

The university campus serves as an ideal setting for hosting living labs because universities provide an optimal research space that bridges the gap between the micro-scale of test facilities,



where research typically originates, and the macro-scale of cities, where research outcomes are ultimately implemented [Martek et al., 2022]. This intermediate space, encompassing entire buildings or the campus itself, facilitates the interaction of numerous variables within a controlled simulation. Consequently, the findings of a living lab serve as a more reliable indicator of an innovation's performance once it is introduced to the broader community. Additionally, universities possess research facilities, expert human resources, and essential resources necessary for living labs [Martek et al., 2022].

Living labs are new forms of cooperation for universities, so it takes time for them to introduce and consolidate the quadruple helix model in practice. Research teams need to understand that the parties involved in the project should actively participate in the co-creation of solutions. Within these educational settings, the researcher's role shifts away from being the sole expert. Instead, they must acknowledge that tackling complex issues and effecting systemic change necessitates collaborative endeavors where the insights of all participants are meaningful [Heijmans, Eweg, 2023]. As research indicates [Heijmans, Eweg, 2023], this is not yet a widespread practice, and implementing the concept of living labs requires time. In the context of living labs, local stakeholders currently participate in research primarily as sources of information, rather than as active partners or catalysts for change. The evolution of living labs suggests that research initiatives should originate from society itself, rather than being solely driven by universities. However, transforming the campus from merely a place of learning to the subject of study enhances the educational value that universities provide [Martek et al., 2022].

Nyborg, Horst, O'Donovan, Bombaerts, Hansen, Takahashi, and Ryszawska [2023] indicate that living labs offer a convenient way for industries to partner with universities on small-scale projects. Companies find it easier to engage with students, and living labs provide students with opportunities to tackle real-world problems, such as reducing energy consumption in buildings. We know that despite numerous efforts, universities have faced challenges in incorporating sustainability into their organizational frameworks and operational strategies. The key strength of the living lab approach is that it provides a systematic approach to facilitate student (and academic) engagement with applied sustainability issues [Evans et al., 2015]. Hence, the living lab seems to be a promising way to support sustainability transitions in universities and their campuses.

## Method

For the purpose of this article, we decided to perform a scoping review. Scoping reviews are a form of knowledge synthesis used to map the existing literature on a specific topic and are particularly useful when a topic is complex and heterogeneous [Galway et al., 2022]. As underlined by Marshall et al. [2018], "Scoping reviews are gaining in popularity across many fields as authors look to replace the traditional narrative literature review with more rigorous,



transparent, and replicable methods for synthesizing research”. And this is certainly the case with LLs literature, which has gained a lot of interest among researchers from various fields in recent years.

## Identifying the research questions

For the purpose of this research, the following research problem was formulated: How can living labs be a tool for transforming universities in the field of sustainability?

We have formulated three research questions in relation to the research problem:

RQ1: In relation to what dimensions of sustainability do universities use living labs?

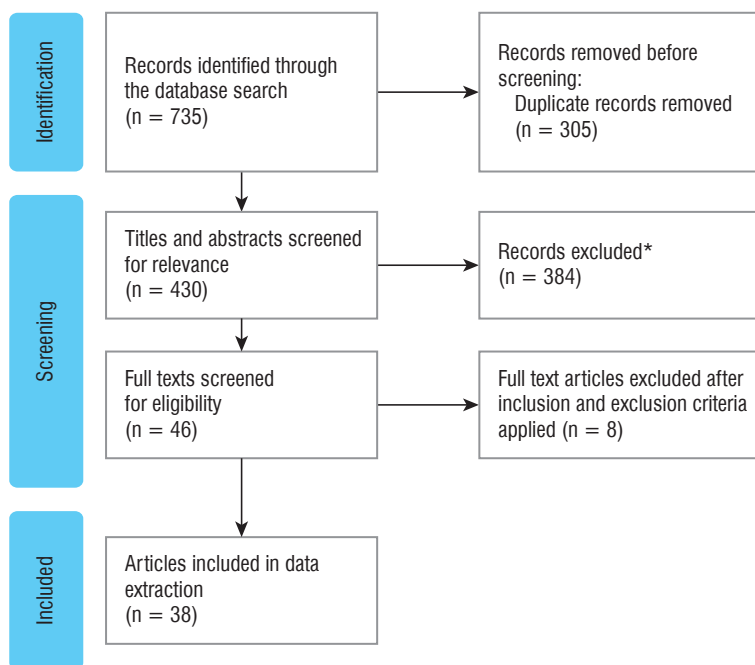
RQ2: How is a living lab understood in the context of implementing the university’s mission?

RQ3: In what areas of university management is a living lab used?

