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Boosting the Spanish Urban Agenda through urban living labs: The case study of Madrid

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Abstract

The Spanish Urban Agenda (SUA) intends to promote sustainable development through the implementation of the 2030 Agenda at the local level. Since all world stakeholders are called to participate in the achievement of the Sustainable Development Goals, diverse instruments adopting a collaborative approach between social actors have gained importance. Among them, urban living labs (ULLs) involve distinct participants to handle urban issues by proposing and testing solutions. This research determines the role of ULLs conducted in Madrid since 2000 as drivers of the SUA. A two-tier methodology was adopted to develop a framework after first conducting an in-depth literature review to identify key features of ULLs. Second, the connection between the SUA and ULLs was defined. Findings revealed a limited impact of the analyzed labs in reaching the SUA. The under-representation of social agents undermines the effectiveness of ULLs. A higher engagement of public institutions is recommended to overcome this shortcoming.

KEYWORDS
co-creation, social participation, Spanish urban agenda, sustainability governance, sustainable development goals, urban living labs

1 | INTRODUCTION

As an extension of the United Nations (UN) 2030 Agenda for Sustainable Development adopted by 193 countries in September 2015 (UN, 2015), the New Urban Agenda was endorsed by the UN General Assembly in 2016 after the celebration of the UN Conference on Housing and Sustainable Urban Development (Habitat III) held in Quito (UN, 2016). This action-oriented initiative is focused on urban settlements as boosters for sustainable development at the local level, however, all stakeholders worldwide are called to be actively engaged in the accomplishment of the 17 Sustainable Development Goals (SDGs) (Sachs et al., 2019; Saric et al., 2023).

Although the UN estimates an increase in the world population living in urban areas to 68% by 2050, 80% of Spanish people now reside in urban centers, which accounts for 20% of the national territory, placing Spain as one of the European Union (EU) countries with the highest proportion of urban population. In this vein, the Spanish Council of Ministers approved in 2019, the Spanish Urban Agenda (SUA) as a strategic but non-binding framework (Ministry of Development, 2019) in line with the premises of the UN 2030 Agenda, the New Urban Agenda, and the Urban Agenda for the European Union (EU) (EU, 2016). The SUA encompasses a series of 10 strategic goals (SDGs) and 30 specific goals (SpGs) covering outstanding issues within the social, economic, environmental, and institutional domains at the urban scale. Citizen participation, transparency, and multi-level governance (Allen et al., 2023) were prescribed to fulfill the StG#10: Improving intervention instruments and governance. Urban living labs (ULLs) have emerged in this context as a

prominent instrument of urban governance (Schliwa & McCormick, 2016; Voytenko et al., 2016) where social actors adopt a collaborative approach (Cognetti & Maranghi, 2023), becoming real agents of change (Akuraju et al., 2020) to transform the urban environment (Turku et al., 2022).

Bylund et al. (2020) define living labs as "an approach or set of methods geared to make change happen in a co-creative way." Living labs, therefore, represent a methodology for recreating multiple and evolving scenarios in a real setting to foster co-creation (Buhl et al., 2017) and open innovation (Leminen et al., 2017; Miranda et al., 2023) in the pursuit of the best responses (Frantzeskaki et al., 2018), where users are considered as innovators or authorities in a recreated experience (Veeckman & van der Graaf, 2014). The multiplicity of addressed research areas and involved stakeholders is a barrier to defining a clear connection between living labs and sustainability (McCrory et al., 2020). As an extension of living labs, ULLs engage diverse stakeholders to create, develop, and test solutions for urban challenges through a co-innovative setting (Caprotti & Cowley, 2017) where theoretical urban concepts (Bulkeley et al., 2016) are under experimentation by users (Liedtke et al., 2015). These issues are predominantly intertwined with concrete social, economic, and environmental aspects to be incorporated into sustainability governance processes (Von Wirth et al., 2019) through the participation and debate of multiple stakeholders (Loorbach et al., 2017).

Although living labs have captured the attention of scholars in the last decade (Verdejo et al., 2022) and a large number are currently operating, mostly in Europe, the inclusion of living labs in the urban realm is still underdeveloped (Rizzo et al., 2021). The promotion of urban sustainability by means of living labs (Milana & Ulrich, 2022) has been explored from several standpoints, inter alia, urban entrepreneurship (Rodrigues & Franco, 2018), climate change (Leal Filho et al., 2021), the attainment of the SDGs (Sierra-Pérez & López-Forniés, 2020), urban climate governance (Bulkeley & Castán Broto, 2013), but the analysis of case studies is scant (Veeckman & van der Graaf, 2015). This investigation thus aims at assessing the level of contribution of ULLs to the fulfillment of the SUA, for which ULLs operating in the city of Madrid during the twenty-first century were examined. Two main research questions were posed to structure the study: (i) What are the determinant factors of ULLs? (ii) How are the examined ULLs instrumental in the realization of the SUA?

