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Driving Equitable and Accessible 15 Minute Neighbourhood Transformations

WP2. Review and comparative analysis

T2.1. Revisiting the definition of 15mC

Deliverable D 2.1

Exploring the 15-minute city concept for urban outskirts : a systematic literature review.

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SUMMARY

This report summarises the findings from a conducted systematic literature review of the 15-minute city concept (15mC), its key components and its adaptation for the neighbourhoods located in the urban outskirts. This report it is part of the DREAMS project, which aims to create sustainable, accessible, and inclusive neighbourhoods in the outskirts through proximity-centred urban planning. The DREAMS project focuses on the 15-minute planning concept for *neighbourhoods* in the *urban outskirts*, we aim to delve into the key components necessary to implement 15-minute neighbourhood (15mN) principles beyond its original setting: the urban core. Urban outskirts are defined in this report as medium-sized areas or neighbourhoods in the near context of an urban area, where high car dependency is present and a strong economical and functional connection to the city is observed, primarily through daily work commutes. The current academic literature and 15-minute city practices are mainly focused on the urban city centres, where the concept emerged, but new contributions and researchers are stating the need to look deeper into how the concept evolves in the context of the urban outskirts.

This report aims to answer the questions: ***what are the components or elements to consider when trying to achieve 15-minute neighbourhoods in the urban outskirts? How similar or different are these elements in an urban core vs urban outskirts?***

To this end, we first frame our research scope in the terms that appear when describing the 15-minute neighbourhood concept, to set the common understanding of definitions along the rest of the project. We therefore provide definitions on four terms (topics): 1) urban outskirts, 2) accessibility, 3) mobility services, 4) governance and 5) business models. Firstly, we define the spatial scope of DREAMS with the previous mentioned definition of outskirts as those mid-dense areas in the near proximity of city. Secondly, we describe the term accessibility (and related terms walkability and proximity) and their relationships due to their common appearance when defining 15-minute neighbourhoods. For the case of our project, we understand proximity as physical distance between two points, while walkability is the extent to which the characteristics of the built environment and land use may be conducted of residents walking. And accessibility as the extent to which the land-use transport system enables (groups of) individuals or goods to reach activities or destinations by means of a (combination) of transport mode(s). Accessibility is the umbrella concept for 15-minute planning concepts where proximity-centred planning (planning for short distances) and active mobility (walk and cycle) becomes crucial. Thirdly, we describe the different mobility solutions or services that can support the development of sustainable and inclusive 15-minute neighbourhoods in the urban outskirts, including on-demand mobility, shared mobility (car-sharing and micromobility services), mobility hubs and flexible activity hubs. And finally, we define governance and business models which are also crucial to implement 15mN principals in different contexts.

With the research framed in the topics of interest, we searched and conduct a systematic literature review analysing 74 papers using the PRISMA methodology (48 with an urban focus and 26 mentioning or focusing on the outskirts). Our findings yield the need to adapt the concept of 15-minute city to different contexts considering public transport and mobility services as a key point to connect people in the outskirts to nearest urban cores and reduce car dependency. Therefore, we propose the following an adapted version of the 15mC for the outskirts (DREAMS 15-minute Neighbourhoods definition) as:

The 15-minute neighbourhood (15mN) is a concept for the urban outskirts that advocates for reducing the need to use a private car in the urban outskirts, allowing its residents to access their essential amenities and thus, fulfilling daily needs through active mobility and local public transport, while also being well connected to other cores with regional public transport, shared mobility and micromobility services.

The focus is put on user's perceptions and preferences regarding acceptable travel costs to amenities. Based on the literature review, we identify six key components for DREAMS 15mN: 1) density, 2) diversity, 3) design, 4) human perspectives and needs, 5) governance and 6) business models. Most of the existing literature focuses on the characteristics of space to comply with 15 minute thresholds (amenities near homes). However, our results highlight important research gaps especially in the studies related to user's perceptions and on the governance and business models that need to be in place for 15mN to happen in the outskirts.

To build upon the revised literature, we end by proposing a theoretical framework called the DREAMS 15mN Mixer. The Mixer is a summary visualisation of these mentioned six components. We extend beyond Moreno's components introducing governance and business models as we think equity-based policies, citizen participation, co-creation processes are needed to implement 15mC principles in the outskirts. But also new social business models are very scarce to find in the literature and they need to be in place to examine the role of different pricing/revenue schemes in the outskirts, as shared mobility, and in general all transport-related infrastructure is highly expensive when being offered in less dense areas. This 15mN Mixer visual helps to position a certain location with respect to these relevant components (diagnosis) to ***hear the current sound*** of the area. Based on the current sound, ***we play some buttons*** (policies) to improve this sound towards the 15-minute neighbourhood ideal song envisioned by its residents. For the purpose of this project, The 15mN Mixer is a contribution as it is a quick visual that policy planners can look at and consider when planning urban outskirts instead summarising findings from literature.

1. INTRODUCTION

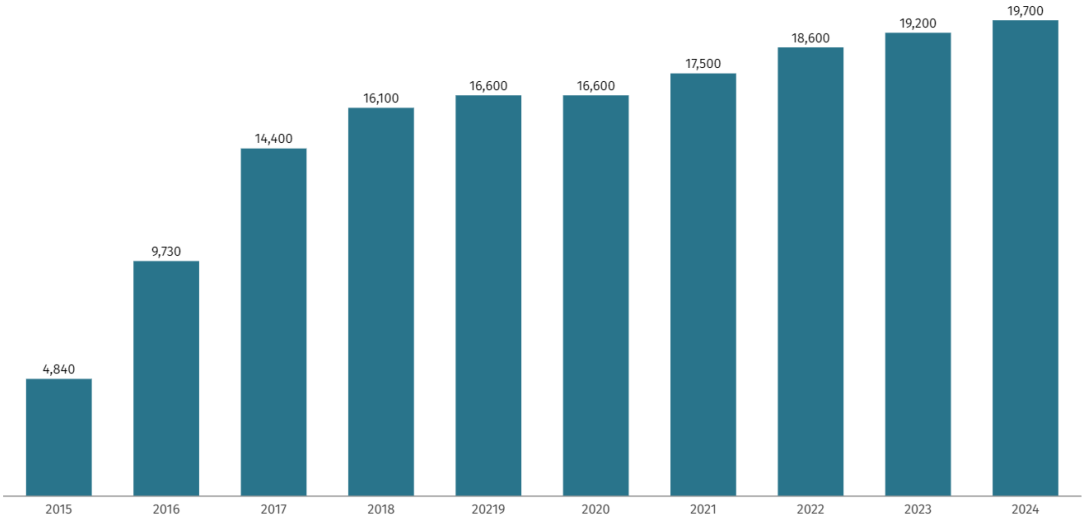
1.1. About the DREAMS Project

The project "Driving Equitable and Accessible 15-Minute Neighbourhood Transformations" (DREAMS) is funded as part of the Driving Urban Transitions partnership (DUT). Its overall objective is to ***examine how co-created and user-centric mobility services, mobility hubs and flexible activity hubs can contribute to accessible, sustainable and inclusive 15-minute neighbourhoods in urban outskirts in European cities and regions***. DREAMS is organised around seven work packages: WP1) Project and data management and quality control, WP2) Review and comparative analysis, WP3) 15-minute city decision support tool, WP4) New governance and business models and transition pathways, WP5) 15mC living labs, WP6) Impact assessment and evaluation and WP7) policy integration and recommendations, transferability and knowledge dissemination. This report is the first deliverable for WP2. The remainder of the report is structured as follows: section 2 describes the main definitions surrounding the concept, section 3 explains the methods used. Next, on section 4 we summarise the findings from the literature and the identification of the components and finally in section 5 we proposed our theoretical framework for the project with section 6 offering conclusions.

1.2. About Deliverable 2.1: revisiting the definition of 15mC

With the current climate emergency, achieving sustainable mobility as well as healthier and safer places to live in, are at the heart of many global and regional public policies. The task is clear: a transition from a car-oriented development into a proximity one, in which humans and the environment are prioritised (European Commission, 2021). In this context, we have seen a paradigm shift. Initially, after Second World War, the focus was put on how to move vehicles and the infrastructure that supported these movements (transport focus). Later, in the 2010s, the focus shifted to the ease with which people can move around, emphasising user's satisfaction levels rather than just the movement of vehicles (mobility focus). Then in the 2015s, the mobility ecosystem grew in complexity with the introduction of shared mobility and micromobility, offering the possibility to cover the first/last mile of those low or unserved areas by public transport. And then in 2020 came the COVID-19 global pandemic, along with its severe lockdowns, which prompted policymakers/politicians to re-think urban planning strategies. The focus shifted once again (as previous movements like the Garden City, Neighbourhood Unit and others outlined), to ensuring that people can easily access essential services and destinations. This approach extends beyond mobility, to consider factors such as proximity and the quality of access (accessibility focus). The ***15-Minute City (15mC)*** emerged as a new planning concept, and currently almost 100 cities around the globe were identified as having 15mC practices (Teixeira et al., 2024) and the growing interest in the concept is also illustrated by Google Scholar searches (see Figure 1).

Figure 1 Searches for the term "15-minute city" on Google Scholar (2015-2024).



Source: own elaboration.

The ideas behind this 15mC concept, were not new, as it builds upon the foundations already defined by previous researchers. For example, Clarence Perry had devised the concept of Neighbourhood Unit between 1909-1929 (Hall, 1989) and in the 2000s Robert Cervero's works outlined the fundamentals of proximity-centred planning with his 3Ds (Density, Diversity and Desing) (Cervero & Kockelman, 1997), which then became 6Ds (Destination, Distance and Demand Management-TOD) (Ogra & Ndebele, 2014)(origins furtherly explained in section 4.1). However, we do acknowledge the success of repacking these old ideas into a modern, time-pertinent, catchy and easy-to-grasp new label called 15-minute city to start the debate and hype around how to plan accessible, sustainable and inclusive cities.

From the theory of "chrono-urbanism" created by Carlos Moreno (Moreno, 2016), the 15mC advocates ***"for an urban set-up where locals are able to access all of their basic essentials at distances that would not take them more than 15 min by foot or by bicycle"*** (Moreno et al., 2021, p. 100). In its own essence, the concept focuses mainly on urban areas, as places where "*proximate access to everyday resources is easily attainable via the efficient provision of pedestrian, cycling and transit infrastructure to a sufficiently large population of consumers that provide demand for the amenities offered by local shops and service providers*" (Poorthuis & Zook, 2023, p. 1). However, we aim to examine how the concept evolves in different contexts beyond its original setting: the urban core. There is evidence now, of great inequalities within and across cities in terms of accessibility metrics (M. Bruno et al., 2024) and therefore, the 15mC definition must also adapt to different contexts, as cities are not homogenous. A global accessibility analysis of 10.000 cities is presented to visualise these inequalities and measure how cities are doing in their 15mC ideal (M. Bruno et al., 2024). Accessibility varies considerably, with disparities often following a core-periphery pattern where city centres are better served than outlying areas. Hence, it may not be feasible or practical to apply the same concept for every urban environment, particularly due to concerns about service quality disparity, local population densities, and geographical differences.

There is a need to consider Moreno's ideas with a context-specific mindset, to avoid its implementation as a "*technocratic, magic fix that ignores the complexities and challenges of social life"* (Shelton et al., 2015, p. 16). Moreno started to consider less densely populated areas around the label of ***30-minute territories*** or ***happy proximities*** (Moreno et al., 2021), highlighting the role of public transport and other mobility services to increase accessibility for longer distances. Regardless of the terminology used or the specific threshold set, the core idea remains the same: ***to implement proximity-centred planning of services and an explicit move away from reliance on cars, leading to fewer and shorter***

trips. In most cities who have adopted 15mC practices around the world (Teixeira et al., 2024) the focus in on urban cores and limited to no explicit attention paid to other areas as the broader periphery/suburban settlements. Several authors in the literature stress the need to move the concept beyond the urban core (Poorthuis & Zook, 2023; Vitale Brovarone, 2022). This is the focus of this report. We aim to focus on areas surrounding city centres, which we label as urban outskirts. See section 1.3 for our definition of urban outskirts.

Our aim then, is to fill major knowledge gaps in the existing literature related to finding successful pathways for the implementation of 15mC as a planning concept to achieve a sustainable and liveable urban transition outside of densely built city centres. It is currently unclear how the principles of proximity can be transferred to the urban outskirts with low- and mid-density neighbourhoods. Accessibility of many destinations, functions and opportunities (shopping and healthcare) is relatively low, and the business models for shared mobility services can be sometimes not so profitable given that there are lower levels of demand compared to dense urban areas. Additionally, the 15mC concept may have different understandings and perceptions in different spatial contexts and by different population groups. There is currently not a completely clear understanding of how people perceive their accessibility to amenities in the urban outskirts neighbourhoods (especially in the framework of 15mC topic), and what opportunities exist to change current car-dominated travel behaviour towards sustainable transport modes or reduce overall travel demand. All of these issues start by the task of revisiting the definition of 5mC. Therefore, this report aims to conduct a systematic literature review, to answer: ***what are the components to consider when trying to achieve 15-minute neighbourhoods in the urban outskirts? How similar or different are these elements in an urban core vs urban outskirts?***

2. SETTING THE COMMON GROUND: DEFINITIONS

The keywords that frame our research topics of interest are: outskirts, accessibility, mobility services, governance and business models. These terms are the ones that typically are related or associated to describe 15-minute planning practices and also are also central in the DREAMS research project. Hence, in this first section we briefly describe, as a glossary of terms, the definitions we will use for the purpose of DREAMS, as it involves researches from different fields and disciplines and we need to have a common ground understanding of terms before working together.

1.3. Topic 1: Urban outskirts

The first topic involves the framing of the research in terms of its spatial scope. On her work the Death and Life of Great American Cities, Jane Jacobs outlined the essential characteristics of the three geographical scales for urban planning (region, city and neighbourhood) (Jacobs, 1961). According to her work, the regional scale involved the interconnected network of cities and towns which are economically independent and functionally diverse. Moreover, cities were these complex, diverse and densely populated human settlements characterised by organised complexity and human-scale interactions. Lastly, she defined the neighbourhood as vibrant, mixed-use areas within a city that promote community feeling, safety and economic stability through diversity and active street life. Within these geographic spectrum, the 15mC concept calls back the attention on neighbourhoods as the *appropriate unit scale* for planning and analysing the relationship between daily mobility and spatial justice (Poorthuis & Zook, 2023).

However, to the question "which neighbourhoods (or types of neighbourhoods) allow residents to reach their essential services within X-minutes?" most studies have given an urban-core-oriented answer focusing mainly on dense city centres. But as Vitale Brovarone (2022) states, beyond the urban core centre, accessibility and mobility take on different features and dimensions and have to be observed

differently. Services and opportunities are rarefied and distant; time–space geographies realms, mobility patterns and modal split are profoundly different from those of dense urban areas. In these contexts, distances are higher, trips are longer and car dependence is higher. In these low-dense areas, residents have to be more mobile to access services and opportunities (including public transport) and this creates more vulnerability to become a car-dependent citizen (Ewing & Cervero, 2010; Pucher & Renne, 2005; Schwanen et al., 2004).

