Adapting the 15-Minute City Model for Suburban Areas: Key Performance Indicators (KPIs) and Multimodal Mobility Strategies

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Abstract
The 15-minute city (15minC) model has emerged as a guiding framework for just and sustainable urban development, prioritising proximity, connectivity, and diversity to enhance residents' quality of life. While widely applied in dense urban centres, its implementation in suburban areas faces particular challenges. In this paper, we define a set of Key Performance Indicators (KPIs) to explore the potential of digitalisation and integrated multimodal mobility strategies as enablers of the 15minC principles in suburban contexts. Six diverse case studies are examined across six countries in Europe: Spain, Portugal, Hungary, Italy, Germany, and Turkey.

Keywords: 15-Minute City – Key Performance Indicators – Multimodal Mobility – Suburban Development

1. Introduction

The 15-minute city (15minC) model has emerged as a guiding framework for just and sustainable urban development, prioritising proximity, connectivity, and diversity to enhance residents' quality of life (Moreno et al., 2023). While widely applied in dense urban centres, its implementation in suburban areas faces challenges due to lower density and limited land-use diversity, which often characterise these areas. From a 15minC model perspective, this results in insufficient connectivity due to poorly integrated and inaccessible transportation networks, such as limited public transport options. This, in turn, leads to car dependency, negatively impacting residents' quality of life in terms of health, time, and financial costs.

To reduce suburban distances, promote accessibility, and achieve the 15minC vision in peripheral areas, this research contributes to the rethinking of distance as a function of time, and defines Key Performance Indicators (KPIs) aligned with the principles of chrono-urbanism—emphasising faster and more cost-effective solutions (Moreno et al., 2023), such as the integration of mobility hubs and the promotion of public transport and active mobility modes. The 15minC model presents itself as a contemporary urban vision (Moreno et al., 2023), as its guiding principles tend to remain aspirational, rather than process-oriented, without clear spatial planning methodologies nor operational frameworks. This paper addresses the aspirational aspect of 15minC mobility strategies and renders them measurable through relevant KPIs.

Accordingly, this study aims to bridge existing research gaps in data-driven methodologies and analytical frameworks, by defining a set of KPIs to assess how digitalisation and integrated multimodal mobility strategies can support the principles of the 15minC in suburban contexts. To achieve this, six diverse case studies are examined across six European countries: Spain, Portugal, Hungary, Italy, Germany, and Turkey.

As part of the FORTHCOMING project (FC)1, the development of the KPIs follows a methodological approach that includes: identifying successful 15minC strategies within selected case studies, assessing available data sources, and integrating insights gathered through focus group workshops with local experts from the respective case study areas.

Ultimately, the study will share preliminary findings on the relevance and applicability of the proposed KPIs in establishing a measurable framework for the 15minC concept, while also reflecting on and examining the challenges and opportunities related to further contextualisation—particularly through the definition and implementation of urban living labs within the case study cities in upcoming project phases.

1 FORTHCOMING: Fostering the City of Proximity through MaaS Integration" is an applied research project under the Driving Urban Transitions (DUT) Partnership. It will develop and test data-driven, user-centric 15-minute city models for suburban contexts, drawing on best practices from central urban areas. https://www.forthcoming.info/

2. Context

2.1. 15minC Dimensions

The dimensions that make up the 15minC framework applied in the FC project are adapted from the concept's core characteristics (Moreno et al., 2023), resulting in the four following dimensions: density, proximity, inclusivity, and digitalisation.

- Density is viewed in terms of mixed land use in a built environment (e.g., retail, residential, offices, leisure & green spaces, etc.), where the number of people in a given area can comfortably sustain the urban service delivery, opportunities, and resources.
- Proximity refers to the spatial and temporal accessibility to opportunities related to transportation, employment, healthcare, education, entertainment, access to green spaces, and retail for every resident through active or sustainable transportation modes.
- Inclusivity refers to addressing everyone's needs and experiences in relation to the opportunities offered by the 15mC, regardless of economic means, age, gender, disability, diversity, race, or ethnicity. Mobility justice, accessibility, social cohesion, and participatory decision-making are at the heart of inclusiveness as well as assessing cautiously the risks of exclusion and gentrification.
- Digitalisation refers to the enabling of the proximity, inclusivity, and density's dimensions using digital technology, such as Mobility-as-a-service (MaaS), smart city management tools, digital twins, and end-user applications.