A two-pronged approach was used in the study to respond to those interrogations. Firstly, information about the characteristics of ULLs was gathered after conducting an in-depth literature review. Afterward, an empirical study examining ULLs of Madrid as the most populated Spanish city was undertaken and resulted in measures towards the SUA.

The research identified three major contributions. A novel scheme covering distinctive features of ULLs was provided to appraise the nature of labs. In second place, the linkage between SUA goals and ULLs was established to facilitate the process of determining lab impacts on the SUA. Lastly, lessons learned were drawn to efficiently design upcoming ULLs that enhance sustainable urban development and therefore, the realization of the SUA.

The article embraces three additional sections. The methodology followed in the study is depicted next, whilst results and discussion to answer the research questions are presented in the subsequent section. And finally, the main conclusions are summarized.

2 | METHODOLOGY

The role of ULLs in the operationalization of the SUA was investigated by adopting a two-step procedure. An in-depth literature review served to pinpoint relevant features of the ULLs in the first phase. ULLs held in the city of Madrid during this century were encountered to be later characterized in the second stage. The coverage of SUA goals (Table A1) among the examined labs was also ascertained.

2.1 | Literature review

Figure 1 schematizes the review protocol harnessed in this research to give a response to the first research question. Besides, a further purpose of this review was to identify the key features and characteristics of ULLs to define a framework that enables the assessment of the appointed Spanish labs (Lee et al., 2020). Data collection, abstract screening, and full paper review are the three stages adopted according to the review process proposed by Dixon-Woods et al. (2006).

Since Scopus is intended to be the largest scientific database (Stahlschmidt & Stephen, 2020), it was used to perform the initial search in November 2022. The combination of four search strings: "urban policy lab*," "urban citizen lab*," "urban sustainability lab*," "urban living lab*," and no further restrictions served to collect respectively 231, 170, 223, and 515 contributions. A total of 751 references were gathered after combining the four searches. This figure was later reduced to 645 ones when removing dead data and duplicates. A timeframe from 2012 to 2022 was defined to cover the period before and after the adoption of the 2030 Agenda, the cornerstone of the New Urban Agenda and hence, of the Urban Agendas customized for certain geographical areas. The period under study, the type of contribution (article, review paper, conference paper, conference review, book and book chapter), publication stage (final), and language of publication (English) were the constraints established to refine the combined list of references up to 503 ones. The title, abstract, and keyword of these publications were screened to discard those not directly correlated to the urban environment. All the 112 remaining documents were downloaded or directly collected from the authors via email to be fully analyzed. The dearth of relevant information and findings along with an unclear or absent method were the main reasons to exclude 29 references in this stage. A total of 83 contributions were thereby selected to substantiate the research.

2.2 | Analysis of the selected ULLs

Primary sources were preferentially used to encounter ULLs conducted in the city of Madrid from the beginning of the xxi century. An

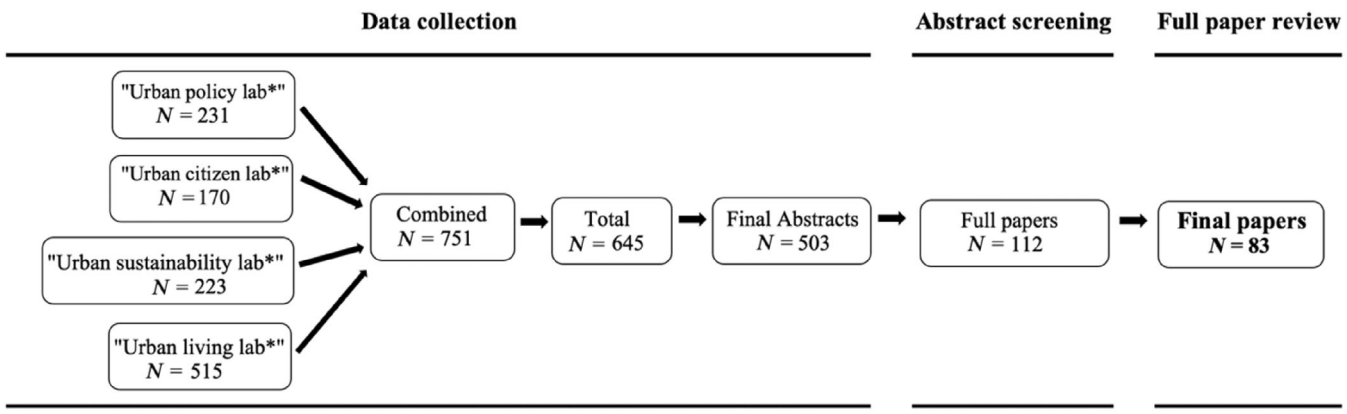

FIGURE 1 Literature review process. *Source*: Author.