Hence, we focus on these areas, also known as satellite cities, suburban towns or peripheral areas which surround the urban city centre (but are not yet rural areas). And even though we acknowledge the difficulty in determining a hard cut-off criteria to decide what's urban and what's urban outskirts, for the purpose of DREAMS, we define *urban outskirts*, our spatial scale of research, as those ***medium-sized areas or neighbourhoods in the near context of an urban area, where high car dependency is present and a strong economical and functional connection to the city is observed, primarily through daily work commutes.***

1.4. Topic 2: Accessibility, proximity and walkability

The second topic involves the framing of the research in terms of its objective. The 15mC aims to create healthier, safer, accessible, sustainable and inclusive neighbourhoods. This objective is achieved by improving accessibility. But very often, searches related to accessibility give results mentioning the terms of walkability and proximity. Hence, we define those and their relationship in this section.

Accessibility is a wide-ranging concept, related to urban spatial layout, qualities of the transport and land-use systems, and to economic and environmental goals (Monteiro et al., 2023). It refers to the potential of opportunities for interaction (the ease of interactions), as well as the intensity of these interactions (Hansen, 1959). Accessibility provides the binding factor of urban structure key components: people, mobility, and social activities, and it is being increasingly incorporated into metropolitan transport plans and national planning guidelines (Järv et al., 2018).

Therefore, we stand by the definition of accessibility as ***the extent to which the land-use transport system enables (groups of) individuals or goods to reach activities or destinations by means of a (combination) of transport mode(s)*** (Geurs & van Wee, 2004). Consequently, accessibility is a function of transport, land-use, temporal and individual components described by (Geurs & van Wee, 2004) as:

- The land-use component: reflects the land-use system, consisting of (a) the amount, quality and spatial distribution opportunities supplied at each destination (jobs, shops, health, social and recreational facilities, etc.), and (b) the demand for these opportunities at origin locations (e.g. where inhabitants live), (c) the confrontation of supply of and demand for opportunities, which may result in competition for activities with restricted capacity such as job and school vacancies and hospital beds.
- The transportation component: describes the transport system, expressed as the disutility for an individual to cover the distance between an origin and a destination using a specific transport mode; included are the amount of time (travel, waiting and parking), costs (fixed and variable) and effort (including reliability, level of comfort, accident risk, etc.). This disutility results from the confrontation between supply and demand. The supply of infrastructure includes its location and characteristics (e.g. maximum travel speed, number of lanes, public transport timetables, travel costs). The demand relates to both passenger and freight travel.
- The temporal component: reflects the temporal constraints, i.e. the availability of opportunities at different times of the day, and the time available for individuals to participate in certain activities (e.g. work, recreation).

- The individual component: reflects the needs (depending on age, income, educational level, household situation, etc.), abilities (depending on people's physical condition, availability of travel modes, etc.) and opportunities (depending on people's income, travel budget, educational level, etc.) of individuals. These characteristics influence a person's level of access to transport modes (e.g. being able to drive and borrow/use a car) and spatially distributed opportunities (e.g. have the skills or education to qualify for jobs near their residential area), and may strongly influence the total aggregate accessibility result.

Accessibility has been recognised as one of the possible paths to sustainable development, as it puts more emphasis on the concept of proximity (having short distances) and using active mobility modes (walking and cycling). In a broad sense, from the understanding of mobility as *the ability to move*, then accessibility is *the quality of this move* in terms of reachability, which includes proximity (how close in distance are things to each other) and the promotion of active mobility (walking and cycling). Accessibility allows daily living to be facilitated without creating a dependency on long distance, fast, and energy-intensive transportation (Deboosere et al., 2018).

From this point of view, proximity refers to the ***physical distance between two points*** **and thus, we consider its definition as the location of people, services, and activities near one another (close in distance)**(Di Marino et al., 2023). Proximity is included in accessibility, as how near are things to each other, but accessibility also involves the ease of overcoming this distance (how easy is to get somewhere regardless of the distance)(Levine, 2019); a store may be 5 minutes away or in close proximity but if there is no sidewalk and stairs it will not be accessible for some people.

In this context, the term walkability plays a central role and is defined as ***the extent to which the characteristics of the built environment and land use may be conductive of residents walking*** (Di Marino et al., 2023). This relevance for walking environments, has brought attention to what has been called "accessibility by proximity", a planning approach that put the emphasis on accessing destinations by using active mobility (walking and cycling)(Bertolini et al., 2005; Priemus & Visser, 1995) and moving opportunities to people instead of people to opportunities (Rodríguez-Pose, 2018).

In summary, we understand accessibility as a the bigger and more complex concept involving the extent to which individuals are enabled to reach destinations and the quality or ease with to reach them, promoting proximity (having things closer) and active mobility (cycling but mostly walking). Hence, walkability plays a central role as it delves with the conditions that need to be in place to make people actually walk. These terms are interrelated and become of key relevance in the 15mC, as it deals with having amenities close by in a walking/cycling distance through the corresponding infrastructure.

1.5. Topic 3: mobility services

The third topic involves the framing of the research in terms of measures or interventions that can help to achieve sustainable and inclusive 15-minute neighbourhoods in the urban outskirts. Technology plays an important role in the 15mC, allowing new mobility solutions to cover the first/last mile of non-served or under-served areas with public transport. From the various range of strategies that cities use to achieve accessibility (Teixeira et al., 2024), we will focus on mobility solutions. We will define in this section the main solutions that will be tested in the DREAMS living lab locations in the urban outskirts of the cities of Brussels, Budapest, Munich, Paris, Utrecht and Vienna. This section will describe our understanding of possible interventions to help develop sustainable and liveable 15-minute neighbourhoods in urban outskirts: on-demand transit, shared mobility (including car-sharing and micromobility), mobility hubs and flexible activity hubs.

On-demand mobility services has been one of the key solutions for car dependency and it is defined as those ***mobility services provided on request, mainly through smartphone apps, with different***

degrees of flexible routes and schedules (UITP, 2024). This includes services like ride-hailing, carpooling, taxis, and demand-responsive transit, being with a driver or with autonomous driving technology. Unlike traditional public transport services, on-demand mobility offers dynamic routing, flexible pick-up and drop-off locations (Mehlert, 2014).

In its most recent Smart Mobility Strategy, the European Commission has highlighted the importance of shared mobility services as they have demonstrated to be crucial for intermodality and the public transport system's resilience (especially after the COVID-19 pandemic outbreak) (European Commission, 2021). It has been defined as a *short-term access to shared vehicles, according to user needs and convenience, rather than requiring vehicle ownership* (Shaheen & Cohen, 2019). With the exception of car-sharing, all other vehicles are for individual use and have low speeds (most up to 30km/hr). In this sense, the term micromobility was coined to refer to ***small, lightweight and low-speed shared modes as mopeds, bicycles and scooters*** (Shaheen & Cohen, 2019). Micromobility offers the same benefits of shared mobility in general, such as the reduction of noise and air pollution and the promotion of intermodality with public transport. But in addition, it offers greater flexibility by avoiding congestion, reducing parking space needed and in the case of mopeds, they provide greater speed, the possibility of traveling medium distances and a very attractive way to overcome the slopes in cities that are not flat (Aguilera-García et al., 2021). In short, we could define micromobility as all shared mobility with the exception of car-sharing (shared bikes, ecooters and modeps). Car-sharing on the other hand, has been defined as a ***system that allows people to use locally available cars at any time and for any duration***, emphasising that it differs from traditional taxis in a sense that the driver of these cars is also the person renting it (Münzel et al., 2019).

Last but not least, shared mobility hubs and flexible activity hubs have recently emerged as relevant innovations, combining conventional and new modes of transport at a specific location for easy access. Shared mobility hubs are ***physical locations where different shared transport options are offered at a dedicated, non-temporary and recognisable location, and where public transport is available within walking distance*** (Geurs et al., 2023). In the context of 15mC for the urban outskirts, shared mobility hubs would allow reaching activities placed in urban centres by using shared modes alone, or in combination with public transport. Similarly, flexible activity hubs (or pop-up stores) ***are temporary retail/activities uses that occupy a site for an intentionally temporary period of time*** (Harris, 2015). Their presence could help the users fulfil their everyday needs without additional car trips to urban centres, while boosting the local economy and encouraging social gatherings and participation (City Hall, 2016; Geurs & Munzel, 2022). These two interrelated innovations focus on the allocation or redistribution of space (mostly taken out from car parking) to include services, mobility options and concentrate all type of information that allows citizens to overcome accessibility issues. All these levers will be interventions to test in DREAMS living labs to measure how they impact on accessibility patterns in the urban outskirts.

1.6. Topic 4: Governance

The fourth topic involves the framing of the research in terms of targeted policies. One of the key challenges of 15mC implementation is to include residents 'perceptions of neighbourhood issues in the planning processes. This co-creation processes involved good governance frameworks to be in place and equity-based policies. Hence, this topic delves with the definition of governance as an umbrella concept enabling 15mC implementation. Although there is no universally accepted definition, the (United Nations, 2009) considers that in a context of ''good governance'', legal frameworks, institutions, political, managerial and administrative processes tend to respond to the rights and needs of the population. We will understand governance as ***the policy frameworks, public management, public-***

private partnerships or systems, processes, and practices that enable collective decision to be taken and carried out (Pierre, 2011; Rhodes, 1996; Stoker, 1998).

The transformations that have occurred from a public-policy perspective over the past decades have led to the development of the concept of governance in a way that reflects the changes in the roles and strategies of public institutions, but above all, the growing importance given to non-governmental entities and citizens during the decision-making processes. Good governance involves a shift from hierarchical control to horizontal coordination (Bevir, 2011).

In urban planning, these new governance approaches play an important role in shaping the spatial, social, and economic dynamics of cities (Healey, 2006). They influence through regulatory frameworks, how the resources are allocated, how policies are implemented, and more importantly, how different interests are balanced (Pierre, 2011). This is particularly relevant for the implementation of emergent concepts like the 15mC, which requires a high level of coordination among a diverse range of stakeholders (Allam & Jones, 2020; Moreno et al., 2021). In that context, good governance powered by adaptive regulatory frameworks is essential to ensure the development of mixed-use zones, efficient public transport and effective measure to address social inequity which are key for the implementation of 15mC (Pozoukidou & Angelidou, 2022).

For the purpose of enabling 15-minute neighbourhoods in the urban outskirts, equity-based regulatory frameworks become crucial. As stated by (Logan et al., 2021), pressing issues (climate change, population growth, fear of future pandemics, etc.) are affecting the distribution of resources and burdens in cities. Unfortunately, this distribution in transport-related infrastructures and services remains far from optimal, especially affecting those vulnerable to exclusion groups (elderly, low-income and marginalised communities) residing in underserved areas (Haxhija et al., 2024).

This unequal access to locations and resources has been analysed by researchers and known as equity-based planning or mobility justice, which shifts from a state-centric perspective to a society-centric one. On the most recent propositions for equity-based planning, authors like (Haxhija et al., 2024) proposed a framework based on distributive justice (fair allocation of resources and burdens) and recognition justice (ensuring that marginalised groups are acknowledged and included in decision-making processes). This equity-based planning approach with an equity perspective ***help in ensuring fair access to services in general (including shared mobility) for disadvantaged groups, targeting policy interventions to underserved neighbourhoods (priority areas) and including marginalised communities in the planning process.***

This latter point gives space to another central point of governance: citizen participation and co-creation processes. On the one hand, citizen participation refers to the ***process of actively engaging citizens, businesses, NGOs or any other relevant stakeholders in the processes of planning, decision-making, and implementation of policies and projects*** *(Geurs et al., 2023).* This process is grounded in the principles of transparency, voluntariness, equity, responsiveness, and respect for diversity. Public participation is considered crucial in planning and research for several reasons: it leverages local knowledge and lived experiences of citizens, builds community capacity, fosters democratic decision-making by involving those affected by the outcomes, and can enhance public support, thereby facilitating the effective implementation of plans (Larson & Lach, 2008). By creating an inclusive environment where stakeholders contribute to the evaluation and design of solutions, public participation aims to achieve more effective, efficient and sustainable results. The extent and intensity of participation can vary depending on the context and the willingness of the community to engage, but its core objective remains to empower all involved parties through a collaborative process that reflects their needs and aspirations.

On the other hand and closely related, co-creation is *a **collaborative process that actively involves various stakeholders, particularly the public, in every stage of the process: from identifying the issues, to designing, evaluating, and implementing possible solutions***. Unlike traditional participatory processes, where citizen engagement is often limited to consultation or feedback after experts have formulated potential solutions, co-creation requires a deeper level of involvement and shared responsibility. This approach not only aims to generate practical solutions to physical or social problems (such as enhancing road safety or increasing green spaces), but also seeks to produce practical knowledge that stakeholders can apply to similar challenges in the future. Co-creation can occur within the framework of research-led initiatives, such as 'Living Labs', or through collaborative efforts with local governments, civil organizations, and private sector entities (SMALL, 2023). It emphasizes the creation of value through joint effort and practical outcomes, distinguishing itself from conventional public participation methods by fostering a more direct and impactful engagement with communities.

For the purpose of 15-minute neighbourhoods in the urban outskirts, equity-based regulatory frameworks (involving fair allocation of resources/burdens and focus on vulnerable to exclusion groups) as well as the promotion of citizen participation with co-creation processes becomes relevant to know the desired times (acceptable travel times) and activities wanted in the neighbourhood and the role that residents could have in the planning process.

1.7. Topic 5: Business models

The last topic involves the framing of the research in terms of implementation/operationalisation. To operationalise 15mC, new business models should be created/adapted. They are often less mentioned in the literature but play a key role in defining new strategies to make land-use and mobility services and interventions sustainable/profitable/permanent in time.

In urban planning, traditional business and social business models play leading roles in shaping sustainable communities. According to (Osterwalder & Pigneur, 2010), a business model ***is a description of the rationale of how an organization creates, delivers and captures value*****.** It consists of various aspects: the value proposition target customer segments; distribution channels; customer relationships; revenue streams; key resources; key activities; key partnerships; and cost structure. The ultimate contribution of a business model is profit generation through effective meeting of the needs within the market.

From the traditional point of view, a business model outlines the strategy that an organisation has to implementing something (Münzel et al., 2019). It is driven by the market dynamics and a competitive landscape that pushes companies to prioritise financial returns, efficiency, and scalability. Success with such companies includes its gauging by metrics such as revenue growth, profitability, and market share. These traditional models have adapted over time to incorporate diverse revenue streams and business strategies, which has allowed them to remain competitive in rapidly changing environments, enabling businesses to respond quickly to new technological advancements and shifting regulatory landscapes.

Moreover, by continuously refining their approaches, traditional business models can capture emerging opportunities and mitigate risks associated with market volatility and evolving customer expectations. The business model would also work for changing market conditions and consumer preferences. From here, there originated innovations like subscription-based services, platform economies, and the sharing economy (Cisterna et al., 2023; Klopčič et al., 2020; Ritter & Schanz, 2019), all of which reflect changed consumer behaviour and technological development. The adaptability and innovation within traditional business models underscore their role in evolving urban environments where consumer needs and technological capabilities continuously shift. Uber's social benefits model exemplifies how technology-driven platforms can disrupt established industries by offering convenience, cost-efficiency,

and a superior customer experience, ultimately influencing urban mobility patterns and community structures.

