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Safe system for sustainable development

Oliver Lah[1*]

Abstract

This paper presents a novel governance concept for sustainable development, introducing the 'Safe System Approach' as a transformative model that shifts focus from individual behavioural change to systemic transformation. This approach challenges traditional governance models that emphasize individual responsibility in achieving sustainable development and decarbonization. Instead, it advocates for creating an enabling environment that inherently guides individuals and communities towards sustainable actions. The Safe System Approach is centred on delivering low-carbon services across essential sectors, including electricity, mobility, industry, buildings, human settlements, and agriculture, thereby embedding sustainability as a default choice in societal systems. Drawing parallels with successful models in road safety, the paper explores the potential of this approach in urban development and climate action. It emphasizes the need for a broad coalition and integrated approaches in managing shared resources, highlighting the significance of systemic adjustments over individual behavioral change. By proposing a structure where sustainability is facilitated by the system's design, the paper builds on key concepts from seminal works by scholars like Garrett Hardin, Mancur Olson, Elinor Ostrom, and Ahrend Lijphart. It discusses the challenges and opportunities in creating safe operating spaces for sustainable development, emphasizing the need for multi-actor, multilevel governance systems that can manage shared resources sustainably and are resilient to political volatility. The paper aims to offer a robust, efficient, and inclusive pathway to sustainable development, contributing to the global discourse on environmental and social resilience.

Keywords Decarbonization, Urban transitions, Sustainable development, Governance, Safe system approach

Introduction

This paper introduces a governance concept for sustainable development that shifts the attention away from individual behaviour changes towards a more systemic transformation. This paper is taking key concepts, in particular by Garret Hardin, Mancur Olson, Elinor Ostrom and Ahrend Lijphart further and aims to explore a potential concept for governing the commons in a systemic manner. The paper delves into the challenges of shared resources management and the necessity for broad coalitions and integrated approaches. Traditional governance models often hinge on the notion that individual behaviour must evolve to achieve sustainable development and decarbonize the economy. However, this paper posits a 'Safe System Approach' that reduces the onus on individual transformation. Instead, it emphasizes creating an enabling environment that inherently guides individuals towards sustainable action. The Safe System Approach concentrates on delivering low-carbon services across pivotal sectors, including electricity, mobility, industry, buildings, human settlements, and agriculture. By doing so, this approach proposes a structure where sustainability is not an active choice, but a default, facilitated by the system's design. The paper argues that governments need to take a much more proactive role in providing sustainable infrastructures, products and services, rather than relying on individual behavioural change. can provide a more robust, efficient, and inclusive pathway to sustainable development. The pressing

*Correspondence:
Oliver Lah
oliver.lah@wupperinst.org
[1] Urban Living Lab Center, UN-Habitat Collaborating Center, Wuppertal Institut, Neue Promenade 6, 10178 Berlin, Germany

urgency of sustainable development and decarbonization calls for massive shifts across all sectors. However, current approaches to climate action and sustainable development place significant emphasis on individual behaviours and collective action, there is a clear need to shift our perspective. The 'Safe System Approach', introduced in this paper, emerges as a novel paradigm, redefining the trajectory of sustainable governance. Instead of urging individuals to change their behaviours—a strategy that has met with varied success—this approach prioritizes the creation of a conducive environment where sustainable actions become the default, facilitated by design.

This paper will draw from key governance concepts and the learnings from adapting a Safe System approach in the area of road safety and will then provide illustrative examples on the overall approach and zoom into urban development to showcase practical steps towards the application of the Safe System approach. The paper introduces a transformative governance concept known as the 'Safe System Approach', designed to usher in a new era of sustainable development. Drawing on an in-depth analysis of political science literature, particularly on safe operating spaces, this work ventures beyond traditional governance models focused on individual behavioural change. Instead, it advocates for a systemic transformation that inherently guides individuals and communities towards sustainable practices.

In the context of escalating environmental and social challenges, the paper seeks to shift the narrative from individual responsibility to a collective and integrated approach in managing shared resources and facilitating sustainable development. This approach is in line with the foundational works of Rockström et al., Hardin, and others, who have highlighted the critical need for transnational cooperation and innovative governance in the realm of sustainable development. At its core, the Safe System Approach aims to embed sustainability within the infrastructure and governance of pivotal sectors such as electricity, mobility, heating, cooling, and agriculture. By doing so, it positions sustainability as a default choice within societal systems, reducing the reliance on individual transformation. This paper will explore the efficacy of this approach, drawing parallels with successful models in areas like road safety, and delve into its practical applications in urban development and climate action. Our objective is to present a comprehensive, resilient, and inclusive model for sustainable development, aligning with global efforts to address the pressing challenges of our times.