experienced head of a former urban lab, a trustee of a banking foundation, and a department manager of the Urban Development Area of the Madrid City Government, as leading representatives of the operation, funding, and governance facets of ULLs, were designated as panelists to assess the selection of labs in Madrid and therefore to address the second inquiry question. They initially performed a qualitative analysis of documentation during the first half of January 2023 by exploring in detail the SUA and data about the short-listed labs (Table A2). The correlation between these labs and the distinct goals itemized in the SUA was agreed upon after reaching a consensus, with at least two votes in favor. As a result of the discussion, prospective labs were suggested to handle specific topics of the SUA. Active participation of all segments of society, efficient knowledge sharing, and implementation of urban-oriented solutions whose progress can be realized by the citizenry in daily life were the three criteria established to propose future ULLs for the city of Madrid. The previous description of the appointed labs according to features collected from the literature review served panelists to argue about the pertinence of considering those labs as real instances of ULLs. And because the SUA is an adaptation of the SDGs to urban areas, the panel expanded its mission to explore the connection between the scope of labs and the SDGs.

3 | RESULTS

The application of the two-tier methodology portrayed above aims to respond to the two research questions posed in Section 1. First, characteristic attributes of ULLs were identified from literature to be later used to examine the main features of the selected labs in Madrid. Second, a qualitative data analysis followed by a focus group consisting of the three panelists served to ascertain the contribution of the labs to the attainment of the SUA.

3.1 | Determinant factors that characterize ULLs

The literature review unveiled a broad variety of approaches to characterizing ULLs by covering numerous respects. Edwards-Schachter et al. (2012) focused their attention on the innovation process (settings, influence), operational environments, user participation, and desired results. Similarly, Voytenko et al. (2016) suggested five key features such as geographical milieu, users, leadership, and outcomes. An analogous approach was also adopted by Leminen and Westerlund (2016). Steen and Van Bueren (2017) conducted an empirical study to identify objectives, actions, participants, and settings as the characteristic traits of ULLs in Amsterdam. McCrory et al. (2020), meanwhile, categorized an assortment of 25 attributes into five groups centered on defining lab concepts, providing descriptive lab information, facilitating the understanding of lab cases, specifying partnership agreements, and determining the objectives of the lab. Multi-method approach, user involvement, multistakeholder engagement, real-life scenarios, and co-creation were emphasized in the living lab methodology designed by Malmberg et al. (2017). Co-creation is the practice of building a learning and collaborative environment where stakeholders interact by performing different roles towards a clearly defined goal (Juujärvi & Pesso, 2013). And thus, co-creation encompasses a multifaceted approach, user engagement, and multistakeholder participation (Guimont & Lapointe, 2016; Scholl & Kemp, 2016). The level of integration displayed by the actors involved, in particular public authorities is another outstanding factor in evaluating effective changes produced that may affect institutional frameworks, practices and policies, and social dimension (Boni, 2023). Besides, the contribution of local residents cannot be ignored, given the diversity and rich variety of experiences and knowledge provided (Nesti, 2018), acting both as instruments against the exclusion and disadvantage of some social groups (Wang et al., 2022).

The heterogeneity of insights prevailed when ULLs were described, but the literature review revealed principal factors to be deemed in the examination of those labs: participants, setting, methodological approach, and expected outcomes. The analysis of the selected ULLs of Madrid was performed on this basis. Actors were hence classified according to the Quadruple Helix representing all segments of society: public authorities, industry, academia, and citizens, whilst the means for selecting participants provided insight into the accessibility of different groups to activities, which reflects the degree of plurality of the labs (Charli-Joseph et al., 2018). Since more and

more public institutions are becoming promoters of innovative actions (Chronéer et al., 2019), the engagement of governance levels in labs is another point to be explored to appraise the effect thereof in regulations and policies (Engels et al., 2019).

The definition of ULLs provided by the European Network of Living Labs establishes as a requisite that lab activities must be situated in real-world settings (Dell'Era & Landoni, 2014), avoiding constructed ones to ease the integration of solutions in real-life communities (ENoLL, 2023). ULLs should be also constrained at the local level where local matters may be experimented upon to contribute to global challenges (Ersoy & Van Bueren, 2020).

ULLs imply much more than a single innovation project, a long-term duration is needed to achieve the overarching objectives that led to building labs in the pursuit of enhancing the urban realm (Kronsell & Mukhtar-Landgren, 2018). In this sense, real changes mainly occur when participatory processes are open to all stakeholders concerned who can actively participate in decision-making (Ataman & Tuncer, 2022). Three categories of projects are defined per participation level: contributory (data collection), collaborative (data collection, analysis, and dissemination of results), and co-created (all participants work together in all project stages) (Greve et al., 2020; Veeckman & Temmerman, 2021).