On another note, there are social business models where social impact is an integral part of the business goals. These models transcend the traditional emphasis on profit maximisation by integrating social value creation as a core objective. A social business model is a concept in which ***entrepreneurial principles are applied to solve social problems, and profits are reinvested into the company for further continuation of its social mission and not for distribution to shareholders*** (Baguet, 2023; Mahfuz Ashraf et al., 2019). In contrast to purely profit-oriented businesses, social enterprises operate at the intersection of economic and social realms, aiming to balance both to foster sustainable communities. Social business models put private incentives and funds to work for public objectives. These models blend the creation of profit while solving social issues and for example, serving marginalised areas (López et al., 2019; Uteng, 2019; Yunus et al., 2010). The evaluation of success in social business models thus extends beyond financial metrics to include social impact metrics, such as community well-being, environmental preservation, and social equity. Innovation in the social business models will often involve new approaches to the allocation of resources, stakeholder engagement, and measurement of impact. Based on the literature, the key distinction between business and social business models lies in their fundamental objectives (Komatsu Cipriani et al., 2020), that are listed in Table 1.

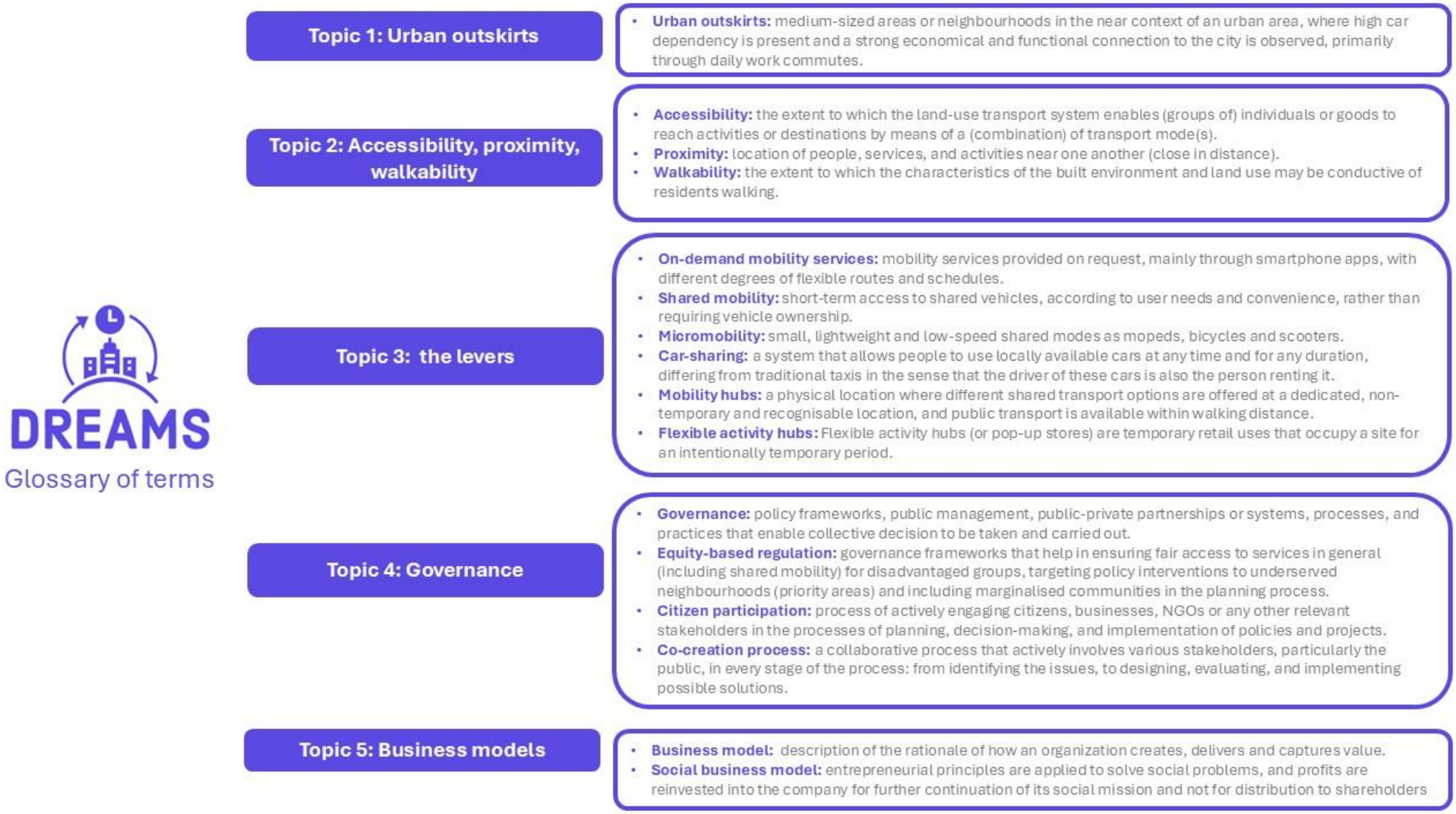
Table 1 Differences between business models and social business models

Aspect	Business Models	Social Business Models
Primary goal	Profit maximisation and shareholder value	Social impact and addressing societal issues
Value Proposition	Creating value for customers to generate revenue	Creating value for the community to solve social problems
Profit Distribution	Profits distributed to shareholders	Profits reinvested into the social mission
Revenue Streams	Sales, services, and products generating profit	Income generated but primarily focused on sustainability
Customer target	Targeted at profitable market segments	Targeted at underserved or disadvantaged communities
Key Metrics	Financial performance, market share, growth	Social impact, community benefits, financial sustainability
Investment Focus	Market opportunities, innovation for profit	Solutions for social issues, community development
Business Strategy	Competitive advantage, market expansion	Social mission achievement, community engagement
Sustainability	Economic sustainability for growth and profit	Balance of social, environmental, and economic sustainability

Source: (Komatsu Cipriani et al., 2020).

As a summary for this section we offer a quick summary of our ground-based definitions (glossary of terms) in Figure 2.

Figure 2 Quick glossary of terms for DREAMS project



Source: own elaboration.

3. SYSTEMATIC LITERATURE REVIEW: METHODOLOGY

Once we have briefly delved into the common definitions that frame our research topic, we now describe in this section the process followed to conduct the systematic literature review. The main objective of the literature review, as has been already mentioned in the previous sections was to answer the following questions:

1. What is the definition of 15-minute city (15mC)?
2. What are the key components of 15mC for urban cores and urban outskirts?

The review includes only academic scientific literature found through ***Scopus database***. As the aim is to capture what the scientific community is discussing on the topic. The documents revised were in English, in a final published stage and from scientific journals. The review was conducted using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. We used four sets of queries to find any journal paper published that mentions the "15-minute city" term in the title/abstract/keywords, as well as other topic keywords surrounding the research (accessibility, outskirts and shared mobility) as shown in Table 2.

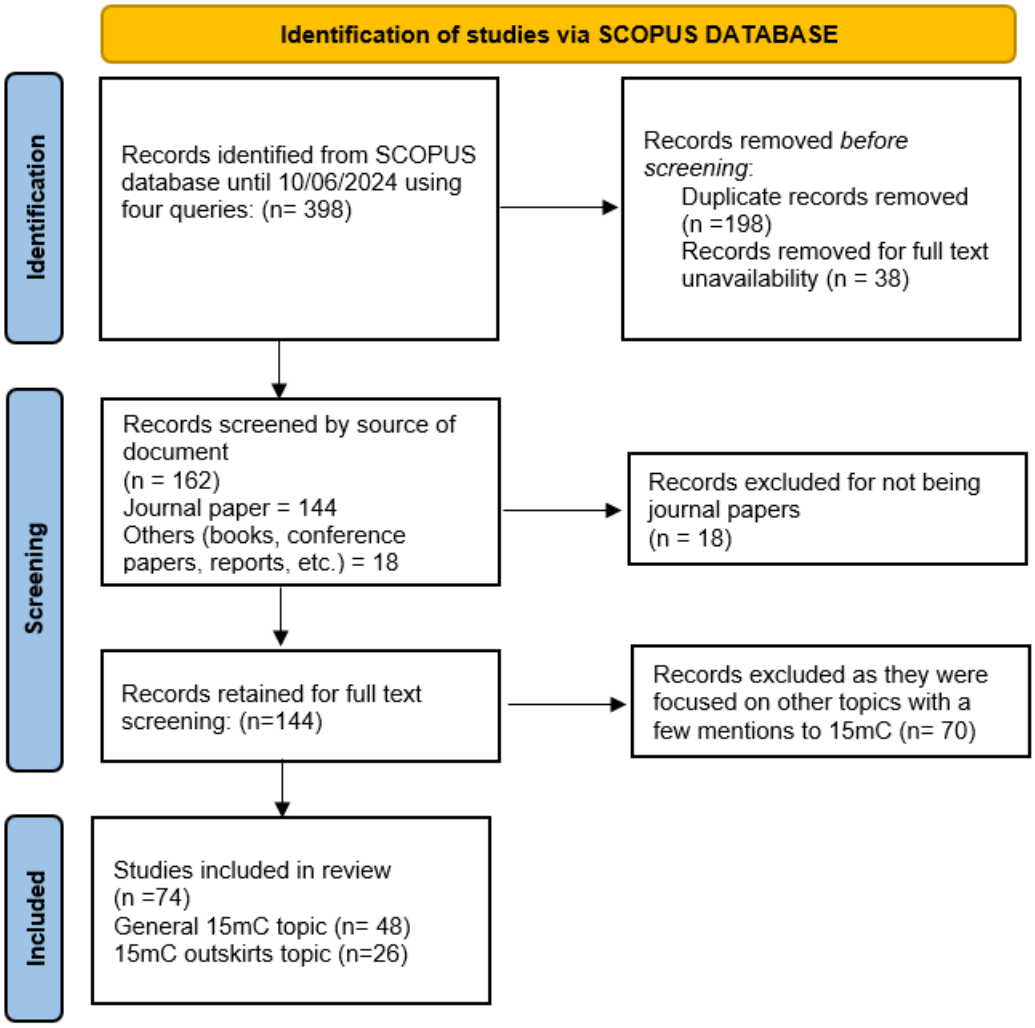
Table 2 Scopus queries used for conducting the literature review.

Queries	Focus	Results
TITLE-ABS-KEY ("15-miute city" OR "15 minute city" OR "10-minute city" OR "10 minute city" OR "20-minute city" OR "20 minute city" OR "30-minute city" OR "30 minute city" OR "x-minute city" OR "x minute city" OR "x-minute region" OR "x minute region") AND (LIMIT-TO (PUBSTAGE , "final"))	Title, abstract or keywords with **15mC** related words and limiting to finalised publications	199
TITLE-ABS-KEY ("minute city" OR "minute region") AND TITLE-ABS-KEY ("accessibility" OR "proximity" OR "neighbourhood" OR "walkable neighbourhood" OR "walkable city" OR "walkability" OR "pedestrian" OR "walk score" OR "chronourbanism" OR "chrono-urbanism" OR "chrono urbanism" OR "city of proximity" OR "liveable city" OR "Carlos Moreno" OR "transit-oriented development" OR "tod") AND (LIMIT-TO (PUBSTAGE , "final"))	Title, abstract or keywords with 15mC **and accessibility** related words and limiting to finalised publications	156
TITLE-ABS-KEY ("minute city" OR "minute region") AND TITLE-ABS-KEY ("outskirtss" OR "outskirts" OR "suburban" OR "suburbs" OR "suburbia" OR "periphery" OR "peri urban" OR "fringes" OR "edge city" OR "dormitory" OR "exurban" OR "satellite") AND (LIMIT-TO (PUBSTAGE , "final"))	Title, abstract or keywords with **15mC and outskirts** related words and limiting to finalised publications	17
TITLE-ABS-KEY ("minute city" OR "minute region") AND TITLE-ABS-KEY ("shared mobility" OR "micromobility" OR "micro-mobility" OR "micro mobility" OR "shared modes" OR "bickeshare" OR "bikesharing" OR "bike-sharing" OR "moped" OR "moped-style scooter sharing" OR "scooter sharing" OR "scooter" OR "scooter-sharing" OR "shared motorcycles" OR "shared scooters" OR "active travel" OR "active mobility") AND (LIMIT-TO (PUBSTAGE , "final"))	Title, abstract or keywords with 15mC **and shared mobility** related words and limiting to finalised publications	26
Total		**398**

Source: own elaboration.

The search was conducted from March 1st until June 10th of 2024 obtaining 398 results. Many documents appeared repeated in the different queries' results, so duplicates were discarded. For further document screening process we needed full-text availability, so we only kept open-access records, those available via university account, and only scientific journal papers (144 records). Furthermore, we did a first screen of documents by reading the title and abstracts discarding some documents that only mention tangentially the 15mC concept. Finally, the full reading of papers was done for 74 papers, which were categorised in two main groups: 1) general: if the document focuses on the 15mC concept around urban city centres and 2) outskirts: if the document mentions or delves into the 15mC implementation for outskirts or other setting beyond city centres. From the 74 documents revised, 48 fell in the general group and 26 in the outskirts one as seen in Figure 3.

Figure 3 PRISMA flowchart to select documents for review.



Source: own elaboration.

After classifying the literature according to general or outskirts (1st categorisation), we did a second categorisation of the documents according to their main focus as shown in Table 3.

Table 3 Second categorisation of studies based on their main focus and topic.

2nd categorisation (focus)	Description	1st categorisation (topic)	Number of studies	
15mC concept	Studies that focus on the concept of 15mC describing its components, history, foundations. Also critical studies that generate debate around the concept and review studies.	General	12	16
		Outskirts	4	
Application of 15mC principles	Studies that propose or used previous methodologies to asses or measure 15mC principles using cases of studies. Studies that conduct comparative analyses and use diverse measurements and approaches to address 15mC.	General	13	29
		Outskirts	16	
Human perspective	Studies that focus on the socioeconomic aspects, the user perceptions, different target groups and equity issues.	General	5	9
		Outskirts	4	
Governance	Studies that delve into planning documents, policy practice, business models and governance frameworks.	General	8	10
		Outskirts	2	
Other	Studies that focused on other specific issues: amenities (health, parks, stores, shops, work) or modes (public transport, shared mobility, etc)	General	10	10
		Outskirts	0	
	Total			**74**

Source: own elaboration.

With the 74 papers classified, we proceeded to read, analyse and synthesise the most relevant results in summary files which we then used to compile findings on a document table. With this main table we were then able to make summary tables and graphs showing the results and findings from the literature review.

The rest of the report describes the results of the literature review indexing the studies (see Appendix 1 and Appendix 2 for the authors' tables), from 1 to 48 for the general literature and from 1 to 26 for the outskirts literature, based on the publication year (low number of index means older study and high means most recent studies). This means that study 1 is older than study 48 for the general topic, and study 49 is older or was published before study 74. In this sense, we can analyse how the literature behaved as time passed by, exploring if authors' position or points of view changed over time.

