

Chapter 8

From Concept to Practice: Crafting Responsive Spaces for Sustainable Urban Living

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Introduction

The beginning of the modern era marked a significant shift in the unsustainable trajectory of urban development. Cities were faced with multiple and contradictory problems; issues of economic development and environmental protection - changes in land use of public open spaces and degradation of natural habitats for extensive construction, vehicle density versus pedestrian, unequal economic opportunities in income distribution, spatial insecurity versus social justice - that were considered to favor population growth and responsiveness to its needs, were some of the acute urban issues that had a negative impact on the quality of life of citizens. These changes led to the emergence of the sustainable urban development movement at the 1972 UN Conference in Stockholm, which aimed to strengthen the human environmental legacy and establish a discourse against upcoming crises (Sustainable Development Commission, 2011). The movement's first pillar was the conservation of natural resources, reduction of non-renewable energy consumption, reduction of pollution, and strengthening of the relationship between humans and nature.

In the late 1990s, dimensions of sustainability beyond the environment began to emerge. Maslow believed that human needs are collective and social in nature, and that urban space is the mediator through which social interactions take place (Maslow, 1943). Its essential prerequisite is the development of a comprehensive and integrated approach to meet social expectations (Kühn & Bobeth, 2022), which can guarantee the quality of human life by adapting urban infrastructure, providing sufficient green spaces, creating walking facilities and public gatherings (Bonnes et al., 2018). Studies (Gehl & Svarre, 2013; Carmona, 2019; Karimi & Suzanchi, 2021; Naya et al., 2023) have shown that public spaces that can provide sufficient quality to their users play an important role in achieving sustainability goals. As a result, urban and environmental planners and designers have sought solutions to adapt sustainable urban spaces to the users' needs, and new insights have emerged to better connect people with their living environment, such as the Responsive Environments Theory. This study attempts to describe the role of Responsive Environments Theory in creating sustainable urban environments through a descriptive review research method and considers the perspectives of different research on these principles for creating livable urban spaces. Conducting this study will help to dispose concerning the myriad challenges that urbanisation constitutes.

Responsive Environments Concept

The acquisition of the term 'responsive urban environments' dates back to the era of consumption reduction strategies and the transition from the industrialization of cities (Bayulken & Huisinigh, 2015). This term was inherently created with the aim of optimizing and balancing multifunctional urban systems. According to Krueger (1977), a "Responsive Environment" defines a conceptual communication that understands human behavior and unites people in a shared visual, auditory and overall sensory experience. Van Poll (1997) described responsive environments as those that depend on the specific physical conditions of the environment to increase the level of social interactions and encounters. In fact, the physical characteristics of the environment increase the individual's sense of well-being and satisfaction. Montgomery (1998) linked responsive urban environments to a wide range of factors such as the functional diversity of the environment, physical characteristics, urban public facilities and the right of individuals to choose activities (Gehl, 2000). According to Falahat (2007), the characteristics of imageability,

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legibility, enclosure, human scale, transparency, complexity, coherence and order make the environment responsive (Lynch, 1960; Jacobs, 1993). Alves Lino argued that a responsive environment is one in which the principles of aesthetics, visual user interaction, physical accessibility, semantic embodiment and intimacy of presence in space are considered in the design and construction phases (Alves Lino et al., 2010). Scott-Harden (2012) explored responsive environments in terms of effective communication in the structural features of the environment. He considered stimuli such as the physical shape, size, colour and composition of physical elements to drive human active interaction with the environment. Lennon et al. (2019) considered responsive environments to be those that ensure public wellbeing and health, and have environmental values such as easy access to green spaces and urban open spaces with walking and cycling facilities. Waal et al. (2021) found that network-oriented urbanism is effective in creating responsive environments.

Studies show that three key dimensions are involved as a constructive tool for improving human-environment interaction and creating an environment that responds to users' needs: physical factors, functional factors and environmental factors (Fig. 1).