## Identifying relevant studies

In order to identify the relevant studies, we used the EBSCO Discovery Service (EDS). We chose this search engine because it provides a simultaneous access to many databases, including these subscribed to by the Jagiellonian University such as (1) ScienceDirect; (2) Web of Science; and (3) PubMed. These databases provided us with breadth and comprehensiveness in terms of journals and disciplinary perspective.

**Figure 2. PRISMA Flowchart**



Source: own study.

Database searches were concluded at the beginning of February 2024 so publications published by the end of January 2024 were also included in the search.

Sustainability AND living lab AND university living lab OR campus living lab OR higher education living lab OR HEI living lab were used as keyword search terms. No restrictions were placed on publication year, as we were interested in synthesizing knowledge and emerging trends specific to campus living labs to add to existing LLs literature reviews [e.g. Bronson et al., 2021; Gomez, Derr, 2021; van den Heuvel et al., 2021]. The database searches identified a total of 735 papers. Once all duplicates were removed ( $n = 305$ ), 430 papers remained for relevance screening (see Figure 2).

### Selecting studies for inclusion in the review

This step consisted of an initial screening of titles and abstracts followed by a full-text review. The title and abstract of each article were assessed for relevance based on the inclusion and exclusion criteria presented in Table 2. These criteria were developed, tested, and refined by two co-authors to ensure that a set of criteria was developed that was sufficiently robust to capture relevant studies while excluding non-eligible and irrelevant studies. Articles meeting any exclusion criteria were excluded, resulting in a total number of 384 articles being excluded at this stage. In the next step, 46 articles underwent the full text screening for eligibility. A total of 38 papers were selected as eligible and included in the data charting and synthesis process. The complete list of articles included in the data extraction is presented in Appendix 1.

**Table 2. Inclusion and exclusion criteria**

| Inclusion criteria                                                                                                 | Exclusion criteria                                                                                                     |
|--------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|
| Paper went through peer review process before publishing                                                           | Paper DID NOT go through peer review process before publishing                                                         |
| Article is published in English                                                                                    | Language other than English                                                                                            |
| campus living lab, Higher Education living lab or HEI living lab(s) are an explicit and central focus of the paper | campus living lab, Higher Education living lab or HEI living lab(s) are NOT an explicit and central focus of the paper |
| Paper explicitly addresses sustainability challenge(s)                                                             | Paper does NOT explicitly address sustainability challenge(s)                                                          |
| Paper is not focused solely on creating a technological innovation as an endpoint/objective                        | Paper is focused solely on creating a technological innovation as an endpoint/objective                                |

Source: own study.

### Data extraction

Articles included in the screening phase were used to create a dataset with relevant extracted data: bibliographic information, description of sustainability dimensions discussed in the papers, understanding of LL (s), description of how LL (s) are understood within the universities' mission. Data extraction was performed by researchers AG and SW and consisted of copy-pasting text directly from the articles into Excel Sheets.

## Content analysis

Qualitative data (direct quotes from articles) were thematically analyzed on Excel Sheets using inductive coding to identify emerging themes [Braun, Clarke 2006]. Two authors (AG, SW) coded quotes for study objectives from the included research articles. Three rounds of coding took place during the analysis phase. The first round of coding served to extract distinct elements relevant to RQ1 and focused on the description of sustainability dimensions discussed in the papers. During the second round of coding, the Authors focused on RQ2 and on understanding of LL(s), a description of how LL(s) are understood within the universities' mission. The third round of coding focused on extracting data relevant to RQ3 on how LL(s) are understood in the context of university management. After each round of coding AG and SW discussed the results and next steps of the analysis.

## Results

We coded whether the environmental or/and economic and/or social dimension of sustainability was explicitly considered and/or discussed in the 38 papers we have chosen for the analysis. The results of this coding are presented in table 1. In the vast majority of cases (22 articles), sustainability was understood and undertaken holistically at the level of the university's mission and vision, taking its all three dimensions into account. Our review has underscored that universities usually choose one of these dimensions as the dominant one. It is often linked to national priorities or the general approach towards sustainability among universities in a given context. In some cases, sustainability was treated selectively, with universities focusing only on their selected dimensions. In 5 cases the focus was only on environmental protection and enhancement, in 2 cases the focus was only on social progress. In none of the studies universities focused only on economic development, it was always linked to another (environmental or social) dimension.