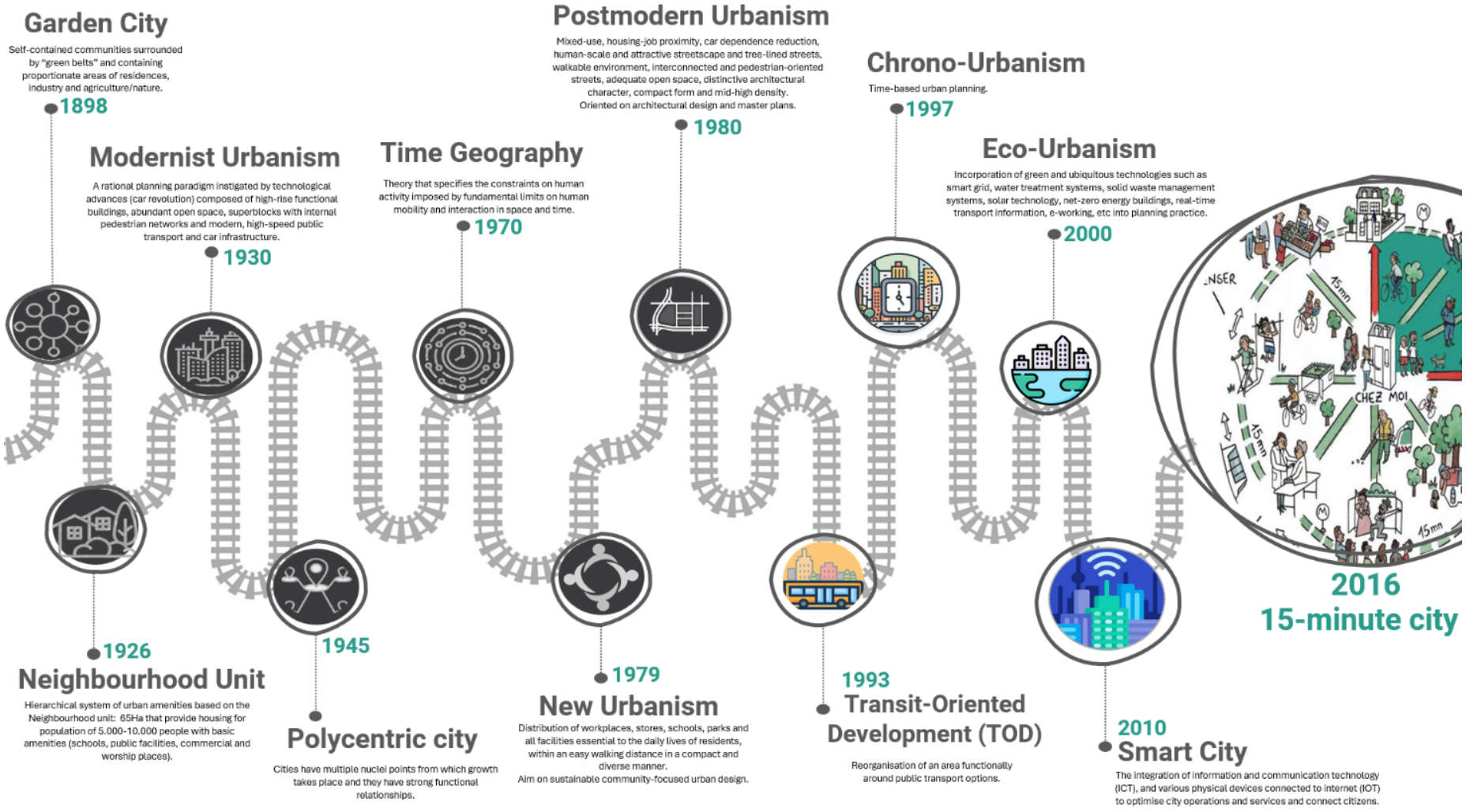
4. TOWARDS THE 15MN CONCEPT ADAPTATION FOR URBAN OUTSKIRTS

Once the methodology has been outlined, this next section describes the main findings from it. To that end, we first revisit the origins/foundations of 15mC, then we explore different definitions of the concept in the literature and explore its evolution over time. Finally, at the end of the section we propose an adaptation of the 15mC concept for the urban outskirts which we will then use for the rest of the DREAMS project (DREAMS 15mN definition).

4.1. The origins of the 15mC concept

Many researchers have called the attention to the fact that 15mC is not a completely new concept (Casarin et al., 2023; Kissfazekas, 2022; Poseidon & Chatziyiannaki, 2021). Recent research (Khavarian-Garmsir, Sharifi, Hajian Hossein Abadi, et al., 2023) shows that it is based on at least, five previous key neighbourhood planning movements: garden city concept, neighbourhood unit plan, post-modern urbanism, and eco-urbanism. Other report (Büttner et al., 2022) highlights the importance of other urban planning approaches like Polycentric City, Cervero's 5Ds, Time Geography, Transit-Oriented Development, New Urbanism and Chrono-Urbanism (see Figure 4). All these movements promoted compact and neighbourhood-oriented settlements, but the automobile revolution altered the urban structure by making it possible to live/work or conduct daily activities further away. Urban sprawl became the norm and cities were challenged with traffic congestion, pollution and social injustice issues. Since then, urban planners have been trying to revive traditional urbanism, reducing car dependency and encouraging sustainable mobility.

Figure 4 Timeline of the 15mC concept



Source: own elaboration with the information compiled from (Büttner et al., 2022; Khavarian-Garmsir, Sharifi, Hajian Hossein Abadi, et al., 2023).

We can briefly describe some of these movements:

- Industrial revolution: planners aim to increase urban efficiency by centralising amenities and activities in the city centres which then resulted in environmental degradation, physical deformities and health emergencies.
- Ebenezer Howard's utopian Garden City: first attempt to address social health issues through physical design. He envisioned a network of interconnected self-contained satellite towns surrounding a central city encircled by a greenbelt. Neighbourhood's size was set on 5.000 people and commercial and job sites were considered relevant.
- Clarence Perry's Neighbourhood Unit: the neighbourhood was set as the basic planning unit. He envisioned neighbourhoods were residents live near elementary schools, parks, meeting places, places of worship and retail complexes. Neighbourhood's size was set on 10 people per acre. Pedestrian networks were encouraged, shopping centres were placed at a 400m walking distance.
- Jacobs, Duany, Platerzyberk and Calthorpe's post modernism: this approach was the umbrella concept for other movements like transit-oriented development, new urbanism, and smart growth. Neighbourhoods characterised by walkability, human scale and compactness including mixed-use, housing-job proximity, green areas. They envisioned well-connected blocks that promote walking and cycling and allocate jobs and leisure activities. Diversity is an essential component of post-modern urbanism, which implies a mix of residential uses, income groups, employment opportunities, shops, parks, and civic institutions.
- Climate change crisis: resulting in the Eco-Urbanism movement based on sustainable development goals, aimed at addressing the pressing issues of climate change and environmental sustainability, in addition to the challenges that cities have traditionally faced. The focus is put on low-carbon cities and lower ecological footprint. Since 2010s, the movement Smart City has also emerged. A smart city considers the six main dimensions of people, mobility, living, environment, economy, and governance to achieve balanced development. It utilises cutting-edge technology to reduce waste and carbon emissions and manage air pollution.
- Nowadays-Post COVID 19 era: after 2020 with the pandemic outbreak, many governments imposed unprecedented movement restrictions and quarantine measures. Physical contact was reduced to minimum and public transit environments were identified as risk zones for contagions. Walking, cycling and micromobility gained popularity, allowing residents to conduct daily activities maintaining social distance measures at the same time. Urban health, which stayed as a secondary concern became a primary one after the pandemic and proximity to services became a focal point of urban policy. The COVID-19 pandemic confirmed the efficacy of complete neighbourhoods during health emergencies, showing that car-dependent neighbourhoods and cities based on modernist ideas and principles are not resilient during adverse events such as pandemics. Therefore, the 15mC, originally introduced by Carlos Moreno in 2016, was revived by Paris Mayor Anne Hidalgo, who promoted it in her re-election campaign during 2020 as part of a COVID-19 recovery strategy. This concept is based on the concept of "chrono-urbanism," which focuses on the decentralisation of cities as a critique of modernist planning that required separation, centralisation, and consequently long distances and high levels of (car)mobility.

In this sense, 15mC is only new in how it repackages existing concepts, presenting them in a simplified and more accessible way. Thanks to a global pandemic, it has gained popularity highlighting the importance of rethinking urban planning to guarantee urban health, ensure access to essential services and green spaces.

4.2. Existing definitions of 15mC

After revisiting the origins of the concept, this section delves in the examples and proposed definitions of 15mC found in the literature review. To this end, we used the 16 out of 74 papers that were focused on conceptualising the 15mC (see Table 4).

We begin highlighting the definition offered by Carlos Moreno, considered the father of the concept, that defines it as a "*concept that advocates for an urban set-up where locals are able to access all of their basic essentials at distances that would not take them more than 15 min by foot or by bicycle*" (Moreno et al., 2021, p. 100). In the project Flowers of Proximity, 15minC is defined as a "*concept of urban planning that aims to create places where all essential services, such as work, education, healthcare, and recreation, are located within a 15-minute walk or bike ride from each other*" (Büttner et al., 2022). According to (Basbas et al., 2023), 15-minute cities are characterised by: easy accessibility, optimisation of the location of services, socio-economically equity, reduction of the use of private vehicles, strong pedestrianisation. As stated in (Abdelfattah et al., 2022), the concept is the contemporary synthesis of the renaissance "ideal city", where the classical "human measure" is now interpreted far beyond the mere geometrical perspective, introducing a health and environmental risk dimension. Time is no longer just the twin concept of space, but a climate agent, a therapy of a regenerative urban medical science. Based on this concept, (Abdelfattah et al., 2022) state that the city is both polyrhythmic (individuals have different daily life rhythms) and polychronic (how places are used varies according to various schedules) and hence, the focus shifts from 'urban planning' to 'urban life planning'.

As shown in Table 4, we can see that definitions vary according to the spatial scope of the research. On the general literature, which is more focused on the 15mC for urban cores, the definitions mainly focus on the 15-minute threshold and the role of active mobility (walking and cycling). The studies in this group describe their goals more oriented into reducing food-shortage and increasing urban health. By contrast, definitions found in the outskirts literature seen more reserved when it comes to setting a fixed time threshold and they even prefer to extend it to 20, 30 or even 45 minutes (Birkenfeld et al., 2023; Both et al., 2022; Calafiore et al., 2022; D. C. Da Silva et al., 2020; Lima et al., 2022). For example, (Both et al., 2022) defined a 15mC as a "*city where most people have their employment and amenities accessible within a 30-minute walk or public transport trip*". In most of the cases they stand by the broader terminologies of "x-minute city" or "x-minute territory" (Knap et al., 2023; Poorthuis & Zook, 2023). Moreover, the outskirts definitions include public transport and shared mobility services in the mix (some even considered them as essential amenities) and goals are mostly oriented to reduced car dependency on a regional area.

Even though some variations are observed, common elements stayed the same throughout all the definitions: the presence of active mobility and the ease with which people may reach essential services. As (Moreno et al., 2021) states, the selling point of the concept is its emphasis on *proximity-centred planning*, where an urban neighbourhood is planned to accommodate an optimal density that would have access to basic essential services within a 15-min walking or cycling distance. But as (Birkenfeld et al., 2023) points out, the 15mC concept emerged mainly from historically older European regions, which were designed prior to the car-domination era. These authors also suggest that as many European decision makers are including this popular concept in their policy guidelines, in the case of North American cities or other contexts like Australian/New Zealand cities, it is still in the discussion whether or not the 15mC fits for all types of urban environments, agreeing with (M. Bruno et al., 2024). In regions where the automobile played a structural role in urban planning, the 30-minute city has emerged as an adaptation to the concept (Birkenfeld et al., 2023; Guzman et al., 2024; Liu, Kwan, & Wang, 2024). Even the concept's founders (Moreno et al., 2021) suggest that their concept is not rigid in nature and is proposed with the intent to be tailored to individual cities based on both their morphology and specific

needs and characteristics. They have reinforced that the time threshold is not relevant, but need to underline that proximity-centred planning which is key in sustaining quality of life and in providing for the basic urban functions. Hence, researchers are confronted with the question of: To what extent can 15mC principles be applied in any urban environment? Should public transport and shared mobility services be included? What about jobs? These questions are the current debate around the definition of the 15mC and is the main motivation of our project to propose an adapted definition of the 15mC for the outskirts.

Table 4 Examples of 15mC definitions offered in the general and outskirts literature

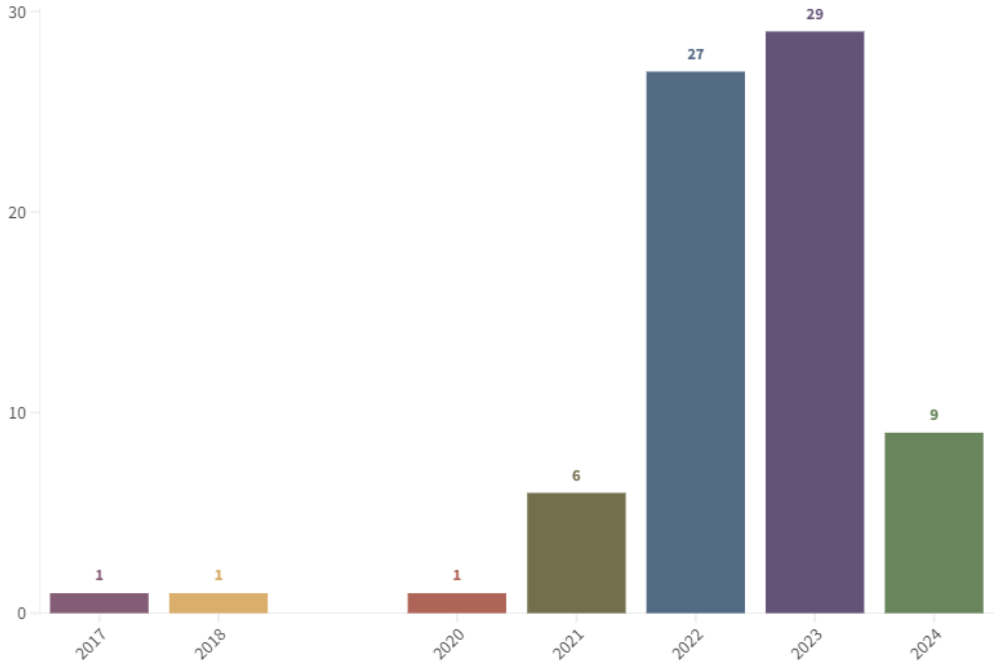
Study ID	Definitions offered for 15mC in the general literature	Key points
3	A planning model in which all citizens are able to meet most or all of their needs within a short walk or bike ride from home.	• Definitions more focused on the walkable and cyclable distances to services. • Emphasis is put on the 15-minute threshold. • Goals: reduce food-shortage and increase urban health.
5	A concept that advocates for an urban set-up where locals are able to access all of their basic essentials at distances that would not take them more than 15 min by foot or by bicycle.	
11	An urban neighbourhood that is planned to accommodate an optimal density that would have access to basic essential services within a 15-minute walking or cycling distance.	
14	A design and management concept to allow access to the urban life experience (essential facilities and services) in a timeframe of a quarter of an hour from home, by walking or cycling.	
19	A model of urban development and planning that seeks to shift attention to the neighbourhood as a "place" rather than merely a spatial and functional planning unit.	
26	A concept that aims to give people access to all essential services and daily needs within X minutes of active transportation, to improve transport equity, sustainability, and traffic safety.	
28	Ensuring equal access to urban services for everyone, within a 15 min radius, while also dispersing city infrastructure and functions to achieve social equity.	
34	An urban planning model in which the idea is to create smaller, more connected, and hyperlocal neighbourhoods, where everything people need is within a 15-minute walk or bike ride.	
37	A concept that aims to create dense and connected socially and functionally mixed neighbourhoods based on the human scale design to encourage walking and cycling.	
44	A concept where urban residents should be able to access locations of urban functions that are essential for supporting their quality of life through active travel like walking or cycling.	
46	An urban setup where residents can access all their basic needs and services within 15 minutes of walking or cycling from their homes without requiring a car	
Study ID	**Definitions offered for 15mC in the broader suburban literature**	**Key points**
49	A city that allows its residents to access most activities required for good living within 20-minute walking, cycling, or using public transit from their homes.	• The threshold is increased to 20, 30 or even 45 minutes. X-minute cities or x-minute territories terms are more common. • Emphasis on car dependence reduction (outskirtss are more car dependent). • Emphasis is put on the role of public transport and shared mobility services to connect people to more specialised services and increase access. • More common to find work and public transit as functions (amenities). • Spatial scales go from neighbourhoods to regions.
54	A type of design aimed at reducing car dependence by enabling urban residents to walk or cycle to essential amenities within x-minutes from their home.	
55	A planning model where residents in every neighbourhood have easy access to goods and services.	
56	The idea that basic human needs in a city must be accessible by the residents within a 15-minute commute from their residence.	
57	A city where most people have their employment and amenities accessible within a 30-minute walk or public transport trip.	
62	The idea that describes a (part of the) city (urban region) whose citizens can access the most necessary activities by walking or biking to cover their basic needs in 15 minutes or less.	
63	An idea of an idealized state whereby residents can access their daily needs within a 15-minute walk, bicycle or transit ride from their home.	
65	A concept that supports the need for proximity-centred approaches, bringing activities to the neighbourhoods rather than people to activities.	
66	A city model in which dwellers can access their vital needs in about a quarter of an hour by walking, cycling, using public transport or a shared micro-mobility service.	
70	Developing multifunctional, walkable neighbourhoods that offer a full range of daily services.	
72	An urban model in which the six fundamental functions (living, employment, education, healthcare, entertainment, and commerce) are located within a modest distance from each residential building to encourage active mobility.	
74	Accessing a range of non-work urban social functions within a short distance from home. All daily services and amenities should be met within a walkable distance of a residential area, including access to high-quality public transport that provides a connection to high order services and employment.	

