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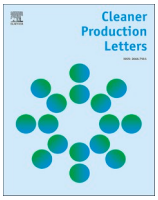

# How can campus living labs thrive to reach sustainable solutions?

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ABSTRACT

Many Higher Education Institutions utilize living labs to address complex societal challenges and foster innovative and sustainable solutions on campus. Despite the perceived benefits of campus environments for transdisciplinary real-world innovation, living labs often encounter challenges. As such, there is a growing need for more knowledge on facilitating these on-campus initiatives in different development phases. Here, enabling factors for on-campus living labs are investigated and their salience across the living labs' development process established. First, a systematic literature review was conducted, identifying sixteen enabling factors. The most pertinent ones were stakeholders and networks, coordination on the organizational level, a conducive work culture, co-creation and collaboration, and suitable methods and practices for living labs. Second, all factors' relevance across living labs' development phases were assessed through the input of an expert panel. To that end, a mapping exercise was developed, which can in itself serve as a discussion tool for living lab practitioners. The results suggested that the initiation phase relies on leadership, coordination, stakeholder engagement, a conducive work culture, and funding. In contrast, operational phases were enabled by shared understanding, internal management, stakeholder collaboration, methodological appropriateness, and evaluation. Lastly, the dissemination phase hinged on transfer, scaling, evaluation, learning, and bridging stakeholders and contexts. These insights contribute to a better understanding of enabling factors for campus living labs during different phases of development, offering tailored guidance for stakeholders while stressing adaptability to local contexts. Subsequently, campus living labs may be better equipped to effectively generate sustainable solutions for the complex societal questions of this time.

## 1. Introduction

As hubs for knowledge creation, dissemination, and transfer, Higher Education Institutions (HEIs) are vital for sustainable development (Cortese, 2003; Findler et al., 2019; Trencher et al., 2014). They contribute to society through education and research and serve as role models by showcasing sustainable transitions through on-campus living labs (Rivera and Savage, 2020). Here, complex societal challenges related to sustainable solutions are tackled by diverse stakeholders within real-world settings and by explicitly involving users (Hossain et al., 2019). As such, on-campus living labs not only impact campus sustainability but may also contribute beyond the organizational borders through HEIs' third mission (Rivera and Savage, 2020). The rising popularity of living labs has resulted in numerous definitions and interpretations across disciplines, alongside a conceptual variety of sustainability related labs, such as urban living labs, real-world labs, or transition labs, to name a few (Greve et al., 2021; Leminen and Westerlund, 2019; McCrory et al., 2020). In this study, living labs are understood as systematic transdisciplinary co-creation approaches to innovation, set in real-life environments, and characterized by public-private-people partnerships (4P) between businesses, governmental entities, academia, and users, aimed at tackling complex societal challenges and finding sustainable solutions.

In the remainder of this study, we will narrow our focus to *on-campus* living labs; those that are specifically situated within the physical environment of HEIs. By "campus," we refer to the buildings and premises owned by the university, which serve as the physical foundation for these living labs. This includes not only academic and research facilities but also any university-owned spaces where students, faculty, and stakeholders can collaborate in real-world experiential settings.

By leveraging these on-campus spaces, HEIs may enhance their societal research relevance through transdisciplinary collaboration and community engagement, possibly generate economic benefits by fostering local partnerships and sharing resources and knowledge,

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attract public attention through visible events and experimentation spaces, and secure funding by demonstrating tangible societal impact (Mtawa et al., 2016; Vargas et al., 2019; Herth et al., 2024). Further, HEIs can mobilize diverse stakeholders and create "neutral" innovation spaces, such as living labs. Such spaces are ideally free from organizational pressure and allow the connection of research, teaching, and societal relevance (Molinari et al., 2023; Purcell et al., 2019; Tercanli and Jongbloed, 2022) and may bridge the theory-practice gap between the academia and society (Bauwens et al., 2023; Compagnucci et al., 2021). On-campus living labs thus have the potential to impact beyond their HEI environment and accelerate broader sustainability transitions by embedding solutions in local structures, translating them into comparable contexts, or upscaling them (Wirth et al., 2019). This expansion beyond organizational and physical campus boundaries may also strengthen the HEI's role as a proactive contributor to sustainable development.

Specific to their context and location (Nyborg et al., 2024; van den Heuvel et al., 2021), on-campus living labs encounter several challenges in their internal operation and external environment, such as their cultural embedding, heterogeneous HEI-internal stakeholder expectations, and navigating their complex inner dynamics (Herth et al., 2024). Some scholars highlight the inherent ambiguity of their internal operations and emergence processes, which challenge their replication (Callaghan and Herselman, 2015; Save et al., 2021) and often lead to perceptions of living labs being obscure, ad hoc and eclectic (Martek et al., 2022; Herth et al., 2024). This hints at various challenges in different living labs development phases, i.e., preparation, start, value creation, and scaling/transfer. Therefore, it is necessary to intentionally facilitate living labs tailored to their contextual and phase-specific needs, calling for investigating phase-specific enabling factors. HEIs can unlock the potential of their sustainable campus landscapes through more research on its critical requirements (Gomez and Derr, 2021).

To date, preconditions and enabling factors of living labs across contexts remain ambiguous and case-dependent. Despite calls from the researchers to move beyond single case studies for more generalizable insights (e.g., Köhler et al., 2019; Sengers et al., 2019), much of the existing literature focuses predominantly on case studies (Bergmann et al., 2021; Martek et al., 2022). Hence, some call for more systematic investigations (Berberi et al., 2023). Therefore, this study aims to identify and analyze enabling factors for on-campus living labs. Since living labs' different development stages translate into varying facilitation needs, this study also aims to highlight the salience of enabling factors across these phases. By presenting a comprehensive overview, prioritizing these factors, and considering their relevance at each stage, the understanding of what facilitates campus living labs is enhanced. Practically, the results aid HEIs and living lab practitioners in enabling on-campus living labs more successfully at any development phase.

Enabling factors are defined as the conditions, practices, and processes necessary to facilitate the well-functioning on-campus living labs to achieve their sustainable innovation aims. In response to calls for more research on enabling factors across campuses (Bergmann et al., 2021; Leal Filho et al., 2022), a two-step approach was employed. First, a systematic literature review was conducted to identify and categorize enabling factors and determine the most discussed ones. Second, the most salient factors for each development phase was mapped out with input from an expert panel.

This study's findings provide a deeper understanding of the enabling factors at the different development phases of campus living labs. With this, campus living labs may be better equipped to tackle the complex societal questions of this time effectively.

## 2. Methods

A two-step approach was followed to serve the research aim. First, a systematic literature review was conducted to derive enabling factors from the academic literature and thematically analyze them (section 2.1). Second, an expert panel was consulted to validate the enabling factors found in step one (section 2.2). Further, they were mapped on the living lab development phases with the help of those experts to contextualize and specify their salience. An overview of the methodological process of this study is summarized in Fig. 2.

### 2.1. Systematic literature review to derive enabling factors

The campus living lab literature was systematically reviewed following the PRISMA guidelines and checklists (Page et al., 2021; Rethlefsen et al., 2021). The searches were conducted in March 2023 on the Scopus and Web of Science databases, as they reflect the academic publication realm. Google Scholar was excluded due to its significant non-journal publication share (Martín-Martín et al., 2018). The search was limited to English-language journal articles to ensure alignment with the current scientific discourse. No limitations on the time frame of publications were applied. The search terms, such as "living lab*, campus lab*," "university," "higher education," "success factor," "lesson learned," and related variations, were required to appear in the title, keywords, or abstract. The complete search string using Boolean operators is provided in Appendix A. The search strategy was discussed and peer-reviewed by an independent colleague.

Scopus yielded 226 records and Web of Science yielded 256 records (see Fig. 1); ultimately twenty-one were included in the sample for full-text analysis. The rest were excluded in two stages due to duplication, off-campus location or divergence from this study's living lab definition (as described in the Introduction). Those articles were published relatively recently, from 2015 to 2022, with a peak of seven in 2021. Predominantly, they report a Western perspective with cases in Europe, Australia, and North America. Other cases were in Turkey, South Africa, Malaysia, Mexico, and Chile. An overview of the articles included in the sample can be found in Appendix B.