Methodology: conceptualising a safe system for decarbonised economies

This paper will draw from key concepts on governance for sustainable development as a conceptual basis for the proposed Safe System approach. This will reflect on a similar shift in focus in the policy area of road safety and the methodology will aim to build on these learnings and translate them into the sustainable development field.

A Safe System approach, modelled after the Vision Zero policy, revolutionised road safety when it was adopted in Sweden in 1997 [1]. While the traditional approach of Engineering, Education, and Enforcement that guided road safety policies for decades helped making some progress, it fell short of paving the way towards the Vision Zero of having no more fatal crashes on the road [2].

Hence, the focus evolved to the Safe System approach. In a very similar way, it is becoming increasingly obvious that the vision of zero carbon emissions in particular when paired with the objective of addressing all Sustainable Development Goals, cannot be achieved with the current policy approach [3].

The Safe System is comprised of two elements of a safe physical system, which includes sustainable colonized services, products, and infrastructures, and a safe governance system that is comprised of a broad coalition of actors and integrates the wide range of policy objectives. The physical system, interest that if individuals failed to address common objectives, this system will ensure that the actions will have minimal impact on sustainable development objectives. The safe governance system insurance, that if individual objectives or actors change, the overall covenant system remains resilient and stable, allowing for certainty for private and public investors.

The paper proposes adapting this approach to address air pollution, greenhouse gas emissions, congestion, and crash rates, all while challenging the assumption that reducing emissions is costly. Technological and operational measures already available can drastically reduce CO2 emissions and improve local air quality [4, 5]. The Safe System approach to transport would require an integrated and systemic change across the entire sector, including energy and resource dimensions (IPCC, 2018). Building upon this approach, the Safe System for Decarbonisation approach aims to bring together selected key concepts that help forming logical elements for the need for the creation of safe operating spaces and ways to achieve them. This includes:

1. The Tragedy of the Commons: Garrett Hardin's "The Tragedy of the Commons" (1968) is a foundational text that outlines the political challenges of shared resources management, a key concern in creating safe operating spaces. This underlines the need for

collective action and mutual agreement to prevent the depletion of shared resources.
2. The Logic of Collective Action: emphasizes the challenges of achieving collective benefits in the presence of individual incentives, is particularly relevant in understanding the dynamics in transition processes. The classic dilemma described by Mancur Olson is a reoccurring feature where the benefits of decarbonization and sustainable practices are collective, yet the costs and efforts are often borne individually.
3. Governing the Commons: The concept of governance is central to the creation of a Safe System. The work of Ostrom (1990) on governing the commons, demonstrates how local communities can manage shared resources sustainably. These will feed into the need for multi-actor, multilevel governance systems.
4. Patterns of Democracy: The concepts by Ahrend Lijphart [6] provide an orientation for the organisation of the governance system, focusing on broad coalitions among key societal actors, emphasizing the need for a stable policy and investment environment that is resilient to political volatility.

Creating safe operating spaces for sustainable development is a complex challenge that requires addressing economic, environmental, and social issues. This involves understanding and addressing the inherent political challenges and conflicts, as well as fostering cooperation at different levels of governance. Such a system would operate on the following principles:

1. Infrastructure complemented by incentives and disincentives: Infrastructure that supports sustainable behaviours (like accessible public transportation or efficient cooling/heating systems) would guide individuals to act sustainably, but also generate funding for re-investment in sustainable infrastrutures and servcies.
2. Low-carbon services as a standard: In sectors like electricity and mobility, services would be restructured to be low-carbon from the outset. For instance, an electricity grid relying predominantly on renewable sources or transport solutions prioritizing public, shared and electric mobility.
3. Sector coupling and integration: Unlocking the potential of sector coupling in energy, mobility, buildings and circular economy can help achieving highest impact on climate mitigation as well as the highest levels of cost-savings, energy and resource efficiencies.
4. Broad coalitions for systemic resilience: For more resilient governance systems a integrated approach creating consensus and coalitions among diverse stakeholders and interests.