Source: own elaboration.

4.3. Evolution of the 15mC concept

As Figure 5 shows, even though the 15mC concept existed since 2016, it was just after the COVID-19 pandemic (after 2020) that it became a popular topic in research.

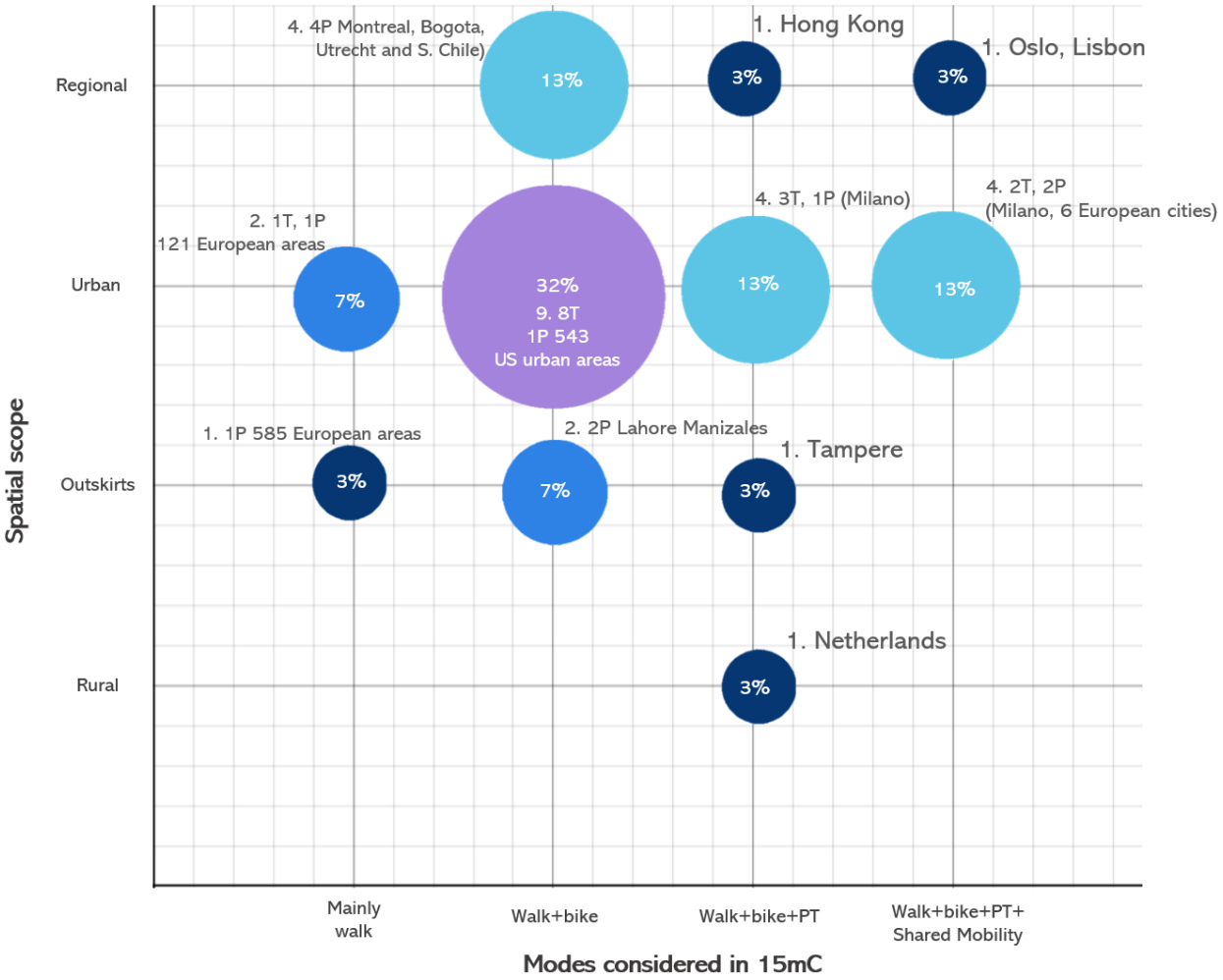
Figure 5 Number of studies revised discussing the 15mC concept.



Source: own elaboration.

From the literature database (74 documents), most studies are from European cities. On the specific case of practical studies (29 studies related to the application of 15mC principles), 18 are from European cities, three from United States, three from Latin America, two from Asia and three from other regions. Of particular interest are those studies that compared results for more than one case study. Examples of these include (Murgante, Patimisco, et al., (2024) that analysed four Italian cities, Barbieri et al., (2023) that compared Rome, London and Paris, (Di Marino et al., 2023) with Oslo and Lisbon and Gaglione et al., (2021) comparing Naples and London. The only study that compared more than three cities was Logan et al., (2022), including the 500 largest cities in the US and the 43 urban areas of New Zealand. Latin American studies Guzman et al., 2021, (2024) focused on low-income population in the global south (particularly in Colombia) highlighting the need to include personal perceptions and perspective in the 15mC approaches. In Figure 6 we can also see how the studies revised position based on the modes included in their analysis and the spatial scale considered (regional, urban, outskirts, rural). As we have already mentioned, most studies focus on the urban cores and include walking and cycling, as the original concept states.

Figure 6 Mapping of literature according to modes/spatial scope considered in the analyses.



Source: own elaboration.

The labels inside the circles represent the percentage (%) of studies in the particular spatial scope/modes position. The labels outside the circles represent the absolute number of studies and the letter "T" stands for theoretical studies (conceptual) while the "P" stands for the practical (application on case studies) studies.

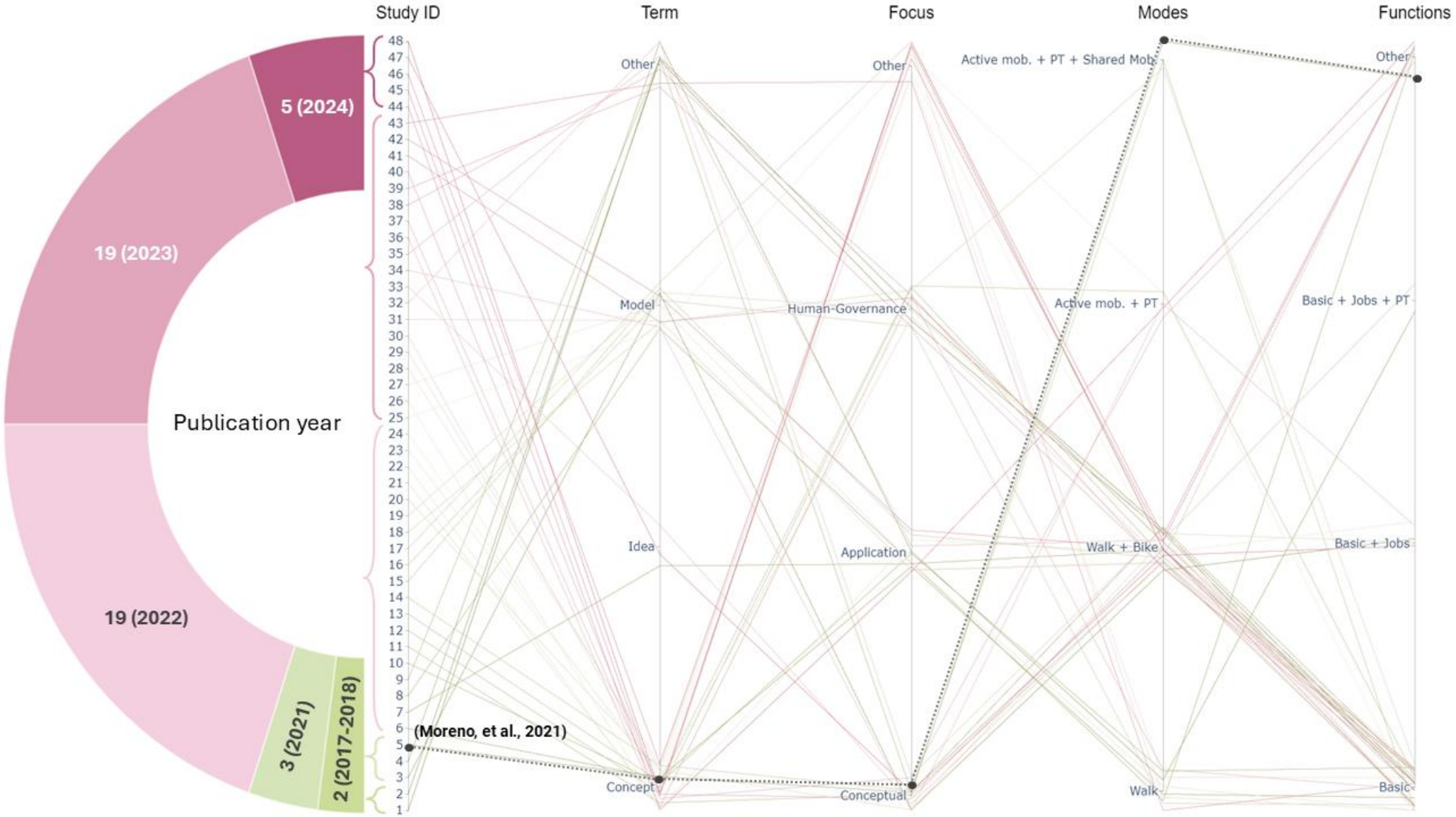
Moreover, in Figure 7 and Figure 8 we observe an overview of the literature (74 studies; 48 general and 26 outskirts) ordered by date of publication (high index number means more recent document). It illustrates the year of publication, the term used by authors to define the 15mC, the focus of their research and the modes and functions (destinations/amenities) included in their analyses.

In the case of the publication dates, we find that the documents in the general topic were published mostly during 2022 and 2023, but in the case of the outskirts topic, we see a latter pattern with most of them published during 2023. This pattern describes how at the beginning the focus, as usually happens with all new concepts, is put on defining and applying it; while just some time after the topic has been established, new research begins to look further into gaps and overlooked topics, being one of those: the adaptation of the concept for the outskirts. This is also noticed when delving into the focus of the studies, as we see that in the general literature, there is a more homogeneously distributed interest in different topics. At the beginning mainly on defining and making critical analyses but more recently looking into diverse topics like governance issues with 15mC, the inclusion of human and equity perspective or very specific topics like the role of universities (Barratt & Swetnam, 2022), park accessibility (Jeon & Jung, 2024; Limerick et al., 2023; Zhang et al., 2023), technology (Allam, Bibri, Jones, et al., 2022; Liu, Kwan, Wang, et al., 2024), informal communities (Dumedah et al., 2024) or even mosques accessibility (Harroucha & Chaouni, 2023) in the 15mC. On the other hand, outskirts literature, which emerges

relatively later after, focuses mainly on methodological approaches or practical studies that apply or test 15mC principles to different urban settings (urban core vs urban outskirts).

