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Understanding eco urbanism development through expert perspectives on drivers and barriers

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Abstract

Amid escalating environmental pressures and rapid urbanisation, eco-urbanism has emergedas an important framework for guiding sustainable urban development. This study aims toexamine built environment professionals' awareness, perceptions, and acceptance of eco-urbanism principles and to determine the factors influencing their adoption in practice. Inthis connection, the study pursues three key objectives: (1) to assess the level of awareness, perception and acceptance of eco-urbanism among professionals from different disciplinary backgrounds; (2) to identify the major drivers encouraging the adoption of eco-urbanism principles; and (3) to determine the key barriers that hinder their effective implementation. A structured questionnaire survey was administered to professionals across planning and design, social and behavioural sciences, policy, economics, and development sectors. The collected data were analysed using SPSS version 26.0, applying descriptive statistics, correlation analysis, and multiple linear regression to explore patterns, relationships, and predictive associations. The findings reveal a high overall level of awareness of eco-urbanism, particularly regarding green space integration, with more than 70% of respondents across professional groups indicating that they are "very aware" of the concept. Rapid urbanisation and population growth were identified as the most significant drivers of professional acceptance, while financial constraints emerged as the most prominent barrier to implementation. Additionally, correlation results indicate that certain demographic factors, including gender, significantly influence professionals' attitudes toward eco-urbanism. Overall, the study provides empirical insights into professional perspectives on eco-urbanism and highlights the importance of supportive policy frameworks, financial incentives, and capacity-building initiatives to facilitate the effective integration of eco-urbanism principles in contemporary urban development.

Keywords Acceptance, Built environment experts, Eco-urbanism, Experts' perception, Sustainable urban development

1 Introduction

Eco-urbanism has emerged as a key paradigm in the field of sustainable development, aiming to balance rapid urbanisation with ecological integrity and economic viability in line with global sustainability principles [1, 2, 3]. It evolves from earlier urban models

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such as eco-towns, which focused on low-carbon housing and renewable energy systems, and resilient cities, which emphasised adaptability to climate change and socio-environmental shocks [3, 4, 5]. Central to eco-urbanism is the integration of green infrastructure, resource efficiency, and climate-resilient urban design, creating urban environments that are both environmentally sustainable and socially liveable.Importantly, the eco-urbanism concept refers to a holistic approach to urban development that integrates ecological, social, and economic considerations to create sustainable, resilient, and liveable cities. It emphasizes the strategic incorporation of green infrastructure, efficient resource use, and community-centred planning to mitigate environmental impacts and enhance urban quality of life. Distinct from general sustainable urbanism, eco-urbanism specifically focuses on embedding ecological principles into the design, planning, and management of urban spaces, promoting both environmental stewardship and human well-being.

In recent years, eco-urbanism has gained increasing prominence by combining ecological strategies with digital technologies to enhance energy efficiency, mobility, and urban governance [6, 7, 8]. Since the early 1980s, integrating sustainability principles into neighbourhood and city development has attracted global attention, beginning with Richard Register's concept of eco-cities, which advocated aligning urban growth with the ecological carrying capacity of a city's bioregion [9, 10, 11]. Building on this foundation, eco-urban initiatives have evolved into comprehensive frameworks informed by urban metabolism and broader sustainability concepts, extending beyond the scope of earlier urban movements [12]. Today, eco-urbanism serves as an umbrella term encompassing diverse approaches aimed at addressing both traditional urbanisation challenges and emerging global issues such as climate change, resource scarcity, and resilience planning [13].

A substantial body of literature documents diverse eco-urban initiatives, including eco-cities, eco-towns, eco-districts, éco-quartiers, garden cities, smart green cities, and resilient cities, reflecting differences in scale, socio-political context, and development type [14–16]. While eco-urbanism builds on earlier sustainable urban movements, its distinctive feature is the systematic integration of advanced green and digital technologies, such as smart grids, integrated water and waste management, solar energy systems, net-zero energy buildings, real-time transport information, and flexible digital work solutions [11, 13]. The perspectives presented [17] further highlight the importance of incorporating intelligent spatial systems within eco-urban frameworks. Their conceptual contributions demonstrate how AI-driven spatial analytics and intelligent decision-support systems can strengthen urban ecological governance and sustainability planning. Integrating such technologies into eco-urban initiatives can therefore enhance the ability of cities to monitor environmental conditions, optimise land-use planning, and promote sustainable tourism development.

Despite variations in form and context, the central aim of eco-urbanism is to reduce environmental impacts while enhancing social well-being and economic viability. In other words, the success of eco-urban strategies depends not only on technological solutions but also on the awareness, engagement, and acceptance of professionals and decision-makers, who play pivotal roles in policy, planning, and implementation [18–19]. However, most research has focused on public perceptions or policy-level analyses, with limited attention to insights from key professional groups such as architects, planners,

engineers, sociologists, environmental psychologists, and economists [20–22]. Thus, understanding expert perspectives is critical because these professionals directly shape urban environments and influence the effectiveness of sustainability interventions.

Adoption of eco-urbanism is also shaped by socio-cultural factors, economic constraints, and institutional capacities. Financial limitations, infrastructural challenges, and competing policy priorities can hinder implementation, while gaps in professional knowledge and awareness may reduce commitment to eco-urban practices [23, 24]. Effective policies and capacity-building programs must therefore be tailored to address these constraints and engage experts meaningfully. Aligned with principles of compact, efficient urban development, eco-urbanism promotes mixed-use zoning, intelligent growth, pedestrian-friendly neighbourhoods, and dynamic urban centres, which counter sprawl and enhance social and economic vitality [2, 24–25]. Active community participation is equally central, fostering a sense of ownership and ensuring that initiatives respond to local needs and aspirations [19]. Collectively, these approaches illustrate the ongoing evolution of eco-urbanism as a framework for balancing environmental responsibility, urban growth, and quality of life.

Despite growing recognition of eco-urbanism, empirical understanding of how built environment professionals perceive, accept, and implement these principles remains limited, particularly across diverse disciplinary and demographic groups. While prior studies have explored theoretical frameworks and technological solutions, few have examined the drivers and barriers that shape professional engagement with eco-urbanism in practice. This gap constrains the effective translation of eco-urbanism from theory into actionable urban policies and development strategies.

This study aims to empirically evaluate built environment professionals' awareness, perceptions, and acceptance of eco-urbanism principles in sustainable urban development practice. The research objectives include:

i. To assess the level of awareness and perceptions of eco-urbanism principles among built environment professionals across diverse disciplinary backgrounds.
ii. To identify and analyse the key drivers that promote the acceptance and adoption of eco-urbanism in professional practice.
iii. To examine the major barriers constraining the implementation of eco-urbanism principles.
iv. To evaluate the influence of demographic and professional characteristics on attitudes toward eco-urbanism adoption.

Building on these objectives, this study contributes to sustainable urban development scholarship by deepening the empirical understanding of built environment professionals' perceptions, priorities, and readiness to adopt eco-urbanism principles. By analysing levels of awareness alongside the drivers and barriers shaping adoption, the research identifies key predictive factors that enhance existing theoretical frameworks on sustainable urban transitions. Furthermore, the study provides practice-oriented insights by highlighting the policy, institutional, and financial mechanisms required to facilitate the effective mainstreaming of eco-urbanism in contemporary urban development. The findings help bridge the gap between theory and implementation by offering evidence-based recommendations for policymakers, urban planners, and sustainability practitioners. Ultimately, the study informs the design of targeted policy interventions, incentive

structures, and professional capacity-building initiatives aimed at strengthening the integration of eco-urbanism principles in sustainable urban planning and development.

This article is structured into five sections. The first section provides an introduction to eco-urbanism, while the second section reviews the literature, covering key concepts, public perceptions, and barriers to eco-urbanism adoption. The third section outlines the theoretical framework for understanding the eco-urbanism movement in urban design and development. The fourth section details the research methodology employed in this study. Finally, the fifth section presents the results, discussion, and implications, highlighting directions for future research on the trends and mechanisms of eco-urbanisation.

2 Conceptualising eco-urbanism and the theoretical framework

Eco-urbanism has been interpreted in diverse ways within urban studies, reflecting its evolution as both a theoretical paradigm and a practical approach to sustainable urban development. Early scholarship positions eco-urbanism as an extension of urban planning and design movements concerned with environmental integration and spatial efficiency [14, 21, 26]. More recent interpretations, however, conceptualise eco-urbanism as a broader ideological and operational process of digital technologies. In view of this, contemporary eco-urbanism increasingly recognises the importance of digital technologies and artificial intelligence (AI) in supporting sustainable urban development and ecological governance. Eco-urbanism traditionally focuses on integrating environmental sustainability, urban planning, and socio-economic development to create resilient and environmentally responsible cities. However, the growing complexity of urban systems and environmental challenges has led scholars to emphasise the role of digital intelligence in enhancing eco-urban planning, monitoring, and management processes. Digital technologies, including AI, big data analytics, geographic information systems (GIS), and the Internet of Things (IoT), provide advanced tools for collecting, analysing, and interpreting environmental and spatial data to support evidence-based decision-making [26–27].

Artificial intelligence is increasingly applied in urban sustainability initiatives to monitor environmental conditions, optimise resource management, and support adaptive governance systems. AI-enabled systems can process large volumes of real-time data related to air quality, energy consumption, land-use dynamics, and urban mobility, thereby facilitating efficient environmental monitoring and management in urban environments [28–29]. In the context of eco-tourism and sustainable urban systems, AI technologies can also assist in monitoring ecological assets, predicting environmental risks, and guiding sustainable planning and management [30]. These capabilities enhance the ability of cities to maintain ecological balance.

Recent studies have also highlighted the conceptual integration of digital intelligence within spatial and urban applications. For instance [17], emphasises the role of intelligent spatial systems in supporting data-driven urban planning and environmental governance. Their work highlights how AI-supported spatial analytics can improve urban ecological monitoring, land-use planning, and sustainable resource management. Thus, it could be argued that the incorporation of intelligent technologies in urban systems enables more adaptive and responsive planning frameworks capable of addressing complex environmental and sustainability challenges. These perspectives reinforce

the notion that digital intelligence is becoming an essential component of contemporary eco-urban frameworks. Within eco-urban development, AI and digital intelligence can support several key sustainability functions. These include predictive modelling of environmental changes, optimisation of energy and water systems, and enhanced monitoring of ecological resources. Additionally, intelligent urban systems can facilitate participatory governance by providing stakeholders with accessible data and decision-support tools. As cities increasingly adopt smart technologies, the integration of AI into eco-urban planning frameworks presents new opportunities to improve environmental performance and support sustainable urban and tourism systems.