Aligning with the explorative nature of this study, a thorough thematic analysis was conducted by open coding enabling factors in Atlas.ti 23 (Saldaña, 2015), including analytic memo writing. Stated and experiential values in the selected articles were coded using trigger words such as "success factor," "key to success," "key elements," "precondition," "contribute to success," "suggest," "recommend," "important factor," and "facilitating factor." However, most of these terms lacked clear descriptions or definitions, with only one article defining "key performance factors" (van Geenhuizen, 2018, p. 1285). The absence of consistent definitions introduces an interpretation margin and leads to coding stated enablers, as factors were not measured or validated in the articles analyzed. A second coding round was conducted to identify thematic clusters and establish categories. Socio-technical systems, which refer to the interconnectedness of social and technical elements within an organization or context and how both dimensions influence each other, provided an initial framework for our analysis (Fuenfschilling and Truffer, 2014; Neyer et al., 2009). However, the development of categories was ultimately guided by our research question focused on identifying enabling factors. These categories are not mutually exclusive, allowing codes to appear in multiple categories, reflecting their complexity and interdependence. The process and codes were continuously discussed within the research team and external validation was sought by discussing random samples with researchers outside the organization (Golafshani, 2015). Last, a document analysis of the categories was conducted to establish the most discussed ones, hinting at their relevance (Bowen, 2009).

### 2.2. Document analysis of the enabling factor categories

A document analysis was conducted to dive deeper into the origins of the factors and determine their relevance. This was done in two ways. First, the different methods employed in the articles were considered to determine if certain enabling factors more frequently appear in articles using particular methods. For that, the sample was divided into case

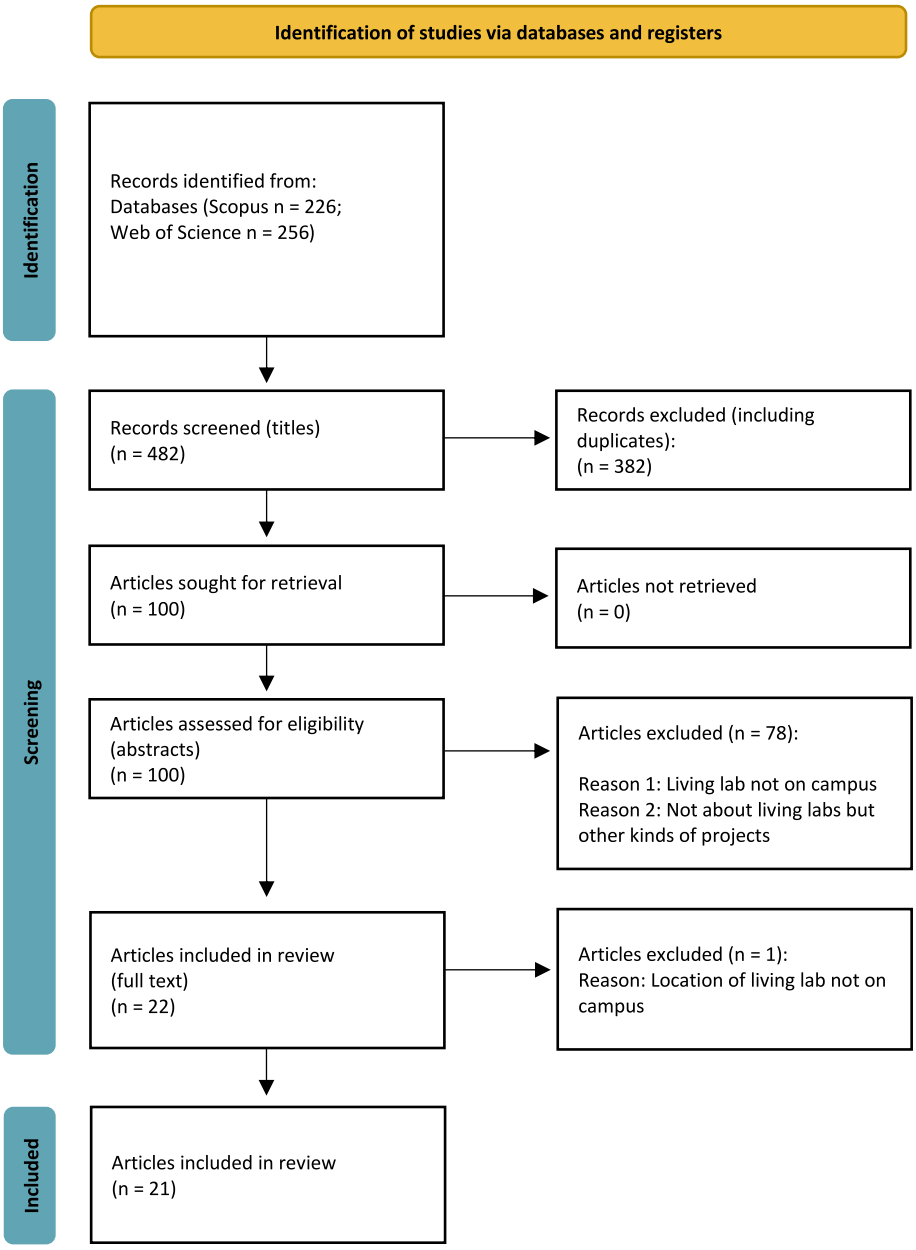


**Fig. 1.** PRISMA flow diagram of the literature search and selection process, according to Page et al. (2021).

studies (9 articles), and literature reviews, some supported by case examples (10 articles); two articles used other methods and were disregarded. In the latter ones, living labs served as the framework for investigating research questions unrelated to living labs. To assess the significance of this methodological distinction for the categories, the count of mentions of the categories from the case studies were plotted against those from the literature articles to identify any linear relationship. Indeed, it revealed a difference, as the plot was scattered. Second, the most frequently discussed enabling factor categories across all articles were analyzed to identify the more significant ones. A binary scoring system was used, assigning one point foe each category mention in an article and two points if mentioned in the abstract or conclusion, indicating greater relevance.

### *2.3. Expert panel session to validate and structure the enabling factor categories*

In the next step, the 17 preliminary categories were aimed to be validated, and their relevance across the development phases of living labs was to be determined. Given that the literature did not provide clear insights into the phases when discussing the enabling factors, field experts were consulted for this step. This involved a three-step iterative process consulting field experts. First, we sought validation of the categories from three experts. Their feedback resulted in merging categories to a final set of 16.

Second, an international expert panel of eight participants with direct research or practice experience in campus living labs was approached, selected from the author team's network. The group consisted of researchers (4), a living lab manager (1), and coordinators (3) who have contributed to conferences or published articles in the field. They were affiliated with six universities or research institutes in the

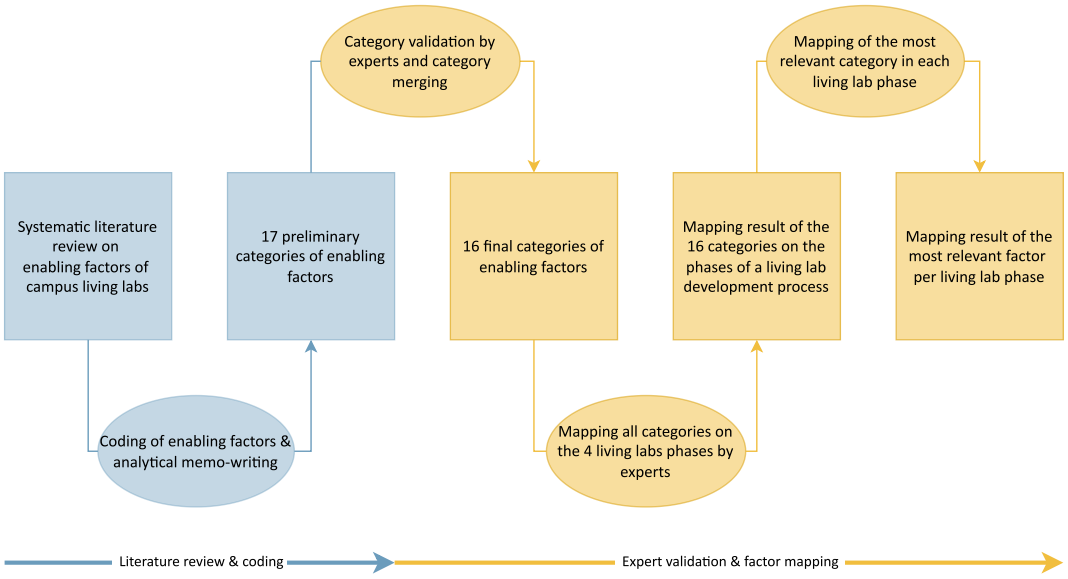


**Fig. 2.** Methodological process steps - overview.

Netherlands, Sweden, and Canada. Those experts were sent a presentation outlining the different living lab development phases in short video statements, together with the content and meaning of the categories in info boxes, asking them to map the categories to the most pertinent phases. Participants could assign categories to multiple phases or indicate their relevance across all phases. They were also encouraged to comment on content and the mapping process. A blank mapping slide and an exemplary result can be found in Appendix C. Seven of the eight participants returned their results. The interrater reliability for each phase was calculated using Fleiss Kappa to assess agreement among participants beyond chance. Fleiss Kappa determines the level of agreement among raters beyond what would be expected by chance alone (Gisev et al., 2013; Nichols et al., 2010).

