Urban planning and design guidelines for integrating autonomous mobility into cities

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Abstract: This research aims to provide practical guidelines for urban planning and design that incorporate the deployment of autonomous vehicles (AVs), offering a roadmap for local authorities and professionals. Using a mixed-method approach including participatory and qualitative and quantitative methodologies, it examines citizen and expert preferences on autonomous mobility and urban space allocation, revealing consensus on compact, green, and accessible cities prioritising active mobility. Planning recommendations include anticipating AVs regulations, integrating them into planning documents, reinforcing density, and discouraging private car use. Design proposals allocate freed space to pedestrians, cyclists, and greenery, with safer intersections and multifunctional streets, fostering more sustainable and people-centred cities.

Keywords: autonomous vehicles; urban planning; urban design; street design; active mobility; guidelines

1. Introduction

Autonomous vehicles (AVs) are considered among the most disruptive innovations in urban mobility since the advent of the automobile [1]–[5]. Their introduction could profoundly reshape cities, influencing travel behaviour, land-use, and public space allocation. While AVs offer opportunities to reduce parking demand and reclaim street space for pedestrians and cyclists [6], they also pose risks of encouraging longer trips and urban sprawl if not properly regulated [7],[8]. These uncertainties stress the need for proactive planning to define desirable futures and identify policy pathways to achieve them, shifting the focus from predicting what might happen to shaping what should happen [9]. This anticipatory perspective can involve experts and citizens through participatory techniques to identify effective and socially acceptable measures [10].

Urban design considerations are equally critical. The removal of on-street parking and narrower traffic lanes could free space for wider pavements, protected cycle lanes, and multifunctional green areas [3],[5]. These interventions align with contemporary models, which prioritise proximity and active mobility. However, their success also depends on participatory processes that incorporate citizens' preferences, consider the interaction of AVs with vulnerable road users, and foster social acceptance.

In this context, integrated guidelines are essential for steering AV deployment within anticipatory planning and sustainable design frameworks, ensuring accessibility, safety, and quality public space, while preserving the core city values endorsed by all citizens.

2. Methods

This article synthesizes findings from multiple related studies on urban planning and design for autonomous mobility, employing a mixed-method approach to envision desirable urban futures and define planning and design strategies (Figure 1). Backcasting, which is particularly suited to contexts shaped by disruptive technologies, was employed

to identify policies for sustainable urban development [7],[11],[12]. This approach was combined with a participatory Q-method to capture experts' and citizens' perspectives and reveal areas of consensus and dissent within the planning process [2],[4]. Regarding urban design, a preference survey in two European cities examined pedestrian behaviour, public space attractiveness, and street redesign under AV scenarios [13], while semi-structured interviews with experts provided insights into cycling design requirements [14].
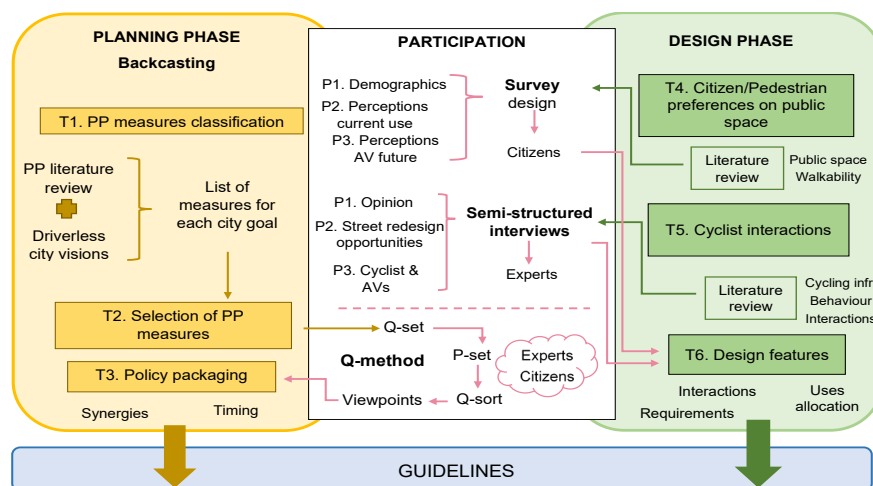

Figure 1. Overview of research methods

3. Guidelines

Table 1 summarises the main urban planning guidelines and urban design principles for integrating autonomous mobility into cities.