Table 1 shows the assessment of the 16 ULLs that have been operating in Madrid for the past two decades, under the consideration of aspects extracted from the literature. Regarding the composition of participants, the citizenry (7) and skilled actors (6) of industry and/or academia were the segments of society most represented in contrast with public authorities (2). All components of the Quadruple Helix were present in three labs. Most labs (13) allowed free participation in activities, whilst access was restricted to certain stakeholders linked to some labs (3). The level of engagement displayed by public institutions was extremely low. Only L.12: Madrid Green Urban Mobility lab and L.13: INNOLAB were powered by the City Council and the Community of Madrid, respectively. Most labs (12) were located in municipal facilities provided specifically to develop their projects. Alternatively, institutional offices hosted L.13: INNOLAB and L.15: EUTEx lab, L.10: Residencies lab was undertaken in three private apartments, and L.2: Commons Lab was developed virtually. The labs studied were focused on issues affecting different geographic scales: global (4), European Union (1), Community of Madrid (1), local (9), and neighborhood (1). Longevity of most labs ranges from 1 to 4 years, the most numerous (6) took a maximum of 12 months. On the other hand, L.1: MediaLab Matadero and L.5: Interactivos? worked for more than 10 years. The methodology employed by labs varies significantly. Workgroups (6), prototyping workshops (3), and participative dialog (2) were the participatory methods most commonly used. Each of the remaining labs implemented workshops, an experimentation platform, participatory work, technical presentations, and a showroom of experiences to conduct their activities. The number of collaborative and co-created projects completed in labs (9) was higher than the collaborative ones (7). Construction and sharing knowledge were the main outcomes generated in labs. However, some labs were purposely conceived to provide determined outputs such as the design of a digital façade, prototypes, digital solutions, or cultural projects. Environment, urban mobility, sustainable urban development, and sustainable human development were some global issues also covered by labs.

The panel of experts discussed the findings of Table 1 to determine whether the labs evaluated were aligned with features that scholars attributed to ULLs. Panelists concluded that some fundamental aspects associated with ULLs were not reflected in the labs examined and therefore, their contribution to the enhancement of the city of Madrid is questionable. Little liaison between lab outcomes and the urban realm also corroborated this assertion. Plurality of labs was seriously compromised by the under-representation of the four sectors of society, while the low level of institutional engagement manifested the impracticality of transferring salient lab outcomes to policy and regulations. Besides, the requirement demanded by ULLs of limiting their activities at the local level was not met by several labs. Long-term duration and the simulation of real-world settings in labs were other points disregarded as well.

3.2 | Implications of the ULLs on the Spanish Urban Agenda

A two-stage approach was adopted by the panel to relate the ULLs with the SUA. The 16 labs were initially arranged in the 10 strategic goals of the SUA without dissent, but no lab was associated with StG#8: Ensuring access to housing. Subsequently, a debate arose about the relationship between labs and the specific goals of each StG. The agreement was unanimously reached for the SpGs of all StGs excluding those belonging to StG#2: Avoiding urban sprawl and revitalizing the existing city and StG#10: Improving intervention instruments and governance. Voting was thus necessary for both. Table 2 illustrates how labs are bound to SpGs. The labs explored tackle SpGs on 59 occasions of which 29 pertain to StG#10, indicating the prominence given to the governance dimension which is consistent with the growing role of ULLs in the governance of cities (Bulkeley et al., 2019). Furthermore, L.13: INNOLAB (10) and L.8: DITOs (8) recorded the highest number of SpGs linked. On the other side, L.3: Mediation-Research, L.7: Digital Façade and La Cosa, L.10: Residencies, L.11: AVLab Meetings, L.14: Urban Ecology and L.16: SBNLab Inclusion with two SpGs each, and L.15: EUTEx with a single SpG. Citizen participation, transparency, and multi-level governance (SpG#10.2.) and training, awareness, exchange, and dissemination of campaigns on urban issues (SpG#10.4.) were mostly addressed by 14 labs each. Urban regeneration (SpG#2.5.), quality and sustainability of buildings (SpG#2.6.), reduction of poverty and social exclusion (SpG#6.1.), striving for equal opportunity (SpG#6.2.), search for local productivity and job creation (SpG#7.1.) and promotion of electronic administration (SpG#9.2.) were covered by only one lab each. The collaborative nature of all lab projects, essential to promote physical and social transformations (Nadin et al., 2021) in the city of Madrid, contrasts with the scant attention given to major urban aspects inter alia, housing, urban regeneration, social cohesion, and gender equality.