**Table 3. Dimensions of sustainability undertaken by universities**

|   | Dimension of sustainability                                                                             | References (as in Appendix 1)                                                      |
|---|---------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| 1 | Focus on sustainability in all 3 dimensions                                                             | 1, 2, 5, 8, 11, 12, 13, 15, 16, 18, 19, 20, 21, 22, 23, 25, 26, 29, 30, 31, 34, 35 |
| 2 | Focus on sustainability only in environmental protection and enhancement                                | 3, 24, 26, 37, 38                                                                  |
| 3 | Focus on sustainability in dimension of environmental protection and enhancement & economic development | 28, 33,                                                                            |
| 4 | environmental protection and enhancement & social progress                                              | 7, 9, 10, 14, 17, 27,                                                              |
| 5 | economic development & social progress                                                                  | 4                                                                                  |
| 6 | Social progress                                                                                         | 6, 32                                                                              |

Source: own study.

With respect to our second research question, four categories of understanding of LLs emerged from the articles we reviewed. Among HEIs' LLs can be understood as: (1) a research method, (2) a form of collaboration with stakeholders, (3) an education tool or as (4) an institutional form. (Table 2). We found that in most of studies, LLs are treated as an innovative form of collaboration with stakeholders. Living labs are then seen "as a sociotechnical platform that organizes its stakeholders into an innovation ecosystem" [Cantù et al, 2021]. Apart from this, as indicated by Yusoff [2018] and Yusoff et al. [2021] LLs at universities are also seen as a research method and educational tool that can help to achieve the goals set by the university. It does not have an institutional form but is rather a kind of methodological framework for conducting the research and teaching at universities. For example, Sroufe [2020] underlines that LL is used for the purpose of "advancing sustainability [at universities] as a place-based pedagogical framework leveraging buildings as a testing ground for innovation and the coproduction of sustainability research, curriculum, and knowledge". Although LL at universities can have an institutional form of independent units, it is not a common case. Only in 14 of studies articles, institutionalized LL was mentioned by the authors.

**Table 4. Understanding of a living lab among universities**

|   | Understanding of living lab             | References (as in Appendix 1)                                                                              |
|---|-----------------------------------------|------------------------------------------------------------------------------------------------------------|
| 1 | research method                         | 1, 5, 6, 8, 9, 12, 13, 14, 16, 17, 21, 22, 23, 24, 25, 26, 27, 28, 35, 37, 38                              |
| 2 | form of collaboration with stakeholders | 1, 5, 7, 8, 11, 12, 13, 14, 15, 17, 18, 21, 22, 23, 24, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38 |
| 3 | education tool                          | 3, 4, 6, 8, 10, 11, 15, 16, 17, 18, 19, 20, 21, 22, 24, 25, 26, 28, 29, 30, 34, 35, 37, 38                 |
| 4 | institutional form                      | 2, 4, 8, 9, 12, 17, 21, 22, 24, 28, 31, 33, 35, 38                                                         |

Source: own study.

Answering the third research question, we identified the most important areas of university management with the use of LL. The dominant areas include communication, cooperation, project management, knowledge management, strategic management, operational management, innovation management, change management, value management, stakeholder management, team management and leadership. Moreover, the research explores the concepts of co-creation, learning environment and establishing long-term relationships with the internal and external environment of the university. As a result, LL is used to facilitate the process of creating and implementing new university development strategies, university visions, evaluation tools for the goals implemented by LL, sustainability action plans and best management practices. In this way, researchers point to the specific needs of universities, for example:

(...) the project team needed to adapt their governance by structuring the collaboration process, by deriving a clear long- and short-term strategy for the future, and by determining how to evaluate the progress and impact of this collaboration. [15]

(...) the need for a structured managerial model and standardized tools for decreasing the complexity of innovation activities and operational processes for living labs have been defined. [31]

## Summary

Universities are striving to redefine their role in society by becoming more open to the external environment and responding to global challenges such as sustainable development. They do so by engaging stakeholders, fostering co-creation, and undertaking targeted projects. The ongoing quest for new forms of collaboration and faster responsiveness to environmental needs is associated with testing various approaches and methods, ranging from action research and design thinking to living labs. As evidenced by our literature review, living labs help to transform the way universities respond to sustainability challenges.

This research investigated living labs as tools for sustainability transition among universities. In the vast majority of cases analyzed, sustainability was understood and undertaken holistically at the level of the university's mission and vision, taking its all three dimensions into account. LLs were understood as: (1) a research method, (2) a form of collaboration with stakeholders, (3) an education tool or as (4) an institutional form. Moreover, the research highlighted the prominent role of living labs in various facets of university management. The findings suggest that living labs serve as pivotal instruments for fostering sustainable practices and enhancing organizational effectiveness within academic institutions.

Previous literature reviews [e.g. Tercanli, Jongbloed, 2022] have highlighted how all three aspects of a university's mission (education, research, engagement with the environment) can be supported by living labs. However, our study signals the emergence of a new trend that has not been widely recognized: living labs are utilized as a management tool, and consequently, are transforming universities.