Third, upon reviewing the initial outcomes of the mapping session, it became clear that a follow-up round would be valuable for interpreting the results. In a subsequent validation step, the same participants were asked to map only the single most relevant factor in each phase, aiming to assess agreement and identify any prominent factors.

## 3. Findings

### 3.1. Enabling factor categories

Before presenting the study's results, how living labs were understood in this data sample is first clarified. Varying interpretations of living labs across different articles were observed during the analysis. For example, Yusoff et al. (2021) emphasized the various opportunities presented by living labs, including participation, bridging research, operations, and management, involving students, and transboundary intra- and extra-organizational collaborations, all of which impact teaching practices, novel methodologies, and organizational sustainability transitions. Another perspective describes living labs as temporary entities for single activities or formal organizations like research units or hubs that engage in internal and external collaborations (Tercanli and Jongbloed, 2022). For others, they represent the ongoing maturation of university sustainability initiatives (Vargas et al., 2019). However, most articles perceive living labs as a means or tool to drive sustainable innovation and organizational sustainability transitions. Gomez and Derr (2021, p. 7) state: "(…) the living laboratory framework was often applied as a tool to generate new ideas about how to enact sustainability in a local context and to engage students in the process of innovation and ideation." Similarly, Purcell et al. (2019, p. 1354) underline the potential for broader institutional change, stating that "the 'living lab' framework can become a part of transformative institutional change that draws on both top-down and bottom-up strategies" to integrate sustainability into core practices and culture within universities. However, there is a need to know how to facilitate that potential.

Sixteen non-mutually exclusive enabling factor categories across the sample were identified, underlining categories' interconnection and interdependence. Table 1 presents these factor categories, such as Leadership, Learning, and Work Culture, together with their detailed descriptions compiled from the articles. Staying close to the data allows for a more specific understanding of their content and avoids additional layers of interpretation. Notably, while characteristics of living labs, such as co-creation and stakeholder inclusion, are foundational to the concept of living labs, their implementation varies significantly. In cases where these characteristics are fully integrated and effectively applied, they not only define the living lab but also act as enabling factors. This implies a dual role and underscores the importance of effectively facilitating these characteristics.

### 3.2. Document analysis regarding the sixteen enabling factor categories

A document analysis was conducted to explore the origins and relevance of enabling factors, specifically examining whether certain factors appeared more frequently in case studies compared to literature and mixed-method reviews, and assessing any correlation between method type and category mentions. The most striking difference could be seen in the category Coordination, which was extensively discussed in the case studies. Funding also received more attention in the case studies. On the contrary, Stakeholders & Networks and Competencies & Skills were more prominently discussed in the literature review and mixed-method studies. This suggests that practical issues surrounding campus living labs are primarily addressed in case studies (e.g., coordination, co-creation, strategic alignment, and funding). In contrast, more conceptual topics are emphasized in literature and mixed-method studies (e.g., stakeholders, competencies and skills, work culture, and environment).

The most frequently discussed enabling factor categories across all articles were analyzed to identify key factors. A binary scoring system was used, assigning one point for each category mention within an article and two points if mentioned in the abstract or conclusion, signifying greater relevance. The results reveal the most discussed categories in academic literature. For validation, a table was also generated

**Table 1**
Description of categories of enabling factors as identified during the analysis (alphabetical order).

| Category | Description | References |
|---|---|---|
| **Bridging** | Bridging the two university internal worlds – namely faculty and operational departments. It also concerns connecting to students and courses. | Du Preez et al. (2022); Gomez and Derr (2021); Purcell et al. (2019); Zen (2017) |
| **Collaboration & Co-creation** | Effective collaboration in this context involves:<br>• stakeholders and users engaging in transdisciplinary collaboration<br>• within a shared governance space<br>• focusing on a common purpose and vision<br>• building trust and closeness among stakeholders<br>• respecting shared goals and interests<br>• addressing community-owned challenges<br>• implementing ethics committees and privacy protocols<br>• and encouraging student and academic involvement in campus living labs. | Callaghan and Herselman (2015); Du Preez et al. (2022); Evans et al. (2015); Leal Filho et al. (2022); Purcell et al. (2019); Tercanli and Jongbloed (2022); van den Heuvel et al. (2021); van Geenhuizen (2018) |
| **Competences & Skills** | Developing competencies and skills for living labs, such as conflict resolution, adaptability, continuous learning, capacity-building for various stakeholders, fostering relationships and communities, aligning motivations and capabilities, and specialized management skills. | Tercanli and Jongbloed (2022); van den Heuvel et al. (2021); van Geenhuizen (2018); Zen (2017) |
| **Coordination** | University-wide coordination and oversight of living labs involving organizational structures, multi-stakeholder committees, strategic documents, clear roles and mandates, thematic clustering, project networking, project pipeline generation, capacity matching, review processes, interdisciplinary teams, technology selection, issue forecasting, change management, and incentive creation. | Callaghan and Herselman (2015); Du Preez et al. (2022); Evans et al. (2015); Callaghan and Herselman (2015); Du Preez et al. (2022); Evans et al. (2015); Leal Filho et al. (2022); Purcell et al. (2019); Save et al. (2021); Sker and Floricic (2020); Tercanli and Jongbloed (2022); van den Heuvel et al. (2021); Yusoff et al. (2021); Zen (2017) |
| **Environment** | Selecting locations where real societal problems occur, with necessary logistical and ICT infrastructure, while fostering a creative learning environment and hosting living labs within stable organizations (like universities). | Callaghan and Herselman (2015); Evans et al. (2015); Martek et al. (2022); Tercanli and Jongbloed (2022); van den Heuvel et al. (2021); van Geenhuizen (2018) |
| **Evaluation** | Establishing comprehensive risk assessment and evaluation processes, encompassing technical, sustainability, and alternative criteria tailored to the living lab's focus. It also highlights the need for continuous evaluation, adjusting academic evaluation criteria to include sustainability and transdisciplinary research, and ensuring the dissemination of results, impacts, continuity, and learning. | Evans et al. (2015); Save et al. (2021); Tercanli and Jongbloed (2022); van Geenhuizen (2018) |
| **Funding** | Receive continuous and early (co-)funding for feasibility, project management, due diligence, and evaluation, aiming for the self-sustainability of the living lab to ensure that the living lab can continue to operate and innovate. | Callaghan and Herselman (2015); Purcell et al. (2019); Save et al. (2021); Tercanli and Jongbloed (2022); van den Heuvel et al. (2021); Yusoff et al. (2021); Zen (2017) |
| **Internal management (of the living lab)** | Improving communication among stakeholders, identifying and sharing everyone's expectations and needs, keeping all parties informed about processes and key decisions, ensuring equal participation in co-creation, having the flexibility for resource allocation, prioritizing sustainability and innovation, and managing processes to achieve desired outcomes. | Du Preez et al. (2022); Save et al. (2021); van den Heuvel et al. (2021) |
| **Leadership** | Leadership action aligned with a shared vision, including both strong and flat leadership styles while reducing competition among living lab participants, and recognizing leadership contributions from students and stakeholders. | Callaghan and Herselman (2015); Purcell et al. (2019); Tercanli and Jongbloed (2022); van den Heuvel et al. (2021) |
| **Learning** | Providing more learning opportunities, gathering stakeholder input, promoting inter-organizational learning, involving skilled users, and enhancing students' creative and innovative real-world experiential learning experiences. | Leal Filho et al. (2022); Purcell et al. (2019); van Geenhuizen (2018); Zen (2017) |
| **Methods & Practices** | Various tools, methods, and practices used by campus living labs, including open communication, multidisciplinarity, setting up innovation processes, overcoming bureaucratic barriers, balancing freedom and frameworks, defining problems clearly, hosting idea contests, carrying out stakeholder analyses, creating decision-making tools, stakeholder engagement events, online platforms for collaboration, and maintaining flexibility in processes. | Callaghan and Herselman (2015); Evans et al. (2015); Kılkış (2017); Leal Filho et al. (2022); Lough (2022); Martek et al. (2022); Save et al. (2021); Sker and Floricic (2020); Tercanli and Jongbloed (2022); van den Heuvel et al. (2021); van Geenhuizen (2018) |
| **Shared understanding** | Stakeholders have a clear, commonly owned living lab vision, a shared purpose, and an understanding of the living lab project. Sustainability and transdisciplinarity are key concepts. Stakeholders use consistent language, share a goal, and foster mutual trust. | Callaghan and Herselman (2015); Gomez and Derr (2021); Martek et al. (2022); Purcell et al. (2019); Save et al. (2021); Tercanli and Jongbloed (2022); van den Heuvel et al. (2021) |
| **Stakeholders & Network** | Involving all relevant stakeholders from the beginning, avoiding imbalance or excessive dependency, excluding those who might compromise core values, forming a university committee, engaging knowledgeable experts, fostering early public consultations, participating in relevant networks, creating communities of interest, and strategically selecting partners. | Burbridge and Morrison (2021); Du Preez et al. (2022); Evans et al. (2015); Leal Filho et al. (2022); Lough (2022); Purcell et al. (2019); Save et al. (2021); Sker and Floricic (2020); Tercanli and Jongbloed (2022); van Geenhuizen (2018); Zen (2017) |
| **Strategic alignment** | Refers to an integrated approach of strategic alignment and anchoring of Living Labs in HEIs' strategies to address campus issues and promote sustainable development (e.g., university's objectives, innovation- and sustainability strategy, real estate, ethics, vision, mission, and curricula). | Burbridge and Morrison (2021); Du Preez et al. (2022); Evans et al. (2015); Gomez and Derr (2021); Leal Filho et al. (2022); Martek et al. (2022); Purcell et al. (2019); Save et al. (2021); Tercanli and Jongbloed (2022) |
| **Transferability & Scaling** | Making initiatives more visible internally and using monitoring systems to gather data for researchers and similar buildings to transfer solutions, focusing on universal solutions for implementation beyond universities, sharing knowledge with other organizations, using formal structures for scalability and commercialization, aligning with Sustainable Development Goals (SDGs), building strong relationships with cities, presenting research | Evans et al. (2015); Leal Filho et al. (2022); Martek et al. (2022); Martínez-Bello et al. (2021); Purcell et al. (2019); Save et al. (2021); Tercanli and Jongbloed (2022); van den Heuvel et al. (2021); van Geenhuizen (2018) |

