Journal of Urban Development and Smart Cities
2025, 2(1), 259-270

ACTIVE MOBILITY AND HUMAN-SCALE URBAN DEVELOPMENT IN SMART CITIES: AN ECOSYSTEMIC URBANISM FRAMEWORK FOR PLANNING, PUBLIC SPACE, AND SOCIAL COHESION

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Urban development in the twenty-first century is increasingly defined by a dual challenge: cities must absorb continued demographic growth while reducing environmental burdens and restoring the social value of public space. A human-scale response to this challenge is found in active mobility (AM), understood as walking and cycling supported by appropriate urban form, public infrastructure, and digital coordination. This article presents a structured conceptual synthesis of AM through the framework of ecosystemic urbanism (EU), positioning the discussion squarely within the concerns of urban development and smart-city governance. The analysis draws on the four principal axes of EU—compactness and functionality, complexity, efficiency, and social cohesion—and the seven contrasting binomials that clarify the tensions between sustainable and car-dependent urbanization. The paper further integrates the five levels of walking needs (feasibility, accessibility, safety, comfort, and pleasurability) and the four social facilitators of meaning-making in movement (breadth of experience, identity expression, pausability, and collaborative creativity). The synthesis shows that active mobility supports compact urban forms, reduces sprawl, improves multimodal accessibility, strengthens environmental performance, and expands opportunities for social exchange. It also demonstrates that digital tools can amplify the benefits of AM through hyperconnectivity and last-mile coordination, provided they are anchored in equitable and legible public space. By reframing active mobility as an urban development strategy rather than a narrow transport option, the article offers a coherent planning argument for neighborhood regeneration, public-space reallocation, climate resilience, and inclusive smart-city transformation.

Index Terms — active mobility; ecosystemic urbanism; smart cities; urban development; human-scale urbanism; public space; social cohesion; sustainability

https://doi.org/10.66033/judsc2025-225

INTRODUCTION

Urban development is now inseparable from the global urban transition. According to the source literature, 56% of the world population currently lives in cities, and this proportion is expected to reach 68% by 2030. At the same time, cities occupy only 3% of the Earth's surface yet account for roughly 70% of carbon emissions [1]. These figures frame an unmistakable planning problem: urban growth is concentrating people, infrastructure demand, and environmental risk into a shrinking spatial footprint.

This pressure is especially acute in rapidly urbanizing contexts, where the pace of growth often outstrips institutional capacity and infrastructure provision. The source article notes that only 83 cities had more than one million inhabitants in 1950, whereas 508 cities now exceed that threshold, with most recent growth concentrated in developing countries [1]. Under these conditions, mobility is not simply a technical transport matter. It is a structuring force in land use, access to services, social equity, urban metabolism, and the lived experience of public space.

The dominant urban mobility paradigm remains heavily shaped by private motorized transport. In many cities, automobiles occupy almost 60% of public space, generating congestion, poor air quality, safety risks, social segregation, and the erosion of civic use in streets and squares [1]. Even the substitution of internal-combustion vehicles with electric or autonomous vehicles leaves the deeper urban problem largely unresolved, because car dependence still promotes dispersion, extensive road infrastructure, and competition for scarce public space.

Within this context, active mobility (AM)—walking and cycling—offers a more fundamental urban response. The source article presents AM as an opportunity to change the paradigm of the dispersed, competitive city by restoring the centrality of human movement, proximity, public-space occupation by people rather than vehicles, and a more sustainable urban metabolism [1]. Rather than approaching AM as a marginal transport mode, this paper treats it as a strategy for urban development and smart-city transformation.

To sharpen that argument, this article organizes the discussion through the framework of ecosystemic urbanism (EU), which conceptualizes the city as an open, interdependent system structured by four axes: compactness and functionality, complexity, efficiency, and social cohesion [1, 2, 5, 9]. This framing is particularly well aligned with the scope of the *Journal of Urban Development and Smart Cities*, because it directly engages urban form, accessibility, digital mediation, public-space design, environmental performance, and neighborhood-scale inclusion.