Building on this literature, this study conceptualises eco-urbanism as an integrated urban development approach that prioritises ecological integrity, resource efficiency, social well-being, and adaptive governance within the built environment. It extends beyond conventional environmental planning by embedding ecological systems thinking into urban form, infrastructure, and socio-economic processes, thereby aligning urban growth with environmental limits. The concept is theoretically grounded in sustainable urbanism, ecological urbanism, and green infrastructure theory, which collectively emphasise compact development, climate-responsive design, ecosystem services, and socially inclusive public spaces [21, 31]. In addition, eco-urbanism draws on systems and resilience theory, which frame cities as complex socio-ecological systems where environmental, institutional, and behavioural dimensions interact dynamically over time [3, 22, 32]. Within this framework, built environment professionals, planners, architects, engineers, and policy actors play a critical role in translating eco-urbanism from normative ambition into operational reality through design decisions, regulatory mechanisms, and implementation practices.

Eco-urbanism is inherently multidimensional, encompassing objectives such as economic revitalisation, material efficiency and recycling, public participation, environmental awareness, and social equity [33]. These objectives closely align with the United Nations Sustainable Development Goals (SDGs), particularly SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action). Empirical applications of eco-urbanism have been documented across European cities [34, 35], as well as in North America and Asia. In the United States, for example, eco-urbanism has evolved from neo-traditionalist and smart growth movements that emphasise resource efficiency, inclusive design, urban retrofitting, and neighbourhood-scale regeneration [19, 36–37]. Despite this growing body of case-based and policy-oriented literature, much of the existing research prioritises spatial, technological, and performance outcomes, with comparatively limited attention to the perceptions and decision-making processes of the professionals responsible for implementation.

Grounded in principles of environmental stewardship and social well-being, eco-urbanism aspires to create resilient and liveable urban environments capable of supporting both present and future generations [2, 26]. Central to this vision is the integration of green infrastructure such as parks, urban forests, and ecological networks, which enhances ecosystem services including air purification, microclimate regulation, and biodiversity conservation [19, 38–39]. These outcomes contribute directly to SDG 3 (Good Health and Well-being) and SDG 15 (Life on Land). Eco-urbanism also promotes low-impact urban design, sustainable mobility, and renewable energy integration as pathways to decarbonisation and climate resilience, aligning with SDG 7 (Affordable and

Clean Energy) and SDG 13. Pedestrian-oriented environments, efficient public transport systems, and the embedding of renewable energy technologies within urban infrastructure are widely recognised as central components of low-carbon urban transitions [40].

Experiences from several global eco-urban projects reveal persistent shortcomings that challenge the core ideals of eco-urbanism. Many developments have been criticised for prioritising economic competitiveness and city branding rather than achieving holistic sustainability outcomes [41]. Governments often promote eco-urban initiatives as flagship projects designed to attract global investment, which can result in an excessive focus on economic performance at the expense of social inclusion and long-term urban resilience [42]. For example, Masdar City in the United Arab Emirates has been criticised for emphasising technological innovation and economic viability while paying limited attention to community attachment and social inclusiveness, raising concerns about its resilience during economic downturns. Similar limitations have been identified in the development of English Eco-towns, Indian eco-cities, and South Korea's Songdo smart city, where technology-driven urban development has not sufficiently addressed social equity concerns [43–45].

Moreover, despite claims of reducing urban inequalities, many eco-urban developments have generated exclusionary outcomes shaped by market mechanisms. Speculative real estate practices and limited housing affordability have been observed in developments such as the Sino-Singapore Tianjin Eco-city, where affordable housing primarily benefits highly skilled workers in technology-related sectors [46]. Similar patterns are evident in China's Caofeidian eco-city, which has been described as an "island of wealth" disconnected from its surrounding regional context [47]. Comparable challenges have also been reported in Morocco's eco-city initiatives, where the benefits of green urban development tend to accrue disproportionately to higher-income groups [48–50]. These cases illustrate the ongoing tension between market-driven urban development and the broader goals of inclusive sustainability.

Critiques further highlight the technocentric orientation of many eco-urban projects, which often rely heavily on technological innovation and physical infrastructure as mechanisms for achieving sustainability objectives. Projects such as Japan's Kashiwa-no-ha Smart City demonstrate substantial investments in green infrastructure and smart technologies, yet they provide limited engagement with behavioural change and social transformation [41]. Evidence from several Chinese eco-cities also suggests that consumption-oriented lifestyles can undermine sustainability goals by producing rebound effects that offset technological gains [26].

Against this backdrop, a significant knowledge gap persists regarding how built environment professionals perceive eco-urbanism, what factors drive their acceptance, and which barriers constrain its practical implementation [17]. Addressing this gap is essential for translating sustainability frameworks aligned with the Sustainable Development Goals (SDGs) into actionable and equitable urban outcomes. Accordingly, this study examines professional awareness, acceptance drivers, and implementation barriers associated with eco-urbanism in order to generate evidence-based insights that can support more inclusive, people-centred, and resilient urban development strategies.

The key drivers shaping eco-urbanism acceptance are summarised in Fig. 1. It illustrates the multidimensional factors influencing the acceptance of eco-urbanism in urban development. At the centre is the acceptance, which is shaped by several interconnected

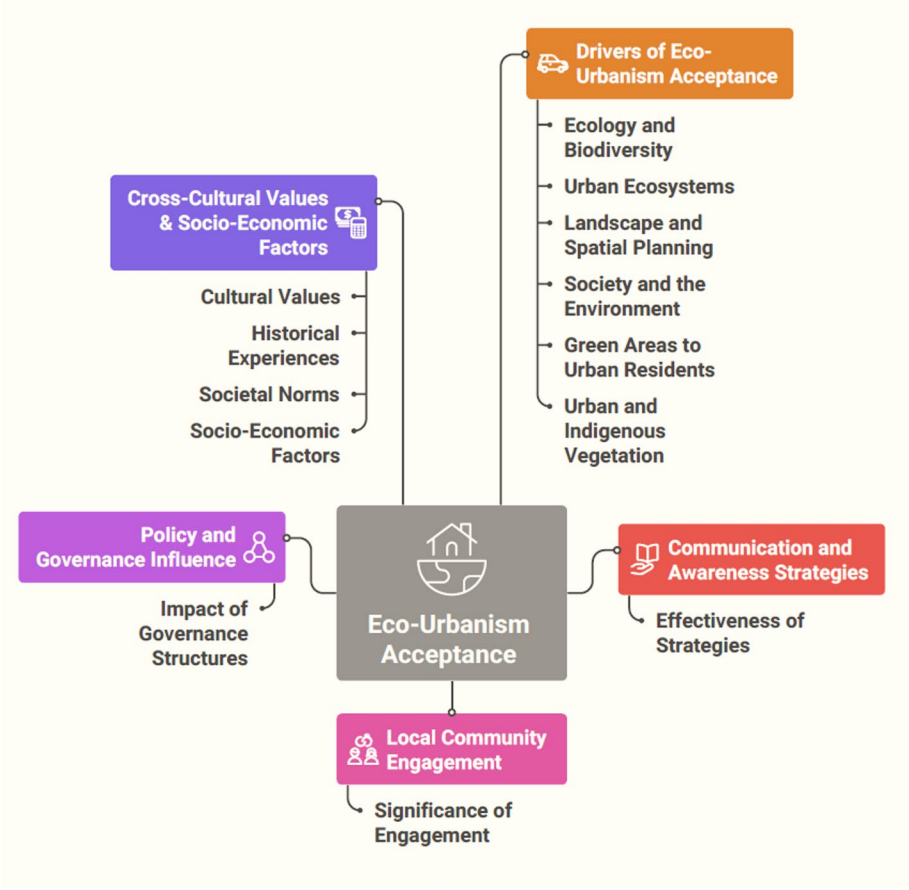


Fig. 1 Drivers of eco-urbanism acceptance

determinants. Drivers of eco-urbanism acceptance include ecological and environmental considerations such as biodiversity protection, urban ecosystems, landscape and spatial planning, green spaces for residents, and the integration of urban and indigenous vegetation. Cross-cultural values and socio-economic factors, including cultural values, historical experiences, societal norms, and economic conditions, also play a significant role in shaping perceptions and attitudes toward eco-urban initiatives. In addition, policy and governance structures influence implementation through regulatory frameworks and institutional support. Communication and awareness strategies enhance understanding of eco-urban concepts, while local community engagement emphasises the importance of participatory approaches in fostering support for sustainable urban practices.

The Fig. 2 illustrates the key strategic components of sustainable and eco-urban development within a city framework. It highlights multiple interconnected dimensions that collectively contribute to environmentally responsible and resilient urban systems. These components include city strategy and long-term planning, which guide sustainable policy frameworks, and education and cultural heritage, which promote awareness and knowledge of environmental values. Governance and social cohesion are emphasised through urban governance, encouraging inclusive and participatory planning, and local food systems, which support urban agriculture and food sustainability. Environmental sustainability is further reinforced through renewable energy, water efficiency,



Fig. 2 Eco-urbanism features. Adapted from [26]

and the protection of green landscapes and public spaces. The framework also stresses the importance of sustainable transport, eco-friendly materials, green buildings, and the retrofitting of urban districts to improve efficiency and reduce environmental impacts. Additionally, livability is highlighted as a core goal, ensuring high environmental quality and well-being for urban residents.

Meanwhile, Table 1 presents a comparative overview of eco-urbanism practices across different regions worldwide, highlighting their key characteristics, objectives, and associated challenges. In China and South Korea, eco-city initiatives are largely technology-driven and state-led, aiming to reduce greenhouse gas emissions and manage rapid urbanisation, although they often face criticisms related to limited public participation and social inclusiveness. Japan's Eco-Town initiatives place a stronger emphasis on recycling, public engagement, and environmental awareness but face challenges in scaling up. European examples such as France, Germany, and Sweden demonstrate more structured planning frameworks and holistic sustainability approaches, although market pressures and context-specific conditions sometimes limit broader applicability. In the United States, eco-urbanism is linked to initiatives such as EcoDistricts and LEED-ND, but market-driven implementation may weaken social equity outcomes. Emerging projects in Africa, Latin America, and Australia remain limited and under-documented. Overall, the table highlights global efforts to promote sustainable urban development while revealing persistent challenges related to governance, inclusivity, scalability, and consistent performance evaluation.