(*continued on next page*)

**Table 1** (*continued*)

| Category | Description | References |
|---|---|---|
| | findings to the right audience, and involving a diverse group of actors for scaling and market acceptance. | |
| **Work culture** | Fostering a culture characterized by flexibility, agility, openness to new approaches, support from top management, interdisciplinary collaboration, open communication, and a willingness to embrace improvements suggested by living labs in the organization. | Callaghan and Herselman (2015); Du Preez et al. (2022); Evans et al. (2015); Leal Filho et al. (2022); Martek et al. (2022); Purcell et al. (2019); Save et al. (2021); Tercanli and Jongbloed (2022); van den Heuvel et al. (2021); van Geenhuizen (2018); Zen (2017) |

indicating whether factors were mentioned or not, without weighting. Comparing the top categories above the median frequency, consistent results were found, with only slight changes in order. This confirms that the top five categories in both results—Stakeholders & Network, Coordination, Work Culture, Co-Creation & Collaboration, and Methods & Practices—are the most frequently discussed and emphasized in abstracts and conclusions (refer to Table 2).

The document analysis identified the primary categories discussed in the literature but does not capture their depth and breadth. Put differently, it does not cover the full range of points within each category. For instance, while Internal Management appeared only in three articles, it encompasses various aspects. Appendix D details the specific contents of the top five categories.

### 3.3. Salience of factors across living labs' development phases

Having extracted enabling factor categories from the literature, this study's next objective was to determine their relevance across the development stages of a living lab. The existing literature has outlined various process and development phases (e.g., Bergvall-Kåreborn and Ståhlbröst, 2009; Martek et al., 2022; Save et al., 2021; Steen and van Bueren, 2017). These were synthesized into four aggregated process phases. It is emphasized that they are not to be perceived as static stage-gate process but instead as iterative and dynamic phases with feedforward- and feedback loops, as depicted by the looped arrows in Fig. 3.

The development process of a living lab is essentially ongoing, with knowledge transfer and scaling potentially leading to new research inquiries and the establishment of further living labs, thus restarting the cycle. The phases are not as clearly delineated in reality, especially in fluid settings like living labs. The initial phase, preparation, precedes the actual launch of the campus living lab and involves tasks such as assessing available competencies, identifying key stakeholders, and aligning on values, issues, and potential impacts. Following this is the getting started phase, where practical aspects like assigning roles and mandates, setting up infrastructure, and defining objectives occur. Next, the value creation phase is marked by active co-creation for innovation, accompanied by continuous evaluation. The final phase, transfer & scaling, involves embedding, translating, or expanding the living lab's outcomes and knowledge, including tangible results and insights garnered throughout the preceding phases (Wirth et al., 2019).

The expert mapping sessions yielded two types of results. To recall, experts were asked to map factor categories onto the living lab phases they considered most pertinent, with an option to indicate if a factor applied across all phases (see Appendix C for exemplary results). First, the top categories from the literature review were compared with the experts' opinions. This approach revealed a different ranking of the top five categories compared to the literature review. Notably, Learning, which ranked low in the literature review, emerged as a top factor in the expert ratings, while Methods & Practices dropped to the bottom (see Table 3).

Second, the mapping results enabled the identification of trends in the relevance of categories across specific phases or throughout the development process of a living lab. Certain categories were deemed particularly relevant during specific phases, while others were considered essential across all phases by the experts (see Table 3). Of course, the table can be read in two ways: by column or by row. Column analysis reveals which factor categories are pertinent to specific phases, while row analysis illustrates the evolving relevance of categories during the living lab process. Given the aim of enabling living labs tailored to their phase, the process is proceeded by column. In the following, the highly relevant categories throughout all phases are first presented, followed by a focus on the top five from the literature review, and finally, emphasis is placed on those categories that stand out per phase.

Attention is drawn to the "Across phases" column, which deserves separate consideration despite being integrated into all other columns via point distribution. The inclusion of factor categories in this column indicates that they were deemed consistently relevant across all development phases by the expert panel. This consistency suggests that developing these factors could support campus living labs at every stage of their evolution, underscoring their essential role in enabling their well-functioning. Further, a difference between the rankings derived from the document analysis and those based on the expert mapping was noted. The cross-phase enabling factors rated by the experts do not fully align with the top five factors emphasized in the literature, highlighting a divergence in perspectives between factors discussed in the scientific debate and priorities of the expert assessments.

Notably, Stakeholders & Network, Learning, Internal Management, Shared Understanding, Co-Creation & Collaboration, and Evaluation, all assigned by most experts across all phases, underscore the significance of living labs' core operational dynamics throughout all phases, as these elements represent the essential processes, structures and practices that enable living labs to function cohesively. Particularly, Stakeholders & Networks stand out, complementary to the findings in the literature and underlining this factor's overall relevance. Contrary to the scientific discussion's focus, Learning and Evaluation also gain relevance when concerning phases. Generally, Stakeholders & Networks and Shared Understanding remain highly relevant from the first phase onwards, with the latter declining in relevance during the transfer and scaling phase. Learning gains significance as phases progress to operational and scaling stages. Internal Management, Co-Creation & Collaboration, and Evaluation's relevance increase during operational phases two and three. Evaluation also remains highly pertinent in the last phase.

When focusing on the experts' mapping of the top five categories of the document analysis (marked with a star in Table 3), they exhibit varying dynamics. As Stakeholders & Networks play an integral role throughout the entire developmental spectrum, Work Culture and Coordination are particularly crucial in the initial phases until the living lab is fully operational. Then, their need for high-level coordination seems to decrease as they establish their own working cultures. Meanwhile, Methods & Practices and Co-creation & Collaboration gain prominence during the launch and operational phases, hinting at their significance in living labs' practical value-creation processes.