The dimensions are evaluated in relation to the city's essential services. According to Moreno et al. (2023), essential services are defined through the High Quality of Societal Life (HQSL) index, which identifies six key urban functions that contribute to residents' daily well-being: living, working, getting supplies, enjoying, learning, and caring/being healthy. These social functions serve as the primary domains through which the four dimensions of the 15minC are assessed in practice.

2.2 Key Performance Indicators (KPIs)

KPIs originated in business management as means to measure the success of specific activities against strategic objectives. In urban planning, KPIs similarly serve as means to monitor the performance of key initiatives, aligning with broader goals such as sustainability, liveability, and inclusivity. They offer both quantitative and qualitative methods to assess the effectiveness of urban development strategies—particularly relevant in the context of planning concepts such as the 15minC concept examined in this study. This urban model emphasises proximity to essential services, aiming to create more accessible and sustainable neighbourhoods. In this context, KPIs ensure that goals such as improved resource allocation, enhanced accessibility, and a better quality of life are met through data-driven planning (Pozoukidou and Chatziyiannaki, 2021).

The 15minC model represents a shift toward more localised urban planning, where essential services are reachable within a short radius—such as a 15-minute walk, bike ride or public transport trip. KPIs are crucial in addressing the vision of 15minC, as they help measure factors such as proximity, walkability, and the effectiveness of public transport—elements vital to achieving strategic urban objectives like reducing carbon footprints (Moreno et al., 2023) and enhancing social equity (Pozoukidou and Angelidou, 2022).

Within the framework of the FC project, which encompasses case studies across six countries, KPIs will guide the transfer of 15-minute city mobility strategies to suburban areas. The overarching objective of the project is to adapt and transfer successful city centre strategies to suburban contexts, with a focus on multimodal mobility, user-centric models, and digitalisation—all within the broader aim of promoting public transportation as the backbone of FC's approach to rethinking distance as a function of time.

Overall, the selected KPIs will serve as key criteria for assessing 15minC strategies, determining their effectiveness in the suburban context, and providing measurable insights

3. Research Methodology

The selection process of KPIs was structured into three main phases: (1) consolidation and assessment of successful 15minC strategies across all six case studies; (2) clustering and drafting a list of potential KPIs; and (3) refinement and validation through local focus groups workshops.

Each case study consists of an urban central area (i.e., higher-density regions) and a corresponding suburban area (i.e., lower-density regions), described below:

- Spain: Madrid (urban) and Las Rozas (suburban)
- Portugal: Lisbon (urban) and Vila Franca de Xira (suburban)
- Hungary: Debrecen (urban) and Kertváros (suburban)
- Italy: Turin (urban) and Settimo Torinese (suburban)
- Turkey: Istanbul (urban) and Küçükçekmece (suburban)
- Germany: Hamburg (urban) and Hamburg-Altona (suburban)

In the following sections, the case studies will be referred to by their respective country names for ease of reference; however, this should be understood as referring specifically to the urban core and its corresponding suburban area, as described above.

3.1. Successful 15-minute City Strategies in Six Case Studies

In the first phase of data collection, a comprehensive questionnaire was designed and distributed across the case studies project partners and their local network. This process facilitated the examination of how local planning strategies align with initiatives adopted by planning bodies and transport authorities—such as Sustainable Urban Mobility Plans (SUMPs) (European Commission, 2023) and other relevant official documents—particularly in relation to the 15minC concept. The questionnaire covered several key areas: integration of the 15minC concept with local planning and strategies; practical application of the 15minC approach; perception and public engagement; progress and evaluation; and future directions and additional comments.

Once the responses were collected, each case study's objectives, guiding principles, and strategies were compiled. These strategies were then organised within a comparative framework to identify overlaps and gaps. This facilitated both the rapid identification and later in-depth review of best practices that strongly align with 15minC-based urban mobility strategies.