Although, the issue of university management through living lab is neither a dominant topic nor even often directly expressed, some researchers combine the usefulness of LL with management methods serving the sustainable development of universities [Leal Filho et al., 2023; Tercanli, Jongbloed, 2022]. LL serves universities for management in two key dimensions – thinking about the university of the future and the university's success. Both dimensions are related to the three missions of universities, and both refer to the need for change.

The four ways of understanding LL distinguished by us (see Table 2) among universities link together the notion of LL as a project. The word “project” is used in relation to living labs in various contexts: as a research method, as a research implementation process, as a management tool and as a means to secure financial resources. This demonstrates a strong trend indicating that the living lab is more a method of transforming universities rather than an end goal. Hence, the living lab appears to be another manifestation of the projectification of universities, as confirmed by the ephemeral nature of living lab creation. As the analysis revealed, only some of them make a transition from a project to a permanent organizational structure. This may have ambivalent consequences for university management. On the one hand, the project grants greater freedom for experimentation; on the other hand, it does not encourage long-term planning.

So, what makes the living lab approach different from standard projects, which universities have mastered to perfection? Primarily, this form allows for transcending the boundaries of the project and the project team. This means that actors who have traditionally remained outside the standard university project team – representatives from business, administration, the third sector – gain influence on the goals and methods of implementation. In a living lab, we deal with ‘management with stakeholders’, not ‘stakeholder management’ [Jałocha, 2023]. Perhaps that’s why universities, understanding the role and impact of the environment, choose living labs as a form of sustainability transformation. Hence, we can conclude that living labs are becoming increasingly popular tools for universities in the realm of sustainability and green transition.

## References

1. Archibald, M.M., Wittmeier, K., Gale, M., Ricci, F., Russell, K., Woodgate, R.L. (2021). Living labs for patient engagement and knowledge exchange: an exploratory sequential mixed methods study to develop a living lab in paediatric rehabilitation. *BMJ Open*, 11(5), p. e041530, doi:10.1136/bmjopen-2020-041530
2. Borel-Saladin, J.M., Turok, I.N. (2013). The Green Economy: Incremental Change or Transformation? *Environmental Policy and Governance*, 23(4), pp. 209–220, <https://doi.org/10.1002/eet.1614>
3. Braun, V., Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, 3(2), pp. 77–101.
4. Braunstein, E., Bouhia, R., Seguino, S. (2019). Social reproduction, gender equality and economic growth. *Cambridge Journal of Economics*, <https://doi.org/10.1093/cje/bez032>
5. Bronson, K., Devkota, R., Nguyen, V. (2021). Moving toward generalizability? A scoping review on measuring the impact of living labs. *Sustainability*, 13(2), p. 502.
6. Brundtland, G.H. (1987). *Our Common Future: The World Commission on Environment and Development*. Oxford University Press.
7. Chang, R.D., Zuo, J., Zhao, Z.Y., Soebarto, V., Zillante, G., Gan, X.L. (2017). Approaches for Transitions Towards Sustainable Development: Status Quo and Challenges. *Sustainable Development*, 25(5), pp. 359–371. John Wiley and Sons Ltd, <https://doi.org/10.1002/sd.1661>
8. Chronéer, D., Ståhlbröst, A., Habibipour, A. (2018, June 17–20). *Towards a unified definition of Urban Living Labs*. Paper presented at the The ISPIM Innovation Conference – Innovation, The Name of The Game, Stockholm, Sweden, <http://urn.kb.se/resolve?urn=urn:nbn:se:ltu:diva-70051>
9. Ede, A.N., Bamigboye, G.O., Olofinnade, O.M., Omole, D.O., Adeyemi, G.A., Ngene, B.U. (2016). Impact of Reliable Built Structures in Driving the Sustainable Development Goals: A look at Nigerian Building Structures. *Cu-Icadi*, pp. 9–12.
10. European Network of Living Labs (2023, March 21–23). *ENoLL – Jagiellonian University Training. Training conducted by Francesca Spagnoli and Joanna Karaś*. Presentation. Kraków: Jagiellonian University.