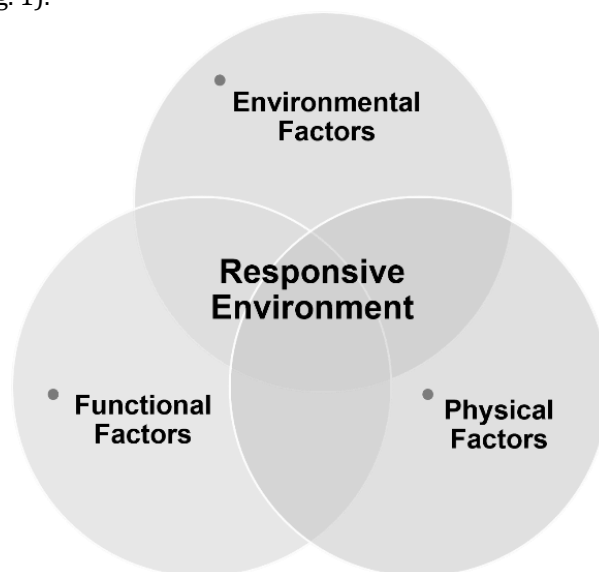


Figure 1. Factors affecting responsive environments.

Fundamentals of Responsive Environments Theory

Bentley *et al.* (1985) focused specifically on the principles of Responsive Environments Theory in a book of the same name, based on seven qualities: permeability, variety, legibility, robustness, visual appropriateness, richness and personalization. As the aim of this research is to identify the domain influences of these principles for sustainable urban spaces, it is necessary to discuss their characteristics and consequences that will shape urban nature.

Permeability

From Bentley's perspective, permeability is a physical and visual quality (Bentley et al., 1985), and has been found in various studies under titles such as form, short and direct connections (Gehl, 1987), hierarchical configuration of streets with urban texture (Purwantiasning, 2022), and access to public transport and parking services (Zhou & Gao, 2020).

Variety

Bentley (1985) argues that functional and spatial variety makes urban space attractive and creates a sense of place. Other researchers consider variety to have positive effects on socio-economic dimensions such as increased productivity (Craven et al., 2020), increased innovation and creativity (Hundschell et al., 2022), increased competitive advantage (Turi et al., 2022), increased socio-economic wellbeing (Livingston et al., 2022) and the consolidation of social capital (Ramos et al., 2024). The study by Zhang et al. (2024) also highlights the importance of urban plant variety in improving socio-economic well-being.

Legibility

Legibility has been defined as a property of visuality and physical clarity (Bentley *et al.*, 1985; Lynch, 1960), like architectural details such as shape, color, and composition (Koseoglu & Onder, 2011). Caduff & Timpf (2008) suggest that legibility can be discussed from three perspectives: perceptual, cognitive and contextual. Lynch (1960) considers focal open spaces, efficient vegetation and transport links to be the causes of spatial legibility.

Robustness

There are different views and definitions of environmental robustness. Bentley (1985) refers to the physical characteristics of the ground surface and the body of the space. On the other hand, Hall (2015) refers to the coherence of pedestrian access networks; Baker *et al.* (2021) to vegetation that absorbs air, sound and visual pollutants; Li *et al.* (2024) to factors such as thermal and environmental comfort, including the use of light, shading, temperature and favourable winds; and finally, Fathi *et al.* (2020) to high walkability, quality and diversity of public transport services.

Visual appropriateness

Visual appropriateness is a component of responsive environments, identified by Gehl (2013) as one of the fundamental principles of urban landscape quality, along with factors such as human scale, distance and depth of space. According to Januchta-Szostak (2010), visual phenomena related to the location of elements, including position, orientation, and apparent form, such as dispersion or continuity, number of facets, transparency or rigidity, and verticality or horizontality, play a special role in the quality of the visual appropriateness of an urban environment.

Richness

Regarding the richness component, research highlights the role of the environment, such as cleanliness (Hikmah & Arifin, 2024), the use of multifunctional and environmentally friendly urban furniture (Shilin, 2022). Gehl (2013) states that vegetation is a factor that increases visual attractiveness and influences environmental richness. Bentley (1985), on the other hand, believes that physical features such as shape, colour, dimensions and materials play a role in enhancing richness (Rapoport, 2005; Lang, 1987). According to Cullen (2004), transport links and space-softening vegetation are also effective in enhancing richness quality.

Personalization

Bentley also looked for the quality of belonging colour in the physical characteristics of the environment through which the user's comfort and control over the environment is realised (Bentley, 1985; Lang, 1987). Hikmah & Arifin (2024) considered urban cleanliness and waste management to be effective in increasing personalization. Other studies (Jacobs, 1993; Falahat, 2007) have pointed to the complexity, structural coherence and cleanliness of the environment in improving this quality.