The paper advances three objectives:

1. to present a coherent urban-development framing of active mobility suitable for smart-city planning;
2. to synthesize the relationship between AM and the four EU axes using the source article's conceptual structure; and
3. to translate the source paper's key insights into clear planning implications for urban regeneration, accessibility, and inclusive public-space governance.

ACTIVE MOBILITY AS AN URBAN DEVELOPMENT STRATEGY

From transport mode to urban condition

The source study defines active mobility as displacement powered by human energy, especially walking and cycling [1]. This definition is simple, but its planning implications are not. Walking and cycling are not merely alternatives to motorized travel; they are modes whose viability depends on the spatial organization of the city, the continuity of the public realm, the distribution of amenities, and the degree to which citizens can safely and meaningfully inhabit urban space.

In pre-industrial cities, walking was not only functional but social and cultural. Streets served as sites of exchange, encounter, and identity formation. Industrial urbanization, and later automobile-centered planning, transformed this relationship by prioritizing speed, distance, and circulation over interaction, thereby contributing to sprawl, congestion, and the decline of shared civic space [1, 3, 4]. In contrast, AM restores proximity and embodied movement, bringing transport back into the domain of human-scale urban life.

The source article identifies two inseparable components in the interaction between the city and AM:

1. a **spatial component**, referring to the physical setting that can facilitate, limit, or motivate movement; and
2. a **social component**, referring to the interactions, perceptions, and shared meanings that emerge while moving through urban space [1, 7].

This duality is crucial for urban development. Cities that support active mobility do not merely install sidewalks or bike lanes; they cultivate environments where movement is feasible, legible, comfortable, socially generative, and integrated with everyday destinations.

Walking needs and socio-spatial facilitators

A major strength of the source article is its synthesis of the five levels of walking needs from Alfonzo and the social facilitators of walking from Demerath and Levinger. These concepts provide an analytically rich basis for planning decisions because they connect physical design to lived urban experience [1, 6, 7].

Together, these concepts shift the conversation from infrastructure quantity to urban quality. They explain why a nominal pedestrian route may still fail if it is unsafe, discontinuous, stressful, monotonous, or detached from meaningful destinations. They also clarify why AM is especially relevant to urban development: the success of walking and cycling depends on land-use mix, public-space design, green integration, visual continuity, and social inclusion.

ECOSYSTEMIC URBANISM AS A SMART-CITY FRAMEWORK

The four axes of ecosystemic urbanism

The EU framework treats the city as an open system whose sustainability depends on the interaction of four axes: compactness and functionality, complexity, efficiency, and social cohesion [1, 2]. The source article notes that this holistic and systemic model has been applied in Spain, including Barcelona, Vitoria-Gasteiz, and Linares, and presents it as a useful lens for rethinking mobility, land use, and public-space governance [1].

Table 1: Core socio-spatial foundations of active mobility

Concept	Planning significance
Feasibility	Basic viability of the trip; shaped by time, physical condition, caregiving responsibilities, and the practical possibility of undertaking movement.
Accessibility	Availability, quality, and proximity of destinations, networks, and opportunities; includes spatial, social, and psychological dimensions.
Safety	Perceived and actual exposure to crime, conflict, and threatening urban conditions; directly linked to design, visibility, maintenance, and social presence.
Comfort	Environmental ease, convenience, and physiological and psychological harmony between the user and the setting.
Pleasurability	Enjoyability of movement; strengthened by diversity, complexity, nature, architecture, and the presence of other people and activities.
Permeability	Physical and visual ability to move through the network without excessive barriers or detours.
Breadth of experience	Richness of sensory and social stimuli encountered while moving.
Identity expression	Capacity for direct recognition, communication, and face-to-face interaction in public space.
Pausability	Ability to stop and resume movement, increasing the potential for interaction, reflection, and spontaneous use of space.
Collaborative creativity	Capacity of movement in public space to generate improvisation, social experimentation, and informal collective behavior.

The first five rows synthesize the hierarchy of walking needs; the latter five capture socio-spatial facilitators of meaning-making in movement.