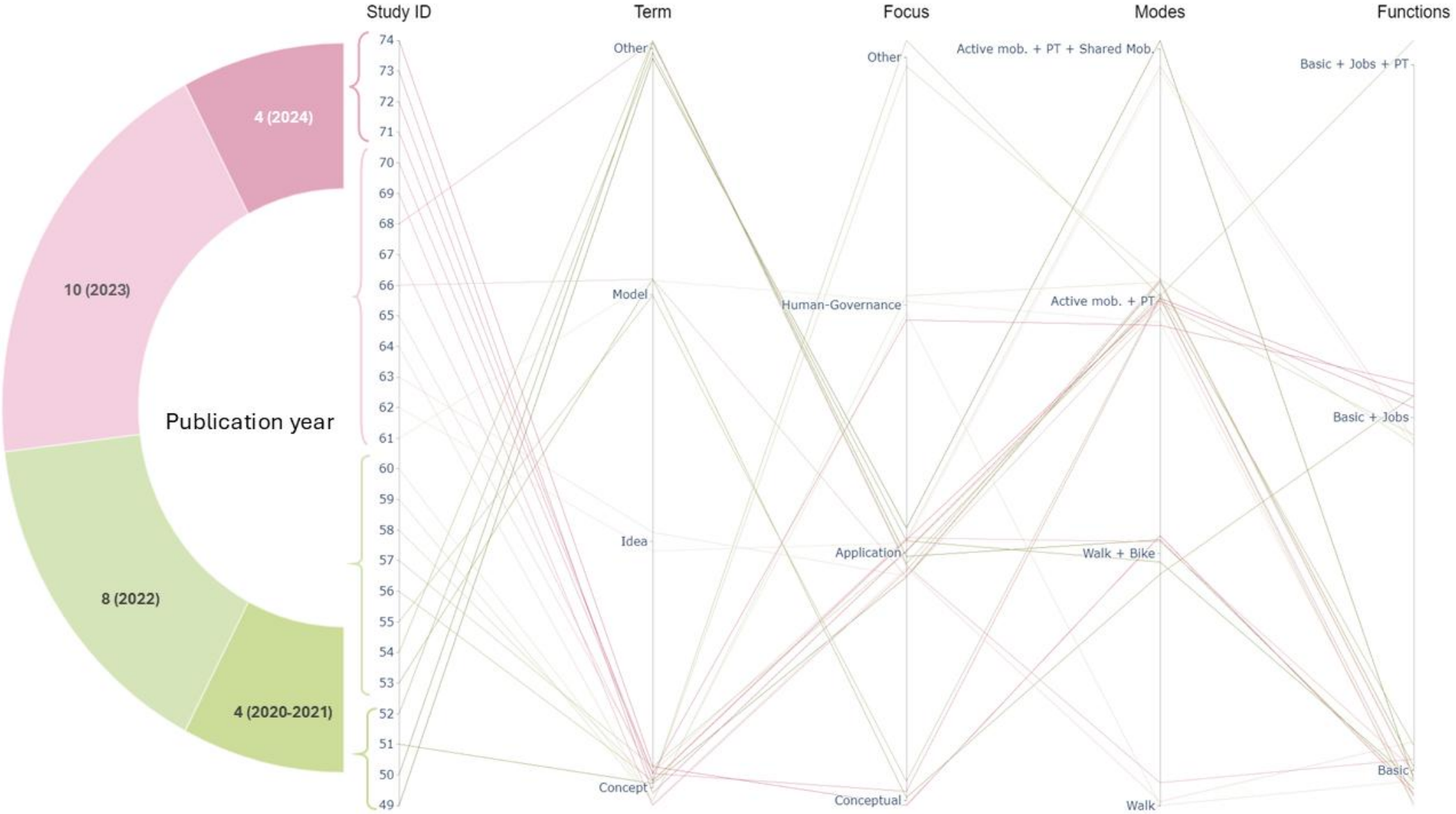
Regarding the terms used to define 15mC, we see that at the beginning (oldest studies) many authors suggest different terms ("model", "idea", "planning policy", ''approach", etc.) as it is a nascent and emerging topic, but then in both cases (general and outskirts literature), the most recent studies stand with the term "concept" when defining 15mC. Finally, in the case of modes and functions included, differences between the two piles of literature are very notorious. On the case of the general literature, most of the studies focus on walking and cycling and basic functions (amenities), while on the outskirts literature we see a clear pattern to include public transport in the mix showing the importance of this service for the outer peripheries (Calafiore et al., 2022; D. C. Da Silva et al., 2020; Fazio et al., 2023; Poorthuis & Zook, 2023; Renaningtyas Manifesty & Park, 2022; Wolański, 2023) and also including job functions (Both et al., 2022; Di Marino et al., 2023) or even public transport as an amenity (Aristizábal et al., 2023; Graells-Garrido et al., 2021; Liu, Kwan, & Wang, 2024; Liu, Kwan, Wang, et al., 2024; Noworól et al., 2022).

Figure 7 Overview of general literature (urban focus): Publication year, terms used to define 15mC, focus and modes/functions considered.



Source: own elaboration.

Figure 8 Overview of outskirts literature: Publication year, terms used to define 15mC, focus and modes/functions considered.



Source: own elaboration.

With this first overview of the literature, we conclude that there is indeed a need to adapt the definition of 15mC for the outskirts. This adaption of the original 15mC concept should include other scales beyond the urban core centres, but also should consider public transport and shared mobility services to fulfil the first/last mile trips and finally a different set of amenities could be necessary, especially a further analysis of job locations is to be studied.

4.4. Equitable, and Accessible 15-minute Outskirts Neighbourhoods (DREAMS 15mN)

The need for a new adapted version of the 15mC concept for the urban outskirts, motivates the introduction of what we call ***Equitable and Accessible 15-minute Outskirts Neighbourhoods (DREAMS 15mN)*** which is an adapted version of the 15mC for the urban outskirts. With the "ON" part of the acronym, we call the attention to our spatial scale of focus: the **O**utskirts **N**eighbourhoods. But we also emphasise that each neighbourhood will have a different starting point and its own transitioning pace to comply with the 15-minute city ideal, based on their current urban structure resulted from previous planning approaches (for example the usual car-oriented design of many American cities) (see Paris vs Atlanta in map) (M. Bruno et al., 2024). We also think that the main idea behind the 15mC concept: planning for happy proximities is more important that any specific time threshold: whether 10, 15, 20 or 30 minutes, we summarise it by considering x-minutes and ON. By doing this, we leave behind this debate and actually shift the focus to what we think is most relevant: how to make access to amenities feasible using innovative mobility solutions and targeting vulnerable groups in the urban outskirts. Consequently:

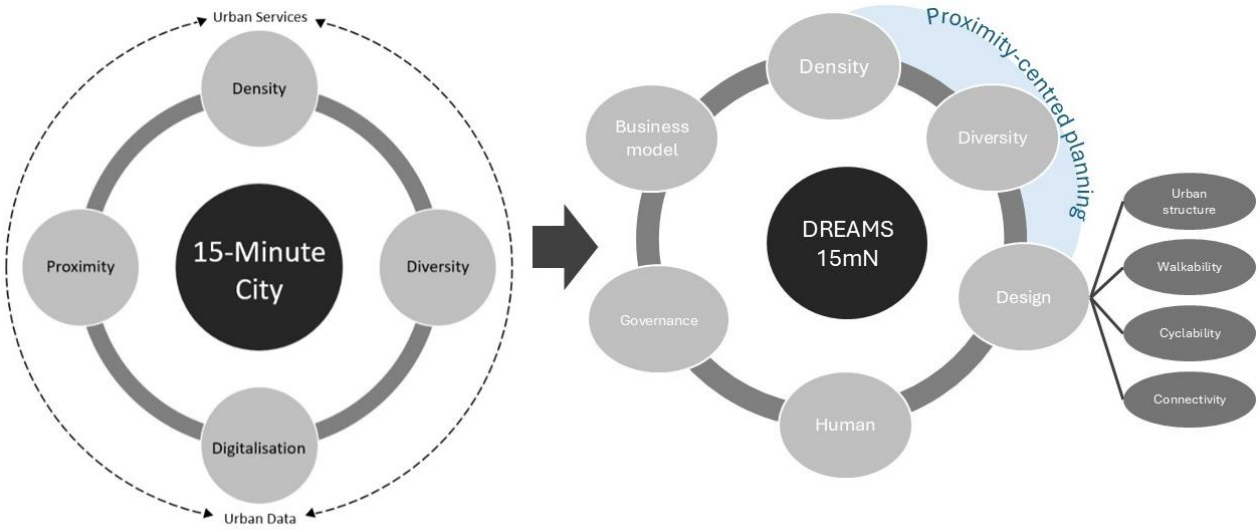
> ***"DREAMS 15mN is an adapted version of the 15mC concept that focuses on the reduction of the need to use a private car in the urban outskirts allowing its residents to access their essential amenities and fulfilling daily needs through active mobility and local infrastructure (like public transport, shared mobility services, mobility/activity hubs among others), while also being well connected to other cores through regional infrastructure. This adaptation of the concept focuses on user's perceptions and preferences regarding acceptable travel costs to amenities".***

As DREAMS 15mN is an adaptation of the 15mC concept, we depart from the consideration of Moreno's original concept components (density, diversity, proximity and digitalisation) (Moreno et al., 2021). Moreno's density refers to the optimal density level in terms of people/km2, the efficient use of spaces (for example schools being used as playgrounds out of schedule hours) and including different cultural and socioeconomic status population. Regarding proximity, Moreno states it should be in both, time and space proposing time-based urbanism: people should be close to services and a multimodal use of basic infrastructure should allow intense use of building throughout the day (multipurpose and multitemporal use of buildings), for example schools as playgrounds in off-hours. Moreover, when referring to diversity, Moreno considers two dimensions: 1) diversity in land use/services/amenities/activities (mixed use) and 2) diversity in cultures (social inclusion) promoting attractive areas. Lastly, Moreno's digitalisation refers to the inclusion of innovations to reduce car dependency and emissions like online shopping and deliveries, virtual communications, teleworking, green energies and mobility solutions.

Based on Moreno, the inclusion of different socioeconomic and cultural groups are in both density and diversity components. This repetition makes it confusing, and thus we separate this in a different component called Human perspectives which will be described in more detail next. Hence, for the DREAMS 15mN concept, density means only residential density (people/urbanisedkm2) and diversity means only quantity and quality of amenities which is the name we use to group all kinds of services

which in the literature also acquired different names like to activities, destinations, attractions, infrastructure, opportunities, functions, etc. Then, design component refers to the urban structure, walkability, cyclability and connectivity conditions that allow people (density component) to reach amenities (diversity component). Public transport and new mobility solutions (including shared mobility but also mobility/activity hubs) is generally considered by Moreno in the digitalisation component. This is something we also differentiate more, making some room for what we call connectivity subcomponent, as it constitutes a key infrastructure that plays a central role in connecting urban outskirts to the nearest urban cores. All the three (density, diversity and design) align with Cervero's fundamentals (Cervero & Kockelman, 1997) and create the main categorisation of proximity-centred planning components: the physical and functional characteristics of space to enable proximity. As was already mentioned, the social component was considered by Moreno in both diversity and density, while in DREAMS 15mN this is a separate component as the concept is very user-centred: 15mC ideals are co-created with its residents desires and expectations of their neighbourhoods. Hence, the component called human perspectives and needs addresses how different target populations understand the 15mC concept and how their particular needs and preferences may vary. Finally we extend beyond all these components already considered by Moreno and other researchers, to include two more than have been less considered in the literature base which are: governance frameworks (equity-based policies/citizen participation/co-creation processes) and business models in place to enable 15mC. At the end, DREAMS 15mN builds upon Moreno's 15mC components, but suffers a relevant (at least for the outskirts) metamorphosis that is visually illustrated in Figure 9.

Figure 9 Moreno's 15mC original concept components and DREAMS 15mN adaptation.



Source: own elaboration.

DREAMS 15mN components are listed in six: density, diversity, design, human perspectives and needs, governance and business models. We extend beyond Moreno's components introducing governance and business models as we think equity-based policies, citizen participation, co-creation processes are needed to implement 15mC principles in the outskirts. But also new social business models are very scarce to find in the literature and they need to be in place to examine the role of different pricing/revenue schemes in the outskirts, as shared mobility, and in general all transport-related infrastructure is highly expensive when being offered in less dense areas. In the next sections we will delve into their specific descriptions.

4.4.1. Density: fitting all sizes through the lens of different scales

One of the most common critiques of the 15mC concept is the issue of scales. Many authors have criticised it for adopting a "one-size-fits-all" approach that fails to account for the unique characteristics of diverse urban environments. For example, (Birkenfeld et al., 2023) stated the need to consider how the 15mC concept could be replicated in different global contexts stating that research should move beyond the *"kenistic discourse"* about x-minute cities (time thresholds), towards greater engagement with unique urban and neighbourhood contexts. They propose more contextualised strategies grounded in people's actual travel experiences, neighbourhood characteristics, and household realities. Others (Casarin et al., 2023; Guzman et al., 2024) suggest that the concept should surpass the "city branding" or "buzzword" status and contribute to define planning units and regeneration formulas that resolve gentrification, spatial inequality and social issues at the neighbourhood scale. More specifically, some authors have claimed that the 15mC is somehow physically determinist, "setting goals without specifying how or by what means they will be achieved" (Khavarian-Garmsir, Sharifi, Hajian Hossein Abadi, et al., 2023, p. 1). Therefore, as Gaglione et al., (2021) suggests, there is an urgent need to the define the spatial unit of 15mC.

To start, many authors clarify that city and neighbourhood are not the same thing. A city can be defined as the place where an extraordinary quantity of activities, from the more every-day and traditional to the more specialised and innovative ones, coexist in relation to each other. It is the coexistence of different activities and services, many of which are "rare" due to the location and distribution in the territory (e.g. museums, universities) and to the size of the demand, that produces the so-called "city effect" and defines the rank of cities (Gaglione et al., 2022). In this context, the availability of time to reach and use these services may well exceed the time threshold of 15 minutes.

The neighbourhood, on the other hand, especially in large cities, can constitute the suitable intervention scale to guarantee the use of essential services by all inhabitants through pedestrian paths. With reference to the second aspect, the location and distribution of essential services (e.g. food and health), the quality of the pedestrian paths useful for reaching them together with the quality of the open spaces and the urban context, and above all people's behaviours can improve accessibility to places and services and contribute to guaranteeing social equity and raising the quality of life for the inhabitants (Brookfield, 2017; Caselli et al., 2022; Gaglione et al., 2021; Kallus & Law-Yone, 2000; Kissfazekas, 2022).

Even if the two terms (associated with the chosen time threshold: e.g., 20-minute neighbourhood or 20-minute city) are often used as synonyms as they describe similar planning concepts, a semantic difference should not be ignored (Calafiore et al., 2022)(Calafiore et al., 2022). In the case of the neighbourhood, the focus is on the proximity of urban functions within each neighbourhood, which means providing a wide array of services locally. In this case, the city can be conceived as a system of neighbourhoods which are somehow self-sufficient for a certain set of services (Duany et al., 2020), and hierarchically dependent on higher-ranking services at the city level. When the city is directly referred to, it is assumed that the walking or biking shed would not necessarily correspond to a single neighbourhood; the emphasis of planning is not on the proximity of functions within each neighbourhood, but on the proximity to local functions throughout the whole city.

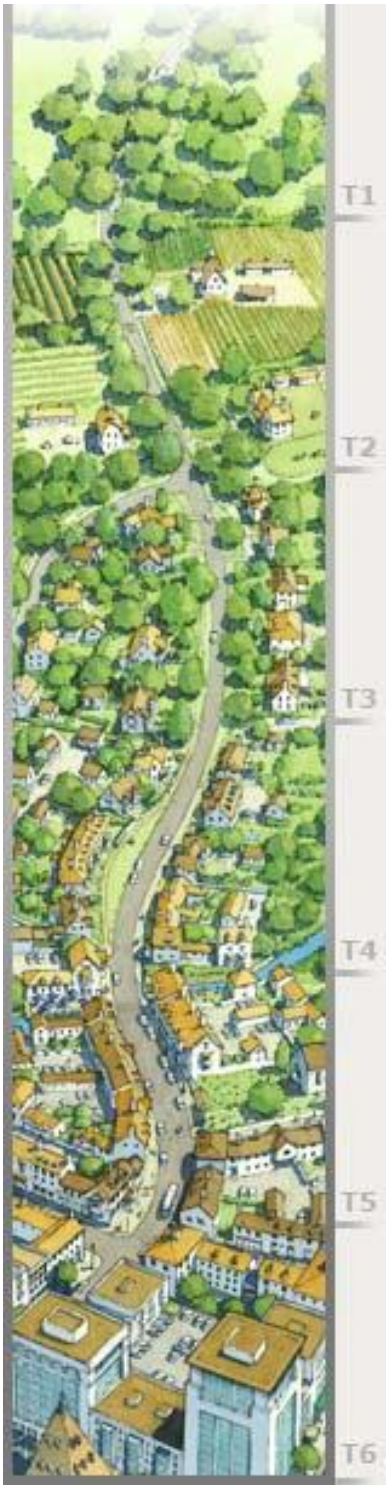
But what are the differences between a neighbourhood and a city in terms of population? Some studies use absolute population metrics to classify urban settlements. Some researchers (Basbas et al., 2023; Papas et al., 2022), classify medium-sized cities according to three groups: the first group consists of small towns with population less than 60.000; the second group includes cities with population more than 60.000 habitants and less than 300.000; and the third group consists of cities (metropolitan areas) with population ranging from 300.000 to 700.000. Other studies (Basbas et al., 2023; Logan et al., 2022) defined urban setting as block groups with either more than 200 housing units per km2 or more than

400 residents per km2. However, for the purpose of the DREAMS project, that involves highly diverse urban settlements in terms of population, a metric that allows fair comparison and categorisation should be identified.