The physical safe system

A Safe System in the physical sense provides access for all to all key basic services at a level that is in line with global decarbonisation pathways and fosters sustainable development. This is guided by the concept of the planetary boundaries and the notion of 'safe operating spaces' by Rockström et al. [7]. These biophysical limits within which humanity can thrive, indicate the operating environment for the physical requirements for a Safe System. Taking inspiration from Rockström, Fig. 1 aims to capture these physical boundaries of the Safe System, highlighting the challenges of lack of access, a safe space of usage of basic services at a sustainable level as well as an excessive use that goes beyond the planetary boundaries.

It also highlights the need for systemic changes rather than reliance on individual behaviour changes. The shifts in the energy system are mostly systemic, with shifts at the supply side from fossil fuels to renewable energies and at the end-use side with efficiency regulations. The individual behaviour remains relatively unaltered, with only smaller changes in energy consumption, mostly triggered by pricing signals. In contrast, the mobility patterns of individuals would need to change significantly for a sustainability transition that also addresses, road safety, congestion, noise, resource efficiency and other concerns. As such, the electricity sector exemplifies the effectiveness of the Safe System approach. This sector's transformation, primarily driven by a shift towards renewable energy sources such as wind, solar, and hydroelectric power, has occurred without necessitating significant lifestyle changes for consumers. This transition to sustainable energy sources has enabled a continuity in daily life while enhancing the sustainability of power consumption [8]. The heating sector is only beginning to experience similar systemic changes, gradually moving towards more sustainable heating solutions. These early steps aim to align the sector with a low-carbon trajectory, mirroring the successful transition observed in the electricity sector [4]. The transport sector, however, presents a more complex challenge. The current focus on transitioning to electric vehicles (EVs) addresses the issue of carbon emissions but does not fully encapsulate the broader sustainability challenges. The popularity of larger, resource-intensive vehicles such as SUVs, even in their electric variants, underscores the limitations of this approach. These vehicles bring additional concerns related to resource consumption, safety due to size, and urban noise pollution. Moreover, the pervasive vehicle-centric urban design continues to prioritize vehicles

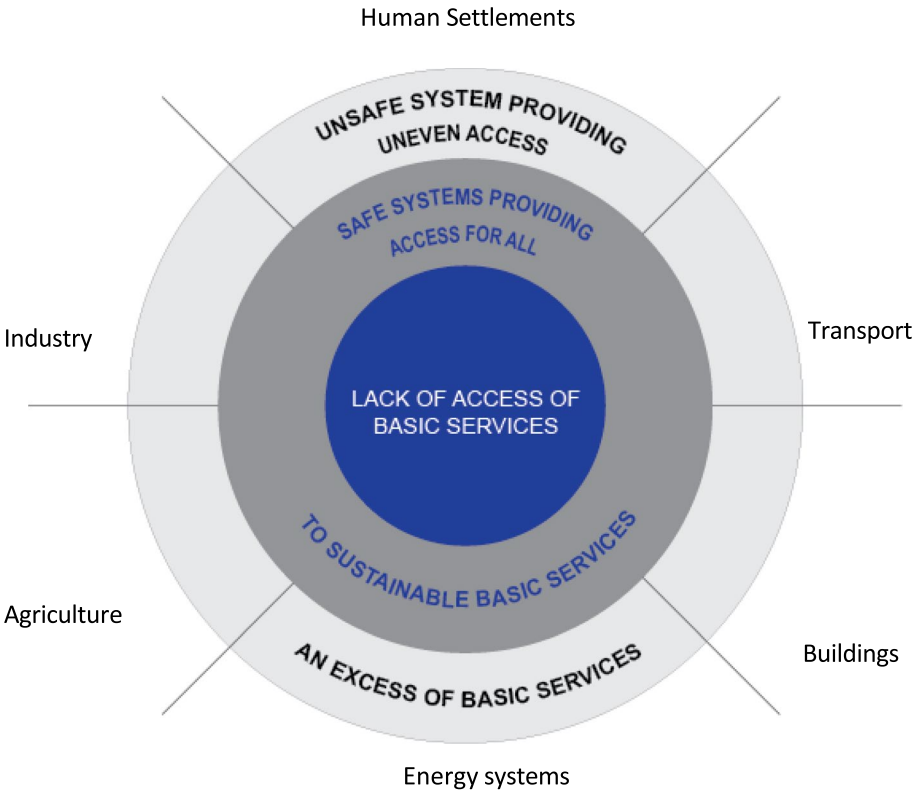

Fig. 1 Physical boundaries of the safe system

over pedestrian spaces and green zones, thereby perpetuating urban congestion and spatial imbalances. To holistically reform the transport sector, a Safe System approach must consider diverse aspects including urban design, mobility choices, and prioritizing environmental and societal needs over a narrow focus on vehicle electrification [9].