11. Evans, J., Jones, R., Karvonen, A., Millard, L., Wendler, J. (2015). Living labs and co-production: university campuses as platforms for sustainability science. *Current Opinion in Environmental Sustainability*, 16, pp. 1–6, doi:<https://doi.org/10.1016/j.cosust.2015.06.005>
12. Galway, L.P., Levkoe, C.Z., Portinga, R.L.W., Milun, K. (2022). A Scoping Review Examining Governance, Co-Creation, and Social and Ecological Justice in Living Labs Literature. *Challenges*, 13, p. 1, <https://doi.org/10.3390/challe13010001>
13. Geels, F.W. (2012). A socio-technical analysis of low-carbon transitions: introducing the multi-level perspective into transport studies. *Journal of Transport Geography*, 24, pp. 471–482. <https://doi.org/10.1016/j.jtrangeo.2012.01.021>
14. Gomez, T., Derr, V. (2021). Landscapes as living laboratories for sustainable campus planning and stewardship: A scoping review of approaches and practices. *Landscape and Urban Planning*, 216, p. 104259.
15. Grin, J., Rotmans, J., Schot, J. (2010). *Transitions to Sustainable Development*. Routledge, <https://doi.org/10.4324/9780203856598>
16. Hammer, T., Lewis, A.L. (2023). Which competencies should be fostered in education for sustainable development at higher education institutions? Findings from the evaluation of the study programs at the University of Bern, Switzerland. *Discover Sustainability*, 4(1), <https://doi.org/10.1007/s43621-023-00134-w>
17. Heijmans, A., Eweg, R. (2023). Transformative research and education in Living Labs using the SDGs as a compass. *International Journal of Sustainability in Higher Education*, 24(9), pp. 335–354, doi:10.1108/IJSHE-11-2022-0350
18. Hossain, M., Leminen, S., Westerlund, M. (2019). A systematic review of living lab literature. *Journal of Cleaner Production*, 213, pp. 976–988, doi:<https://doi.org/10.1016/j.jclepro.2018.12.257>
19. Jałocha, B. (2023) Wykorzystanie koncepcji living labu w praktyce zarządzania (z) interesariuszami projektów, *Studia i prace Kolegium Zarządzania i Finansów*, 193, pp. 107–120.
20. Kuźniarska, A., Mania, K., Jedynak, M. (Eds.) (2024). *Organizing Sustainable Development*. Taylor & Francis.
21. Leal, S., Azeiteiro, U.M., Aleixo, A.M. (2024). Sustainable development in Portuguese higher education institutions from the faculty perspective. *Journal of Cleaner Production*, 434, <https://doi.org/10.1016/j.jclepro.2023.139863>
22. Leal Filho, W., Ozuyar, P.G., Dinis, M.A.P., Azul, A.M., Alvarez, M.G., da Silva Neiva, S., Salvia, A.L., Borsari, B., Danila, A., Vasconcelos, C.R. (2023). Living labs in the context of the UN sustainable development goals: state of the art. *Sustainability Science*, 18(3), pp. 1163–1179, <https://doi.org/10.1007/s11625-022-01240-w>
23. Loiseau, E., Saikku, L., Antikainen, R., Droste, N., Hansjürgens, B., Pitkänen, K., Leskinen, P., Kuikman, P., Thomsen, M. (2016). Green economy and related concepts: An overview. *Journal of Cleaner Production*, 139, pp. 361–371, <https://doi.org/10.1016/j.jclepro.2016.08.024>
24. Lupp, G., Zingraff-Hamed, A., Huang, J.J., Oen, A., Pauleit, S. (2021). Living Labs – A Concept for Co-Designing Nature-Based Solutions. *Sustainability*, 13(1), p. 188.
25. Markard, J., Raven, R., Truffer, B. (2012). Sustainability transitions: An emerging field of research and its prospects. *Research Policy*, 41(6), pp. 955–967, <https://doi.org/10.1016/j.respol.2012.02.013>