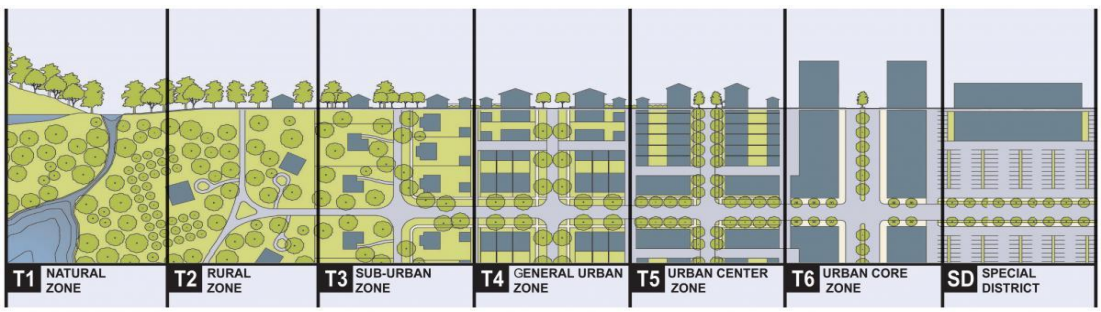
Therefore, we stand by the literature that considers residential density as the metric to classify areas in the rural-urban continuum and the *neighbourhood* as the minimal planning unit scale (Birkenfeld et al., 2023; Gaglione et al., 2022; Kissfazekas, 2022; Pozoukidou & Angelidou, 2022)(Birkenfeld et al., 2023; Gaglione et al., 2022; Kissfazekas, 2022; Pozoukidou & Angelidou, 2022). We will understand residential density as the concentration in a given area of a sufficient number of residents to make it profitable to do business and provide a variety of public services (Murgante, Valluzzi, et al., 2024). With this respect, some authors have highlighted the importance of having an optimal (minimum) density (Di Marino et al., 2023), as new multimodal and shared mobility services require a relatively dense and diversified urban structure before starting operating. It is also mentioned in (Calafiore et al., 2022), whom separated the services available at the neighbourhood and regional scale; at the neighbourhood scale, services such as universities or hospitals were excluded, as they require higher densities. We will consider residential density in terms of residents/urbanised area (km2) as proposed by (Logan et al., 2022; Moreno et al., 2021). By defining the minimal scale (neighbourhood) and its metric (residents/urbanised area km2), we can have different types of urban settings (15-minute typologies) and adapt 15mC principles to each.

Based on the Neighbourhood Unit movement, a neighbourhood unit was an area of around 65 HA with 5.000-10.000 people (resulting in a population density ranging from 7.500 to 15.000 people/km^2). On the Transect of Urbanism (Duany et al., 2020), the authors suggest that a well-designed neighbourhood should have a population sufficient to support local amenities and services and they propose the following population densities for each transect zone (see Figure 10):

Figure 10 Transect of Urbanism.



- T1 (Natural): 0 people/km^2. This zone is essentially undeveloped and consists of natural landscapes such as forests, wetlands, and other preserved natural environments.
- T2 (Rural): 0 - 308.88 people/km^2. This zone includes areas like agricultural land, open space, and very low-density rural residential developments. It is characterized by farms, ranches, and large lots.
- T3 (Sub-Urban): 617.76 - 2,471.04 people/km^2. The sub-urban zone is primarily residential with single-family homes on larger lots. It often features a more natural or landscaped character with considerable open space.
- T4 (General Urban): 2,471.04 - 7,413.12 people/km^2. This zone represents moderate-density urban residential areas. It includes a mix of housing types, such as single-family homes, townhouses, and small apartment buildings, often with some commercial establishments within walking distance.
- T5 (Urban Centre): 7,413.12 - 24,710.4 people/km^2. this zone is characterized by higher-density mixed-use environments. It includes a variety of housing types (apartments, condos, townhouses) and a significant presence of commercial, retail, and office spaces. It's more pedestrian-friendly with narrower streets, frequent sidewalks, and public transit options.
- T6 (Urban Core): 24,710.4 - 61,776+ people/km^2. The Urban Core is the densest and most urban zone. It features the highest concentration of mixed-use buildings, including high-rise residential, commercial, and office spaces. This zone is highly walkable with minimal setbacks from the street, narrow streets, and robust public transit.



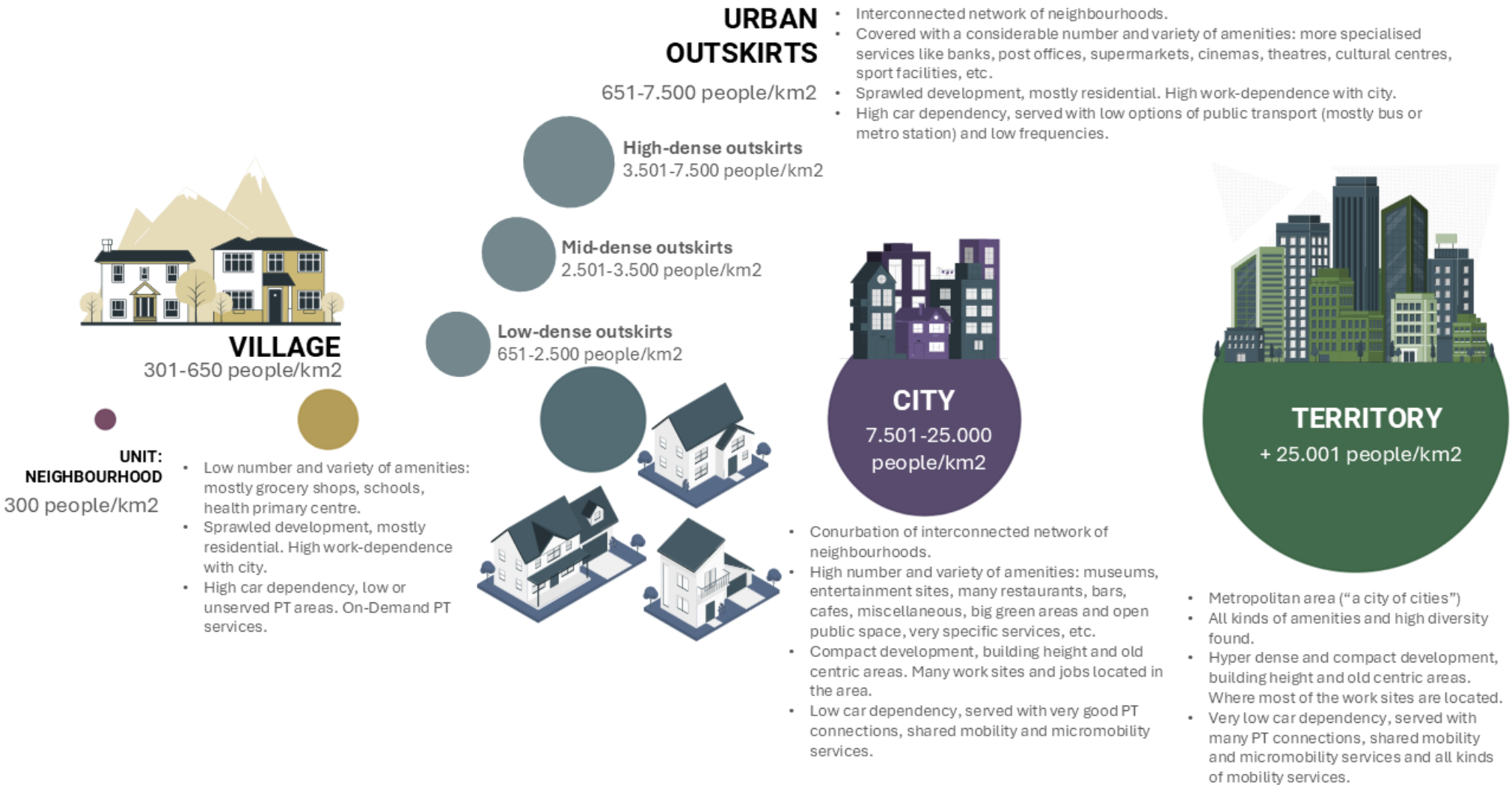
Source: (Duany et al., 2020)

Inspired by the reference of the transects (in the sense of dividing space in different categories), but adapting the residential densities thresholds to the DREAMS living lab areas in Brussels, Budapest, Munich, Paris, Utrecht and Vienna, we create DREAMS 15-minute neighbourhood typologies(see Figure 11). To this end, we used the KOUNTUR dataset (KONTUR, 2024), which is an open source global density population map represented by H3 hexagons with population counts at 400m resolution. This dataset is constructed using population calculations based on the Global Human Settlement Layer (GHSL), a framework relying on a large set of sensors, including radar and optical public and commercial missions, which are also overlaid with Facebook population data (HRSL) where available. This dataset is chosen as it provides accurate population data from the same source and for all the project's living lab areas. This process allow us to consider three types of outskirts based on the DREAMS living labs:

- **Low-dense Outskirts:** 651-2.500 people/km2
- **Mid-dense Outskirts:** 2.501-3.500 people/km2
- **High-dense Outskirts:** 3.501-7.500 people/km2

This typology is useful to position the DREAMS living labs with respect to each other. It is a simplification and should not be taken as general typology that can be applied categorise urban outskirts, as other factors such as functional and socioeconomical relationships can be considered when defining outskirts. In this section and for the purpose of the literature review we only propose to use residential density as indicator of the density component. However, how each project defines the density thresholds (numbers) depends on the characteristics of the areas studied. For our project these thresholds cover the complete list of living labs but for other project these thresholds may need to change due to different characteristics (bigger of smaller areas) (see Figure 11).

Figure 11 The 15-minute neighbourhood typologies based on residential density.



Source: own elaboration.

4.4.2. Diversity: quantity and quality of amenities

DREAMS 15mN involves considering different types of outskirts (low, mid or high-dense), as we described in the previous section, but it also involves having an optimal (minimum) mix of amenities. These amenities, receive many different names in the literature like activities, infrastructures, services, locations, destinations, attractions, Points of interest (POIs), etc. For the purpose of the project, we will group all of these terms into one called "amenities". There are multiple (quantity) and very different (quality) types of amenities. Diversity is generally conceptualised as entropy (Murgante, Patimisco, et al., 2024; Murgante, Valluzzi, et al., 2024), and it is measured via different indicators like Shannon's diversity index (Graells-Garrido et al., 2021) or the Simpson's diversity index (Di Marino et al., 2023). Alternative metrics of diversity include the number of categories of services available in the service area from an origin point (Abdelfattah et al., 2022; Calafiore et al., 2022). This latter has been the most commonly found approach in the literature reviewed as shown in Table 5.

As we can see, most of the studies used official datasets (population, statistical, road network, mobility surveys, etc.) and OpenStreetMap (OSM) as data sources. Consequently, most of the analyses take into consideration residential "census tracts" and "blocks/cadastral parcels" as origins of trips. Some studies differ in this aspect, taking into account different origins, for example Di Marino et al., (2023) considered a selection of working spaces as departure points and in the case of Wolański, (2023), railway stations to evaluate the amenities around these important functions (job and public transport).

Moreover, with respect to the selection of amenities, most of the studies considered a generalised group of functions: living, working, commerce, healthcare, education, and entertainment. "Living" refers to housing, while the rest are amenities/functions that people to varying degrees need/want in their daily lives. "Working" includes workplaces and the opportunity to earn a livelihood. "Commerce" includes the possibility of supplying groceries and other daily essentials, as well as a range of other durable and non-durable goods. "Healthcare" includes, among other things, local healthcare centres, hospitals, pharmacies, and dentists. "Education" is for all ages, from preschools to universities, but also includes various types of cultural activities such as museums and libraries. "Entertainment" is the broadest category and includes recreation and leisure activities. It covers facilities like parks, cinemas, various types of sports facilities, restaurants, and bars (Elldér, 2024).

Usually, these amenities are aggregated into isochrones. However some studies take a step further by aggregating, but also weighting them according to their relative importance using official mobility data (trip frequency) (Graells-Garrido et al., 2021; Knap et al., 2023; Monteiro et al., 2023; Noworól et al., 2022; Olivari et al., 2023), using social media data (check-ins) (Liu, Kwan, & Wang, 2024), or using Analytic Hierarchy Process (Murgante, Patimisco, et al., 2024; Murgante, Valluzzi, et al., 2024). Interestingly, some studies addressed specific amenities, like (Both et al., 2022)(Both et al., 2022) that used only work locations and (Caselli et al., 2022) considering only kindergartens.

Table 5 Origins, amenities and data sources considered in the literature reviewed.