Table 1 Comparative study of eco-urbanism practices worldwide

Region/country	Main characteristics/objectives	Criticisms/weaknesses	References
China	Over 200 eco-city projects; large-scale, technology-focused; state-led (central & local governments); aim to reduce GHG emissions, enhance competitiveness, and manage urbanisation	Blueprint planning limits local specificity; weak bottom-up participation; lack of human scale (Tianjin Eco-city with high-rise towers & wide streets); externalities of urbanisation already present	[40,51–52]
South Korea	Similar to China, but with a stronger emphasis on ICT and eco-technology	Over-reliance on technology and limited social inclusiveness	[11]
Japan	Eco-Towns are aimed at economic revitalisation, recycling, public participation, environmental awareness, and social justice	Better integration of social aspects than China/Korea, but limited scalability	[19]
Indonesia, Vietnam, UAE	Adoption of eco-urbanism concepts in selective cities	Limited documentation; often influenced by top-down planning and global image-building	[36,38]
France (ÉcoQuartiers)	Focus on sustainable neighbourhoods with strong planning frameworks	Implementation varies; market pressures sometimes compromise inclusivity	[47]
Germany (Eco-districts via DGNB)	Promotes sustainable building standards and eco-district planning	More emphasis on environmental performance than on social equity	[53–54]
Sweden (e.g., Malmö)	Strong integration of sustainability in city planning; holistic approaches	Relatively successful but context-specific (difficult to transfer globally)	[55]
European Union	Funding eco-city programs across multiple countries	Fragmentation across nations; inconsistent success	[13,55]
United States	Eco-urbanism evolved from Neo-traditionalism; it includes the EcoDistricts initiative (Portland); LEED-ND promotes density, mixed use, green infrastructure, etc	Market-driven nature limits inclusiveness and ecological depth; LEED-ND is criticised for weak performance on equity and green infrastructure	[56]
Africa, Latin America, Australia	Emerging eco-urban projects with limited scope	Sparse documentation; knowledge gap in performance outcomes	[13, 24–25]
Global development	Knowledge transfer enhanced via bilateral collaborations (Germany, France, Japan, India, China). Assessment toolkits (CASBEE-UD, LEED-ND, Masdar, Tianjin, Portland EcoDistricts) have been developed for performance monitoring	Implementation of toolkits is inconsistent; verification of sustainability targets is often weak	[19,43,56–57]

The theoretical framework as eco-urbanism increasingly recognises that successful implementation that relies on technological innovation; spatial design; institutional capacity, governance structures, and social acceptance as presented in Fig. 3. While regulatory incentives and policy frameworks shape the enabling environment for eco-urban initiatives, public and professional attitudes toward green infrastructure, renewable energy, and sustainable lifestyles play an equally decisive role [31, 58]. As highlighted in the preceding discussion, many eco-urban projects fail to deliver inclusive and resilient outcomes precisely because they overemphasise economic and technological dimensions while underestimating behavioural, cultural, and social dynamics. This underscores the need for a theoretical framework that explicitly links individual and collective behaviour with institutional and structural conditions.

To address this gap, the study adopts the Theory of Planned Behaviour (TPB) as its guiding theoretical lens. TPB posits that behaviour is shaped by three core determinants:

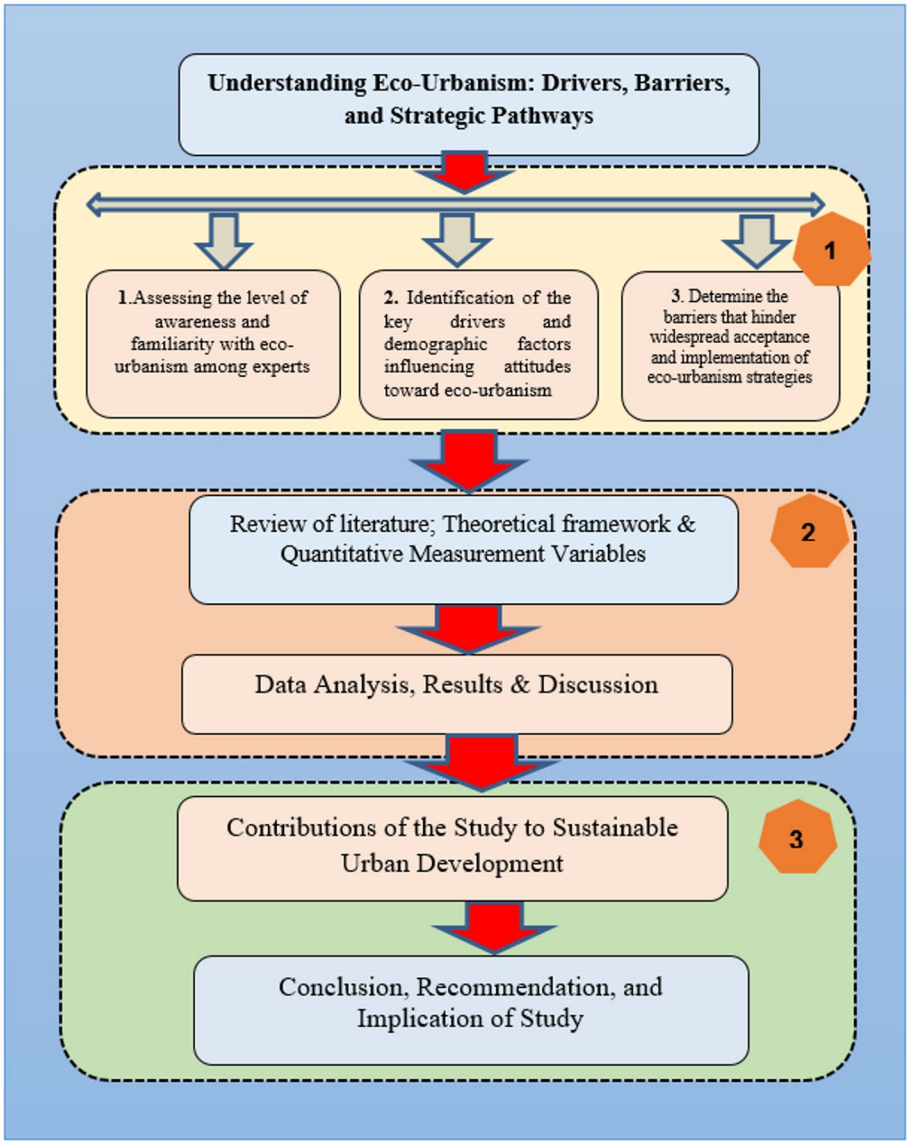


Fig. 3 The study's theoretical framework

attitudes, subjective norms, and perceived behavioural control [58, 59]. Applied to eco-urbanism, the theory suggests that acceptance and support for eco-urban initiatives are influenced by professionals' evaluations of sustainability outcomes (attitudes), perceived social and professional expectations (subjective norms), and their assessment of institutional, financial, and technical capacity to act (perceived behavioural control). TPB is therefore well suited to unpacking why awareness of eco-urbanism does not always translate into support or implementation, a challenge repeatedly identified in eco-urban practice [2, 60].

Within this behavioural framework, socio-cultural and institutional contexts function as critical conditioning factors. Knowledge and education shape attitudes toward eco-urbanism by enhancing understanding of its ecological, social, and economic benefits [27, 61], while environmental values and concern for ecological protection strengthen normative support [19, 58]. At the same time, trust in governance systems, transparency in decision-making, and inclusive planning processes increase perceived legitimacy

and reduce resistance [26, 33]. Positive lived experiences, such as access to green spaces, exposure to renewable energy technologies, and interaction with low-impact infrastructure, further reinforce acceptance by translating abstract sustainability goals into tangible benefits [62–63]. By integrating these dimensions, TPB enables a systematic examination of how behavioural factors interact with broader governance and policy conditions. The input stage captures professional awareness of eco-urbanism, alongside demographic and contextual variables such as age, education, socio-economic status, and cultural background. Institutional and policy conditions, including governance quality and regulatory incentives, are also treated as critical inputs shaping perceptions and behavioural intentions. The process stage operationalises TPB by examining how attitudes, subjective norms, and perceived behavioural control mediate the relationship between awareness and acceptance. Key drivers (environmental values, perceived benefits, social cohesion) and barriers (e.g., financial constraints, weak governance, limited inclusiveness) are analysed to identify patterns across professional and demographic groups. This approach responds directly to gaps in the literature by revealing whether acceptance of eco-urbanism is uniform or differentiated across social and professional contexts [64, 65].

Finally, the output stage synthesises empirical findings into theoretical and practical contributions for sustainable urban development. These include insights into behavioural drivers of eco-urbanism acceptance and evidence-based strategies such as targeted policy reforms, financial incentives, capacity-building initiatives, and participatory governance mechanisms. By linking behavioural theory with institutional analysis, the proposed framework offers a structured pathway for addressing the social and governance barriers identified in eco-urban practice, thereby supporting more inclusive, resilient, and people-centred urban sustainability transitions.

3 Methodology

3.1 Overview and research design

This study adopted a quantitative, cross-sectional survey design to systematically examine built environment professionals' awareness, perceptions, and acceptance of eco-urbanism principles. A quantitative approach was selected to enable the collection of structured and measurable data suitable for statistical testing of relationships, group differences, and predictive effects among variables [67, 68]. The survey strategy is particularly appropriate for expert-based sustainability research, where the objective is to identify patterns of perception and acceptance across professional domains rather than generate narrative accounts. To enhance transparency and replicability, the methodological process followed a clearly defined sequence comprising: (i) research design and framework development; (ii) participant selection and sampling; (iii) instrument design and pilot testing; (iv) data collection; and (v) data analysis and validation. Figure 4 presents the methodological protocol adopted in this study. The process begins with questionnaire design and pilot testing. Subsequent stages include stratified expert sampling and data collection, quantitative data analysis using SPSS, and finally interpretation and reporting of findings with policy and practice implications. This structured workflow enhances transparency and enables methodological replication.