26. Marone, L., Onofrio, R., Masella, C. (2020). The Italian Case of Lecco Innovation Living Lab: Stakeholders' Needs and Activities to Contribute to the Technological Innovation Process in Healthcare. *Sustainability*, 12(24), p. 10266.
27. Marshall, R.E., Levison, J.K., McBean, E.A., Brown, E., Harper, S.L. (2018). Source Water Protection Programs and Indigenous Communities in Canada and the United States: A Scoping Review. *J. Hydrol.* 562, pp. 358–370.
28. Martek, I., Hosseini, M.R., Durdyev, S., Arashpour, M., Edwards, D.J. (2022). Are university “living labs” able to deliver sustainable outcomes? A case-based appraisal of Deakin University, Australia. *International Journal of Sustainability in Higher Education*, 23(6), pp. 1332–1348, doi:10.1108/IJSHE-06-2021-0245
29. McCowan, T. (2023). The crosscutting impact of higher education on the Sustainable Development Goals. *International Journal of Educational Development*, 103, <https://doi.org/10.1016/j.ijedudev.2023.102945>
30. Midilli, A., Dincer, I., Ay, M. (2006). Green energy strategies for sustainable development. *Energy Policy*, 34(18), pp. 3623–3633, <https://doi.org/10.1016/j.enpol.2005.08.003>
31. Nyborg, S., Horst, M., O'Donovan, C., Bombaerts, G., Hansen, M., Takahashi, M.,... Ryszawska, B. (2023). University Campus Living Labs: Unpacking Multiple Dimensions of an Emerging Phenomenon. *Science & Technology Studies*,. doi:10.23987/sts.120246
32. Pietrzak, P. (2022). The Involvement of Public Higher Education Institutions (HEIs) in Poland in the Promotion of the Sustainable Development Goals (SDGs) in the Age of Social Media. *Information (Switzerland)*, 13(10), <https://doi.org/10.3390/info13100473>
33. Purcell, W.M., Henriksen, H., Spengler, J.D. (2019). Universities as the engine of transformational sustainability toward delivering the sustainable development goals. *International Journal of Sustainability in Higher Education*, 20(8), pp. 1343–1357, doi:10.1108/IJSHE-02-2019-0103
34. Romero Herrera, N. (2017). The Emergence of Living Lab Methods. In: D.V. Keyson, O. Guerra-Santin, D. Lockton (Eds.), *Living Labs. Design and Assessment of Sustainable Living*: Springer.
35. Rotmans, J., Kemp, R., van Asselt, M. (2001). More evolution than revolution: transition management in public policy. *Foresight*, 3(1), pp. 15–31, <https://doi.org/10.1108/14636680110803003>
36. SALL (2022). Transforming schools into living-labs: What it brings to students, teachers and partners, <https://www.schoolsaslivinglabs.eu/>
37. Sroufe, R. (2020). Business schools as living labs: Advancing sustainability in management education. *Journal of Management Education*, 44(6), pp. 726–765.
38. Tercanli, H., Jongbloed, B. (2022). A Systematic Review of the Literature on Living Labs in Higher Education Institutions: Potentials and Constraints. *Sustainability*, 14(19), p. 12234. <https://doi.org/10.3390/su141912234>
39. United Nations Environment Programme. (2018). *Pathways to sustainable development and poverty eradication*, <https://www.unep.org/resources/report/pathways-sustainable-development-and-poverty-eradication>
40. van den Heuvel, R., Braun, S., de Bruin, M., Daniëls, R. (2021). A closer look at living labs and higher education using a scoping review. *Technology Innovation Management Review*, 11(9/10).
41. van Geenhuizen, M. (2018). A framework for the evaluation of living labs as boundary spanners in innovation. *Environment and Planning C: Politics and Space*, 36(7), pp. 1280–1298, doi:10.1177/2399654417753623

42. von Wirth, T., Fuenfschilling, L., Frantzeskaki, N., Coenen, L. (2018). Impacts of urban living labs on sustainability transitions: mechanisms and strategies for systemic change through experimentation. *European Planning Studies*, 27, pp. 229–257.
43. WCED (1987). *Report of the World Commission on Environment and Development: Our Common Future*.
44. Yusoff, S. (2018). Toward integrated and sustainable waste management system in University of Malaya: UM zero waste campaign. *E3S web of conferences*, 48, p. 04007. EDP Sciences.
45. Yusoff, S., Abu Bakar, A., Rahmat Fakri, M.F., Ahmad, A.Z. (2021). Sustainability initiative for a Malaysian university campus: Living laboratories and the reduction of greenhouse gas emissions. *Environment, Development and Sustainability*, 23, pp. 14046–14067.

## Annex 1. Articles included in the analysis

|    |                                                                                                                                                                                                                                                                                           |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | Boroff, C., Eickmeier, J., Eklund, K., Garcia, C., Miller, S., Newton, B.,... Whittaker, O. (2018). Community, campus, and climate at central community college – 3C initiative: kearney center living learning lab and ecosystem. <i>Journal of Green Building</i> , 13(1), pp. 139–156. |
| 2  | Bracco, S., Delfino, F., Laiolo, P., Morini, A. (2018). Planning & open-air demonstrating smart city sustainable districts. <i>Sustainability</i> , 10(12), p. 4636.                                                                                                                      |
| 3  | Bradshaw, K., Baldizon, H., Morris, J., Velez-Castrillon, S. (2019). Our Personal Landfill: Using the Campus as a Living Laboratory to Teach about Sustainable Waste Management. <i>Business Education Innovation Journal VOLUME 11 NUMBER 2 December 2019</i> , p. 212.                  |
| 4  | Callaghan, R., Herselman, M. (2015). Applying a Living Lab methodology to support innovation in education at a university in South Africa. <i>TD: The Journal for Transdisciplinary Research in Southern Africa</i> , 11(1), pp. 21–38.                                                   |
| 5  | Cantù, C.L., Schepis, D., Minunno, R., Morrison, G. (2021). The role of relational governance in innovation platform growth: the context of living labs. <i>Journal of Business &amp; Industrial Marketing</i> , 36(13), pp. 236–249.                                                     |
| 6  | Cole, C., Srivastava, C. (2013). Energy blitz leads to measured reductions on campus: students embrace campus as a living lab at Yale. <i>Sustainability: The Journal of Record</i> , 6(1), pp. 37–41.                                                                                    |
| 7  | Compagnucci, L., Spigarelli, F., Coelho, J., Duarte, C. (2021). Living Labs and user engagement for innovation and sustainability. <i>Journal of Cleaner Production</i> , 289, p. 125721.                                                                                                 |
| 8  | Di Salvatore, S., Magatti, G., Acciarri, M., Rossetti, M., da Costa, L.P., Ribeiro, I. (2022). Solid Waste Management Approach at the University through Living Labs and Communication Strategies: Case Studies in Italy and Portugal. <i>Sustainability</i> , 14(9), p. 5240.            |
| 9  | Du Preez, M., Arkesteijn, M.H., den Heijer, A.C., Rymarzak, M. (2022). Campus Managers' Role in Innovation Implementation for Sustainability on Dutch University Campuses. <i>Sustainability</i> , 14(23), p. 16251.                                                                      |
| 10 | Gomez, T., Derr, V. (2021). Landscapes as living laboratories for sustainable campus planning and stewardship: A scoping review of approaches and practices. <i>Landscape and Urban Planning</i> , 216, p. 104259.                                                                        |