TABLE 1 Characterization of the selected urban living labs (L.#.) of Madrid.

Factors	L.1. MediaLab Matadero	L.2. Commons lab	L.3. Mediation-research	L.4. Experimenta Distrito	L.5. Interactivos?
Actors*	Citizens	Multidisciplinary actors	Citizens & users	Citizens	Citizens
Selection process*	Free registration	Free registration	Free registration	Free registration	Free registration
Governance level engaged*	None	None	None	None	None
Setting**	Municipal facility	Virtual	Municipal facility	Municipal facility	Municipal facility
Influence area**	Local	Local	Local	Neighborhood	Local
Duration***	2002-now	2007–2008	2021-now	2016–2020	2006–2019
Participatory method***	Workgroups	Online workgroups	Participatory dialog	Prototyping workshops	Prototyping workshops
Type of project***	Collaborative & co-created	Collaborative	Collaborative	Collaborative & co-created	Collaborative & co-created
Outcomes****	Open cultural projects	Raise awareness about some relevant issues	Informal learning	Projects licensed under Creative Commons	Digital outcomes

L.6. Collective intelligence	L.7. Digital facade and La Cosa	L.8. DITOs	L.9. Digital fabrication	L.10. Residencies	L.11. AVLab meetings
Multidisciplinary actors	Digital practitioners	Citizens	Digital users	Multidisciplinary actors	Those interested in experimental music
Free registration	Free registration	Free registration	Free registration	Free registration	Free registration
None	None	None	None	None	None
Municipal facility	Municipal facility	Municipal facility	Municipal facility	Three apartments	Municipal facility
Global	Local	European Union	Global	Global	Global
2018	2009–2012	2021-now	2021	2017–2021	2007
Workshops	Work & experimentation platform	Workgroups	Prototyping workshops	Participatory workgroups	Technical presentations
Collaborative & co-created	Collaborative & co-created	Collaborative	Collaborative & co-created	Collaborative	Collaborative
Prototypes	Design of a digital facade	Environmental knowledge	Digital tools & techniques	Construction of knowledge	Sharing of knowledge

L.12. Madrid green urban mobility	L.13. INNOLAB	L.14. Urban ecology	L.15. EUTEx	L.16. SBNLab inclusion
Experts & Madrid City Council	Experts & Community of Madrid	Citizens	Experts and Elcano Royal Institute	Citizens
Members of the partnership	Members of the partnership	Free registration	Upon invitation	Free registration
Madrid City Council	Community of Madrid	None	None	None
Municipal facility	The head office of the laboratory	Municipal facility	Elcano Royal Institute	Municipal facility
Local	Regional	Local	Local	Local
2021-now	2022-now	2020	2022	2020-now
Workgroups	Workgroups	Participatory work	Workgroups	Showroom of experiences
Collaborative & co-created	Collaborative & co-created	Collaborative	Collaborative	Collaborative & co-created
Solutions in urban mobility	Proposals for the Sustainable Urban Development of Madrid	Sharing of knowledge	Construction of knowledge	Projects to boost sustainable human development

Note: Aspects deemed in the analysis: * Participants. ** Setting. *** Methodological approach. **** Expected outcomes.
Source: Author.

TABLE 2 Nexus between the labs (L.#) and the specific goals (SpG#.#.) of the Spanish Urban Agenda.

SpG#.#.	L.1	L.2	L.3	L.4	L.5	L.6	L.7	L.8.	L.9	L.10	L.11	L.12	L.13	L.14	L.15	L.16
1.1.																
1.2.	√			√												
1.3.													√			
2.1.																
2.2.																
2.3.																
2.4.				√									√			
2.5.				√												
2.6.								√								
3.1.		√						√					√			
3.2.		√						√					√			
3.3.		√						√					√			
4.1.								√					√			
4.2.		√						√					√			
4.3.																
4.4.																
5.1.																
5.2.												√	√			
6.1.															√	
6.2.																√
7.1.																√
7.2.																
8.1.																
8.2.																
9.1.					√	√			√							
9.2.									√							
10.1.																
10.2.	√	√	√	√	√	√	√	√	√	√	√	√	√	√		
10.3.						√										
10.4.	√	√	√	√	√	√	√	√	√	√	√	√	√	√		

Source: Author.

As shown in Figure 2, the share of StGs per lab manifests an unequal distribution. L.13: INNOLAB and L.8: DITOs involved the largest amount of StGs with six and four, respectively. Only one StG was instead covered by the aforementioned labs with the lowest number of SpGs encompassed. All labs except L.15: EUTEx comprised at least two SpGs. L.2: Commons Lab, L.8: DITOs, and L.13: INNOLAB were aimed at the three SpGs of the StG#3: Prevention and reduction of climate change impacts and improvement of resilience, whilst L.9: Digital fabrication also referred to the two SpGs of the StG#9: Leading and encouraging digital innovation. Therefore, these labs are fully oriented to handle climate change effects and digital innovation process as their preferred topics of the SUA as against other matters much less regarded (urban planning, city revitalization), and even ignored (housing) by the remaining labs.