Table 1 summarizes studies on seven environmental qualities.

Table 1. Summary of Responsive Environments Principles.

Principles	Definitions	References
Permeability	Physical and visual access	(Bentley <i>et al.</i> , 1985)
	Shape and short connection, Hierarchical configuration of streets with urban texture	(Gehl, 1987) (Purwantiastning, 2022)
	Access to public transport and parking	(Silavi <i>et al.</i> , 2017) (Zhou & Gao, 2020)
Variety	Functional/spatial variety	Strengthening the sense of place (Bentley <i>et al.</i> , 1985) (Moussa, 2023)
		Enhance innovation and creativity (Hundschell <i>et al.</i> , 2022)
	variety of service and commercial activities	Increase competitive advantage (Turi <i>et al.</i> , 2022)
		Increasing economic productivity (Craven <i>et al.</i> , 2020)
		Socio-economic wellbeing (Livingston <i>et al.</i> , 2022)
	Ethnic and social variety	Strengthening social capital (Ramos <i>et al.</i> , 2024)
	Variety of plant species	Socio-economic well-being (Zhang <i>et al.</i> , 2024)
	Imageability, Structural transparency	(Bentley <i>et al.</i> , 1985) (Falahat, 2007) (Jacobs, 1993) (Lynch, 1960)

Legibility	Colour, Shape, Dimensions, Stimulating the five senses, Different functions over time	(Caduff & Timpf, 2008)
	Focal open spaces, Combination of vegetation with physical elements, Coherent traffic links	(Lynch, 1960)
Robustness	Uniform surfaces on the floors of urban spaces	(Bentley <i>et al.</i> , 1985)
	Thermal and environmental comfort (Lighting, Temperature, Favourable wind, Shading)	(Li <i>et al.</i> , 2024)
	Effectiveness of flooring materials in absorbing surface run-off, Multipurpose and modular urban furniture	(Shilin, 2022)
	Pedestrian network coherence, Quality and variety of public transport services	(Hall, 2015) (Fathi <i>et al.</i> 2020)
Visual appropriateness	Building skyline, Facade composition details	(Bentley <i>et al.</i> , 1985)
	Dispersion or continuity, Number of facets, Transparency or Rigidity, Verticality or horizontality	(Januchta-Szostak, 2010)
	Enclosure, Human scale, Distance and Depth	(Gehl, 2013)
Richness	Shape, Color, Dimensions, Material, Facade composition	(Bentley <i>et al.</i> , 1985) (Rapoport, 2005) (Gyurkovich & Pieczara, 2021)
	Green spaces and efficient vegetation (Absorbs air, Noise and Visual pollution)	(Baker <i>et al.</i> , 2021)
	Trees, Building forms, Traffic functions	(Cullen, 2004)
	Complexity, Coherence and Elegance	(Falahat, 2007) (Jacobs, 1993)
Personalization	Environment Physical structure	(Bentley <i>et al.</i> , 1985); (Lang, 1987)
	Cleaning and waste management	(Hikmah & Arifin, 2024)
	Complexity, Coherence and Elegance	(Falahat, 2007) (Jacobs, 1993)

Materials and Methods

In terms of purpose, this research is based on applied and this is a review and descriptive study methodologically, which will use in-depth documentary studies according to the research question, what is the role of the Responsive Environments Theory in creating a sustainable urban environment. The aim of this study is to identify the impact of the Responsive Environments Theory in shaping and strengthening sustainable urban spaces, which, given its positive recognition, plays a significant role in creating inclusive cities, improving economic dynamism and enhancing environmental quality. In general, this method involves interpreting the literature related to the foundations of the Responsive Environments Theory and extracting its criteria with the process of achieving sustainable development goals.

Relationship between Responsive Environments Theory and Sustainability Dimensions

Sustainable urban spaces are achieved through the harmonious interaction of the three social, economic, and environmental dimensions, as follows:

- **Social Sustainability:** Maintaining a balance between the interactions of cultural and social systems with natural ecosystems (Muhar *et al.*, 2018), integrating a hierarchy of human demands and needs with natural resources, and promoting respect for nature. It seeks to reduce alienation and increase civility and attachment to place (Eizenberg & Jabareen, 2017).
- **Economic Sustainability:** Optimising dynamic processes, avoiding irreversible patterns, and wasting materials and energy, etc. (Velenturf & Purnell, 2021, Notteboom *et al.*, 2022).
- **Environmental Sustainability:** Strengthening the biodiversity of ecosystems (Matta *et al.*, 2011), using flexible, cyclical and self-regulating natural systems for human purposes (Naveh, 2010).