Table 2: Ecosystemic urbanism axes and their urban-development meaning

Axis	Urban-development meaning
Compactness and functionality	Concerns the physical structure of the city, the relationship between built volume and public space, and the proximity among uses and functions.
Complexity	Refers to organizational richness, diversity of functions and legal entities, biodiversity, and the exchange of information within the urban system.
Efficiency	Addresses urban metabolism, including material, water, and energy flows, and seeks autonomy with minimal ecological disruption.
Social cohesion	Focuses on social mix, inclusion, public participation, equitable access, and the stabilizing role of diverse communities in urban life.

For urban development practice, the relevance of EU is immediate. It links transport to land use, energy, biodiversity, and social equity, thereby avoiding the fragmentation that often characterizes sectoral planning. It is also particularly appropriate for smart-city debates because it does not reduce “smartness” to technology alone; instead, it situates digital tools within a broader ecological and civic structure.

The seven contrasting binomials

The source article strengthens the EU model by organizing it through seven contrasting binomials that clarify the tensions between sustainable and unsustainable urban trajectories [1]. These binomials function as an effective diagnostic and didactic device for urban analysis.

Table 3: Contrasting binomials used to interpret AM within ecosystemic urbanism

Binomial	**Planning tension addressed**
Compactness vs. dispersion	Whether urban form reduces distances and supports proximity or produces sprawl and long travel requirements.
Accessibility vs. private mobility	Whether the city prioritizes access to people and rights or privileges vehicles and speed.
Self-provided energy vs. dependence	Whether mobility systems minimize external energy dependence and environmental burden.
Hyperconnectivity vs. disconnection	Whether digital and physical systems enable information-rich, multimodal access or deepen isolation and exclusion.
Urban green vs. urban grey	Whether public space integrates nature, shade, biodiversity, and comfort or is dominated by hard infrastructure and vehicles.
Social cohesion vs. social exclusion	Whether mobility and public space support diverse coexistence or reinforce separation and competitive territorial logic.
Equity vs. disparity in access to amenities	Whether services and infrastructure are distributed in ways that support inclusion across neighborhoods and social groups.

These binomials make the manuscript especially suitable for urban development scholarship because they connect everyday mobility to structural planning questions: land-use mix, infrastructure allocation, climate adaptation, accessibility justice, and the governance of public space.

ACTIVE MOBILITY ACROSS THE FOUR AXES OF ECOSYSTEMIC URBANISM

Compactness and functionality

The source article identifies compactness and functionality as the EU axis most directly connected to mobility in the original Rueda formulation [1]. In compact urban environments, the proximity of homes, workplaces, schools, commerce, and services shortens travel distances and increases the practical viability of walking and cycling. The source text explicitly links this logic to the 15-minute city, using Paris as a contemporary example of proximity-centered urbanism [1, 8].

Compactness does more than shorten trips. It also supports more efficient public transportation and stronger multimodality, allowing AM to serve as the local and interstitial layer of a broader mobility system. In this sense, active mobility and compactness are mutually reinforcing: compact form makes AM viable, and greater AM use intensifies public-space occupation by people rather than cars, encouraging denser and more socially productive urban activity.

The source paper also emphasizes the inverse relationship between active mobility and dispersion. Dispersed urbanization increases dependence on the automobile, expands mono-functional areas, consumes land for transit and parking, and deepens social exclusion by separating people from services and opportunities

[1]. This observation is central to urban development because it reframes sprawl not merely as a land-use inefficiency but as a mobility and access crisis.

A further planning insight emerges from the article's discussion of accessibility versus private mobility. Accessibility is defined not only as overcoming physical distance but as enabling the exercise of urban rights through appropriate space, opportunities, and individual capacity [1]. A city dominated by private mobility becomes dysfunctional because it prioritizes vehicle throughput over the accessibility of citizens. This is highly relevant to neighborhood regeneration: reallocating street space, improving permeability, and linking active routes to transit and public amenities directly strengthens the functional dimension of urban development.