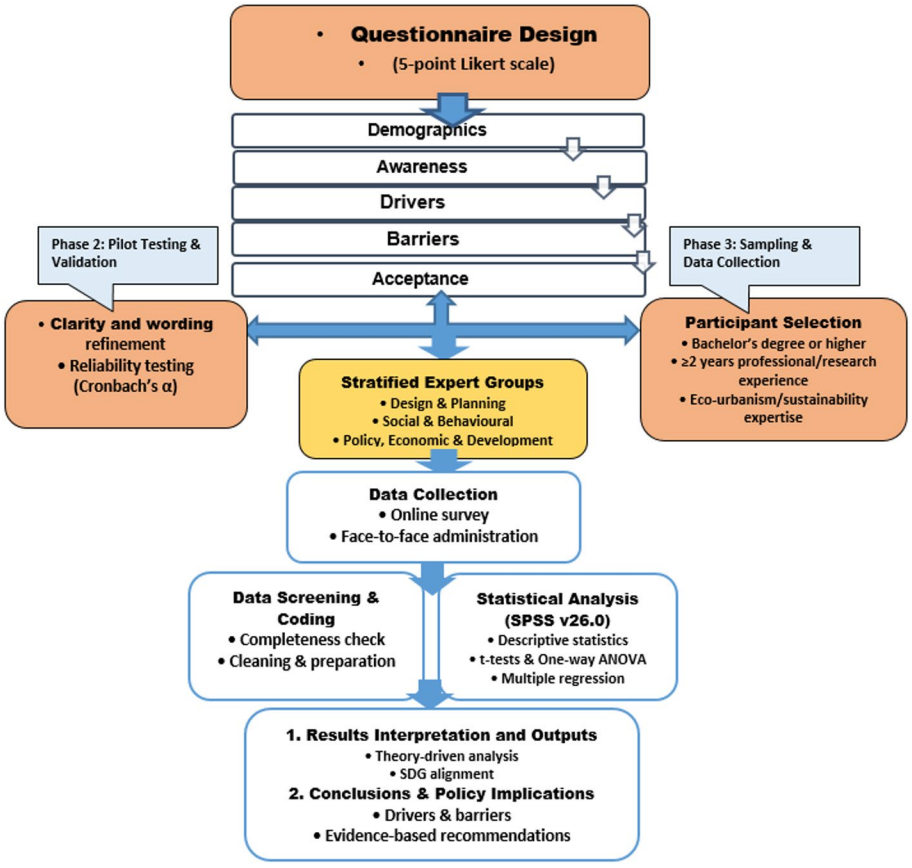


Fig. 4 Overview of the study's research design from the questionnaire design to the conclusion

3.2 Target population and participant selection

The target population consisted of professionals actively engaged in the study, planning, design, governance, or implementation of eco-urbanism and sustainable urban development. Participants were categorised into three expert groups to reflect the multidimensional nature of eco-urbanism: (i) Design and Planning Experts: urban planners, architects, landscape architects, environmental engineers, and sustainability consultants directly involved in shaping urban form and infrastructure; (ii) Social and Behavioural Experts: sociologists, anthropologists, environmental psychologists, public health professionals, and community leaders focusing on human behaviour, social equity, and societal interactions within urban environments; (iii) Policy, Economic, and Development Experts: policymakers, economists, urban managers, and real estate developers responsible for regulatory frameworks, financial mechanisms, and implementation processes [5, 66].

Participants were selected based on clearly defined inclusion criteria to ensure that the data reflected informed and credible expert perspectives on eco-urbanism rather than general public opinion. Eligible participants were required to possess at least a bachelor's degree in a relevant discipline, such as urban planning, architecture, engineering, social sciences, environmental studies, or related fields, ensuring a foundational level of academic training. In addition, participants were required to have a minimum of two years of professional or research experience directly related to urban sustainability, eco-urbanism, or closely aligned areas. This requirement was intended to ensure that respondents

had practical or scholarly exposure to sustainability-oriented urban processes and challenges. Furthermore, participants needed to demonstrate familiarity with sustainability, planning, or environmental governance concepts, either through professional practice, policy engagement, or academic research. Individuals who did not meet these criteria were excluded from the study. This exclusion strategy was applied to enhance the validity and reliability of the findings by ensuring that all responses were grounded in expert knowledge and professional experience relevant to eco-urbanism.

3.3 Sampling strategy and sample size

A multistage stratified random sampling technique was employed to ensure proportional representation across the three expert categories. Stratification was necessary to enable meaningful comparisons between professional groups and to reduce sampling bias [67]. The required sample size was calculated using the Raosoft sample size calculator, assuming a 95% confidence level, a 5% margin of error, and a 50% response distribution. This yielded a target sample of 402 respondents. Although the geographic distribution of respondents varied across countries, the study was designed as an exploratory expert-based survey, prioritising disciplinary representation over national proportionality. This approach aligns with established practices in sustainability and urban governance research, where expert accessibility and specialised knowledge often constrain large, nationally representative samples [68–69].

3.4 Instrument design and variable measurement

Data were collected using a structured questionnaire developed through a comprehensive review of the literature on eco-urbanism, sustainable urbanism, and behavioural theory. The instrument was explicitly designed to align with the study's research objectives and theoretical framework, ensuring that it captured the key dimensions of professional engagement with eco-urbanism. The questionnaire comprised four main sections:

i. Demographic and professional characteristics: this section collected information on participants' age, gender, marital status, education level, years of professional experience, country of practice, and expert category. Variables such as age and marital status were included because previous studies in environmental behaviour and sustainability research indicate that demographic and household characteristics can influence environmental attitudes, risk perception, and long-term sustainability preferences. In particular, household structure and family responsibilities may shape individuals' perspectives on long-term environmental quality. In this study, marital status was therefore included solely as a background demographic variable to provide a comprehensive respondent profile and to explore potential variations in attitudes toward eco-urbanism.
ii. Awareness and knowledge of eco-urbanism: participants' familiarity with core concepts, including green infrastructure, low-carbon planning, ecosystem services, and digital sustainability solutions, was assessed to gauge their baseline awareness and understanding.
iii. Drivers of eco-urbanism acceptance: this section examined factors influencing professional acceptance, including environmental values, perceived benefits, institutional support, and social norms, allowing for an assessment of motivators that encourage adoption.

iv. Barriers to implementation: participants were asked to evaluate obstacles to eco-urbanism adoption, such as financial constraints, governance challenges, technical capacity, and social resistance, providing insights into critical impediments to implementation.

Key studies examining environmental planning barriers, sustainability adoption, and eco-urban development frameworks informed the identification of relevant constructs and measurement variables. These studies provided the conceptual foundation for selecting indicators related to financial, institutional, social, technical, and market-related barriers to eco-urbanism adoption. The measurement items were subsequently adapted and refined to suit the context of built environment professionals, including planners, designers, policy experts, and development specialists. Each construct was operationalised through clearly defined statements representing common challenges to the acceptance and implementation of eco-urbanism.

Table 2 presents the measurement items representing the drivers of eco-urbanism acceptance that were derived from a comprehensive review of literature on sustainable urban development, eco-urban planning, and environmental governance. Key studies examining urban sustainability drivers informed the identification of relevant constructs such as urbanisation pressures, policy frameworks, community engagement, technological innovation, and economic incentives. These constructs were translated into questionnaire statements suitable for professionals in planning, design, policy, and development sectors. The items were refined to ensure clarity, relevance, and applicability to the empirical context of the study. Also, Table 3 presents questionnaire items that were developed based on established literature on eco-urbanism, sustainable urban development, and urban planning challenges. It shows the commonly reported challenges to the acceptance and implementation of eco-urbanism, including financial

Table 2 Measurement constructs and variables for drivers of eco-urbanism acceptance

Construct	Measurement variable (questionnaire item)	Relevant studies
Urbanisation and population growth	Rapid urban expansion and population growth increase pressure on infrastructure and create a need for sustainable urban planning approaches	[71]
Community engagement and social inclusion	Active participation of communities and stakeholders in urban planning encourages inclusive and sustainable urban development	[20,72]
Awareness and education on eco-urbanism	Training programmes, public awareness campaigns, and eco-literacy initiatives improve understanding and acceptance of eco-urban principles	[22,33]
Policy and regulatory frameworks	Supportive government policies, urban development regulations, and green building standards promote eco-urbanism adoption	[73]
Environmental sustainability drivers	Environmental concerns such as climate change mitigation, green infrastructure development, and emission reduction initiatives motivate eco-urban practices	[8]
Technological advancements	Adoption of smart city technologies, renewable energy systems, and digital infrastructure supports eco-urban development	[33, 34]
Economic viability and resilience	Perceived long-term economic benefits and cost savings from sustainable investments encourage eco-urban initiatives	[74]
Corporate social responsibility (CSR)	Private sector involvement through sustainability commitments and CSR initiatives supports eco-urban development	[15,21]
International cooperation and knowledge sharing	Global partnerships, policy exchange, and knowledge sharing contribute to the diffusion of eco-urban practices	[71]

Responses were measured using a five-point Likert scale (1 = strongly disagree to 5 = strongly agree)

Table 3 Measurement constructs and variables for challenges to the acceptance and implementation of eco-urbanism

Construct	Measurement variable (questionnaire item)	Relevant studies
Financial constraints	High financial investment is required for developing or retrofitting urban areas to align with eco-urban principles	[75]
Lack of awareness and education	Limited awareness and understanding of eco-urbanism principles among policymakers, planners, and the public	[15]
Regulatory and institutional barriers	Existing regulations and institutional frameworks do not adequately support the integration of eco-urban concepts	[14]
Resistance to change	Stakeholders and residents may resist adopting unfamiliar eco-urban practices due to a preference for conventional urban lifestyles	[76]
Short-term profit orientation	Preference for short-term economic returns discourages investment in eco-urban projects with longer payback periods	[32]
Infrastructure limitations	Existing urban infrastructure is inadequate to support eco-urban systems such as renewable energy and sustainable mobility	[33,77]
Limited technical expertise	Shortage of professionals with specialised knowledge in sustainable design, ecological planning, and renewable technologies	[27]
Social equity concerns	Eco-urban initiatives may create concerns about gentrification or displacement of vulnerable communities	[31]
Cultural and social factors	Cultural norms, social preferences, and behavioural patterns influence acceptance of eco-urban practices	[43]
Perceived inconvenience	Eco-friendly practices such as public transport use or cycling may be perceived as inconvenient	[13]
Market demand and consumer preferences	Limited demand for eco-friendly housing or sustainable services discourages developers from investing in eco-urban projects	[14]
Complexity of system integration	Integration of multiple systems (energy, water, waste, and transport) within eco-urban frameworks is technically complex	[44]

Responses were measured using a five-point Likert scale (1 = strongly disagree to 5 = strongly agree)

constraints, institutional and regulatory barriers, limited technical expertise, infrastructural limitations, and socio-cultural resistance.

Respondents were asked to evaluate each statement using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). This approach ensured that the measurement items were theoretically grounded in existing research while remaining suitable for empirical analysis. The instrument was further expanded to assess participants' perceptions and overall acceptance of eco-urbanism principles, ensuring that the questionnaire captured both cognitive and attitudinal dimensions of professional engagement. Eligible participants were built environment professionals actively engaged in urban planning, design, architecture, engineering, policy-making, economics, or environmental management. To qualify, respondents needed at least two years of professional experience, involvement in roles influencing urban development or sustainability, and voluntary consent to complete the questionnaire. These criteria ensured that participants could provide informed and meaningful insights on eco-urbanism practices.