Across the six case studies, the derived strategies converge around several core themes. A common priority was the improvement of public transport through increased service frequency, expanded network coverage, upgraded rolling stock, and the introduction of new modes. For example, Portugal and Turkey focus on infrastructure, with Istanbul advancing public transport optimisation via station upgrades and hub renovations. Hungary emphasises speed and comfort enhancements in public transport. Germany and Italy aim to increase service frequency and modernise rolling stock, with Turin also expanding intercity rail services. Spain introduces peak-hour express buses, zero-emission routes, fleet renewal, and on-demand services.

Shared mobility solutions are implemented through micro-mobility services and free shuttle systems. Germany enhances its local mobility app, while Italy offers free internal shuttles for students and the elderly. Spain, for instance, develops integrated hubs featuring secure bike parking, EV charging stations, and car-sharing facilities. Turin incorporates a pay-as-you-go system to promote affordability and Mobility-as-a-Service (MaaS) integration.

Active mobility strategies are also prominently featured. All six case studies highlight the expansion of cycling infrastructure, with emphasis on safety improvements and reducing car dependency. Turkey and Spain additionally focus on improving bicycle parking and, in Spain's case, promoting e-bike sharing. Walkability is a shared objective, with initiatives to enhance sidewalks, create pedestrian zones, and develop attractive public spaces that encourage walking. Turkey introduces "shared streets" and prestige corridors accommodating multiple transport modes, while Hamburg promotes flexible public space usage.

People-centered urban design and tactical urbanism are central to several case studies. These include strategies to redevelop public spaces, enhance safety, and support community engagement through participatory processes. Madrid reduces speed limits on school streets; Germany develops multifunctional street furniture; and Lisbon promotes interventions in public squares. Community engagement strategies include workshops, surveys, and public consultations, with Turkey and Spain also utilising digital tools like Decide Madrid [2] to enable digital participation.

2 https://decide.madrid.es/

Additional actions address environmental sustainability, such as expanding green spaces, promoting clean transport, and creating nature-integrated cycling paths or traffic-calmed zones like Italy's "Zone 30."[3] Digital tools are increasingly adopted across the case studies but remain underdeveloped in Portugal, indicating potential for future enhancement. Strategies such as digital twins and MaaS applications are being used to advance planning and digital innovation.

Urban logistics strategies also integrate digital solutions. These focus on improving loading zones and real-time data applications. Turkey implements smart logistics measures, including construction material consolidation centres and the use of ICT/IoT technologies.

3.2. Cluster Formation of Key Performance Indicators for 15minC Strategies

Following the consolidation and assessment of successful 15minC strategies and best practices across the case studies, a collaborative strategy mapping exercise was conducted. This aimed to establish a structured approach for developing KPIs aligned with the identified strategies. During the exercise, a pre-defined set of strategies and policies was reviewed, refined, and validated by project partners from each city to ensure completeness and accuracy in light of their specific contexts. Project partners also contributed to identifying and developing relevant KPIs within their focus areas, organised by both strategy and scope.

Building on the outcomes of this collaborative process, an initial list of KPIs was drafted. This list was then expanded through literature review, which served to establish working definitions and gather additional potential KPIs alongside successful measures identified in previous project phases. Throughout this phase, representatives from the six case studies provided continuous input and feedback to ensure the KPIs reflected locally grounded realities.

This resulted in a list of over 90 draft KPIs—relevant to a range of dimensions in the assessment of 15minC—, capturing in greater detail all relevant gathered inputs, expanding on key elements while avoiding premature definitions of specific metrics and data sources. The intention was to provide a flexible but structured foundation for subsequent filtering and detailed definition. These KPIs were grouped into eight thematic clusters:

- Proximity
- Inclusivity
- Digitalisation
- Density
- Sustainability and Climate Action
- Governance
- Modal Share
- Economic Impact

The clusters of Proximity, Inclusivity, Digitalisation and MaaS, and Density and Land Use reflect adaptations of Moreno's (2023) core dimensions (see Section 2.1). Governance and Modal Share emerged from the specific thematic priorities of the FC project, emphasising the role of policy frameworks and mobility patterns:

- Governance refers to transparent, accountable, and participatory urban management, ensuring that public policies align with local planning strategies and that citizens and stakeholders are actively involved in the decision-making process (Chinellato, M. and Morfoulaki, M., 2019).
- Modal Share refers to the distribution of various transportation modes (such as walking, cycling, public transit, and driving) used by residents within a short, easily accessible radius (Poorthuis and Zook 2023).