Panelists concurred that the contribution of the ULLs reviewed in the achievement of the SUA is limited as exhibited in Table 1 and

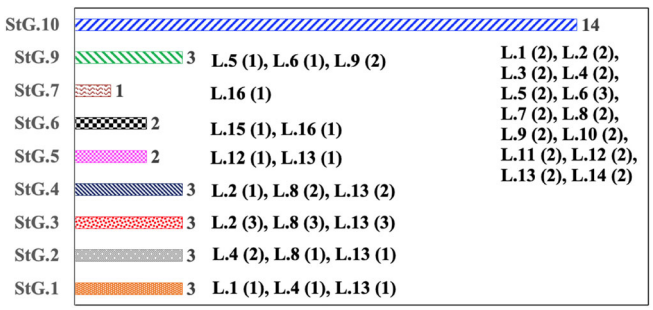

FIGURE 2 Number of specific goals (in brackets) for each analyzed lab per strategic goal (StG). *Source*: Author.

Figure 2. The extent of coverage of the StGs and SpGs is very uneven. Hence, none of the labs is enough to cover half of those goals. Besides, the varied combination of StGs addressed by each lab does

TABLE 3 Liaison between the urban living labs and the SDGs.

SDG#	L.1	L.2	L.3	L.4	L.5	L.6	L.7	L.8	L.9	L.10	L.11	L.12	L.13	L.14	L.15	L.16
SDG1																
SDG2																
SDG3																
SDG4	√		√							√						
SDG5																√
SDG6		√						√								
SDG7		√						√								
SDG8					√	√	√		√							
SDG9					√	√	√		√			√				
SDG10																√
SDG11				√								√	√			
SDG12								√								
SDG13		√						√						√		
SDG14		√						√						√		
SDG15		√						√						√		
SDG16						√				√	√	√			√	
SDG17						√				√	√	√	√			

Source: Author.

not enable to identification of a clear course of action. For instance, L.13: INNOLAB embraces diverse issues such as urban planning (StG#1), urban revitalization (StG#2), climate change (StG#3), circular economy (StG#4), sustainable mobility (StG#5) and governance (StG#10). Such a variety of matters decreases the effectiveness of actions performed within the lab scope.

Criteria defined in Section 2.2. were adopted by the panel to identify potential SpGs prone to be dealt with in specific ULLs to enhance the city of Madrid. Compact urban model (SpG#2.1.), universal accessibility to public spaces (SpG#2.3.) and urban regeneration (SpG#2.5.) were thus shortlisted to foster urban revitalization (StG#2), whilst energy efficiency (SpG#4.1.), water consumption reduction (SpG#4.2.), materials recycling (SpG#4.3.) and waste reduction (SpG#4.4.) to promote circular economy (StG#4). Proximity City (StG#5.1.) seeks to strengthen the proximity and sustainable mobility of the city (StG#5).

The Spanish Urban Agenda was born in response to the need to tailor the New Urban Agenda approved by the United Nations to the Spanish context, as the vehicle to realize all the SDGs in urban areas, including SDG#11: Make cities and human settlements inclusive, safe, resilient and sustainable. As such, it may be deemed as an integrated plan to boost sustainable urban development at the local level. From this perspective, the study of the relationship between the SDGs and the labs analyzed is relevant. Table 3 exposes the connection between the labs and the SDGs. The level of implication of labs in the achievement of the SDGs is low. About a third of the SDGs were engaged by L.8: DITOs (6) and L.2: Commons Lab (5), however, L.1.: MediaLab Matadero, L.3: Mediation-Research, L.4: Experimenta Distrito and L.15: EUTEx just involved one. All labs completely ignored SDG#1: No poverty, SDG#2: Zero hunger, and SDG#3: Good health and

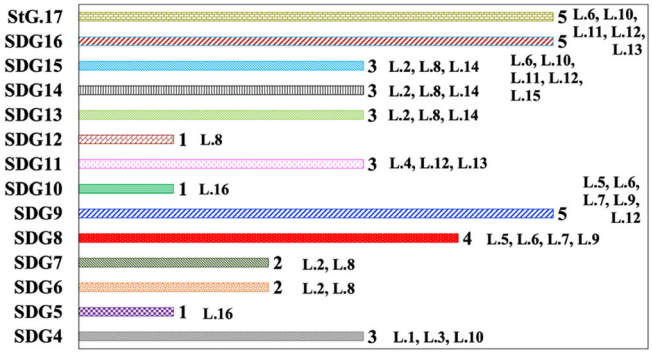

FIGURE 3 Distribution of labs by covered Sustainable Development Goals (SDGs). *Source*: Author.