The study included professionals from multiple countries and regions, covering both developed and emerging urban contexts. This diverse geographic scope enabled the exploration of how regional policies, socio-economic conditions, and urban challenges shaped perceptions, acceptance, and implementation of eco-urbanism principles. The questionnaire was piloted with 20–30 professionals from the target population to evaluate clarity, relevance, and reliability [70]. The pilot assessed item comprehensibility, formatting, and response options, while also calculating internal consistency using Cronbach's alpha. Feedback from the pilot led to minor revisions in item phrasing, section sequencing, and response options, ensuring that the final instrument was valid,

reliable, and user-friendly for the full-scale survey. A summary of questionnaire content and measured variables is provided in Appendix 1, supporting transparency and methodological replication.

3.5 Pilot testing, data collection, and ethical considerations

Prior to full deployment, the questionnaire was pilot-tested with a small group of experts to assess clarity, relevance, and comprehension. Feedback from the pilot phase led to refinements in wording, scale consistency, and item sequencing to enhance face and content validity [31]. Internal consistency was assessed using Cronbach's alpha, yielding $\alpha = 0.90$, indicating excellent reliability for the overall instrument [70]. Data collection was conducted between 3 September and 15 November 2024, using a combination of online and face-to-face survey administration. Online distribution was facilitated through email invitations, professional networks, academic mailing lists, and social media platforms to maximise geographic reach. Face-to-face administration was used to engage participants with limited digital access and to improve response rates within professional settings [67]. Participation was voluntary, and informed consent was obtained before questionnaire completion. Ethical standards were strictly observed, including obtaining informed consent, maintaining anonymity, ensuring confidentiality, and handling data securely. No personal identifiers were collected. The study acknowledges limitations related to self-reported data, potential non-response bias, and uneven geographic representation. Nevertheless, the use of stratified sampling, pilot testing, and robust statistical analysis strengthens the reliability and validity of the findings.

4 Data screening and analysis

Before conducting the main statistical analyses, the collected data were subjected to a comprehensive screening process to ensure accuracy, completeness, and suitability for quantitative analysis [66]. The clean datasets were analysed using SPSS, version 26.0 [70]. Data screening involved several steps, including checking for missing values, outliers, normality, and response consistency [78–79]. Missing data were first identified and assessed for patterns. Cases with substantial missingness were excluded, whereas minor missingness was addressed using appropriate techniques, such as mean imputation or pairwise deletion, to preserve the integrity of the dataset. Outliers were examined using boxplots and z-scores; extreme values were carefully evaluated to determine whether they reflected genuine responses or data-entry errors [80–81]. The normality of continuous variables was assessed using skewness and kurtosis statistics, as well as visual inspection of histograms and Q–Q plots. Variables exhibiting substantial deviation from normality were considered for appropriate transformations or non-parametric tests, depending on the requirements of subsequent analyses [70]. Additionally, data consistency checks were conducted to ensure that responses fell within expected ranges and adhered to the logical structure of the questionnaire. Likert-scale items were reviewed to confirm that all responses conformed to the 1–5 scale, and categorical variables were coded correctly for analysis. This rigorous data screening process ensured that the dataset was clean, reliable, and suitable for further descriptive and inferential statistical analyses, thereby enhancing the validity and robustness of the study's findings.

Descriptive statistics were first employed to summarise respondents' demographic and professional characteristics and to identify general trends in awareness, perceptions,

and acceptance of eco-urbanism principles [36, 38]. Measures such as frequencies, percentages, means, and standard deviations were used to provide an initial overview of the dataset. Subsequently, inferential statistical analyses were conducted to examine differences in perceptions across professional and demographic groups. In addition, correlation analysis was performed to assess the strength and direction of relationships between key variables, including demographic characteristics (e.g., age and educational background) and respondents' awareness of eco-urbanism concepts. Finally, multiple linear regression analysis was conducted to identify the most significant predictors influencing professionals' perceptions and acceptance of eco-urbanism. This approach enabled the assessment of how demographic factors, professional background, and perceived drivers and barriers collectively influence eco-urbanism adoption. Overall, these analytical techniques provided a systematic evaluation of relationships among variables and generated robust empirical insights into the factors shaping expert perspectives on eco-urbanism [70]. The summary of these analyses is presented in Appendix 2 which outlines the main descriptive findings, correlation results, and regression outcomes. This systematic approach ensures reproducibility, transparency, and statistical rigour, providing a clear link between the identified determinants of eco-urbanism adoption and expert perceptions across diverse professional groups [70, 78].

5 Results and discussion

The results of the Measure of Sampling Adequacy (MSA) are presented in Table 4. The reliability and internal consistency of the scale were evaluated using Cronbach's alpha coefficient. The Kaiser–Meyer–Olkin (KMO) value was 0.891, indicating that the sample was adequate for factor analysis. Consistent with the minimum standard of 0.70 suggested by [78]. The overall Cronbach's alpha values of 0.891 and 0.804 obtained in this study confirm the scale's reliability for subsequent statistical analyses, which both fall well within the acceptable thresholds [78–79]. To assess the suitability of the dataset for parametric analyses, normality tests were conducted. Skewness and kurtosis statistics were examined, with the expectation that skewness and kurtosis Z-values should be less than ± 1.96 and that the Shapiro-Wilk *p*-value should exceed 0.05 to indicate normal distribution [70]. The results indicated that 91% of the Z-values fell within the acceptable range, confirming that the dataset satisfied normality assumptions and was suitable for further analysis.

5.1 Respondents' socio-demographic results

A total of 402 respondents participated, comprising 224 females (55.72%) and 178 males (44.27%), as presented in Fig. 5. The higher proportion of female respondents suggests that any findings related to perceptions and acceptance of eco-urbanism may be more reflective of female viewpoints. Efforts to promote eco-urbanism in the built environment might benefit from understanding gender-specific perspectives and addressing any

Table 4 Sampling adequacy

KMO and Bartlett's test		Value
The measure of sampling adequacy		0.891
Sphericity	Chi-Square value	182,051. 807
	Df value	3.6114
	Sig/supported	0.002

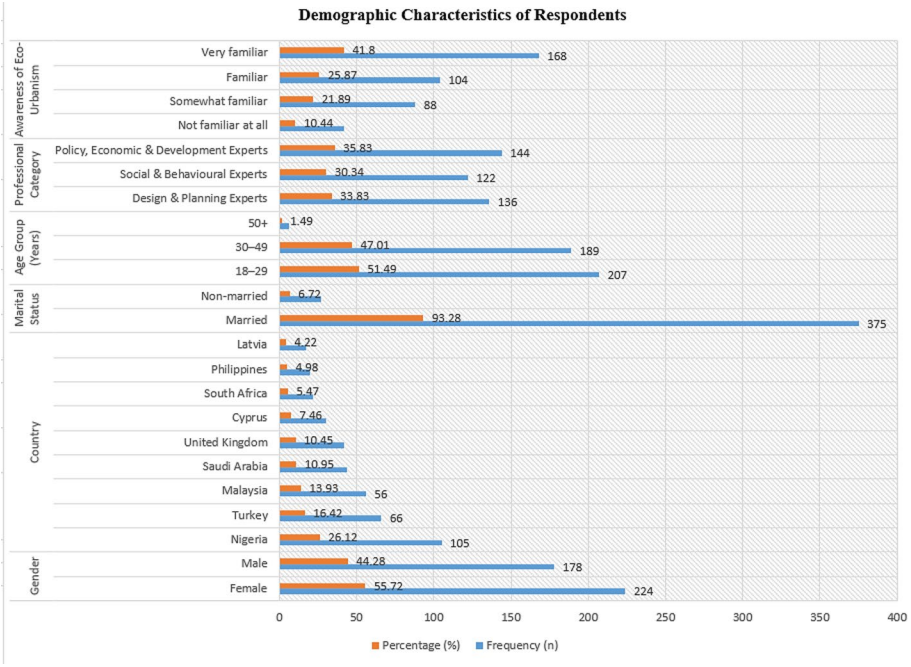


Fig. 5 Demographic characteristics of respondents

differing attitudes or barriers [79, 80]. The sample was internationally diverse, reflecting a wide range of professional perspectives across ten countries. The largest proportion of respondents came from Nigeria, with 105 participants (26.12%), followed by Turkey with 66 respondents (16.42%) and Malaysia with 56 respondents (13.93%). Saudi Arabia contributed 44 participants (10.95%), while the United Kingdom accounted for 42 respondents (10.45%). Other significant contributions came from Cyprus with 30 participants (7.46%), South Africa with 22 participants (5.47%), the Philippines with 20 participants (4.98%), and Latvia with 17 participants (4.23%). This enhances the study's contextual relevance across varying socio-cultural settings. A more thorough grasp of how eco-urbanism ideas are viewed and accepted across many institutional, cultural, and environmental planning frameworks is made possible by this diversity [21, 23]. It also gives insights into how regional variations may affect sustainable urban development methods and enhances the findings' generalizability to larger contexts.

Most respondents are non-married, 27 (6.71%), with only 93.28% being married. Most respondents are non-married (6.71%), while the majority, 375 (93.28%), are married. Given that the majority of experts are married, eco-urbanism initiatives could benefit from focusing on the preferences and lifestyles of married individuals. Programs and communication strategies should be tailored to address the needs and priorities of this demographic, while also considering younger, single professionals as a growing segment in the adoption of eco-urbanism concepts. The respondents are fairly evenly split between the age groups 18–29 (51.49%) and 30–49 (51.49%), with a small fraction (1.49%) being 50 or older. Given the diverse age distribution, eco-urbanism strategies should consider the varying needs and values of both younger and middle-aged experts [17, 18, 19]. Different age groups may have distinct priorities, such as career concerns for younger experts and family or career stability for older ones.