Meanwhile, Sustainability and Climate Action and Economic Impact correspond to two of the three pillars of sustainable development—Environmental Sustainability and Economic Sustainability:

- Sustainability and Climate Action aims to reduce environmental impact by cutting carbon emissions, enhancing energy efficiency, promoting green spaces, and climate-conscious policies to mitigate climate change (Sahertian and Sari, 2024).

3 https://www.nuoverigenerazioni.eu/tutte-le-news/1298-citta30subito

- Economic Impact refers to the financial impact on local businesses, property values, and employment resulting from urban planning strategies that prioritise accessibility to essential services within a 15-minute walk or bike ride (Bartzokas-Tsiompras, 2022).

The interim list of KPIs addressed diverse analytical scopes relevant to each cluster and was organised accordingly. The following provides an overview of the clusters and the scopes addressed in that interim list:

- Proximity: Public Transport Access; Essential Services Access; and Green and Blue Space Access.

- Inclusivity: Social Inclusion; Affordable Housing; Socio-ecological Equity.

- Digitalisation: Smart Traffic Management; Smart Technologies Integration; Data Governance; Multimodal Integration and MaaS.

- Density: Diversity of Land Use; Urban Density, Public Space Utilisation; Building Utilisation; Traffic Calming.

- Sustainability and Climate Action: Emission Reduction; Air Quality and Green Coverage; Resilience and Climate Adaptation; Energy Efficiency.

- Governance: Citizen and Stakeholder Engagement; Policy Integration and Governance; Economic Sustainability; Sustainable Mobility Policies.

- Modal Share: Public Transport Modal Share; Active Mobility; Shared Multimodal Mobility; Modal Shift; Car Dependence Reduction.

- Economic Impact: Local Business Growth; Real Estate and Property Value; Circular Economy; Freight and Logistics Efficiency; Return on Investment (ROI).

3.3. Focus groups workshops to define the list of KPIs

Following the consolidation of the interim draft list of KPIs, focus group workshops (FGs) were conducted in each case study city. These workshops involved a broad range of local experts and stakeholders—including representatives from academia and research, planners and transport professionals, municipal staff from urban and suburban transport and planning departments, as well as local transport associations. These stakeholders will later participate in the establishment of urban living labs in their respective case studies (see Section 5).

The primary objective of these workshops was to gather insights and expert opinions to advance the implementation of 15minC strategies and to validate and refine the initial KPI list according to contextual relevance and feasibility. The focus group process included two main parts:

1. A SWOT analysis was conducted to identify local opportunities, challenges, and priorities in urban planning, mobility, and sustainability across the four core dimensions of the 15minC concept (see Section 2.1).
2. A ranking process followed, in which participants evaluated the eight thematic clusters and their corresponding interim list of KPIs (see Section 3.2).

3.3.1. SWOT Analysis Results

The discussions during the FGs revealed contrasting strengths and challenges across the case studies, shaped by varying levels of urban density and infrastructure. Experts from Germany and Portugal highlighted that higher-density areas naturally support walkability, mixed-use development, and efficient public transport. In contrast, participants from Spain and Hungary, where urban density is lower, highlighted the struggle with car dependency and service accessibility.

Reports from the local FGs also showed significant variation in public transport effectiveness. Germany and Portugal reported benefits from well-integrated networks, whereas experts from Turkey noted that heavy congestion reduces efficiency. Areas with ongoing revitalisation efforts, such as Hungary and Italy, focus on improving infrastructure and redistributing populations to enhance connectivity.

Urban diversity and socioeconomic factors also influence mobility patterns. Inequalities in transport access were highlighted in Turkey and Spain, particularly for vulnerable populations. Meanwhile, Germany and Portugal emphasised inclusive housing policies and mixed-use developments, although gentrification was noted as a shared concern.