#### 3.3.1. Phase 1

In the preparation phase, unanimously *Leadership* stands out as highly relevant. This is unexpected in light of the little attention the category received in the literature. However, the factor might also be seen in relation to creating momentum for the living lab to start, ensuring a *Shared Understanding*, and creating suitable conditions. Connected to the latter are also *Stakeholders & Network*, *Competencies & Skills*, *Work Culture*, *Coordination*, and *Environment*, all deemed

**Table 2**
Results of the document analysis; one dot representing a mention, and two dots indicating a mention in the conclusion and/or abstract.

| | Burbridge & Morrison 2021 | Callaghan & Hereelman 2015 * | Du Preez et al. 2022 | Evans et al. 2015 * | Gomez & Darr 2021 | Kilkis 2017 * | Leal Filho et al. 2022 | Lough 2022 | Martek et al. 2021 | Martinez-Bello et al. 2021 | Purcell et al. 2019 * | Rivera & Savage 2020 * | Save et al. 2021 * | Sker & Floricic 2020 | Tercanli & Jongbloed 2022 | Van den Heuvel et al. 2021 | Van Geenhuizen 2018 | Vargas et al. 2019 * | Westerlund et al. 2018 | Yusoff et al. 2021 * | Zen 2017 * | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Stakeholders & Network | •• | | •• | •• | | | •• | • | | | • | | • | •• | • | | • | | | | • | 16 |
| Coordination | | • | •• | • | | | | | | | • | | • | • | • | • | | | | •• | •• | 13 |
| Work Culture | | • | •• | • | | | •• | | • | | • | | • | | • | • | • | | | | • | 13 |
| Co-Creation & Collaboration | | •• | •• | • | | | •• | | | | • | | | | • | • | •• | | | | | 12 |
| Methods & Practices | | • | | • | | •• | • | •• | • | | | | • | • | • | • | • | | | | | 12 |
| Strategic Alignment | • | | • | • | •• | | •• | | • | | • | | • | | • | | | | | | | 11 |
| Transferability & Scaling | | | | • | | | • | | • | • | • | | • | | • | • | •• | | | | | 10 |
| Funding | | •• | | | | | | | | | • | | • | | • | • | | | | •• | • | 9 |
| Shared Understanding | | • | | | •• | | | | • | | • | | • | | • | • | | | | | | 8 |
| Bridging | | | •• | | •• | | | | | | • | | | | | | | | | | • | 6 |
| Environment | | • | | • | | | | | • | | | | | | • | • | • | | | | | 6 |
| Learning | | | | | | | •• | | | | • | | | | | | •• | | | | • | 6 |
| Competencies & Skills | | | | | | | | | | | | | | | • | • | •• | | | | • | 5 |
| Evaluation | | | | • | | | | | | | | | • | | • | | •• | | | | | 5 |
| Leadership | | •• | | | | | | | | | • | | | | • | • | | | | | | 5 |
| Internal Management (LL) | | | • | | | | | | | | | | • | | | • | | | | | | 3 |

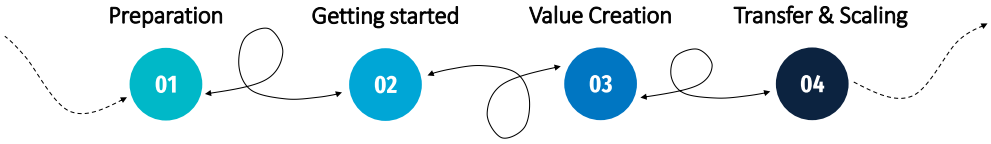


**Fig. 3.** Development phases of living labs.

**Table 3**
Results of the expert mapping (n = 7) of the categories on the living labs phases, color-coded and sorted by sum of points per category. Multiple mentions of the same factor across different phases were permitted. The top five from the literature review are marked with a star.

| | 01 - 04 | 01 | 02 | 03 | 04 |
|---|---|---|---|---|---|
| | Across all phases | Preparation | Getting started | Value creation | Transfer & scaling |
| Stakeholders & Network * | 5 | 6 | 6 | 5 | 5 |
| Learning | 4 | 4 | 6 | 6 | 6 |
| Shared Understanding | 4 | 5 | 7 | 5 | 4 |
| Internal Management (of the LL) | 4 | 4 | 6 | 7 | 4 |
| Co-creation & Collaboration * | 4 | 4 | 6 | 6 | 4 |
| Evaluation | 4 | 4 | 4 | 6 | 6 |
| Leadership | 3 | 7 | 4 | 4 | 4 |
| Work Culture * | 3 | 6 | 6 | 4 | 3 |
| Coordination * | 3 | 6 | 5 | 4 | 3 |
| Environment | 2 | 6 | 3 | 5 | 3 |
| Bridging | 2 | 4 | 3 | 3 | 5 |
| Competencies & Skills | 2 | 5 | 3 | 4 | 3 |
| Funding | 1 | 6 | 2 | 3 | 4 |
| Transferability & Scaling | 0 | 4 | 1 | 1 | 6 |
| Methods & Practices * | 0 | 1 | 4 | 5 | 1 |
| Strategic Alignment | 0 | 4 | 2 | 2 | 2 |

| Color legend | |
|---|---|
| | 0 - 2 |
| | 3 - 4 |
| | 5 - 7 |

especially relevant during this phase. Unsurprisingly, *Funding* is also highly relevant in securing the financial means for starting a living lab.

#### 3.3.2. Phase 2

The start phase underscores again the high importance of a *Shared Understanding* of *Stakeholders & Networks*. Besides, some more operational factors gain relevance, such as *Internal Management*, *Co-creation & Collaboration*, and *Coordination*, all underpinned by a conducive *Work Culture*. *Learning*, as mentioned previously, also emerges as vital from the start.

#### 3.3.3. Phase 3

During the value-creation phase, *Internal Management* is seen as most relevant (despite having received the least attention in the literature), alongside the more operational factors mentioned in Phase 2, such as *Shared Understanding*, *Co-Creation & Collaboration*, *Stakeholders & Network*, and *Learning*. As living labs are starting, their previous needs for coordination and establishing fitting work cultures seem to decrease, while a suitable *Environment*, and employing appropriate *Methods & Practices* are becoming more relevant.

#### 3.3.4. Phase 4

In the final transfer and scaling phase, unsurprisingly, the factors of *Learning*, *Evaluation*, and *Transfer & Scaling* take precedence. For the latter to happen, yet again, *Stakeholders & Networks* are relevant, alongside *Bridging* to extend opportunities to other stakeholders and contexts.

### 3.4. Validation of the mapping results

The interrater agreement was assessed to determine if the expert panel's factor mapping reflected genuine consensus or occurred by chance (Gisev et al., 2013; Nichols et al., 2010). The results showed Fleiss Kappa values close to zero (positive) for each phase (refer to Appendix E). This indicates slight agreement among raters beyond chance expectations (Landis and Koch, 1977). Therefore, the mapping results suggest first tendencies rather than absolute statements, indicating that living lab experts hold divergent views on the specific relevance of factors across phases.

After the initial mapping round, the same experts were asked to identify the single most relevant factor category per phase, limiting their choice to one factor compared to the previous round. The aim was to determine if one particular factor category was more consistently deemed critical in specific phases. However, the results showed even greater divergence. Through discussions and explanation rounds with the experts to explain their choices it was suggested that the experts' disciplinary lenses and concrete living lab experiences influenced their responses. This interpretation, however, indicates a need for further investigation to fully understand the nuances of these influences and their implications for the findings. Although experts identified different factors as the most relevant in each phase, their reasoning revealed a shared perspective: they believed that when living labs are able to operate "smoothly"—in alignment with core principles and intended practices—other enabling factors are likely to emerge or develop organically. In essence, if a living lab's foundational elements are in place and functioning well, this creates an environment where additional enabling factors can naturally evolve without requiring explicit prioritization. For example, some experts argued that living labs with well-established stakeholder networks have the inherent potential to facilitate scaling and transferability.

Although this shared reasoning among experts suggests that certain enabling factors might emerge organically, this perspective may not apply universally to all factors. For example, previous research indicates that transfer and scaling can remain significant challenges for campus living labs if these elements are not explicitly integrated into the initial planning processes (Herth et al., 2024). This highlights that while a well-functioning foundation may allow some factors to develop naturally, others, like transfer and scaling, require intentional planning and proactive strategies from the beginning to avoid becoming barriers to broader impact.