While there are assumptions about the high costs of transitioning to sustainable transport, the long-term benefits and cost savings of sustainable mobility infrastructures, services, and technologies are significant. Comprehensive strategies that encompass not only vehicle technology but also urban planning and mobility patterns are crucial. This includes promoting accessible public transport, cycling, and walking infrastructure, and encouraging urban development models that support compact, mixeduse, and poly-centric structures [10, 11]. The transformation towards sustainability in the transport sector requires a multi-faceted approach, encompassing policy integration, urban planning, and technological innovation. This transition, while requiring upfront investment and innovation, is expected to yield substantial long-term benefits, making it a financially and environmentally viable strategy [12].

The safe system governance

The second pillar of the Safe System section emphasizes the 'Safe Governance System,' a crucial component of sustainable development. The key objective for this pillar is to create a policy environment that is resilient to political volatility. Drastic shifts in political priorities following changes of government can disrupt the transition to a lowcarbon economy, which relies on long-term investments that require a stable policy environment [13]. The concept of Safe System Governance, rooted in coordination and consensus, is imperative for sustainable development. This model aligns with the principles of corporatism and coordinated market economies, reflecting the organizational high level and the representation of interests by a limited number of peak organizations. This structured approach provides a manageable framework for decision-makers, enhancing the predictability and stability of stakeholder positions, which is instrumental in shaping effective policies and ensuring successful implementation. These principles, underpinned by theories from Lijphart [6] and Hall and Soskice [14], are key at both local and national levels, facilitating consensus-building and identifying synergies in policy objectives.

The Safe Governance System recognizes the integral role of co-benefits in sustainable urban mobility. Factors like air quality, energy efficiency, and accessibility to mobility services are primary drivers for policy interventions, especially at the local level [15–18]. The interlinkages between energy security and climate change mitigation, emphasizing fuel switch options and demand-side measures, contribute significantly to this dynamic. Urban strategies that promote energy efficiency and shifts to efficient transport modes not only enhance accessibility and reduce transport costs but also positively impact productivity and social inclusion. The challenges posed by urban congestion, with its substantial economic costs, underscore the necessity of an integrated multi-level policy and governance approach. This approach caters to diverse policy objectives such as climate change, air quality, safety, and energy security, each with varying priorities at local and national levels.

Figure 2 aims to show that the creation of coalitions and the coupling of sectors and objectives are critically interlinked at the other end of the spectrum of this perspective are individual actors addressing their objectives with isolated measures, which is likely to fall short, both with regard to stability of the policy environment and comprehensiveness of the strategies that are needed to transition towards sustainable, decarbonised economies [3].

In the Safe Governance System, an integrated policy approach is paramount, aiming to create synergies among various policy objectives and foster stakeholder coalitions. This approach transcends the singular focus on climate change mitigation, encompassing a broader perspective of sustainable development. Strategies that reduce the need for travel, promote compact city designs, and advocate for low-carbon transportation modes are pivotal. The combination of city and national-level policy interventions forms a critical element in advancing sustainable mobility. Despite the uniqueness of institutional structures, the general principle of policy integration and synergy creation lays the groundwork for a comprehensive approach to urban mobility policy and planning. This integrated strategy entails developing a broad strategic framework and building extensive coalitions, essential for ensuring policy continuity in the urban transport sector, a field heavily reliant on long-term planning and investment.

The Safe Governance System involves creating an environment conducive to sustainable actions, reducing reliance on individual behaviour modification. This system is key to implementing the Safe System Approach across various sectors, including electricity, mobility,