The distributions among experts are design and planning experts 136 (33.83%), social and behavioural experts 122 (30.34%), and policy, economic, and development experts 144 (35.82%). As there is a relatively balanced distribution across experts, eco-urbanism programs should be designed to engage experts at different stages of their professional journey. Tailored initiatives might be needed to address the unique interests and responsibilities of each level. The awareness of eco-urbanism, which varies with 42 (10.44%) not familiar at all, 88 (21.89%) somewhat familiar, 104 (25.87%) familiar, and 168 (41.79%) very familiar. The significant proportion of very familiar experts (41.79%) with eco-urbanism suggests a strong foundation of awareness that can be leveraged to further promote sustainable practices. However, the presence of a sizable group with limited awareness 10.44% indicates a need for educational campaigns to enhance understanding and acceptance among less experienced experts [43, 66]. Efforts should be made to increase overall awareness, perhaps through workshops, seminars, and integration into policy developments. Overall, these demographics highlight the need for targeted, inclusive, and age-appropriate strategies to effectively promote and implement eco-urbanism concepts in the built environment. Understanding these demographic nuances aid in designing more effective sustainability programs that resonate with the diverse professional body.

5.2 Quantitative results

5.2.1 Level of awareness of the eco-urbanism principle among built environment experts

Respondents were asked to assess their level of awareness of eco-urbanism principles using a five-point Likert scale, where 1 = Very Unaware (very little or no knowledge of eco-urbanism), 2 = Somewhat Unaware (having heard of eco-urbanism but with limited understanding), 3 = Neutral (moderate understanding of eco-urbanism concepts), 4 = Somewhat Aware (fairly knowledgeable about eco-urbanism and its impacts), and 5 = Very Much Aware (possessing a deep understanding of eco-urbanism principles and their impacts). Table 5 presents the frequency and percentage distribution of experts' awareness levels across three professional groups: design and planning experts, social and behavioural experts, and policy, economic, and development experts. To derive the percentage values (%), the basic equation used is a standard percentage calculation based on frequency values (f) and the total sample size ($n = 402$):

$$\text{Percentage } \% = \left(\frac{\text{Frequency (f)}}{\text{Total Sample Size}} \right) \times 100 \tag{1}$$

Table 5 Respondents' level of awareness of the eco-urbanism principles of the three levels ($n = 402$)

Frequency of going to green areas	Design and planning experts		Social and behavioural experts		Policy, economic, and development experts	
	Frequency (f)	Percentage (%)	Frequency (f)	Percentage (%)	Frequency (f)	Percentage (%)
Very unaware	4.0	1.0	6.0	1.5	7.0	1.8
Somewhat unaware	8.0	2.0	14.0	3.5	10.0	2.5
Neutral	12.0	3.0	0.0	0.0	5.0	1.3
Somewhat aware'	72.0	18.0	90.0	22.5	82.0	20.5
Very aware'	306.0	76.0	291.0	72.5	297.0	73.9
Total	402	100	402	100	402	100

The percentage distribution of responses was calculated using the same equation across all expert categories and awareness levels. The results show that a substantial proportion of experts demonstrate high awareness of green areas. Specifically, the "Very Aware" category accounts for 76.0% of Design and Planning Experts, 72.5% of Social and Behavioural Experts, and 73.9% of Policy, Economic, and Development Experts. This strong awareness aligns with previous eco-urbanism research indicating that professionals engaged in planning, governance, and sustainability-related fields generally exhibit higher environmental consciousness due to their exposure to sustainability discourse and green planning initiatives [22, 33]. The findings therefore confirm earlier studies suggesting that professional engagement in environmental planning tends to reinforce awareness of ecological assets within urban systems.

Despite this generally high awareness, a slightly higher proportion of "Somewhat Unaware" responses is observed among Social and Behavioural Experts (3.5%) compared with Design and Planning Experts (2.0%) and Policy, Economic, and Development Experts (2.5%). This pattern partly extends existing literature, which suggests that awareness does not always translate uniformly across professional domains within eco-urban governance frameworks [33]. It indicates that knowledge of green infrastructure may vary depending on disciplinary orientation and professional experience, highlighting the need for cross-disciplinary sustainability education.

Neutral responses are most evident among Design and Planning Experts (3.0%), while none are recorded among Social and Behavioural Experts and only a small proportion among Policy, Economic, and Development Experts (1.3%). This distribution supports earlier research emphasising the role of professional training and institutional exposure in shaping environmental perceptions [15, 66]. In eco-urbanism studies, professionals directly involved in spatial planning are often expected to demonstrate strong awareness of green infrastructure, although varying degrees of engagement may still occur depending on institutional contexts.

The presence of small proportions in the "Very Unaware" and "Somewhat Unaware" categories further suggests that awareness levels may fluctuate across professional trajectories. Previous eco-urbanism literature notes that sustained engagement with sustainability concepts often depends on continuous professional development and policy reinforcement rather than initial training alone [15, 26, 66]. In this sense, the present findings extend earlier work by demonstrating that even among expert populations, awareness may weaken without ongoing institutional support.

From a broader eco-urbanism perspective, the overall high awareness observed among experts provides encouraging evidence that professional communities increasingly recognise the importance of green areas in sustainable urban systems. However, consistent with prior studies on eco-urban governance, awareness alone is insufficient to ensure effective implementation of sustainability strategies. Moving forward, eco-urban initiatives should therefore focus not only on awareness but also on strengthening active engagement through practical planning interventions, collaborative projects, and policy integration. Such approaches can help translate professional awareness into tangible actions that support resilient and inclusive eco-urban development.

5.2.2 Variations in attitudes toward eco-urbanism principles across expert groups

Table 6 presents the correlation analysis examining the relationship between experts' attitudes toward eco-urbanism principles and selected demographic characteristics, including gender, age group, marital status, and professional–academic category (design and planning experts; social and behavioural experts; and policy, economic, and development experts). Although the primary objective of this study is to explore expert perceptions of eco-urbanism, demographic variables remain important contextual factors, as previous research has shown that individual characteristics can influence environmental awareness, risk perception, and sustainability-oriented decision-making [79, 80]. The results indicate a statistically significant, moderate positive correlation between gender and attitudes toward eco-urbanism ($r = 0.516$, $p = 0.028$). This finding suggests that gender plays a meaningful role in shaping expert attitudes, with one gender group exhibiting more favourable views toward eco-urban principles. This outcome aligns with earlier studies reporting gender-based differences in environmental concern and pro-environmental behaviour, often attributed to socialisation processes and value orientations [79, 81–82].

Age group exhibited a moderate positive correlation with eco-urbanism attitudes ($r = 0.528$), but this relationship was not statistically significant at the 0.05 level ($p = 0.062$). Similarly, marital status showed a moderate but non-significant positive correlation ($r = 0.463$, $p = 0.074$). These findings suggest that, within this expert sample, age and marital status are not strong or consistent determinants of attitudes toward eco-urbanism. This contrasts with some studies that identify age and family status as influential factors in sustainability preferences [81–82], but may reflect the relatively homogeneous professional backgrounds and narrower age ranges of expert respondents compared with general population samples. More pronounced differences emerged when attitudes were examined across professional–academic expert groups. Among design and planning experts, a weak to moderate positive correlation was observed ($r = 0.329$, $p = 0.032$), indicating a statistically significant but modest association between professional positioning and favourable attitudes toward eco-urbanism. This suggests that while design and planning professionals recognise the relevance of eco-urban principles, their attitudes may be influenced by practical constraints, regulatory environments, or market pressures inherent in professional practice.

In contrast, social and behavioural experts demonstrated a very strong positive correlation with eco-urbanism attitudes ($r = 0.837$, $p = 0.001$), indicating a robust and statistically significant relationship. This finding suggests that experts trained in social, behavioural, and human-centred disciplines are particularly receptive to eco-urban

Table 6 Correlations between the attitudes towards eco-urbanism principles across different demographics

Demographic information							
		Gender	**Age groups**	**Marital status**	**Design and planning experts**	**Social and behavioural experts**	**Policy, economic, and development experts**
Attitudes towards eco-urbanism	Correlation coefficient	**0.516**	**0.528**	**0.463**	**0.329**	**0.837****	**0.820****
	Sig. (2-tailed	0.028	0.062	0.074	0.032	**0.001**	**0.000**
	N	402	402	402	136	122	144

Bold values indicate correlation coefficients that are statistically significant at the 0.01 level

concepts, likely due to their emphasis on social equity, community engagement, and behavioural change—core dimensions of eco-urbanism. Similarly, policy, economic, and development experts exhibited a strong positive correlation ($r = 0.820$, $p < 0.001$), indicating high alignment between governance-oriented expertise and eco-urban sustainability objectives. These patterns are consistent with previous studies showing that higher levels of education and professional specialisation in sustainability-related fields are associated with stronger pro-environmental attitudes and policy support [2, 82]. The particularly strong correlations among social–behavioural and policy-oriented experts highlight the importance of interdisciplinary knowledge in fostering a holistic understanding of eco-urbanism beyond its physical and technological dimensions.

The findings have several implications for education, policy, and professional capacity-building. First, the strong receptiveness observed among social–behavioural and policy experts suggests that these groups can serve as key agents of change in advancing eco-urban agendas. Targeted professional training and leadership development initiatives could leverage their favourable attitudes to support cross-sector collaboration and institutional reform [1, 14, 18]. Second, the significant role of gender indicates the potential value of gender-responsive communication and engagement strategies in promoting eco-urbanism. Tailoring outreach and education efforts to address differential perceptions may enhance inclusivity and broaden support for sustainable urban initiatives [80–82].

Third, the comparatively weaker correlation among design and planning experts underscores the need to strengthen the integration of eco-urbanism principles within technical and professional curricula. Early and continuous exposure to sustainability concepts throughout professional education and training could help bridge the gap between theoretical endorsement and practical implementation [14–16]. Finally, although age and marital status were not statistically significant predictors in this study, they should not be disregarded. Future qualitative and mixed-methods research may reveal more nuanced ways in which life stage and household responsibilities shape professional attitudes toward eco-urbanism. Overall, these results demonstrate that attitudes toward eco-urbanism vary meaningfully across expert groups, reinforcing the importance of differentiated educational, policy, and engagement strategies to support inclusive and effective sustainable urban transitions.