Efficiency

The efficiency axis is grounded in urban metabolism: the flows of materials, water, energy, and emissions that sustain city life [1, 2]. Within this frame, AM is not merely low-carbon; it is structurally efficient because it relies primarily on human energy, occupies far less space, and reduces dependence on energy-intensive infrastructures.

The source article provides a particularly strong empirical contrast: cycling around the city is reported to require 25 times less energy than public transport and 53 times less energy than driving a car [1]. This is one of the most concrete quantitative points in the source literature, and it powerfully supports the argument that active mobility should be treated as a central urban development tool rather than a secondary lifestyle choice.

The efficiency contribution of AM unfolds in several ways:

1. it reduces direct external energy demand in everyday displacement;
2. it lowers the need for spatially extensive car infrastructure;
3. it improves air quality and reduces emissions;
4. it supports multimodality by complementing public transport for short and last-mile trips; and
5. it aligns with climate mitigation and adaptation goals through lower heat, noise, and pollution burdens in public space.

The source article also makes an important conceptual distinction: even electric cars remain dependent on externally supplied energy and on infrastructures that preserve automobile-centered urban form [1]. Thus, the urban development question is not only what powers vehicles, but what kind of city a mobility system reproduces.

Complexity

The source article identifies complexity as the EU category with the greatest number of conceptual connections to AM [1]. This is a major finding and should be placed at the center of any urban-development interpretation of the manuscript. Complexity, in this context, refers to the diversity of uses, actors, institutions, biodiversity, and informational exchange that create a rich and resilient urban ecosystem.

Active mobility supports complexity because it allows people to move slowly enough to perceive, use, and connect diverse urban elements. Walking and cycling increase the probability of encountering services, other people, green spaces, and spontaneous stimuli. The source paper argues that this richness of experience increases information exchange, creativity, and urban interaction, particularly where mixed land uses and spatial continuity are present [1].

Two contrasting binomials are especially important here.

Hyperconnectivity vs. disconnection. The source article explicitly links smart-city technologies to AM through platforms such as Uber, Cabify, Google Maps, Waze, TripAdvisor, Foursquare, and food-delivery applications [1]. These tools improve access to information, support multimodality, and help organize last-mile travel. When properly integrated, they reduce the need for personal vehicle ownership, save time, decrease parking demand, and strengthen social interaction.

However, the article also warns that unequal access to technology, long distances, and the isolating effects of speed can create disconnection. In urban development terms, this means that digital smartness cannot compensate for structurally poor urban form. Digital coordination is most beneficial where public space is already accessible, legible, and safe.

Urban green vs. urban grey. The source paper treats the presence of nature in the city as a symptom of complex organization [1]. Green infrastructure supports biodiversity, CO_2 absorption, soil regeneration, climate balance, and biophilic urban experience. For AM specifically, trees and vegetation provide shade, reduce the urban heat island effect, improve thermal comfort, support stormwater management, and make walking and cycling more attractive and resilient in extreme weather.

By contrast, urban grey—roads, parking lots, and hard infrastructures oriented toward automobiles—reduces social interaction, weakens sensory richness, and diminishes the comfort and livability of public space. This contrast is highly relevant to urban development and smart-city design because it reveals that environmental adaptation and mobility planning should be treated as mutually reinforcing rather than separate agendas.

Social cohesion

The social cohesion axis is where mobility most directly intersects with equity, public life, and democratic urbanism. The source article argues that active mobility promotes social cohesion by activating interdependent urban networks and reducing the barriers created by car dependence [1]. Because walking and cycling are far more economically accessible than private automobile use, they can reduce the exclusionary effects of income-based transport systems.

The paper organizes this discussion through two binomials.

Social cohesion vs. social exclusion. In the EU perspective, the city should function as a diverse ecosystem where different ages, incomes, and social groups converge in public space [1]. AM supports this convergence by increasing opportunities for encounter, reducing traffic barriers, and making streets more available for play, care, leisure, and collective presence. The source text also emphasizes that the exclusive use of the street by private motorized transport diminishes the independence of children and older adults and weakens the social function of urban space.