Meanwhile, several studies have examined the impact of the principles of responsive environments on dimensions of sustainability in urban spaces. Gehl's (1987) research focused on three benefits of the quality of permeability in urban spaces. First, the proper connection of streets to the urban fabric improves social interactions among citizens; second, shortening the length of the street leads to easier access and reduced traffic congestion; and finally, better access to commercial areas increases property values and the prosperity of commercial businesses. Appropriate use of this quality therefore helps to reduce road traffic and increase the presence of pedestrians. As a result, creating permeability in cities creates sustainable conditions in various social, economic and environmental dimensions. Oloyede Alabia & O Abubakar (2023) pointed out the positive correlation between increasing street permeability and the social goals of sustainable development, in particular the reduction of crime. A study by Moulay *et al.* (2017) on the legibility of urban parks in Malaysia showed a direct relationship between clear structure and increased accessibility and social interaction for users. In Cairo, Ahmed Abdel Ghaffar & Abd El Aziz (2021) investigated the relationship between economic sustainability and urban form. The results showed that the three components of permeability, legibility and robustness of urban areas in terms of access to public transport services ensure optimal urban functionality, which has a direct role in the economic growth of commercial areas, improving the quality of housing projects, minimizing travel costs and maximizing economic benefits and mutual benefits. Barton & Gutiérrez-Antinopai (2020) highlighted to the role of physical diversity and structural complexity of the environment in increasing visual richness and its positive impact on social and environmental sustainability. Boongaling Agaton *et al.*, (2020) found that the use of electric public transport is effective in increasing urban robustness and therefore environmental sustainability. Research by Mouratidis *et al.* (2024) on factors influencing social sustainability in Scotland showed that personalisation, as it is known, increases public participation and a sense of control over places, neighbourhoods and the development of urban areas. In this study, the physical standardization of public spaces and the public transport system increases social interaction, identity, belonging and safety for citizens. Amanpour & Delfannasab (2024) showed that physical factors resulting from the physical integrity of urban facades, including dimensions, proportions and overall urban design based on aesthetic principles, contribute significantly to the sustainability of urban spaces. Bharmoria & Sharma (2024) emphasize the impact of the visual quality of urban landscapes through physical change on social, economic and environmental aspects. This study identified measures based on improving urban robustness, including improving urban transport infrastructure and pedestrian networks, reducing vehicle speeds and increasing pedestrian safety, as solutions to increase the environmental sustainability of urban design. The results of the study by Yaralioglu & Kara (2025) found that the physical structure is the most important measure of the sustainability of urban space. Increasing urban robustness through green infrastructure and environmental efficiency emerged as the highest priority parameters. Social measures influenced by urban robustness include safety and control, comfort, interaction, continuity, recognizability and meaning. Measures of economic vitality include contribution to the local and urban economy and increased local employment.

Discussion and Conclusion

The present study identified three factors that influence the sustainability of urban spaces, which can also be achieved by adopting the theory of Responsive Environments in macro policies on the characteristics of physical design, appropriate urban function and measures to preserve and improve the environment (Fig. 2).