Digitalisation presents both opportunities and barriers. Case studies with more advanced digital integration can improve accessibility and mobility services but also risk widening social inequalities, as noted in Portugal and Germany. Meanwhile, Spain and Turkey stated that the struggle with real-time data availability and digital infrastructure gaps could limit their ability to implement smart mobility solutions effectively.

Overall, the discussions showed varying degrees of adaptability toward the 15minC concept. While both groups of experts from Italy and Portugal agreed on the relevance of exploring strategies for proximity-based urban living, practitioners from Spain and Hungary separately concluded that there are substantial structural limitations. The reuse of public spaces emerges as a common opportunity, yet governance, funding, and administrative silos remain persistent challenges across multiple cities.

The discussions ultimately suggest that sustainable urban mobility is contingent upon the establishment of a balance between infrastructure investment, accessibility, and density. Addressing congestion and gentrification risks is imperative for high-density cities, while innovative solutions are required for low-density areas to reduce car dependency and improve the viability of public transportation. Digitalisation offers a pathway for cities to optimise mobility, but its success relies on equitable implementation and governance.

3.3.2. 15minC-derived thematic KPIs Cluster Ranking

The eight aforementioned KPI clusters and their corresponding potential KPIs were ranked using a simple dotmocracy method - a participatory approach to prioritisation, where attendees of a focus group rank ideas, statements, or proposals to determine collective preferences (Hidalgo, 2018). The results of the ranking are summarised in the following table, with 1 representing the highest priority and 9 the lowest across the case studies:

Table 1: Table Overall table of KPI clusters ranking results by case studies

KPI Cluster	Spain	Germany	Hungary	Italy	Portugal	Turkey	All
Modal Share	1	2	1	3	2	1	1
Proximity	2	1	1	5	1	3	2
Density	3	3	4	6	5	2	3
Sustainability & Climate Action	4	7	3	2	4	5	4
Inclusivity	6	3	8	1	7	4	5
Governance	7	6	6	4	6	6	6
Digitalisation	5	5	5	7	8	6	7
Economic Impact	8	8	7	8	3	8	8

The Modal Share cluster ranks highest in importance across all case studies, reflecting a strong focus on transportation mode distribution. Proximity and Density follow in ranks 2 and 3, emphasising the role of accessibility and urban planning in mobility strategies.

Sustainability and Climate Action holds a mid-level joint ranking of 4, highlighting varied national priorities in environmental policy. Inclusivity, Governance and Digitalisation are ranked 5, 6 and 7 respectively, indicating that

while they are considered important, they are not the primary focus. Economic Impact has the lowest ranking at 8, suggesting that economic considerations may be less immediate than social, environmental, and infrastructural aspects.

The results indicate that Modal Share and Governance exhibit the lowest variation, showing strong consistency across case studies. Digitalisation, along with Density, also demonstrate stable importance. Proximity and Sustainability and Climate Action show moderate variation, while Economic Impact and Inclusivity have the highest deviations, indicating significant fluctuations in their rankings among different case studies. This suggests a general consensus on the importance of Modal Share and Governance, while Inclusivity and Economic Impact are more context-dependent.

4. Definition of the Key Performance Indicators (KPIs)

Based on the previously mentioned research and analysis conducted across the six case studies, we identified a selection of KPIs. These are categorised as follows: 1) Common KPIs – applicable across all six case studies and 2) Specific KPIs – relevant to one or more of the case studies

The KPIs outlined in the following sections represent a concise yet comprehensive baseline, developed within the resource and capacity boundaries of the FC project. We acknowledge that these indicators are not definitive, as further refinement and updates are expected in subsequent project phases, particularly during the data collection stage and the further development of the Urban Living Labs (ULLs) (see Section 5) in suburban regions.

We defined both quantitative and qualitative KPIs. Notably, studies focusing on end-user KPIs remain relatively scarce in the urban field (Soriano-Gonzalez et al., 2023). As such, we prioritised indicators accessible from a "City Manager" perspective—more often quantitative—drawing on open-source and readily available datasets. This approach aligns with the practical limitations of the project, which does not include extensive surveying or in-depth user data collection. Nonetheless, qualitative indicators are also represented where they can be drawn from in situ observations, interviews, and exchanges with local stakeholders—documenting, for example, the presence or absence of specific spatial or service-oriented characteristics relevant to 15minC mobility strategies.