cont. Annex 1

|    |                                                                                                                                                                                                                                                                                                                                                             |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 11 | Heijmans, A., Eweg, R. (2023). Transformative research and education in Living Labs using the SDGs as a compass. <i>International Journal of Sustainability in Higher Education</i> , 24(9), pp. 335–354.                                                                                                                                                   |
| 12 | Horan, W., Shawe, R., O'Regan, B. (2019). Ireland's transition towards a low carbon society: the leadership role of higher education institutions in solar photovoltaic niche development. <i>Sustainability</i> , 11(3), p. 558.                                                                                                                           |
| 13 | Hugo, H., Espinoza, F., Morales, I., Ortiz, E., Pérez, S., Salcedo, G. (2018). Delta project: Towards a sustainable campus. <i>Sustainability</i> , 10(10), p. 3695.                                                                                                                                                                                        |
| 14 | Jiang, C., Xiao, Y., Cao, H. (2020). Co-creating for locality and sustainability: design-driven community regeneration strategy in Shanghai's old residential context. <i>Sustainability</i> , 12(7), p. 2997.                                                                                                                                              |
| 15 | Kalinauskaite, I., Brankaert, R., Lu, Y., Bekker, T., Brombacher, A., Vos, S. (2021). Facing societal challenges in living labs: Towards a conceptual framework to facilitate transdisciplinary collaborations. <i>Sustainability</i> , 13(2), p. 614.                                                                                                      |
| 16 | Kapenieks, J. (2020). Spaced E-learning for sustainable education. <i>Journal of Teacher Education for Sustainability</i> , 22(2), pp. 49–65.                                                                                                                                                                                                               |
| 17 | Kretschmer, S., Dehm, S. (2021). Sustainability transitions in university food service – A living lab approach of locavore meal planning and procurement. <i>Sustainability</i> , 13(13), p. 7305.                                                                                                                                                          |
| 18 | Leal Filho, W., Emblen-Perry, K., Molthan-Hill, P., Mifsud, M., Verhoef, L., Azeiteiro, U.M.,... Price, E. (2019). Implementing innovation on environmental sustainability at universities around the world. <i>Sustainability</i> , 11(14), p. 3807.                                                                                                       |
| 19 | Lindstrom, T., Middlecamp, C. (2017). Campus as a living laboratory for sustainability: The chemistry connection. <i>Journal of Chemical Education</i> , 94(8), pp. 1036–1042.                                                                                                                                                                              |
| 20 | Martínez, I., Zalba, B., Trillo-Lado, R., Blanco, T., Cambra, D., Casas, R. (2021). Internet of things (Iot) as sustainable development goals (sdg) enabling technology towards smart readiness indicators (sri) for university buildings. <i>Sustainability</i> , 13(14), p. 7647.                                                                         |
| 21 | Martínez-Acosta, M., Vázquez-Villegas, P., Mejía-Manzano, L.A., Soto-Inzunza, G.V., Ruiz-Aguilar, K.M., Kuhn Cuellar, L.,... Membrillo-Hernández, J. (2023). The implementation of SDG12 in and from higher education institutions: universities as laboratories for generating sustainable cities. <i>Frontiers in Sustainable Cities</i> , 5, p. 1158464. |
| 22 | Mastelic, J., Sahakian, M., Bonazzi, R. (2015). How to keep a living lab alive? <i>info</i> , 17(4), pp. 12–25.                                                                                                                                                                                                                                             |
| 23 | Mohamad, Z.F., Abd Kadir, S.N., Nasaruddin, A., Sakai, N., Zuki, F.M., Hussein, H.,... Salleh, M.S.A.M. (2018). Heartware as a driver for campus sustainability: Insights from an action-oriented exploratory case study. <i>Journal of Cleaner Production</i> , 196, pp. 1086–1096.                                                                        |
| 24 | Mouchrek, N., Cullen, C., Ganino, A., Gliga, V., Kramer, P., Mahesh, R.,... Shaikh, T. (2022). Investigating environmental values and psychological barriers to sustainable behaviors among college students. <i>Consilience</i> , (26), pp. 1–18.                                                                                                          |
| 25 | Omar, W., Rahman, A.A., Din, M.F.M., Taib, S.M., Zen, I.S., Hanafi, N. (2018). Greening campus experience: moving towards living laboratory action plan. <i>E3S Web of Conferences</i> , 48, p. 02006. EDP Sciences.                                                                                                                                        |