## 4. Discussion

### 4.1. General discussion of process and findings

This study aimed to uncover enabling factors for campus living labs throughout their development. The mere presence of all enabling factor categories in the literature inherently suggests their relevance, albeit with some receiving more attention than others. This does not necessarily indicate their direct importance. It may also reflect that other, less-discussed factors were overlooked, challenging to research, or that our understanding of them remains limited. Nevertheless, an order of relevance was established through the document analysis and the phasing of categories. Generally, the five most discussed categories seem to cover the "soft skills" of factor categories and general attributes of living labs, such as co-creation, collaboration, and stakeholder involvement. This might lead to friction in the rather traditional organizational setting of HEIs until new working practices, like early transdisciplinary stakeholder and user involvement are firmly established.

Notably, the category of Stakeholders & Networks stands out as highly relevant in both analyses, emphasizing the importance of careful stakeholder involvement and maintenance throughout all phases. Also, Co-Creation & Collaboration, another fundamental characteristic of living labs, surfaced as vital in both analyses. However, differences exist between the identified factors in the document analysis and the phasing. Whereas the document analysis also yielded contextual factors, such as Work Culture or Coordination, the phasing analysis highlights factors related to practical inner workings, such as Shared Understanding, Internal Management, and Learning.

Overall, the inventory of enabling factors underscores living labs' complexity and diverse needs. The non-mutually exclusive factors reflect their interconnectedness and interdependence (see Table 1). For instance, Co-creation & Collaboration rely on Stakeholders & Networks. Generally, the factors are not to be understood as prescriptive but rather as guideposts for campus living labs and their environment, which need adaptation to various contexts and circumstances. This aligns with findings from similar studies on success factors that found interdependencies and point to the need for adaptation to specific contexts (Bergmann et al., 2021). Additionally, some factors are inherent attributes of living labs, as noted in other studies (Berberi et al., 2023; Bergmann et al., 2021). Despite overlapping categories, the dataset demonstrates coherence as the factors depict the characteristics, requirements, and complex interdependencies for well-functioning living labs.

Contextualizing cross-case enabling factors by specifying their evolving relevance across living labs' developmental phases enhances understanding of their varying needs throughout different stages, contributing to the living lab literature. While process phases have been acknowledged in campus living lab literature (Martek et al., 2022), there has been a lack of specificity regarding considerations for these phases, a gap addressed with this study's findings. It is suggested that by better understanding living labs' phase-specific needs, their complexity is partly unraveled, enabling more effective and tailored facilitation. This, in turn, complements and advances previous case-specific studies (analyzed in this study), investigations of challenges, and the emerging field of living labs within higher education contexts (van den Heuvel et al., 2021). Practically, this study's findings enable HEIs, living lab coordinators, and practitioners to create favorable conditions for flourishing living labs on their campuses while leveraging them to drive sustainable innovations for broader transitions. The identified enabling factors and their phased approach can serve as a navigation guide to focus facilitation efforts on the most critical areas.

To steer these efforts, the mapping exercise (see Appendix C) emerged as a tool with two potential applications. Firstly, it can be utilized as input for living lab coordinators and stakeholders to clarify phases and enabling factors, fostering a common understanding, managing expectations, and reducing uncertainty in the living lab process. Secondly, it can facilitate internal discussions, decision-making, and project management, revealing different understandings and expectations, clarifying stakeholder roles and mandates, and addressing leadership questions across different tasks or phases. The expert discussions highlighted the mapping exercise's value as an adaptable discussion tool for elaborating and refining the status quo in various campus living labs and phases rather than as a top-down input to establish a predefined one. This approach resonates with the dynamic and context-specific nature of living labs. Therefore, regular revisions and re-establishment of the initial mapping result, co-created with all living lab stakeholders, are essential to incorporate new insights and ensure ongoing alignment. As such, the mapping can serve as a tool for reflection and evaluation. One panelist has already intended to adapt the mapping exercise for their institution, incorporating sticky notes for actors and tasks.

### 4.2. Limitations and future research

This study's limitations concern the database, coding, and mapping processes. The database was drawn from only two sources, considered to reflect the scientific literature comprehensively, but having restricted the sample to English-language peer-reviewed articles. Next, this study's analysis did not account for specific campus contexts, potentially overlooking cultural influences or alternative worldviews. Future research could investigate those contexts to uncover additional enabling factors. Efforts were made to mitigate potential biases in the interpretation and clustering of codes through internal and external discussions. However, further research should provide more detailed descriptions of enabling factors to avoid such biases in future studies and provide actionable insights.

The phase-specific results, derived from a small group of experts, could benefit from validation through repetition with a larger participant group and diverse stakeholders, for example, in the form of focus groups. Further, the phases themselves should be further elaborated and validated. It was found that the mapping outcomes are influenced by experts' disciplinary backgrounds and experience, suggesting that narrower selection criteria may yield clearer results. However, living labs' transdisciplinary nature suggests that restricting the expert group could misrepresent their functioning. Likewise, further development of the mapping tool, such as integrating actors, responsibilities, and tasks, may be practically beneficial in creating a shared understanding and reflexivity in the different living lab initiatives. Applying and adapting the tool in use cases may further its generalizability. Future research should consider living labs' phase-specific needs when developing governance and management approaches while integrating enabling factors. More research is needed, particularly through cross-case analyses, to understand the pathways of on-campus living labs better.

Given the overlapping and interdependent nature of the enabling factor categories, conducting a factor analysis, which is a statistical method that identifies underlying relationships among variables, is recommended, using a significantly extended dataset to streamline the number of enabling factors for better practical application. It was also discussed how the presence of enabling factors could support the resilience of campus living labs, even if not all factors are present, as others may naturally emerge. Future research could investigate the critical factors for each phase and identify tipping points. Additionally, a point often overlooked, or at least not published, is failed cases (Bauwens et al., 2023; Fanelli, 2010; Turnheim and Sovacool, 2020). However, they could reveal which enabling factors were lacking in which phase, validating or refuting the findings of this study.

## 5. Conclusion

Current studies have not yet offered general insight into the enabling factors for campus living labs across the scientific literature. This study addresses this gap by providing an inventory of relevant factors, highlighting their complexity and interdependence, and offering detailed insights into the most pertinent ones: stakeholders, coordination, co-creation and collaboration, work culture, and inner work practices within campus living labs. Prioritizing the inventory of factors throughout their development phases may enable contextualization and more effective catering to their phase-specific needs. Although firm statements cannot yet be made due to a small sample size and modest participant agreement, some trends for the factor's relevance in those phases can be concluded. In the first phase, especially leadership, coordination, the relevant stakeholders, a conducive environment and work culture, and funding are crucial enablers for initiating a living lab. As it progresses, operational phases highlight the importance of shared understanding, internal management, stakeholder co-creation and collaboration, appropriate methods and practices, and evaluation and learning. Finally, disseminating outcomes and insights is enabled by, unsurprisingly, transfer and scaling, evaluation and learning, and bridging stakeholders and contexts.

The better understanding of these dynamics might also aid the factors' application in practice, offering guidance for Higher Education Institutions to actively support the facilitation process and create suitable conditions for campus living labs to flourish, literally "in their front yard." Additionally, the results provide method-driven guidance for campus living lab coordinators and participants to tailor their facilitation efforts to the specific development needs. Here, the set of factors serves as a starting point, highlighting areas for focus while emphasizing the need for adaptation to specific local contexts. The mapping exercise can facilitate internal discussions and reflections, fostering a common understanding among stakeholders. By leveraging their capacities and resources more efficiently, HEIs, coordinators, and practitioners can enable the contexts to drive sustainable solutions for the complex societal challenges of this time and the future.