5.2.3 Drivers of eco-urbanism as perceived by experts

The results of the multilinear regression analysis presented in Table 7 provide insight into the key factors shaping experts' acceptance of eco-urbanism and its integration into urban development practice. The analysis identifies six predictors that are statistically significant at varying levels, highlighting the multidimensional drivers influencing eco-urban transitions. Urbanisation and population growth emerged as the most influential predictors of eco-urbanism adoption ($\beta = 1.020$, $t = 6.742$, $p = 0.001$). This finding reflects the intensifying pressures faced by rapidly growing cities, where demand for housing, infrastructure, energy, and services often exceeds available capacity. In such contexts, eco-urbanism is increasingly viewed as a necessary framework for managing growth, mitigating environmental degradation, and ensuring long-term urban sustainability. Without proactive and integrated planning approaches, accelerated urbanisation risks

Table 7 Drivers of eco-urbanism

Drivers of Eco-urbanism			
	Beta	**t**	**Sig.**
[a](Constant)		2.162	0.003
Urbanisation and population growth	1.020	6.742	0.001
Community engagement and social inclusion	0.220	6.152	0.002
Economic viability and resilience factors	0.122	1.022	0.045
Policy and regulatory frameworks	0.174	0.842	0.002
Awareness and education on eco-urbanism	0.321	1.563	0.003
Environmental sustainability drives	0.306	1.720	0.003
Technological advancements	-0.558	6.386	0.001
Corporate social responsibility (CSR)	0.371	1.632	0.068
International cooperation and knowledge sharing	0.306	1.800	0.358

[a]Dependent variable: drivers of eco-urbanism

exacerbating congestion, pollution, resource depletion, and social inequality, reinforcing the urgency of eco-urban strategies [1, 6, 7, 16].

Community engagement and social inclusion also demonstrated a strong and positive influence on the acceptance of eco-urbanism ($\beta = 0.220$, $t = 6.152$, $p = 0.002$). This result underscores the importance of participatory planning processes that actively involve local communities in decision-making. Eco-urban initiatives that reflect community values, cultural identities, and lived experiences are more likely to achieve social legitimacy and sustained adoption. Meaningful engagement not only promotes equity but also strengthens trust between stakeholders, enhancing the long-term effectiveness of sustainability interventions [15, 16, 82]. Awareness and education related to eco-urbanism were significant predictors ($\beta = 0.321$, $t = 1.563$, $p = 0.003$), reaffirming the role of knowledge in shaping pro-sustainability attitudes and behaviours. Respondents recognised that informed professionals and citizens are more inclined to support eco-urban policies, adopt environmentally responsible practices, and advocate for systemic change. This highlights the importance of public awareness campaigns, professional training, and the integration of sustainability concepts into formal education as foundational enablers of eco-urbanism [14, 16, 82].

Policy and regulatory frameworks were also associated with eco-urbanism acceptance ($\beta = 0.174$, $t = 0.842$, $p = 0.002$). This finding emphasises the central role of governance in translating sustainability principles into practice. Clear regulations, supportive policy instruments, and enforceable standards provide the institutional structure needed to incentivise sustainable development, reduce uncertainty, and ensure accountability. Effective governance mechanisms, therefore, serve as critical bridges between eco-urban theory and implementation [14, 16, 82]. Environmental sustainability drivers were likewise significant ($\beta = 0.306$, $t = 1.720$, $p = 0.003$), reinforcing the foundational ecological rationale of eco-urbanism. Protecting natural systems, reducing pollution, conserving resources, and enhancing biodiversity remain core motivations for adopting eco-urban approaches. This result confirms that ecological priorities continue to underpin expert support for sustainable urban planning, consistent with resilience and systems-based perspectives on urban development.

In contrast, technological advancement exhibited a significant but negative coefficient ($\beta = -0.558$, $t = 6.386$, $p = 0.001$). Although technology is commonly portrayed as a key enabler of eco-urbanism, this finding suggests a more nuanced expert perspective. Over-reliance on technological solutions, particularly when poorly adapted to local

contexts or implemented without adequate social and institutional support, may undermine sustainability outcomes. This result implies that technology alone is insufficient and must be integrated within broader social, ecological, and governance frameworks to be effective [26–27, 61]. The analysis also identified three predictors that were not statistically significant. Economic viability and resilience factors, while approaching significance ($\beta = 0.122$, $t = 1.022$, $p = 0.045$), did not emerge as dominant drivers, suggesting that respondents may perceive them as longer-term or secondary considerations rather than immediate motivators. Corporate Social Responsibility (CSR) was also non-significant ($\beta = 0.371$, $t = 1.632$, $p = 0.068$), indicating that isolated corporate initiatives may have limited influence without complementary policy frameworks and community engagement. International cooperation and knowledge sharing showed the weakest relationship ($\beta = 0.306$, $t = 1.800$, $p = 0.358$), implying that global networks, while valuable, may not directly shape local eco-urbanism practices as perceived by experts.

Taken together, these findings carry important implications for urban planning and sustainability governance. First, managing the pressures of urbanisation and population growth must remain a central priority, requiring integrated land-use planning, sustainable transport systems, and resource-efficient urban design [71]. Second, strengthening community engagement is essential to ensure that eco-urban initiatives are socially inclusive, contextually relevant, and broadly supported. Third, expanding education and awareness initiatives can cultivate a culture of sustainability and empower stakeholders to participate meaningfully in eco-urban transitions [14–16]. Fourth, robust and coherent policy frameworks are necessary to provide institutional support, incentives, and enforcement mechanisms for sustainable urban development [71]. Finally, while technological innovation remains important, its role must be carefully balanced. Rather than serving as a standalone solution, technology should complement social participation, ecological priorities, and effective governance. The negative association observed in this study highlights the need for context-sensitive, people-centred applications of technology in eco-urbanism. Overall, these results align with prior research emphasising the roles of urbanisation, community engagement, education, and governance in sustainability transitions [2, 60, 71], while also contributing new insight into the conditional and potentially limiting role of technology in eco-urban development. The findings relate to the broader context of emerging digital intelligence and AI-driven urban sustainability frameworks. Increasingly, eco-urban development is supported by digital technologies that enhance environmental monitoring, resource management, and sustainability governance. The integration of AI-based systems enables cities to collect and analyse large volumes of environmental data, thereby improving the capacity of planners and policymakers to respond to ecological challenges and support sustainable urban development [5, 15, 27].

5.2.4 Potential barriers to the widespread acceptance and implementation of eco-urbanism

This section examines the key barriers constraining the acceptance and implementation of eco-urbanism, as ranked by respondents using the Relative Importance Index (RII) (Table 8). The findings reveal that eco-urban transitions are impeded by a combination of financial, infrastructural, institutional, and socio-cultural challenges, underscoring the complexity of advancing sustainable urban development. Financial constraints emerged as the most critical barrier ($RII = 0.89$, $Rank = 1$), reflecting the high upfront costs

Table 8 Barriers to acceptance and implementation of eco-urbanism

S/*N*	Barriers	*N*	Mean	Std. Error	Std. Dev.	Skewness	Kurtosis	RII	Rank
1.	Financial constraints	402	3.853	0.093	1.231	-0.542	-0.765	0.85	1st
2.	Lack of awareness and education about eco-urbanism	402	3.850	0.082	1.544	-0.312	-0.396	0.83	4th
3.	Regulatory and policy gaps are hindering implementation	402	3.005	0.036	1.344	−0.176	0.288	0.80	5th
4.	Resistance to change traditional urban practices	402	3.106	0.046	1.468	−0.105	0.347	0.88	2nd
5.	Limited availability of eco-friendly infrastructure	402	3.691	0.067	1.066	−0.089	0.389	0.73	6th
6.	Infrastructure limitations	402	3.758	0.097	1.704	−0.061	0.3,53	0.89	1st
7.	Limited technical expertise	402	3.457	0.057	1.348	−0.100	0.362	0.73	7th
8.	Rapid urbanisation and insufficient planning	402	3.468	0.049	1.655	−0.069	0.410	0.72	8th
9.	Cultural and social factors	402	3.668	0.332	1.523	−0.059	0.405	0.71	9th
10.	Lack of green spaces and recreational areas	402	3.804	0.059	1.655	−0.062	0.308	0.87	3rd
11.	Market demand and consumer preferences	402	3.348	0.062	1.523	−0.092	0.887	0.70	10th
12.	Complexity of integrating systems	402	3.355	0.052	1.523	-0.043	0.765	0.75	12th

associated with eco-urban interventions such as green infrastructure, renewable energy systems, and sustainable construction technologies. Limited public budgets, restricted access to financing, and uncertain returns on investment often delay or discourage the adoption of eco-urban initiatives. Closely linked to this challenge are infrastructure limitations (RII = 0.89, Rank = 1), particularly in cities with outdated or inadequate systems that are incompatible with sustainability standards. Retrofitting existing infrastructure to support eco-urban practices is both capital-intensive and logistically demanding, further compounding financial pressures.

Resistance to change from traditional urban practices ranked as the second most significant barrier (RII = 0.88). This resistance reflects institutional inertia and behavioural reluctance among policymakers, developers, and communities who may perceive eco-urban approaches as risky, complex, or disruptive to established development models. Such resistance highlights the behavioural and governance dimensions of eco-urbanism, complementing the structural challenges identified above. The lack of green spaces and recreational areas (RII = 0.87, Rank = 3) was also identified as a major constraint. Green infrastructure is central to eco-urbanism, providing ecosystem services, enhancing environmental quality, and improving physical and mental well-being. Urban contexts with limited green space face structural disadvantages in implementing eco-urban principles effectively. Similarly, insufficient awareness and education regarding eco-urbanism (RII = 0.83, Rank = 4) constrain stakeholder support and participation. Without adequate knowledge of the environmental, social, and economic benefits of eco-urbanism, both professionals and the wider public are less likely to engage with or advocate for sustainable urban initiatives.

Regulatory and policy gaps (RII = 0.80, Rank = 5) further hinder implementation by creating uncertainty and weakening institutional support for eco-urban projects. Inconsistent regulations, fragmented governance, and the absence of clear sustainability mandates can deter investment and slow adoption. Limited technical expertise (RII = 0.73, Rank = 7) was also identified as a notable barrier, indicating a shortage of specialised

skills in sustainable design, construction, and systems integration required for eco-urban development. At the broader urban scale, rapid urbanisation combined with insufficient planning (RII = 0.72, Rank = 8) presents a structural challenge, particularly in fast-growing cities where development pressures outpace planning capacity. Cultural and social factors (RII = 0.71, Rank = 9), including prevailing norms, values, and behaviours, may also conflict with sustainability goals, reducing public acceptance of eco-urban practices. Market demand and consumer preferences (RII = 0.70, Rank = 10) play a complementary role, as low demand for sustainable products and services can discourage private-sector investment. Additionally, the complexity of integrating multiple eco-urban systems, such as energy, transport, water, and green infrastructure, was identified as a further constraint (RII = 0.75, Rank = 12), reflecting the technical and managerial challenges of coordinating interdisciplinary solutions.