The manuscript further introduces the idea of *mobility of care*, highlighting the gendered dimensions of transport and the need for safe, inclusive mobility systems that address the practical realities of caregivers and women [1]. This is a critical urban-development point: a mobility system cannot be considered successful if it works only for the fast, the able-bodied, or the economically advantaged.

Equity vs. disparity in access to urban amenities. The source paper underscores that proximity to amenities shapes both mode choice and the quality of social interaction [1]. When services, sidewalks, bike lanes, and green spaces are absent or unevenly distributed, participation in AM declines, local consumption falls, and civic engagement is weakened. Conversely, equitable access to amenities supports walking, spontaneous encounter, neighborhood vitality, and the use of public space as a shared civic resource.

This argument fits squarely within urban development scholarship because it connects transport, local economic life, public-space design, and distributive justice. It also moves the discussion beyond mode share toward a deeper question: who can actually access urban opportunity without being forced into car dependence?

DOCUMENTED URBAN-DEVELOPMENT FINDINGS FROM THE SOURCE LITERATURE

The manuscript benefits from replacing generic claims with the source article's own explicit findings. Table 4 consolidates the most important conclusions reported in the source study and translates them into direct urban-development implications.

These findings make the article especially relevant to the *Journal of Urban Development and Smart Cities*. The core contribution is not a transport engineering model; it is a planning argument about how mobility can reorganize land use, public-space priorities, environmental performance, and social inclusion in urban neighborhoods.

PLANNING IMPLICATIONS FOR SMART AND HUMAN-SCALE URBAN DEVELOPMENT

The source article repeatedly suggests that the integration of AM into urban systems requires coordinated measures rather than isolated interventions [1]. This principle can be translated into five urban-development implications.

Reallocate public space toward human use

Because automobiles occupy a disproportionate share of public space, an AM-oriented urban strategy must prioritize sidewalks, crossings, cycle infrastructure, seating, lighting, shading, and green frontage. The design objective is not merely traffic management; it is the restoration of the street as a multifunctional civic environment.

Plan for proximity and mixed uses

Compactness is only meaningful when it connects residents to daily needs. Therefore, neighborhood development should promote the co-location of housing, employment, commerce, schools, transit, and recreation. Mixed-use and proximate urban form reduces travel distances and makes active mobility a viable default rather than a residual option.

Table 4: Source-grounded findings and their planning implications

Finding from source article	**Implication for urban development and smart-city planning**
AM supports compact urban forms and neutralizes urban sprawl.	Land-use planning, service proximity, and public-space design should be coordinated with active travel infrastructure.
AM promotes social cohesion by activating interdependent urban social networks.	Streets should be treated as social infrastructure, not only transport corridors.
Compactness driven by AM improves creativity and complexity in urban environments.	Mixed-use neighborhoods, local services, and continuous routes strengthen economic and civic vitality.
AM shapes future cities by establishing a mobility paradigm beyond car dependence.	Smart-city strategy should prioritize human-scale access, multimodality, and reallocation of road space.
Complexity is the EU category with the greatest number of connections to AM.	Planners should use AM to enhance informational, spatial, social, and ecological richness.
Compactness and functionality are the second strongest EU dimensions linked to AM.	Proximity, accessibility, and feasible short-distance travel are core urban-development priorities.
Breadth of experience is the AM concept with the greatest flow toward EU.	Urban design should value sensory richness, legibility, and experiential quality, not only throughput.
Pleasurability is a major opportunity for ecosystemic urbanization.	Successful mobility policy must make active travel enjoyable, not merely possible.

Treat digital tools as complements to urban form

The smart-city relevance of the source paper lies in its recognition that hyperconnectivity can improve AM through routing, information exchange, and multimodal coordination. Yet digital systems should reinforce, not substitute for, equitable and navigable public space. Technology is most effective when the underlying urban structure supports human-scale movement.

Integrate climate resilience with active mobility

Urban green infrastructure, tree canopy, permeable surfaces, and comfortable microclimates should be treated as mobility infrastructure because they improve the feasibility, comfort, and safety of walking and cycling. This integration is particularly important in heat-prone and flood-prone cities.