Table 1. Summary of urban planning guidelines and urban design principles

	Guidelines	Key studies	Supporting literature
	Plan ahead and integrate AVs into planning frameworks. Anticipatory planning is essential to avoid uncoordinated adaptation to disruptive technologies. AV-related measures should be incorporated into tools such as planning documents to align deployment with sustainability objectives.	[7],[12]	[15],[16]
	Promote proximity and compactness. Compact urban form, supported by mixed-use and proximity-based models, reduces car dependency. Fiscal and regulatory measures discouraging urban sprawl—such as higher development taxes for distant locations—are considered effective for maintaining compactness.	[7]	[8],[17],[18]
	Prioritise pedestrians and active mobility. Citizens and experts strongly support policies to prioritise pedestrians, widen pavements, and create safe walking routes, particularly for vulnerable groups. These measures reclaim public space and enhance walkability, contributing to healthier, more inclusive cities.	[7],[19]	[15],[20],[21]
	Strengthen public transport. Recommended actions include encouraging transit-oriented development (TOD), as well as increasing service frequency, improving technological systems, and delimitation of exclusive lanes for public transport.	[7]	[16],[20],[21]
Urban Planning	Promote shared AVs (SAVs). AVs integration must be governed by clear regulations before deployment, including restrictions on private AV use in central areas and incentives for shared mobility. Prioritising SAVs reduces car dependency and frees space for green and open public spaces, enhancing active mobility and environmental well-being.	[2],[4],[7],[11],[12]	[15],[17],[20],[21]
	Use positive incentives. Financial incentives and educational campaigns promote sustainable travel choices. Evidence shows that policies such as subsidies for public transport and shared services are generally more socially acceptable than punitive measures, even if the latter may be more effective.	[4],[7]	[22]
	Increase policy acceptability through integrated strategies. Policies limiting personal choices—such as private car ownership and use—often face resistance. Several approaches can help: combining measures rather than isolated actions, implementing pilot projects, and using marketing and communication strategies to build awareness.	[4]	[23],[24]
	Maintain participatory processes. Citizen and stakeholder engagement is crucial to identify consensus and dissent, ensuring socially acceptable pathways and avoiding artificial agreement.	[2],[4]	[10],[25]

Urban / Street Design	Reallocate space from motor traffic. Reduce the number and width of traffic lanes up to 50% and eliminate on-street parking to free space for pedestrians, cyclists, and public transport. AV lanes can be narrowed to 2.5–2.75m without compromising efficiency. The reclaimed space enables wider pavements and the integration of green areas, cycle lanes, social spaces, and street commerce…	[13],[14],[19]	[3],[5],[26]–[28]
	Develop flexible zones. Introduce adaptable areas for multiple uses—such as pick-up/drop-off points, micro-mobility storage, outdoor seating, and kiosks—while prioritising greenery and sheltered spaces. These zones should enhance street vibrancy and support dynamic community needs.	[13],[14],[19]	[3],[5]
	Promote green areas. Convert freed-up parking and traffic areas into green corridors and parks to improve environmental quality and encourage active mobility. Green spaces should be expanded, especially in residential streets where they can exceed 50%.	[2],[4],[11],[13],[14],[19]	[5],[28]
	Prioritise pedestrian accessibility. Expand sidewalks to meet or exceed minimum standards—1.8-2.0 m—and design streets as multifunctional public spaces with greenery, benches every 100 m (especially on busy roadways), and sheltered areas to foster interaction and walkability.	[13],[14],[19]	[3],[29],[30]
	Promote context-sensitive solutions by street type. On primary corridors, provide segregated infrastructure for pedestrians and cyclists and allocate space for public transport and AV lanes. On secondary streets, use shared layouts with traffic calming and signage to maintain low speeds (≤30 km/h). On mixed-use streets, integrate flexible zones and visual separation between modes.	[13],[14],[19]	[5],[28]
	Integrate cycling infrastructure. Allocate reclaimed space to continuous, well-maintained cycle lanes. Two-way lanes should be 2.4–3.2 m wide, one-way lanes 1.8–2.5 m, ensuring separation from motor traffic. Where space is limited, prioritise reducing carriageway and parking space over the pavement.	[14]	[29],[30]
	Enhance safety at intersections. Implement advanced stop lines, coloured pavements, and clear signage to improve visibility and reduce conflicts between AVs, cyclists, and pedestrians. Lighting and priority rules must be reinforced to ensure safety during the transition phase.	[14]	[31]

4. Conclusion

The advent of AVs offers a unique opportunity to reshape cities towards more sustainable, inclusive, and liveable futures. However, realising this potential depends on proactive planning and design strategies that anticipate technological change while reinforcing core urban values. By drawing on backcasting and participatory techniques, the present article offers an integrated perspective that translates previous empirical findings into actionable guidelines for planners and designers.

This research demonstrates broad consensus among citizens and experts on prioritising active mobility, compact urban form, and green public spaces. Urban planning recommendations focus on integrating AVs into regulatory frameworks, curbing sprawl, and incentivising shared and collective modes. Urban design guidelines advocate reallocating space from motor traffic to pedestrians, cyclists, and flexible zones, supported by safety measures at intersections and context-sensitive solutions for different street typologies. While AVs may reduce the need for parking and enable narrower lanes, their integration must be carefully managed to avoid unintended consequences such as increased car dependency. Ultimately, the transition to autonomous mobility should be leveraged to advance broader goals of urban resilience, equity, and environmental quality—creating cities that are not only smarter but also healthier and more human-centred.

Conflicts of Interest: The authors declare no conflict of interest.

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