4.1. Common KPIs

The following table (Figure 3) provides an overview of nine Common KPIs, thematically clustered and ordered based on their relevance as determined through the focus group workshops. It is important to note the following:

- The KPIs vary in complexity, as reflected in their associated key metric(s). These differences will be further explored in later phases of the project.
- All KPIs will be gathered during the upcoming project phase. Consequently, the data release year will reflect the most recent available datasets and may vary slightly across case studies and individual KPIs due to differences in data availability.
- We acknowledge that KPIs should ideally be calculated over different time intervals to fully evaluate their performance. However, due to the limited duration of the project, the KPIs will be calculated specifically for low-density areas and subsequently cross-analysed both within and across the individual case studies.

Cluster	KPIs	Key Metrics Description	Units
Modal Share	Active Mobility Infrastructure[4]	Percentage of the active road length with sidewalks, cycle paths, and pedestrian zones, relative to the total road length of the selected area	%
Proximity	Proximity to Green, Blue and Public Spaces[5]	Percentage-based estimate of the selected area that lies within a 15-minute walking or biking distance to green, blue, and public spaces such as parks, recreational areas, city waterfronts, ponds, lakes, and more. <u>Breakdown as follows:</u> • Walking access – Area within a 15-minute walk. • Biking access – Area within a 15-minute bike ride	%
	Proximity to Essential Services[6]	Percentage-based estimate of the selected area that lies within a 15-minute walking or biking distance of each of the six essential service categories (i.e., points of interest POIs). <u>Breakdown as follows:</u> • Walking access – Area within a 15-minute walk for each category • Biking access – Area within a 15-minute bike ride for each category	%
	Proximity to Public Transport and Demand-Responsive Transport Services[7]	Percentage-based estimate of the selected area that lies within a 15-minute walking distance of fixed-route public transport and, if applicable, demand-responsive transport (DRT) services. <u>Breakdown as follows:</u> • Public transport access – Area within a 15-minute walk of a fixed-route public transport stop • (If applicable) DRT access – Area within a 15-minute walk of DRT service stops or operating zones	%
		<u>Service Frequency:</u> Average number of public transport vehicles (buses, trams, trains, etc.) arriving per hour at stops within the selected area. Include a breakdown by transport mode (e.g., inter-urban vs. intra-urban lines), peak vs. non-peak hours, and weekdays vs. weekends.	rides per hour
Density	Built-up Surface (Urban Density)[8]	<u>Built-up Surface:</u> Amount of built-up land area available per person in a selected area	m2/ppp
		<u>Total Built-Up Area Ratio.</u> Ratio of the total built-up area (including residential, commercial, industrial, etc.) to the total land area.	%
	Diversity of Land Use[9]	<u>Types of Mixed-Use Developments:</u> Identification and count of the different combinations of mixed-use developments[10] within the selected area.	count
		<u>Ratio of Key Land Uses to Total Area:</u> Ratio of key land uses (e.g., educational, residential, commercial, recreational, green spaces, etc.) to the total urbanised area.	%

4 Sources: Bartzokas-Tsiompras and Bakogiannis, 2023; Soriano-Gonzalez et al. 2023
5 Source: Soriano-Gonzalez et al. 2023
6 Sources: Zhang et al., 2022; Graells-Garrido et al., 2021; IUTP et al. 2019
7 Sources: Moreno et al., 2023
8 Sources: Abbiasov et al., 2022; Dutta et al. 2020
9 Source: Carpio-Pinedo et al., 2021; Pozoukidou and Chatziyiannaki, 2021
10 Developments refer to urban built and construction (e.g. existing and new buildings) and land-use changes (e.g. infrastructures such as roads, parks, public spaces)