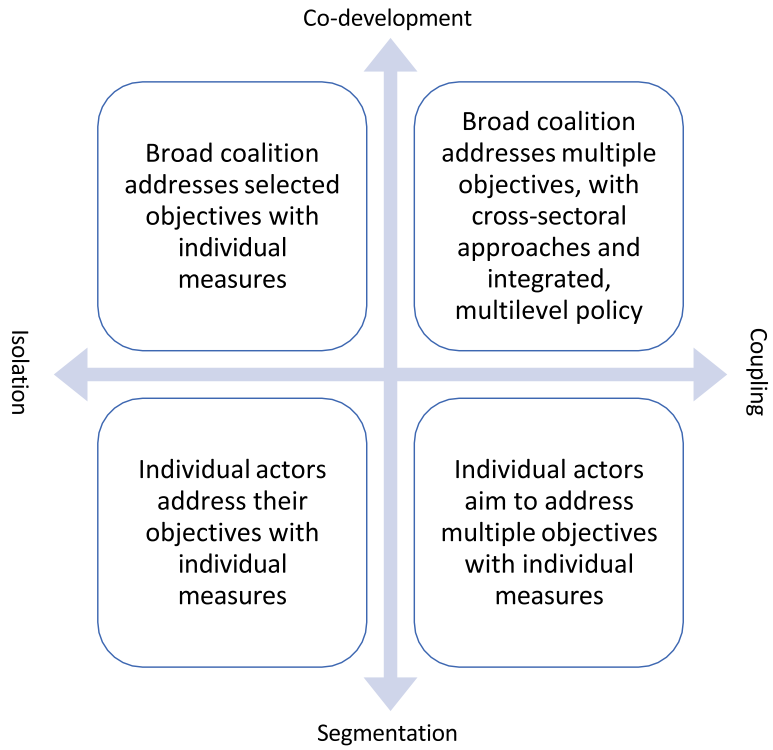

Fig. 2 Safe system governance

industry, and agriculture. By integrating multiple actors and objectives, this governance model ensures resilience and stability, even amidst changing individual objectives or political landscapes. The Safe Governance System acknowledges the political and institutional nuances influencing policy implementation. It draws upon consensus-building and institutional arrangements to achieve long-term policy stability. This aspect is vital for changes in sectors that require substantial long-term investments.

The necessity for an integrated policy approach becomes evident, where strategies must go beyond mere CO2 emission reductions. Issues like urban congestion, with its profound economic and social impacts, demand comprehensive solutions that include improving public transportation, encouraging cycling and walking, and redesigning urban spaces for efficiency and accessibility. These efforts align with broader goals of social inclusion, productivity enhancement, and environmental sustainability. In contrast, the energy sector has experienced a systemic transformation with a significant shift towards renewable sources like wind, solar, and hydroelectric power. This transition has been largely systemic, primarily occurring at the supply side, and has not necessitated substantial alterations in consumer behaviour. The shift towards renewables in the energy sector exemplifies the effectiveness of a Safe System approach, where the change is embedded in the system's design, making sustainable choices the default for consumers. This sector's success story demonstrates how systemic interventions can facilitate a transition to sustainability without imposing drastic lifestyle changes on consumers.

The following section provide an illustrative example for the application of the Safe System in an urban context. The Safe Governance System is a pivotal aspect of the Safe System Approach, offering a robust, efficient, and inclusive pathway to sustainable development. By focusing on systemic adjustments and integrated policy-making, it provides a framework for managing shared resources and fostering broad coalitions, essential for achieving long-term sustainability goals.

Applying the safe system approach to urban climate action

Air quality, safety, energy efficiency, access to energy and mobility services and other factors that are considered to be co-benefits of sustainable urban development measures from a climate change perspective are in fact the driving factors for policy intervention, in particular on the local level [19–21]. There is a direct link between energy security and climate change mitigation actions that focus on fuel switch options, such as biofuels and electrification [22–24] and demand side measures, such resource and fuel efficiency and compact urban design [25–27]. These city level strategies are also likely to improve access and contribute to productivity and social inclusion [10, 28], provide better access to jobs, markets and social services [29–31]. Improved access is a major objective in the New Urban Agenda as it provide opportunities for employment, education and other basic needs [32]. The combination of various policy objectives that can be addressed by an integrated multi-level policy and governance approach provides a solid basis for durable polices that can have long-lasting impacts. Climate change, air quality, noise prevention, safety, energy security and productivity are key policy objectives for policy makers at the local and national level, even though to varying degrees [24, 33–35]. While this creates substantial opportunities for benefits across these policy areas, it also creates a highly complex policy environment with a large number of actors and stakeholders.

An integrated policy approach is driven by a systemic approach that aims to generate synergies among policy objectives, which links to the desire to build coalitions among stakeholders. For example, while from a climate change mitigation perspective vehicle efficiency and low-carbon fuels may provide the biggest CO2 emission reduction potential, this does not fully reflect a broader sustainable development perspective. A multimodal and integrated policy approach can minimise rebound effects, overcome split-incentives and achieve a higher level of socio-economic co-benefits [11]. Energy efficiency and low-carbon fuels have a key role to play in decarbonizing urban energy, mobility and resources systems. However, the strategies, in particular avoiding travel through compact city design and shifting to low-carbon modes are the measures that yield substantial opportunities to contribute to sustainable development. An approach that combines city and national level policy interventions is considered to be a vital factor to enable the transition towards sustainable cities. While institutional structures are not easily transferable, the general approach of policy integration and seeking of synergies, can provide a basis for a more comprehensive approach to urban policy and planning. This would include the development of a wider strategic framework and the aim to build broader coalitions to create policy continuity, which is particularly important for the urban basic services, which rely on long-term infrastructure and investment.