## CRediT authorship contribution statement

**Annika Herth:** Writing – review & editing, Writing – original draft, Visualization, Validation, Resources, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Robert Verburg:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Kornelis Blok:** Writing – review & editing, Supervision, Methodology, Conceptualization.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Appendix A. Search string

*Search string for Scopus:*

(("Living lab*") OR ("Urban living lab*") OR ("Real-world lab*") OR ("Transition lab*") OR ("campus lab*") OR ("Innovation lab*") OR ("campus innovation") OR ("sustainability lab*") OR ("Real-labor*") AND ("university") OR ("campus") OR ("higher education") AND TITLE-ABS-KEY ("success factor*") OR TITLE-ABS-KEY ("lesson* learned")) AND (LIMIT-TO (PUBSTAGE, "final")) AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "cp")) AND (LIMIT-TO (LANGUAGE, "English"))

*Search string for Web of Science:*

(TS=(("Living lab*" OR "Urban living lab*" OR "Real-world lab*" OR "Transition lab*" OR "campus lab*" OR "Innovation lab*" OR "campus innovation" OR "sustainability lab*" OR "Real-labor*") AND ("university" OR "campus" OR "higher education")) AND LA=(English))

Further filter criteria in both cases: Articles only.

## Appendix B. Included articles

Articles included in the review.

Burbridge, M., & Morrison, G. M. (2021). A Systematic Literature Review of Partnership Development at the University–Industry–Government Nexus. *Sustainability*, *13*(24), 13780. https://doi.org/10.3390/su132413780

Callaghan, R., & Herselman, M. (2015). Applying a Living Lab methodology to support innovation in education at a university in South Africa. *The Journal for Transdisciplinary Research in Southern Africa*, *11*(1), 21–38. https://doi.org/10.4102/td.v11i1.30

Du Preez, M., Arkesteijn, M. H., Heijer, A. C. den, & Rymarzak, M. (2022). Campus Managers' Role in Innovation Implementation for Sustainability on Dutch University Campuses. *Sustainability*, *14*(23), 16251. https://doi.org/10.3390/su142316251

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*, 1–6. https://doi.org/10.1016/j.cosust.2015.06.005

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*, 104259. https://doi.org/10.1016/j.landurbplan.2021.104259

Kılkış, &Scedil. (2017). Comparative analyses of sustainable campuses as living laboratories for managing environmental quality. *Management of Environmental Quality: An International Journal*, *28*(5), 681–702. https://doi.org/10.1108/MEQ-06-2015-0107

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. (2022). Living labs in the context of the UN sustainable development goals: state of the art. *Sustainability Science*. Advance online publication. https://doi.org/10.1007/s11625-022-01240-w

Lough, B. J. (2022). Decentering social innovation: the value of dispersed institutes in higher education. *Social Enterprise Journal*, *18*(1), 12–27. https://doi.org/10.1108/SEJ-08-2020-0059

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*. Advance online publication. https://doi.org/10.1108/IJSHE-06-2021-0245

Martínez-Bello, N., Cruz-Prieto, M. J., Güemes-Castorena, D., & Mendoza-Domínguez, A. (2021). A Methodology for Designing Smart Urban Living Labs from the University for the Cities of the Future. Sensors (Basel, Switzerland), 21(20). https://doi.org/10.3390/s21206712

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), 1343–1357. https://doi.org/10.1108/IJSHE-02-2019-0103

Rivera, C. J., & Savage, C. (2020). Campuses as living labs for sustainability problem-solving: trends, triumphs, and traps. *Journal of Environmental Studies and Sciences*, *10*(3), 334–340. https://doi.org/10.1007/s13412-020-00620-x

Save, P., Terim Cavka, B., & Froese, T. (2021). Evaluation and Lessons Learned from a Campus as a Living Lab Program to Promote Sustainable Practices. *Sustainability*, *13*(4), 1739. https://doi.org/10.3390/su13041739

Sker, I., & Floricic, T. (2020). Living Lab - creative environment and thinking techniques for tourism development. *Interdisciplinary Description of Complex Systems*, *18*(2-B), 258–270. https://doi.org/10.7906/indecs.18.2.13

Tercanli, H., & Jongbloed, B. (2022). A Systematic Review of the Literature on Living Labs in Higher Education Institutions: Potentials and Constraints. *Sustainability*, *14*(19), 12234. https://doi.org/10.3390/su141912234

van den Heuvel, R. H. R., Braun, S., Bruin, M. de, & Daniëls, R. (2021). A Closer Look at the Role of Higher Education in Living Labs: a scoping review. *Technology Innovation Management Review*, *11*(9/10), 30–46. https://doi.org/10.22215/timreview/1463

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), 1280–1298. https://doi.org/10.1177/2399654417753623

Vargas, L., Mac-Lean, C., & Huge, J. (2019). The maturation process of incorporating sustainability in universities. *International Journal of Sustainability in Higher Education*, *20*(3), 441–451. https://doi.org/10.1108/IJSHE-01-2019-0043

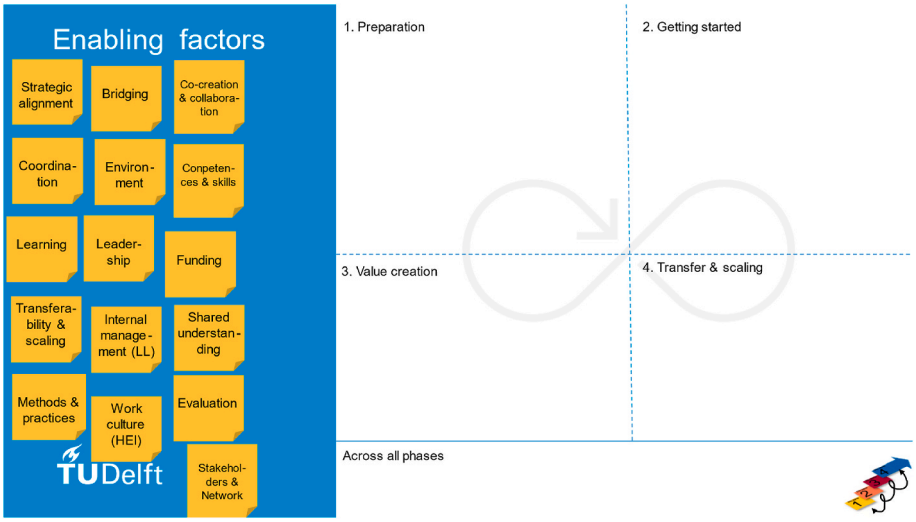
Westerlund, M., Leminen, S., & Rajahonka, M. (2018). A Topic Modelling Analysis of Living Labs Research. Technology Innovation Management Review, 8(7), 40–51. https://doi.org/10.22215/timreview/1170

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*(9), 14046–14067. https://doi.org/10.1007/s10668-021-01250-1

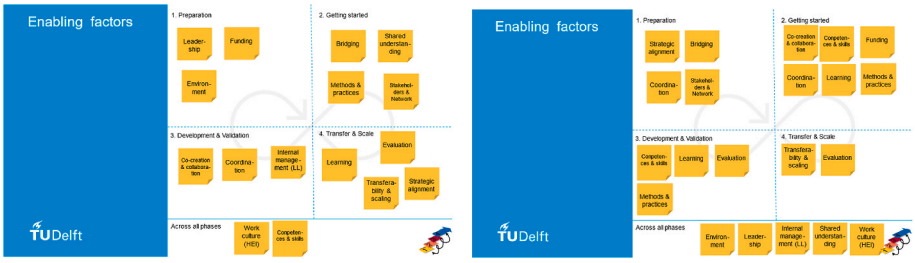
Zen, I. S. (2017). Exploring the living learning laboratory. *International Journal of Sustainability in Higher Education*, *18*(6), 939–955. https://doi.org/10.1108/IJSHE-09-2015-0154

## Appendix C. Mapping presentation and exemplary mapping

Blank mapping presentation.




Indicative mapping examples.




## Appendix D. Deep-dive into the five most mentioned factors

*Stakeholders & Network*

A diverse set of relevant stakeholders (internal and external) with different expertise areas should be engaged (Leal Filho et al., 2022), together with knowledgeable experts and knowledge brokers (Du Preez et al., 2022). All relevant stakeholders, including users like students or citizens, should be involved from the start (Tercanli and Jongbloed, 2022; van Geenhuizen, 2018). However, van Geenhuizen (2018) also draws attention to keeping an eye on balance and avoiding too many diverse actors, one stakeholder dominating others, and strong interdependencies between actors. Actors that might endanger maintaining the living lab's core values should also be avoided (van Geenhuizen, 2018). Next, participation in several networks is essential for campus living labs partnerships: Student and user networks, sustainability networks and communities, and the broader innovation ecosystems (Burbridge and Morrison, 2021; Lough, 2022; Tercanli and Jongbloed, 2022). Also, early and proactive public consultation processes and public engagement should occur (Lough, 2022; Save et al., 2021). This goes hand in hand with creating communities of interest around specific problems or topics, which is considered effective towards real-world impact (Burbridge and Morrison, 2021; Evans et al., 2015). According to Zen (2017), an HEI-internal committee with key stakeholders, including the top management, academics, operational staff, students, and other relevant campus organizations, should be set up to strengthen the support base and engagement and increase a sense of belonging. All in all, to choose the right

stakeholders and networks, a strategic selection process should be in place (Save et al., 2021) while focusing on prioritizing the (social) purpose of organizations and incentivizing public engagement and collaboration (Lough, 2022).