well-being. But, conversely, five labs focused on SDG#9: Industry, innovation, and infrastructure, SDG#16: Peace, Justice, and strong institutions, and SDG#17: Partnerships for the goals, which also highlights the salience of governance. The combination of the SDGs addressed by each lab is diverse as displayed in Figure 3. There are some labs that affect SDGs belonging to a unique sustainability dimension such as social (L.16: SBNLab Inclusion), economic (L.5: Interactivos?, L.7: Digital Facade and La Cosa and L.9: Digital Fabrication), environmental (L.14: Urban Ecology) or institutional (L.13: INNOLAB). Others combine different aspects, namely L.2: Commons Lab (social and environmental), L.6: Collective Intelligence and L.12: Madrid Green Urban Mobility (economic and institutional), L.10: Residencies (social and institutional), L.11: AVLab Meetings (environmental and institutional) and L.8: DITOs (economic and environmental).

The breakdown of the SDGs handled by sustainability components revealed the prevalence of governance (13) followed by environment (11) and economy (10), society only accounted for seven SDGs. Furthermore, a mismatch was found between the exclusive scope of the lab (environmental knowledge) and the SDGs and sustainability facets concerned in the latter case.

In light of the results, the panel suggested the next actions to bolster the contribution of the ULLs to the achievement of the SDGs and the SUA:

- Consider the ULLs as an effective instrument to be implemented by private and public stakeholders in the achievement of the UN 2030 Agenda and the SUA.
- Design a comprehensive action plan comprising a series of labs that cover all the SDGs and the SUA goals.
- Associate the scope, objectives, and activities of each ULL to any of the SDGs and SUA goals according to the roadmap previously defined.
- Digitize all information over the full lifecycle of the lab to increase impact and promote broader dissemination of lab outcomes.
- Include in each lab the development of digital skills to promote social participation in-person or virtual.

4 | CONCLUSIONS

The research examined the ULLs operating during this century in the city of Madrid to ascertain their contribution to the attainment of the Spanish Urban Agenda (SUA), for which two research questions were posed. A systematic literature review served to identify attributes that characterize ULLs to be used in the preliminary analysis of the selected labs. A panel of three experts in the field determined the implications of labs in the SDGs and the SUA. The panel also suggested a set of proposals for future ULLs that boost sustainable urban development in Madrid. The main conclusions are outlined below:

- Considering features from the literature, the studied labs revealed the absence of some fundamental characteristics associated with ULLs.
- The under-representation of all sectors of society, as well as the low engagement of public institutions were the main shortcomings found in the labs of Madrid.
- The correlation between the SUA goals and the assessed labs was very scant. Major urban issues inter alia, housing, urban regeneration, social cohesion, and gender equality were totally overlooked.
- The SDGs and the four sustainability dimensions were scarcely represented in the labs, and therefore, there is no evidence of the contribution of the labs to the sustainable urban development of Madrid.
- Despite the labs covering half of the specific goals of the SUA, mostly oriented to the enhancement of governance instruments, there was observed no effect on municipal policies and regulations.
- A clear action plan towards the SUA was not identified in the labs due to the variety of the handled SUA goals, which significantly reduces the performance of labs.

Because the case study was purposely focused on Madrid under the assumption that this city hosted the most representative sample of ULLs in Spain, this limitation might have biased the results of the study. As the future line of research, the assessment of ULLs in the biggest Spanish cities, namely those with more than half a million inhabitants (Barcelona, Valencia, Sevilla, Zaragoza, and Málaga) would provide a greater overview of the ULLs in the country to establish a national action plan to align prospective labs with the SUA. Likewise, the creation of a catalog deeming different topics associated with the strategic and specific goals of the SUA might assist local authorities in efficiently planning a comprehensive participatory strategy toward sustainability through the conduct of ULLs.

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APPENDIX A

TABLE A1 Strategic and specific goals defined in the Spanish Urban Agenda (Ministry of Development, 2019).