Consensus oriented societies aim to base political decisions on a broad coalition between major political parties and relevant stakeholders. In corporatist countries, there is a high level of organisation and interest groups are represented by a small number of peak-organisations, which means that decision makers have a manageable

number of negotiating partners who represent large constituencies. Coordination with the major peak organisations, public participation, co-production and related aspects that help shaping policies and to pave the way for successful implementation, which can be tested in demonstration projects and living Labs. This builds on the concepts of corporatism and coordinated market economies by Lijphard [6]; Hall and Soskice [14] and reflects on some of the key features of these concepts at the local and national level, which helps to identify opportunities for consensus building based on the policy objectives of key stakeholders and the potential synergies of proposed policy packages. To apply the Safe System approach to sustainable urban development it is vital to go beyond the perspective of climate change mitigation and take a systemic approach. The Living Lab concept outlined in the following section aims to assist in the wider transition. Testing innovative solutions in Living Labs can enable scale-up and replication can contribute to a supportive political, legal, economic and fiscal landscape [9]. An integral part of effective Living Lab approach is the facilitation of close cooperation between local, regional and national decision-makers, operators, industry and businesses to develop innovative solutions that not only fit into the local context but also are scalable and replicable. The Living Lab approach outlined here integrates the Safe System approach into the socio-technical system that consists of technologies, regulations, institutional settings, the economic system, interests, influence and power structures, behavioural patterns, and social norms. It considers that individual innovations should be integrated with existing services and networks in the frame of cross-sectoral integration concepts tailored to the specific local economic, technological, social, political and environmental context.

Operationalising the safe system in urban living labs

The Safe System relies on a broad multi-level governance coalition, on highly integrated policies and the national and local level, close coordination among public and private sector actors, investments, fiscal policy, regulation and service provision. However, also at the small-scale local level Safe System components can be co-developed and tested to validate the overall approach.

Participatory urban living labs are experimental spaces where diverse stakeholders collaborate to develop, test, and validate innovative solutions for sustainable urban development. By integrating participatory approaches and inclusive governance, co-design, co-production, and co-development, epistemic communities, and corporatist institutions, these labs create societal consensus for sustainable urban development. This chapter discusses the role of these elements in participatory urban living labs and explores their potential for promoting sustainable urban development.

Participatory approaches and inclusive governance in urban living labs

Participatory approaches and inclusive governance are crucial for fostering collaboration among various stakeholders in urban living labs. Different levels of citizen participation and empowerment can influence the outcomes of urban living labs [36–38]. By adopting participatory approaches, living labs can ensure that diverse perspectives are taken into account, leading to more contextually appropriate and inclusive solutions.

Inclusive governance, on the other hand, emphasizes the need for transparent decisionmaking processes that involve all relevant stakeholders. It also highlights the importance of accountability and continuous engagement of stakeholders throughout the lifecycle of urban living labs. When participatory approaches and inclusive governance are combined, they create an environment conducive to innovation and the development of sustainable urban solutions.

Co-design, co-production, and co-development in sustainable urban development

Co-design, co-production, and co-development are essential processes in sustainable urban development [39–41]. Co-design involves the collaborative generation of ideas, concepts, and prototypes, while co-production refers to the joint creation of services or products. Co-development, on the other hand, encompasses the collective implementation of solutions in real-world settings. These collaborative processes foster a sense of ownership among stakeholders and ensure that the solutions generated are contextually appropriate, userfriendly, and effective. Furthermore, they encourage the sharing of knowledge, skills, and resources, leading to more innovative and resilient urban solutions.

Epistemic communities and their role in urban living labs

Epistemic communities play a vital role in urban living labs by providing expert knowledge and facilitating the transfer of ideas across different domains [42, 43]. These communities, which consist of professionals and experts with shared beliefs and interests, can inform decision-making and bridge gaps between various stakeholders. By leveraging the expertise of epistemic communities, urban living labs can develop evidence-based, robust, and scalable solutions for sustainable urban development.