Inclusivity	Inclusivity in Accessing Mobility Infrastructure[11]	Availability of Discounted Public Transport Ticket Types: Types of discounted fare options available for different user groups (e.g. students, seniors, low-income individuals, people with disabilities, families, and more).	count
		Quality of Barrier-Free Walking Infrastructure: Existence and quality of inclusive and accessible pedestrian infrastructure based on pre-defined criteria (e.g. tactile paving, audible pedestrian signals, curb ramps at intersections, etc.)	count and rating
Governance	Citizen Participation in Urban Planning[12]	Number of Public Consultations and Forums: Number of public consultations, forums, and public engagement events held. Include a breakdown by top-down and bottom-up process (if applicable).	count
		Citizen Feedback on Public Consultations: Quality of public consultations from the citizen perspective, based on available feedback (e.g. from municipality records or online platforms).	N/A
Digitalisation	Availability of Multi-modal Mobility Services[13]	Availability of Mobility Services Types: Availability of mobility services in the selected area, including public transport, shared mobility, and micro-mobility services.	count
		Level of Integration Across Mobility Services Degree of integration among various mobility services, focusing on shared travel planning, booking, and payment functions. (e.g. real-time route planning, ticketing integration, in-app payment, etc.)	level

Table 2: Common KPIs List

4.2 Specific KPIs

Consistent with the common KPIs, the following table provides an overview of six specific KPIs, thematically clustered and ordered according to their relevance as determined through focus group workshops. It is important to note that not all case studies include the same number of specific KPIs; for example, in the case of Lisbon, no additional specific KPIs were required to capture local urban strategies and characteristics unique to that context.

Cluster	KPIs	Key Metrics Description	Units	Case Studies
Density	Traffic Calming Zones[14]	Roads with Lower Speed Limits: Percentage of total street kilometers in the selected area with speed limits of 20–30 km/h or lower.	%	Italy; Spain
		Car-free, pedestrian zones streets: Percentage of total street kilometers in the specified area designated as pedestrian-only or car-free zones through traffic-calming measures.	%	
	Public Space Utilisation[15]	Percentage of public spaces (e.g., parks, plazas) actively used by residents, based on measured foot traffic. Breakdown by factors such as time of day and user demographics to be clarified.	%	Hungary
	Land Use Density Around Transit Corridors[16]	Land Use Density Percentage-based estimate of the total built-up area (residential, commercial, industrial, etc.) within a specific radius (e.g., typically 400-800 m) from public transit stations or stops	%	
		Average total floor area (FRA) of all (residential) buildings located within that specific radius	ratio	Turkey; Germany

11 Source: Bartzokas-Tsiompras and Stefanidas 2022
12 Source: Belausteguigoitia, 2021
13 Source: Strommer et al., 2022; Kriswardhana and Esztergár-Kiss 2022; Narayanan and Antoniou 2023
14 Sources: Distefano and Leonardi, 2022; Bartzokas-Tsiompras, 2022; Salleh et al. 2020
15 Source: Khoshkhah et al. 2022
16 Sources: Carpio-Pinedo et al., 2021; Pozoukidou and Chatziyiannaki, 2021

Digitalisation	Investment in Smart City Technolo-gies[17]	Total amount of (public) funds allocated for the development and implementation of Smart City technologies, including Digital Twins, within a specific year.	euro per year	Turkey
	Parking Control Man-age-ment[18]	Average Parking Occupancy: Percentage of parking spaces occupied or available during daily use. Breakdown by day of the week and time of the day.	% per day per time	Spain
		Parking Turnover Rate Number of different vehicles that occupy a single parking space over a specified period of time (typically per day)	count per space per day	
Economic Impact	Pilots and Innovation Implemen-tation[19]	Number of innovative mobility projects—such as carpooling systems, shared e-bike networks, or similar sustainable mobility initiatives—launched within a specific year.	count	Hungary

Table 3: Specific KPIs List

5. Next steps and Urban Living Labs (ULLs)

The list of Common and Specific KPIs, developed from general insights across the case studies, will be further refined during the next project phase through the establishment of ULLs (Nesti, 2018; Molinari and Concilio, 2015) in the lower-density suburban areas. These living labs will be set up in collaboration with the local stakeholders identified in the focus groups workshops (see Section 3.3). Their role will be to contextualise the KPIs and to collect data necessary for calculating them, considering each area's specific local characteristics—such as land-use structure, transport options and mobility patterns, as well as existing planning and mobility regulations (Noennig et al. 2025).