|    |                                                                                                                                                                                                                                                                                                                                                                   |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 26 | Purcell, W.M., Henriksen, H., Spengler, J.D. (2019). Universities as the engine of transformational sustainability toward delivering the sustainable development goals: "Living labs" for sustainability. <i>International Journal of Sustainability in Higher Education</i> , 20(8), pp. 1343–1357.                                                              |
| 27 | Rauschenberg, C., Goetzl, C., Schick, A., Koppe, G., Durstewitz, D., Krumm, S., Reininghaus, U. (2021). Living lab AI4U-artificial intelligence for personalized digital mental health promotion and prevention in youth. <i>European Journal of Public Health</i> , 31 (Supplement_3), ckab164–746.                                                              |
| 28 | Rizzo, S., Cappellaro, F., Accorsi, M., Orsini, F., Gianquinto, G., Bonoli, A. (2017). Co-design for a circular approach in green technologies: adaptation of reused building material as growing substrate for soilless cultivation of lettuce ( <i>Lactuca sativa</i> var. capitata). <i>Environmental Engineering &amp; Management Journal (EEMJ)</i> , 16(8). |
| 29 | Rogers, S., Jeffery, A., Pringle, J., Law, A., Nobajas, A., Szkornik, K.,... Hobson, L. (2023). Experiential and authentic learning in a Living Lab: the role of a campus-based Living Lab as a teaching and learning environment. <i>Journal of Learning Development in Higher Education</i> , (28).                                                             |
| 30 | Rukspollmuang, C. (2022). Transforming learning for sufficiency economy philosophy and sustainable development through the triangle of living learning lab. <i>Asia Pacific Education Review</i> , 23(4), pp. 595–610.                                                                                                                                            |
| 31 | Save, P., Terim Cavka, B., Froese, T. (2021). Evaluation and lessons learned from a campus as a living lab program to promote sustainable practices. <i>Sustainability</i> , 13(4), 1739.                                                                                                                                                                         |
| 32 | Shvetsova, O.A., Lee, S.K. (2021). Living labs in university-industry cooperation as a part of innovation ecosystem: Case study of South Korea. <i>Sustainability</i> , 13(11), p. 5793.                                                                                                                                                                          |
| 33 | Soutullo, S., Aelenei, L., Nielsen, P.S., Ferrer, J.A., Gonçalves, H. (2020). Testing platforms as drivers for positive-energy living laboratories. <i>Energies</i> , 13(21), p. 5621.                                                                                                                                                                            |
| 34 | Sroufe, R. (2020). Business schools as living labs: Advancing sustainability in management education. <i>Journal of Management Education</i> , 44(6), pp. 726–765.                                                                                                                                                                                                |
| 35 | Van Geenhuizen, M. (2019). Applying an RRI filter in key learning on urban living labs' performance. <i>Sustainability</i> , 11(14), p. 3833.                                                                                                                                                                                                                     |
| 36 | Vargas, L., Mac-Lean, C., Huge, J. (2019). The maturation process of incorporating sustainability in universities. <i>International Journal of Sustainability in Higher Education</i> , 20(3), pp. 441–451.                                                                                                                                                       |
| 37 | Yusoff, S. (2018). Toward integrated and sustainable waste management system in University of Malaya: UM zero waste campaign. <i>E3S web of conferences</i> , 48, p. 04007. EDP Sciences.                                                                                                                                                                         |
| 38 | Yusoff, S., Abu Bakar, A., Rahmat Fakri, M.F., Ahmad, A.Z. (2021). Sustainability initiative for a Malaysian university campus: Living laboratories and the reduction of greenhouse gas emissions. <i>Environment, Development and Sustainability</i> , 23, pp. 14046–14067.                                                                                      |

Source: own source