Corporatist institutions and societal consensus in urban living labs

Corporatist institutions help create societal consensus by promoting cooperation among diverse interest groups and facilitating negotiations between them [44, 45]. In the context of urban living labs, corporatist institutions can facilitate dialogue and collaboration among stakeholders, leading to the development of shared goals, mutual understanding, and trust. This consensus-building process is critical for the successful implementation and long-term sustainability of urban development solutions. Participatory urban living labs provide a valuable framework for developing and validating sustainable urban development solutions through the integration of participatory approaches, inclusive governance, co-design, co-production, and codevelopment, epistemic communities, and corporatist institutions. By fostering collaboration among diverse stakeholders and promoting societal consensus, urban living labs can generate innovative, contextually appropriate, and scalable solutions for sustainable urban development.

Integrating participatory approaches and inclusive governance into urban living labs

To effectively integrate participatory approaches and inclusive governance into urban living labs, practitioners should consider the following strategies:

- Stakeholder Identification and Engagement: Identify and engage a diverse range of stakeholders, including citizens, community organizations, public institutions, private sector actors, and academic institutions. Ensure that marginalized and underrepresented groups are included in the decision-making processes.
- Capacity Building and Empowerment: Develop the capacity of stakeholders to participate effectively in urban living labs by providing training, resources, and opportunities for skill development. Encourage a sense of ownership and empowerment among participants by giving them the tools and knowledge needed to contribute meaningfully to the process.
- Transparent and Inclusive Decision-Making: Establish clear and transparent decision-making processes that are open to input from all stakeholders. Encourage open dialogue, debate, and the sharing of ideas, ensuring that all voices are heard and considered in the development of sustainable urban solutions.
- Continuous Feedback and Iteration: Establish mechanisms for ongoing feedback and iteration, allowing for the continuous improvement of solutions and approaches in response to stakeholder input and changing circumstances. This includes regularly evaluating the outcomes and impacts of urban living labs to inform future initiatives.

Fostering co-design, co-production, and co-development through collaborative processes

To promote co-design, co-production, and co-development in sustainable urban development, practitioners should:

- Create Collaborative Spaces: Develop physical and virtual spaces that facilitate collaboration among stakeholders, encouraging the sharing of ideas, knowledge, and expertise.
- Implement Participatory Design Methods: Utilize participatory design methods, such as workshops, charrettes, and focus groups, to involve stakeholders in the design process and ensure that their perspectives are incorporated into the final solutions.
- Encourage Cross-Sectoral Collaboration: Foster collaboration among stakeholders from different sectors, such as government, academia, private sector, and civil society, to harness their diverse skills and expertise in the development of innovative solutions.
- Celebrate and Share Success Stories: Highlight and share success stories of co-designed, co-produced, and co-developed solutions, showcasing the value of collaborative approaches in sustainable urban development.

Leveraging epistemic communities and corporatist institutions for societal consensus

To effectively leverage epistemic communities and corporatist institutions in urban living labs, practitioners should:

- Build Bridges between Epistemic Communities and Decision-Makers: Facilitate communication and collaboration between epistemic communities and decision-makers, ensuring that expert knowledge is incorporated into the development of sustainable urban solutions.
- Integrate Corporatist Institutions into Decision-Making Processes: Involve corporatist institutions in the decision-making process, allowing them to represent the interests of their members and contribute to the development of consensus around policy goals and outcomes.
- Promote Dialogue and Deliberation: Encourage open dialogue and deliberation among stakeholders, epistemic communities, and corporatist institutions,

fostering a shared understanding of the challenges and opportunities associated with sustainable urban development.
- Establish Joint Working Groups and Task Forces: Create joint working groups and task forces comprising representatives from various stakeholder groups, epistemic communities, and corporatist institutions, ensuring that diverse perspectives are represented in the development of urban living lab initiatives.

By implementing these strategies, practitioners can effectively integrate participatory approaches, inclusive governance, co-design, co-production, and co-development, as well as leverage the expertise of epistemic communities and corporatist institutions, in urban living labs. This will lead to the creation of more inclusive, innovative, and sustainable urban solutions that benefit all members of society.

Monitoring, evaluation, and learning in urban living labs

To ensure the long-term success of urban living labs, it is crucial to establish robust monitoring, evaluation, and learning processes. These processes help practitioners understand the effectiveness of their approaches and adjust them as needed, fostering a culture of continuous improvement.