Collectively, these barriers have important implications for urban sustainability policy and practice. First, addressing financial and infrastructural constraints requires increased and diversified investment from both public and private sectors, including innovative financing mechanisms. Second, expanding education, awareness, and capacity-building initiatives is essential to strengthening understanding, reducing resistance to change, and building professional expertise. Third, regulatory reform and coherent policy frameworks are necessary to provide clear guidance and incentives for eco-urban implementation. Fourth, meaningful community engagement can help overcome socio-cultural resistance by fostering trust, inclusivity, and shared ownership of sustainability goals. Finally, targeted technical training and professional development programmes are needed to equip stakeholders with the skills required to manage the complexity of eco-urban systems.

The barriers identified in this study are consistent with findings in the existing literature. Financial constraints and infrastructure limitations have been widely reported as dominant obstacles to sustainable urban development [24, 25, 75]. Resistance to change and lack of awareness are also frequently cited as key challenges, reinforcing the importance of education and stakeholder engagement [32, 76]. Regulatory and policy gaps remain persistent impediments across diverse contexts, highlighting the central role of effective governance [14, 33, 5]. Similarly, limited technical expertise and the pressures of rapid urbanisation are recurring themes, emphasising the need for skilled professionals and proactive planning [35, 65, 73]. Although cultural and social factors are less commonly foregrounded, growing evidence suggests they play an increasingly important role in shaping urban sustainability outcomes [31, 43].

6 Contributions of the study to sustainable urban development

This study makes several substantive contributions to both the theory and practice of sustainable urban development, as summarised in Fig. 6. First, it advances a multidisciplinary understanding of eco-urbanism by systematically disaggregating expert perceptions across three professional domains: design and planning, social and behavioural sciences, and policy, economic, and development practice. This approach moves beyond treating expert opinion as a homogeneous construct and instead reveals profession-specific patterns of awareness, motivation, and constraint that are critical for the effective operationalisation of eco-urban principles. Second, the study provides robust empirical evidence on levels of awareness, perceived drivers, and barriers shaping eco-urbanism



Fig. 6 Study's contributions to sustainable urban development

adoption. These findings directly address a gap in the literature, which has largely prioritised spatial, technological, and performance-based outcomes while paying limited attention to the perceptions and decision-making processes of the professionals responsible for implementation. By foregrounding expert attitudes and institutional conditions, the study generates actionable insights for the design of targeted capacity-building initiatives, professional training programmes, and governance frameworks.

Third, the study contributes to theory-building in sustainable urban research by identifying key predictors of eco-urbanism acceptance and situating them within the Theory of Planned Behaviour (TPB). The results demonstrate how attitudes toward eco-urbanism, perceived behavioural control, and professional norms (subjective norms) jointly shape experts' willingness to support and implement eco-urban strategies. This empirical grounding refines existing conceptual models linking professional knowledge, behavioural intention, and sustainability-oriented urban practices. In the context of eco-urbanism, digital intelligence can significantly enhance the effectiveness of environmental management strategies. AI-enabled tools can assist in monitoring ecological resources, predicting environmental pressures, and optimising urban infrastructure to minimise ecological impacts. These technological capabilities support the development of more resilient and adaptive urban systems capable of balancing economic development with environmental sustainability [26–27, 61].

Importantly, the findings are framed within the broader objectives of eco-urbanism, which encompasses economic revitalisation, material efficiency and recycling, public participation, environmental awareness, and social equity. These objectives closely align with the United Nations Sustainable Development Goals, particularly SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action). The study further reinforces the role of green infrastructure, low-impact urban design, sustainable mobility, and renewable energy integration as core components of eco-urbanism that contribute to SDG 3 (Good Health and Well-being), SDG 7 (Affordable and Clean Energy), and SDG 15 (Life on Land). Finally, the study offers practical value for policymakers and urban practitioners by identifying enabling

conditions for eco-urbanism implementation. In particular, it highlights financial support mechanisms, regulatory clarity, and institutional incentives as critical levers for strengthening perceived behavioural control and accelerating the mainstreaming of eco-urban principles within urban development processes. Collectively, these contributions position the study as a bridge between behavioural theory, sustainability frameworks, and applied eco-urban policy and practice.

7 Conclusion and recommendations

The study reveals that awareness, perceptions, and acceptance of eco-urbanism principles differ significantly across professionals in the built environment, including urban planners, designers, social and behavioural experts, and policy and economic specialists. Adoption of eco-urbanism is influenced by multiple interrelated drivers, such as urbanisation pressures, supportive policy and regulatory frameworks, advances in technology, environmental sustainability imperatives, and active community engagement in planning processes. These factors highlight that eco-urbanism adoption is not solely a technical or design-oriented challenge, but also a socially embedded process that requires multi-stakeholder participation and inclusive governance. Despite these drivers, several barriers continue to hinder effective implementation. Financial constraints, limited institutional capacity, insufficient technical expertise, resistance to change, and regulatory gaps remain significant obstacles. Additionally, professional attitudes, perceived behavioural control, and prevailing social norms play a crucial role in shaping support for eco-urban initiatives.

This underscores that behavioural and perceptual factors are equally critical alongside structural, technical, and policy considerations in promoting sustainable urban transitions. Overall, advancing eco-urbanism in contemporary cities requires a comprehensive approach that integrates supportive policies, financial mechanisms, technical capacity-building, and active social participation to overcome both structural and perceptual barriers. Addressing these factors will enhance the practical implementation of eco-urbanism principles and contribute to resilient, sustainable, and inclusive urban development. Based on these insights, the following recommendations (Table 9) are proposed for policymakers, urban planners, and other stakeholders. In light of these developments, the integration of digital intelligence within eco-urban planning represents a significant opportunity for advancing sustainable urban systems. By combining traditional ecological planning principles with analytical capabilities, cities can develop more responsive and data-driven strategies for managing environmental resources and promoting sustainable development. Consequently, incorporating intelligent technologies into eco-urban frameworks can strengthen sustainability governance, enhance environmental monitoring, and support long-term urban resilience.

Future research should focus on comparative studies across different regions and governance systems, the role of emerging technologies in eco-urban transitions, and the behavioural drivers of public engagement. Understanding these factors will support the design of adaptive, inclusive, and widely supported eco-urban interventions capable of addressing contemporary urban sustainability challenges.

Table 9 Summary of the policy and practice recommendations for enhancing eco-urbanism adoption

Recommendation area	Specific actions	Expected outcome
Financial support	Implement public–private partnerships, green bonds, targeted subsidies, and environmental levies	Reduce investment risks and expand funding for eco-urban projects
Education & capacity building	Strengthen professional training programmes, workshops, and university curricula on sustainable urban development	Enhance technical expertise, institutional capacity, and professional readiness
Public awareness & engagement	Conduct awareness campaigns, community workshops, and participatory planning initiatives	Increase community support, social inclusion, and stakeholder engagement in eco-urban projects
Policy & regulatory frameworks	Reinforce regulations, close policy gaps, and provide clear guidelines for sustainable urban planning	Ensure consistent application of eco-urban principles and reduce implementation bottlenecks
Innovation & technology	Promote smart city solutions, green infrastructure, and circular economy approaches	Facilitate the adoption of innovative and scalable eco-urban solutions
Monitoring & evaluation	Establish performance indicators, audits, and feedback mechanisms	Track progress, improve accountability, and adapt strategies for long-term sustainability

Author contributions
OP-A : Conceptualisation, Methodology, Formal analysis, Software, Validation, Visualisation, Writing- Original Draft, Writing-Reviewing & Editing. IT : Methodology, Validation, Visualisation, Supervision, Writing- Reviewing & Editing. AA : Visualisation, Writing- Reviewing & Editing. Validation.

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Data availability
The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
Ethical approval for this study was waived by the Istanbul Gelisim University Ethics Committee in accordance with institutional requirements, applicable national guidelines, and the ethical principles outlined in the Declaration of Helsinki for research involving human participants. The study involved non-invasive and anonymous data collection with no personally identifiable information obtained from participants. All participants were informed about the purpose of the study and provided informed consent prior to participation. Participation was entirely voluntary, and respondents retained the right to withdraw from the study at any stage without consequence. The research posed minimal ethical risk and complied with accepted ethical standards and regulations governing qualitative and social science research.

Competing interests
The authors declare no competing interests.

Consent to publish
Not applicable.

Clinical Trial Number
Not applicable.

Appendix 1
Summary of the questionnaire development and variables measurements.

Sections	Constructs	No. of items	Scales	Sources
Four (4) Sections				
1.	Demographic and other socio-economic variables	Multiple	Nominal & Ordinal	Researchers' compilations
2.	Respondents' level of awareness of eco-urbanism	One (1)	5-point Likert scale ranging from '1'"Not Aware at all" to '5'"Very aware.	Researchers' compilations
3.	Respondents' rating of indicators of drivers of eco-urbanism acceptance	Nine (9)	5-point Likert scale from '1' = strongly disagree; '5' = strongly agree	Researchers' compilations
4.	Respondents' rating of perceived challenge/barriers to acceptance and implementation of eco-urbanism	Twelve (12)	5-point Likert scale Likert scale from '1' = strongly disagree; '5' = strongly agree	Researchers' compilations

Appendix 2
Summary of the statistical tools adopted and their significance.

Research objectives	Statistical tools	Detailed tools employed	Significance
Objective 1: To assess the level of awareness and perceptions of eco-urbanism principles among built environment professionals across diverse disciplinary backgrounds	Descriptive statistics	Frequencies, percentages, means, and standard deviations	These statistics summarised respondents' awareness levels and perceptions of eco-urbanism principles, providing an overall profile of knowledge and attitudes across different professional groups
Objective 2: To identify and analyse the key drivers that promote the acceptance and adoption of eco-urbanism in professional practice	Inferential statistics	Multiple linear regression analysis	This analysis identified significant predictors of eco-urbanism acceptance, enabling the quantification
Objective 3: To examine the major barriers constraining the implementation of eco-urbanism principles	Descriptive and inferential analysis	Mean ranking analysis; regression modelling	These methods helped identify and rank the most critical barriers while determining their statistical influence on eco-urbanism implementation
Objective 4: To evaluate the influence of demographic and professional characteristics on attitudes toward eco-urbanism adoption.	Correlation analysis	Pearson correlation coefficients	Examining the strength and direction of relationships between demographic variables (age, education, professional experience, and discipline) and attitudes toward eco-urbanism adoption
Measurement reliability and validity	Reliability and validity testing	Cronbach's Alpha; Kaiser–Meyer–Olkin (KMO) Measure; Bartlett's Test of Sphericity	These tests confirmed the internal consistency and construct validity of the questionnaire items used to measure awareness, perceptions, drivers, and barriers
Statistical significance testing	Significance testing	p-value threshold set at $p < 0.05$	This ensured robust interpretation of the statistical relationships and confirmed whether the observed associations were statistically significant

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