#. Strategic goal	#.#. Specific goal
1. Implementation of regional and urban planning tools to make a rational use of land, keeping and protecting natural resources.	1.1. Develop the land in a way that is compatible with its territorial environment
	1.2. Preserve and improve the natural and cultural heritage and protect the landscape
	1.3. Improve green and blue infrastructures and link them to the natural setting
2. Avoiding urban sprawl and revitalizing the existing city	2.1. Define an urban model that encourages compactness, urban balance, and the provision of basic services.
	2.2. Ensure functional complexity and diversity of use
	2.3. Ensure the quality and universal accessibility of public spaces
	2.4. Improve the urban environment and reduce
	2.5. Boost urban regeneration
	2.6. Improve the quality and sustainability of buildings
3. Prevention and reduction of climate change impacts and improvement of resilience in towns and cities	3.1. Adapt the territorial and urban model to the effects of climate change and advance in its prevention
	3.2. Reduce greenhouse gas emissions
	3.3. Improve resilience to climate change
4. Sustainable management of resources and promotion the circular economy	4.1. Be more energy efficient and save energy
	4.2. Optimize and reduce water consumption
	4.3. Promote the materials cycle
	4.4. Reduce waste and promote its recycling
5. Fostering the proximity and sustainable mobility	5.1. Promote the city of proximity
	5.2. Promote sustainable modes of transport
6. Enhancing cohesion and looking for equity	6.1. Reduce the risk of poverty and social exclusion in disadvantaged urban settings
	6.2. Strive for equal opportunity from the perspective of gender age and disability
7. Promoting and encouraging the urban economy	7.1. Seek local productivity, job creation, and the dynamization and diversification of economic activity
	7.2. Promote smart, sustainable, and quality tourism and the key sectors of the local economy
8. Ensuring access to housing	8.1. Promote the existence of an adequate housing stock at an affordable price
	8.2. Guarantee Access to housing, especially for the most vulnerable groups
9. Leading and encouraging digital innovation	9.1. Promote the Knowledge Society and advance towards the development of smart cities
	9.2. Promote the electronic administration and bridge the digital divide
10. Improving intervention instruments and governance	10.1. Achieve an updated, flexible, and simplified regulatory and planning framework that also improves management
	10.2. Ensure citizen participation, and transparency and favor multi-level governance
	10.3 Boost local empowerment and improve financing
	10.4. Design and implement training and awareness, campaigns on urban issues, as well as on the exchange and dissemination of knowledge

TABLE A2 Urban living labs analyzed.

L.#. Lab name	Description	Website
L.1. MediaLab Matadero	Laboratory where citizens participate in the production of open cultural projects	https://www.medialab-matadero.es/en/medialab
L.2. Commons Lab	Activities are focused on *"Commons"* as assets belonging to humankind such as air, water, mountains, seas, etc.	https://www.medialab-matadero.es/en/programs/commons-lab
L.3. Mediation-Research	Promotes contact between different agents in the search for informal learning	https://www.medialab-matadero.es/en/programs/mediation-research
L.4. Experimenta Distrito	Projects are specifically designed for selected neighborhoods and licensed under Creative Commons	http://experimentadistrito.net/
L.5. Interactivos?	Free hardware and software foster creative experimentation	https://www.medialab-matadero.es/en/programs/interactivos
L.6. Collective Intelligence for Democracy	Prototypes are created to stimulate collective Intelligence, democracy, and citizen engagement	https://www.medialab-matadero.es/en/programs/collective-intelligence-democracy
L.7. Digital Facade and La Cosa	Collective platform to design urban digital facades	https://www.medialab-matadero.es/en/programs/digital-facade-and-la-cosa
L.8. Doing It Together Science (DITOs)	Fosters scientific approaches to address environmental sustainability and bio design	https://www.medialab-matadero.es/en/programs/ditos-doing-it-together-science
L.9. Digital Fabrication Laboratory (FabLab)	Experimentation with digital fabrication tools and techniques	https://www.medialab-matadero.es/en/programs/fablab-digital-fabrication-laboratory
L.10. Residencies	Cohabitants on residencies construct work of knowledge	https://www.medialab-matadero.es/en/programs/residencies
L.11. AVLab Meetings	Creates knowledge in experimental music, audio, and video processing fields	https://www.medialab-matadero.es/en/programs/avlab-meetings
L.12. Madrid Green Urban Mobility Lab	Develops solutions for sustainable urban mobility	https://www.emtmadrid.es/Noticias/Arranca-'Madrid-Green-Urban-Mobility-Lab'-con-la-c.aspx
L.13. Innovation Lab in Urban Solutions (INNOLAB)	Boosts public-private collaboration to promote sustainable urban development in Madrid	https://www.comunidad.madrid/noticias/2022/07/14/comunidad-madrid-abrira-laboratorio-innovacion-madrid-nuevo-norte-0
L.14. Laboratory of Urban Ecology	Helps to understand ecological processes in the urban realm	https://www.lacasaencendida.es/encuentros/laboratorio-ecologia-urbana-10864
L.15. EUTEx Living Lab	Seeks the reintegration of violent offenders at the local level	https://www.realinstitutoelcano.org/en/activities/eutex-living-lab-in-madrid/
L.16. SBNLab Inclusion	Generates job opportunities to reduce inequalities and promote social cohesion	https://ciecmadrid.es/sbn-lab-inclusion/