- Develop Key Performance Indicators (KPIs): Establish measurable KPIs that align with the objectives of the urban living lab. These indicators should be designed to assess the progress and impact of the lab's initiatives, as well as the effectiveness of participatory processes and collaborative efforts.
- Implement Regular Monitoring and Evaluation: Conduct regular monitoring and evaluation activities to assess the performance of urban living labs against the established KPIs. This data should be used to inform decision-making and adjustments to the lab's strategies and approaches.
- Foster a Culture of Learning and Adaptation: Encourage stakeholders to embrace a culture of learning and adaptation, recognizing that urban living labs are dynamic and iterative processes. Ensure that feedback and lessons learned are shared among stakeholders and used to inform future initiatives.
- Disseminate Results and Share Best Practices: Share the results of urban living lab initiatives with a wider audience, including policymakers, practitioners, and other urban living labs. This helps build a community of practice and fosters the exchange of best practices and lessons learned.

Scaling up and out of urban living lab solutions

Successful urban living lab initiatives often have the potential to be scaled up and replicated in other contexts. To support the scaling up and out of urban living lab solutions, practitioners should:

- Develop Scalable and Adaptable Solutions: Design urban living lab initiatives with scalability and adaptability in mind, ensuring that they can be easily adjusted to fit different contexts and situations.
- Establish Partnerships for Scaling: Build partnerships with other urban living labs, municipalities, and organizations that can support the scaling up and out of successful initiatives. These partnerships can provide valuable resources, knowledge, and expertise to help adapt and implement solutions in new contexts.
- Document and Share Experiences: Document the experiences and lessons learned from urban living lab initiatives, making this information available to others who may be interested in replicating or scaling the initiatives. This can include developing case studies, guidelines, or toolkits to facilitate the transfer of knowledge and best practices.
- Advocate for Policy Change: Work with policymakers and other stakeholders to advocate for policy changes that support the scaling up and out of urban living lab solutions. This may involve promoting the adoption of participatory approaches, inclusive governance, and collaborative processes at larger scales or in other policy domains.

By integrating participatory approaches, inclusive governance, co-design, co-production, and co-development, and leveraging the expertise of epistemic communities and corporatist institutions, urban living labs can create innovative and sustainable urban solutions. Implementing robust monitoring, evaluation, and learning processes, and focusing on scaling up and out, will ensure the long-term success and impact of these initiatives, ultimately contributing to more sustainable, resilient, and inclusive urban environments.

Conclusion

This paper has presented a comprehensive exploration of the Safe System Approach, a transformative governance model for sustainable development. Through its systematic analysis and integration of key concepts from political science, environmental policy, and urban planning, the paper highlights the urgency and necessity of shifting from traditional governance models, which rely heavily on individual behavioral changes, towards more systemic, infrastructural transformations.

The Safe System Approach, rooted in the principles of sustainability, proposes an innovative framework for managing shared resources and fostering collaborative, multilevel governance. By focusing on the creation of an enabling environment that inherently guides individuals and communities towards sustainable practices, this approach redefines the trajectory of sustainable governance. It ensures that sustainability becomes not just an active choice but a default option, facilitated by the design of the system itself.

In applying this approach to urban climate action and mobility, the paper has underscored the need for comprehensive strategies that go beyond technological fixes. It emphasizes the importance of integrating policy objectives across various sectors to achieve socio-economic co-benefits, enhance energy security, and promote inclusive urban development. The comparison between the energy and transport sectors vividly illustrates the differential progress in sustainable transformation, emphasizing the need for a holistic approach to urban planning and policy-making.

The operationalization of the Safe System in Urban Living Labs exemplifies the practical application of this approach. These labs serve as innovative platforms for testing and scaling sustainable urban solutions, leveraging the collaborative efforts of diverse stakeholders. By integrating participatory approaches, inclusive governance, and cross-sectoral collaboration, these labs create societal consensus and pave the way for more resilient and sustainable urban environments.

The Safe System Approach offers a robust, efficient, and inclusive pathway to sustainable development. It aligns with global efforts to address the pressing challenges of climate change and urbanization. By shifting focus from individual behaviour to systemic change, this approach provides a framework for sustainable development that is not only environmentally sound but also socially inclusive and economically viable. As we move forward, the principles and strategies outlined in this paper will be instrumental in guiding policymakers, urban planners, and communities towards a more sustainable and resilient future.

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Availability of data and materials
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Declarations

Ethics approval and consent to participate
This research project did not require ethics approval and consent to participate as it did not involve human subjects or sensitive data.

Consent for publication
This research project did not contain any individual person's data in any form.

Competing interests
The author declares that he has no competing interests.

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