Center inclusion, care, and neighborhood equity

Urban development must address gender, age, income, and caregiving constraints. Safe public spaces, short travel distances, accessible amenities, and inclusive route design are essential to ensure that AM supports social cohesion rather than becoming an amenity available only to already advantaged groups.

DISCUSSION

The manuscript demonstrates that active mobility is not simply compatible with smart cities; it offers a corrective to technologically narrow interpretations of smartness. The source article shows that AM can coexist with and be strengthened by digital tools, but only within an urban structure that is compact, functionally mixed, environmentally moderated, and socially inclusive [1]. This is a critical insight for urban development research: the intelligence of a city should be judged not only by sensors and platforms, but by how effectively it supports human-scale access, encounter, and adaptation.

The ecosystemic urbanism framework is especially valuable because it prevents the fragmentation of planning thought. Compactness without social cohesion can produce exclusionary density. Hyperconnectivity without accessibility can deepen digital divides. Green space without permeability may remain decorative rather than functional. Efficiency without public-space quality can reproduce sterile and inequitable forms of optimization. By placing AM at the intersection of these axes, the manuscript offers a more integrated urban-development perspective.

This also clarifies why the paper belongs within the scope of a journal concerned with urban development and smart cities. Its substantive concerns are land-use structure, public-space allocation, multimodality, environmental resilience, neighborhood vitality, digital mediation, and inclusive access to urban opportunity. These are core questions of contemporary urban policy and design.

CONCLUSION

Active mobility should be understood as a foundational element of human-scale urban development in smart cities. As synthesized through the framework of ecosystemic urbanism, walking and cycling do far more than reduce emissions or diversify transport options. They support compact and functional urban form, increase the complexity and richness of city life, improve the efficiency of urban metabolism, and strengthen social cohesion by making public space more accessible, legible, and inclusive.

The source literature makes four decisive points. First, automobile-centered urbanization is environmentally and socially costly, consuming excessive public space and reinforcing dispersion. Second, active mobility is structurally aligned with compactness, multimodality, and proximity-based planning. Third, the strongest conceptual relationship between AM and EU lies in complexity, where diverse uses, green infrastructure, and digital hyperconnectivity enrich urban life. Fourth, the success of AM ultimately depends on social cohesion: equitable access, safety, care-sensitive mobility, and the reclaiming of public space as a shared civic environment.

For urban development practice, the implication is clear. Cities seeking to become smarter and more sustainable should not treat active mobility as a peripheral transport enhancement. They should treat it as a central organizing principle for neighborhood design, public-space governance, climate resilience, and inclusive urban regeneration.

DATA AVAILABILITY STATEMENT

No new data were created or analyzed in this study. The article is a conceptual synthesis grounded in published literature.

FUNDING

No external funding was received for this work.

CONFLICTS OF INTEREST

The author(s) declare no conflict of interest.

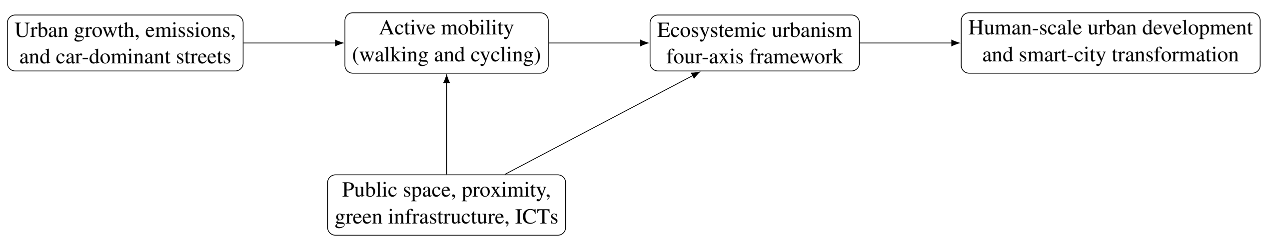

Figure 1: Conceptual pathway linking active mobility to human-scale urban development in smart cities

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Manuscript Published; 15 November 2025.