ULLs are widely recognised as experimental spaces, testbeds, in cities where diverse stakeholders collaborate to develop, test, and refine innovative solutions for urban sustainability challenges (Nesti, 2018; Molinari and Concilio, 2015). Key characteristics of ULLs include geographical embeddedness, participatory experimentation, active user involvement, leadership, and continuous evaluation (Voytenko et al., 2015).

Notably, while traditional ULLs are predisposed to situations that call for real-world implementation and/or scaling of a sustainable innovation (von Wirth et al., 2018), the FC project adopts a modified approach to ULLs, to emphasise knowledge exchange and vision-sharing. Unlike traditional ULLs that often engage in pilot testing a physical intervention (e.g., smart technologies or urban mobility interventions), FC ULLs serve as a platform for analytical and co-creation in selected neighbourhoods across six partner cities.

In the FC ULLs, researchers and local stakeholder (e.g., public administration, citizens, private actors) engage in more focus group discussions to a) build a common understanding of the 15mC concept; b) identify potential KPIs for measuring 15mC adaptation to suburban areas and c) discuss possible future outcomes & governance impact of operationalisation.

FC ULLs emphasises stakeholder alignment and shared visioning, which is critical for long-term policy integration (Nesti, 2018). The proposed ULL format addresses a gap in the concept's literature regarding conceptual adaptation (e.g., applying 15mC to suburbs) rather than just technological experimentation. However, the lack of implementation focus raises questions about long-term efficacy, suggesting a need for hybrid models that combine visioning with prototyping. Future research could explore how such "soft ULLs" intersect with traditional governance and participatory planning.

17 Sources: Boreham, 2024; Klimek, 2024
18 Source: Jakob and Menendez 2020
19 Source: Aba and Estergár-Kiss 2024

6. Conclusion

On the background of the growing traction of the 15minC concept as a paradigm shift towards a more proximate and diverse lifestyle in dense urban areas, we sought to identify and define KPIs that assess the transferability of 15minC mobility strategies from higher-density to lower-density areas. This assessment draws on six diverse case studies across Spain, Portugal, Hungary, Italy, Germany, and Turkey, highlighting variability in local priorities and the maturity of (planned) 15minC-based mobility strategies.

Through a series of stakeholder exchanges and data collection activities in each case study, it became clear that all locations emphasised the importance of achieving the 15minC through favouring active and sustainable transportation modes. This emphasis underscores the importance of proximity to essential services for local residents. At the strategic level, this is reflected in efforts to improve active and public transport services in all locations—such as increasing service frequency, enhancing network coverage, and expanding cycling infrastructure—with the goal of reducing car dependency. These efforts predominantly address the proximity and digitalisation dimensions of the 15minC.

However, less consensus emerged regarding the other 15minC priorities such as inclusivity, sustainability, and density. For instance, case studies in Italy and Germany ranked these aspects as high priorities, in contrast to Hungary and Portugal, which assigned them lower priority.

Taking this variability into account, we introduced a list of Common KPIs—applicable across all case studies—and Specific KPIs—tailored to individual contexts. Combined, they aim to capture and establish a baseline understanding of the 15minC concept within the mobility domain, while considering the project's time, resource, and capacity constraints.

These KPIs include both quantitative and qualitative measures. Quantitative indicators involve data-intensive methods (e.g, GIS-based analyses) to assess KPIs such as proximity to essential services, proximity to green/blue public spaces, and public transport availability. In contrast, qualitative indicators rely on more observation-based approaches (e.g., in-situ observations or data from open-access sources) to evaluate land-use diversity, availability of shared mobility services, and levels of citizen engagement.

The definition of these KPIs was derived—and in some cases challenged—by the diversity of the case studies: a process that was imperative to capture their broad spectrum, while acknowledging the potential risk of generalisation. Moving forward, iterative data collection and validation processes will be carried out in collaboration with case study stakeholders, primarily relying on publicly accessible sources. Therefore, the precision and applicability of the KPIs will be contingent upon—and informed by—the quality, availability and quantity of data provided by municipalities and local stakeholders.

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