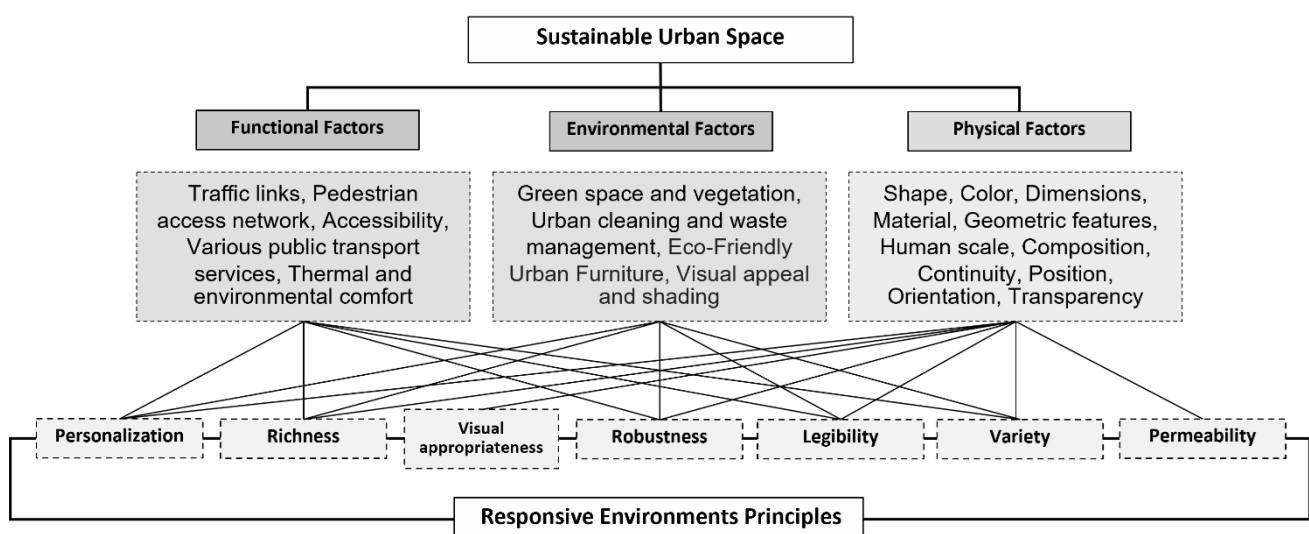


Figure 2. The effectiveness of 'responsive environment' principles in achieving urban sustainability.

The quality of permeability plays a significant role in improving the social, economic and environmental levels of urban areas that can be achieved through physical change. Better pedestrian access to urban areas creates a suitable context for the formation of social relationships, areas of greater economic stability and reduced vehicle density, which can have a significant impact on improving the quality of the environment.

However, the quality of variety contributes to the social, economic and environmental dimensions of sustainability in different ways. Ethnic and demographic variety enhances social relations and strengthens social capital. On the other hand, functional variety enhances economic growth in urban areas. The variety of plant species also contributes to biodiversity and the balance of urban ecosystem cycles.

The quality of legibility is also directly related to each of the three social, economic and environmental dimensions. Legible spaces give users a stronger sense of place and increase the opportunities for social interaction. From an economic perspective, legible spaces ensure the future of development and better economic exchange. This quality can be transformed into sustainable urban spaces through physical, functional and environmental changes. Improving the quality of green spaces and urban nature also enhances people's images and sense of attachment to urban landscapes.

Visual appropriateness can have a direct impact on presence in space, the formation of social relationships and appropriate economic opportunities. Physical changes to improve visual quality play an effective role in social and economic sustainability.

The two qualities of robustness and richness have a tangible relationship with environmental characteristics. Considering environmental criteria in thermal and environmental comfort and using eco-friendly urban furniture play an important role in environmental and economic sustainability. Increasing the robustness of urban spaces through better pedestrian access, better public transport links or appropriate physical structure increases social interactions and improves economic relationships.

The quality of richness, like the quality of legibility, enhances the sense of place in the space and is achieved by combining physical, functional and environmental factors that play a particular role in the process of social, economic and environmental sustainability.

Making physical changes according to personal preferences increases the sense of satisfaction with the environment, while strengthening physical, functional and environmental features increases the sense of belonging to the urban spaces and provides a stronger social and economic base.

Overall, the results emphasize the convergence of three key factors: physical, functional and environmental in the modern urban context to create sustainable urban spaces, which is achieved as a result of a balanced and proportionate distribution of 'responsive environments' principles. It is also necessary to accept this reality that the improvement of only one factor affecting the achievement of urban sustainability can have a profound conclusion in the whole process of creating Responsive Environments. Although the research findings mostly point to the impact of physical changes on the responsiveness of the environment to citizens' needs, they also point to the need to preserve and enhance the urban natural environment because of its tangible impact on sustainable urban development, in a way that enhances the durability of urban relationships and facilitates the continuation of growing generations in cities.

Generally, the results indicate a high correlation between the principles of Responsive Environments and the empowerment of different social, economic and environmental levels. This suggests that adopting urban spatial plans within the framework of physical, functional and environmental measures is a reliable way to achieve sustainable, livable urban development with a human-centered focus. In short, the results of this study will help satisfy the daily needs of a wide range of users and, in particular, create order, balance and control in the planning and urban redesign of areas lacking environmental values.

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Conflict of Interests

The Authors declare that there is no conflict of interest.

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