*Coordination (at the HEI level)*

This category addresses strategic coordination and oversight of campus living labs on an HEI-wide level. It includes the organizational structure for the living lab coordination and a single coordination and information point, often the sustainability office (Evans et al., 2015; Purcell et al., 2019; Save et al., 2021; Zen, 2017), with a clear vision for sustainability and innovation on campus (Callaghan and Herselman, 2015; Du Preez et al., 2022). Further, it is vital to create a tailored living lab approach setup and to define process phases (Sker and Floricic, 2020), setting up a governance model, and ensuring the availability of human resources and strategic documents and the related processes (Save et al., 2021). All while drawing on both top-down and bottom-up approaches (Purcell et al., 2019; Zen, 2017). Clear roles of campus managers, mandates (Du Preez et al., 2022), and clear administrative procedures are required. As is continuous communication with partners (Tercanli and Jongbloed, 2022). Connected to good communication is making the campus living labs visible and showcasing their impact regarding the SGDs on the institutional level (Purcell et al., 2019).

It also includes being strategic about review proposals, having an interdisciplinary business case review team, developing selection criteria, strategic decision-making tools, a list of technology for implementation, success metrics, reporting processes, forecasting campus issues, and developing work plans to deal with them (Callaghan and Herselman, 2015; Save et al., 2021). The coordination body should support capacity building; if funding is unavailable, this can also be done by, e.g., developing guidelines and training material (Callaghan and Herselman, 2015). Equally, generating a pipeline of living labs projects (Evans et al., 2015) and matching projects with capacities and operational systems (Zen, 2017) should be ensured. Thematic clustering of living labs (Zen, 2017) and inter-project networking opportunities (Callaghan and Herselman, 2015) can help in that regard. Also, a change management team, including all HEI stakeholders (Purcell et al., 2019), champions throughout the organization, and a multi-stakeholder committee structure for decision-making (Save et al., 2021), should be implemented.

*Work Culture*

This category relates to the way of working and the work culture in campus living labs and the HEI organization to enable them. There is a role for HEIs to support multi-disciplinary approaches, including administratively, with their organizational structures and top management (Callaghan and Herselman, 2015; Evans et al., 2015; Leal Filho et al., 2022; Zen, 2017). Likewise, experimentation for sustainable solutions in living labs should be encouraged (Purcell et al., 2019). To that end, "room to maneuver" needs to be granted and supported regarding finances, project- and risk management, and human resources (Du Preez et al., 2022). This room needs to extend to designed serendipity (meaning the room for unexpectedness, discovering unforeseen findings and insights while adding value), which is generally embraced by the living lab approach (van den Heuvel et al., 2021). Martek et al. (2022, p. 8) state it bluntly: "(…) for living labs to be successful, there must be a means to insulate them from the stultifying impact of university bureaucracy." Of course, HEIs need to be open and ready to accept and incorporate resulting suggestions from the living labs (Zen, 2017). Equally, commitment from academics to work outside their administrative and disciplinary channels is required (Evans et al., 2015), as well asa strong interest from academics and students in sustainability and living labs (Tercanli and Jongbloed, 2022). Living labs on campus require a matching work culture that is characterized by high flexibility, informality, result orientation, and intentional action (Du Preez et al., 2022; Martek et al., 2022; van den Heuvel et al., 2021), a win-win and work-smarter-not-harder mentality (van den Heuvel et al., 2021), open communication (Leal Filho et al., 2022), and supporting each other in network settings (Callaghan and Herselman, 2015). They also require respect for important values like sustainability and the social values of all stakeholders (van Geenhuizen, 2018).

*Co-Creation & Collaboration*

This category includes the collaboration of stakeholders and both internal and external users in transdisciplinary ways, which calls for a shared governance space that can take the form of a living lab (Purcell et al., 2019). In general, the living labs are integrated directly into the work on campus (Evans et al., 2015), which inherently requires collaboration from internal and external stakeholders, central to the co-creation process of living labs (Purcell et al., 2019). The collaboration needs to be inevitably based on agreement and trust (Leal Filho et al., 2022; van den Heuvel et al., 2021) and a sense of closeness between the living lab stakeholders (internal and external ones) (van den Heuvel et al., 2021). This requires respecting shared goals and interests and a sense of community-owned challenges addressed in the living lab (Callaghan and Herselman, 2015; van Geenhuizen, 2018). Participants and living lab managers should be able to detect and respond to opportunities, successes, and challenges related to the participants, stakeholders, the wider community, and living lab activities (Callaghan and Herselman, 2015). Needed skills should be developed, also for conflict handling and inter-mediation, with an eye on shared goals and interests (see also category Competencies & Skills) (Callaghan and Herselman, 2015; van Geenhuizen, 2018). The presence of an ethics committee and privacy protocol should be considered (Tercanli and Jongbloed, 2022). Co-creation in campus living labs needs to happen around a shared purpose and vision (Callaghan and Herselman, 2015; Purcell et al., 2019; van den Heuvel et al., 2021). Even the vision should be co-created to be commonly owned (Callaghan and Herselman, 2015). In general, the engagement and involvement of users is vital to campus living labs (see also Stakeholders & Network) (Evans et al., 2015; Leal Filho et al., 2022; van den Heuvel et al., 2021). In the context of HEIs, this might also concern students. As is a bottom-up push from students and academics (Tercanli and Jongbloed, 2022).

*Methods & Practices*

This category includes tools, methods, and practices that enable campus living labs, sometimes presented as best practice examples. The more general ones are the promotion of open communication and multidisciplinarity (Leal Filho et al., 2022), the use of multiple approaches and tools (van Geenhuizen, 2018), the application of innovation processes (Callaghan and Herselman, 2015), getting around bureaucratic barriers for innovations (Lough, 2022), and finding a balance between "freedom and framework" (van den Heuvel et al., 2021, p. 36). This also translates into keeping flexibility in processes, balancing formalization, and not over-formalizing to stay true to the nature of living labs (Save et al., 2021).

There are also a number of more concrete enablers, like: Breaking down complex questions into complementary projects by taking a systems approach (Evans et al., 2015), exact definition and analysis of the problem to solve (Sker and Floricic, 2020), idea generation practices to

anticipate stakeholders' challenges and opportunities (Callaghan and Herselman, 2015), preparations to timely dealing with vulnerable users (van Geenhuizen, 2018), development of a process roadmap with action steps (Save et al., 2021), hosting contests for ideas and linking feasibility studies to them (Save et al., 2021), broadscale stakeholder analyses (Martek et al., 2022), development of strategic decision-making tools (Save et al., 2021), living lab project categorization based on size for overview (Save et al., 2021), hosting a kick-off event with all stakeholders (Save et al., 2021), having a "door-opener" to connect with communities (Tercanli and Jongbloed, 2022), launching a living lab website to search and connect people and projects (Evans et al., 2015), map and identify researchers across campus (Kılkış, 2017) and selecting research champions (Save et al., 2021), physical and virtual communication and interactions (Callaghan and Herselman, 2015), use of social media tools for stimulation (van den Heuvel et al., 2021), and regular face-to-face interaction (Callaghan and Herselman, 2015; van den Heuvel et al., 2021). Also, engagement with active sustainability communities that are ready for involvement can be beneficial (Tercanli and Jongbloed, 2022).

## Appendix E. Fleiss kappa per phase

| | Kappa | Z | Prob > Z |
|---|---|---|---|
| **01 - Preparation** | 0,0448 | 0,82 | 0,2056 |
| **02 - Getting started** | 0,1390 | 2,55 | 0,0054 |
| **03 - Value creation** | 0,0730 | 1,34 | 0,0904 |
| **04 - Transfer & scaling** | 0,0204 | 0,37 | 0,3542 |

## Data availability

The data that has been used is confidential.

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