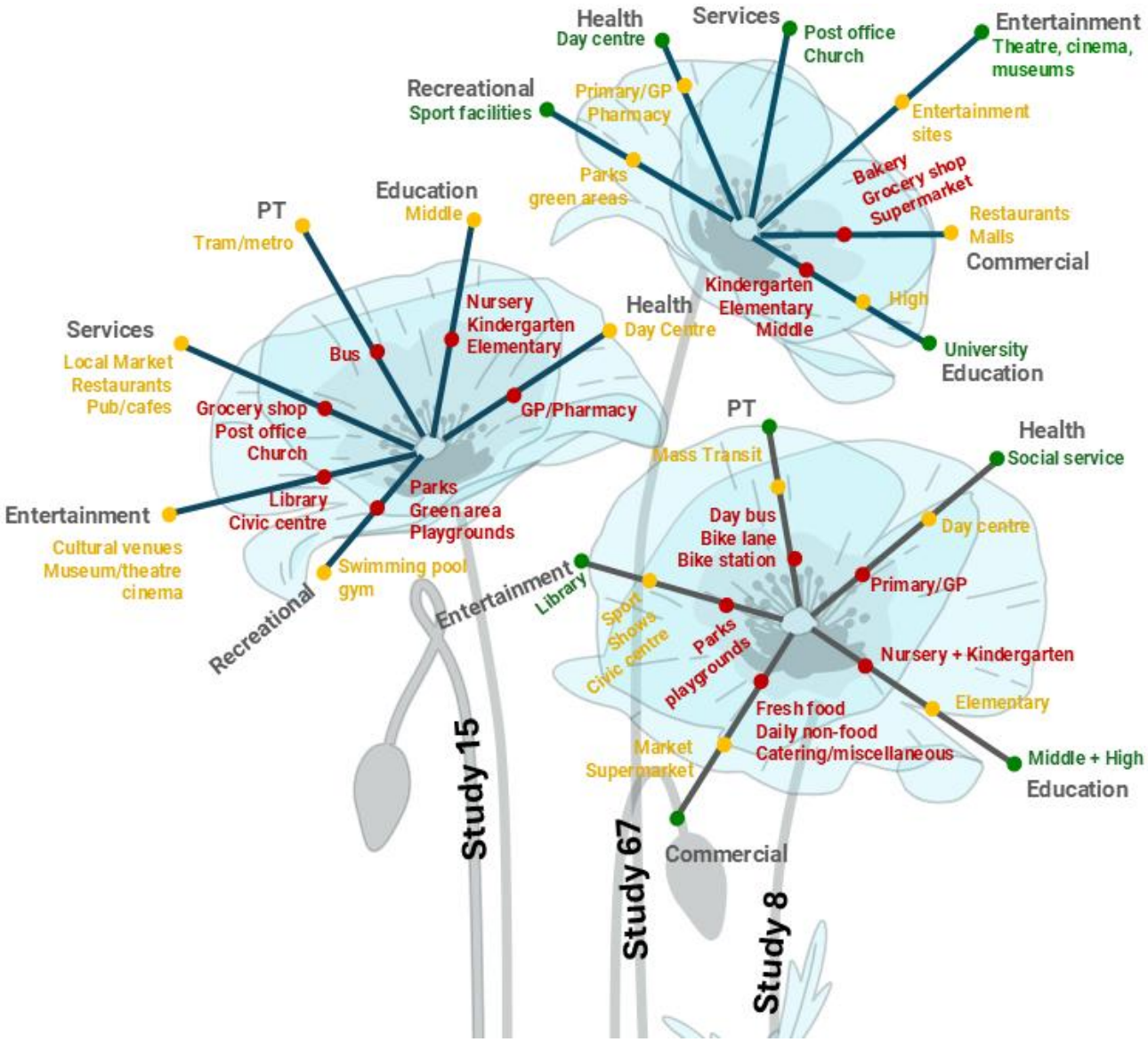
	Study ID	Spatial feature considered as origin						Amenities				Data Sources					
		Grid-based	Census tracts	Postal code	Blocks/Cadastral parcels	Home address	Other	General	Weighted	Specific amenity	Other	Official sites (population, road network, etc.)	Mobility survey	OpenStreetMap (OSM)	Google Maps	GTFS	Other
General	4		x						x (trip frequency)			x		x			x (Mobile Phone data)
	6		x					x				x					
	7				x			x				x		x			x (Urban Grammar data)
	8				x			x				x					
	10					x				x (Kindergartens)		x					
	15		x						x (trip frequency)			x		x			
	22		x					x				x			x		
	26	x							x (trip frequency)			x	x				
	27	x							x (trip frequency)					x			
	31				x			x						x			
	35						x (Traffic Analysis Zones- TAZ)	x				x					
	42						x (survey respondents)				x (survey respondents)						x (online survey)
	44		x						x (# of check-ins)			x		x			x (check-ins from WEIBO app)
Outskirts	49				x			x				x					
	50		x					x							x		
	51				x			x				x		x			
	52						x (survey respondents)				x (survey respondents)						x (online survey)
	54		x					x				x		x			x (OpenSourceRoutingMachine)
	57		x							x (Work)		x		x		x	
	66						x (literature				x (literature						x (online scientific databases)

2				review study)			review study)							
6 3		x			x			x	x			x	x (OpenTripPlanner)	
6 4			x		x			x		x				
6 5				x (Selection of working spaces)	x					x				
6 6				x	x			x	x	x		x		
6 7			x			x (trip frequency)		x	x				x (City's Master Plan)	
6 8	x				x			x					x (BAIDU app)	
6 9				x (selection of railway stations)	x					x				
7 2	x					x (Analytic Hier-archy Process)		x		x	x			
7 3	x					x (Analytic Hier-archy Process)		x		x	x			

Source: own elaboration.

The approaches and methodologies may vary, but most authors seen to agreed that some amenities require the accumulation of residents to be efficient/profitable, especially nowadays, due to the shrinking financial resources of public administrations (Staricco, 2022). Therefore, many experts recommend to have an optimal (minimum) mix of amenities that fit the specific neighbourhood's needs for a certain threshold, and this has been known as *the "Flowers of Proximity" approach* (Büttner et al., 2022) (see Figure 12). For example, (Ferrer-ortiz et al., 2022) (study 8), proposed a flower of proximity based on time thresholds, with some amenities at a 5-minute threshold (primary healthcare, parks/playgrounds, nursery/kindergartens, fresh food, bike station/lane and day bus) and others to 10 or 15 minutes for the case of Barcelona. They observed that the city did relatively well in terms of coverage, with the exception of the most mountainous peripheral areas. They argued that these locations' coverage shortfalls were the result of the urban development models and architectural styles characterised by a functionalist approach, featuring high-rise buildings, private green spaces, and minimal commercial space, conditions that are all not favourable to fostering proximity dynamics.

Figure 12 Examples of flowers of proximity proposed by authors of study 8, 15 and 67.



Source: own elaboration.

Moreover in study 15, (Noworól et al., 2022), the authors proposed a flower of proximity based on two versions of the city: the minimal version, which involved only basic local services, and the optimal version which included more complex/advanced amenities. In both cases, it was assumed that public transport was accessible in a 10-minute walk; as Krakow's public transport system is based on buses and the tram (this latter being the most important one in terms of usage), a 10-minute walk for buses in the minimal version and a 10-minute walk for tram in the optimal. Apart from the same amenities as study 8, the authors also considered elementary schools, pharmacies, post offices, libraries and churches/civic centres for the minimal version. Another example is study 67 (Monteiro et al., 2023), that proposed a flower of proximity based on weights of importance (considering the frequency of use of each amenity based on mobility survey). The most important amenities are food and education-related ones, followed by other specialised services like entertainment sites, restaurants, pharmacies and universities.

Flowers of proximity constitute a creative illustrative way of how people's needs and preferences may vary from one neighbourhood to another. And to add more complexity, researchers state that type and

quantity of amenities are relevant, but also *their quality* (Logan et al., 2022). The same 15-minute walk can be much more pleasant if done under the shadow of a row of trees along the road where car speed is moderate/low; carrying groceries for more than 5 minutes could be challenging for all, but even more for elderly population. This was particularly notorious in the study conducted by (Kelobonye et al., 2020), which showed that over-70s population were very time-sensitive to the trip distance to public transport and considered a 15-minute walk unsuitable for their age. Therefore, accessibility metrics for amenities should weight their attractiveness (including not only time costs but also qualitative issues) (Staricco, 2022). Under this approach, amenities falling within a certain isochrone are counted, but also weighted according to its attractiveness (Guzman et al., 2024).

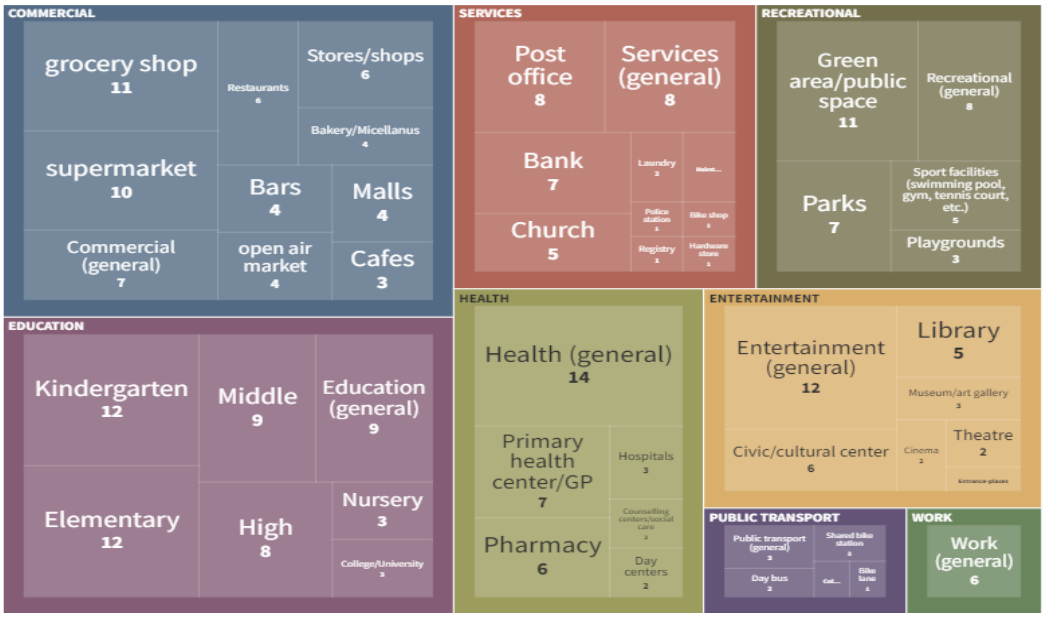
As some authors have already stated: "*accessibility is a metric, but what are acceptable parameters of what is considered accessible must be set through policies*" (D. C. Da Silva et al., 2020, p. 1). Adapting time thresholds to density typologies (for example, increasing the threshold to 30 or 45 minutes for those car-oriented cities), but also different amenities (for example, 10 minutes for green areas and 15 minutes for cinemas) is highly recommended. This would probably mean identifying different desired accessibility time thresholds through surveys, interviews etc., which can be carried out to co-define with residents which services are essential at the neighbourhood level and the maximum time citizens would accept to take to walk to a location of these services. The results of these surveys and the normative adoption of the desired thresholds could allow identifying which actions – e.g., walkability improvement or spatial re-distribution of service locations –are primary in the different parts of the city.

From the literature review, the amenities that are supposed to be reached within the set time threshold vary in detail (see Table 6), but generally agree on certain broad categories of services, such as education, healthcare, commerce (food-related in particular) and entertainment (Calafiore et al., 2022; Staricco, 2022) (see Figure 13). Other particular amenities included are public baths, dining and laundry services (Liu, Kwan, & Wang, 2024) for low-income population that lives in apartments without kitchens/bathrooms/laundries that are very common in high-dense cities like New York/Hon Kong.

Similarly to (Abdelfattah et al., 2022) whom determine accessibility for 7 out 9 basic functions, the study conducted by (Elldér, 2024) proposed three sets of groups for amenities: Basic15min, Full15min and Optimal15min. Basic15min meant that at least 7 out of 8 categories were accessible within 1km (grocery store, other food, restaurant, preschool, school, health centre, pharmacy, and dentist). Full15min captured those areas where at least 16 out of the 17 amenities are accessible within 1 km and finally, Optimal15min included Full15min and also where there was a wide range of choice options (>150 amenities in 1km from home). The 150 number criteria was used based on previous studies based on the National Swedish Travel Survey in which authors identified that when the number of amenities exceeded 150 in an area, a clear majority of residents chose walking and cycling for grocery shopping, medical appointments, or dropping/picking up children from school.

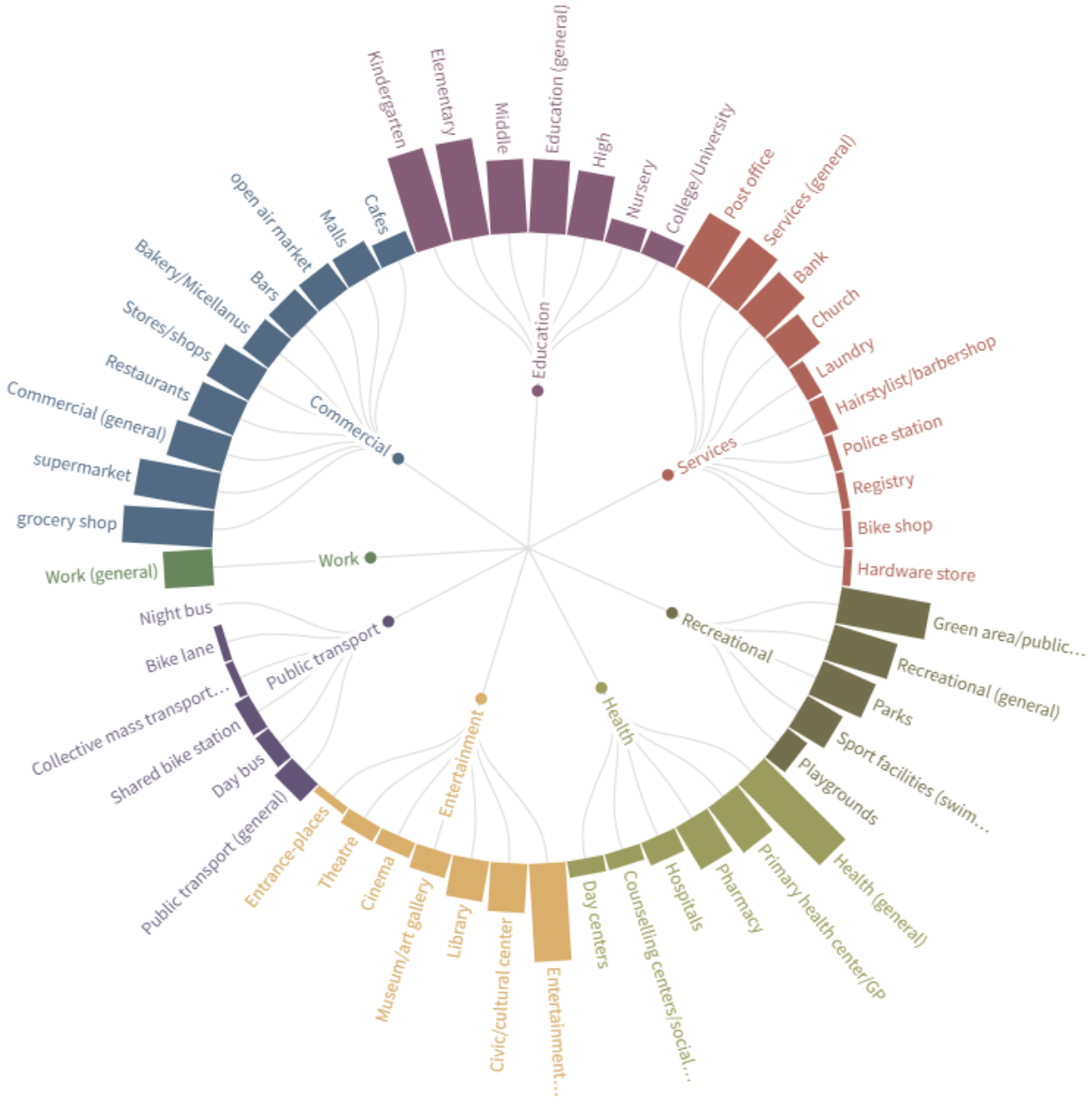
Table 6 Amenities considered in the studies revised.

	Amenities/Study ID	4	6	7	8	10	15	22	26	27	31	35	42	44	49	50	51	52	54	57	62	63	64	65	66	67	68	69	72	73	Total
Education	Nursery		☑				☑								☑																3
	Kindergarten		☑		☑	☑	☑					☑		☑	☑	☑	☑		☑				☑			☑					12
	Elementary	☑	☑		☑		☑						☑	☑	☑	☑	☑		☑				☑			☑					12
	Middle	☑	☑										☑	☑	☑	☑	☑						☑			☑					9
	High	☑	☑										☑	☑	☑	☑	☑						☑								8
	College/University	☑										☑			☑																3
	Education (general)			☑					☑	☑		☑													☑		☑	☑	☑	☑	9
Entertainment	Museum/art gallery													☑	☑								☑								3
	Cinema		☑																				☑								2
	Theatre		☑																				☑								2
	Library		☑				☑						☑	☑	☑																5
	Civic/cultural center				☑		☑						☑	☑	☑								☑			☑					6
	Entrance-places	☑																													1
	Entertainment (general)			☑					☑	☑			☑	☑	☑			☑							☑		☑	☑	☑	☑	12
Services	Post office		☑				☑	☑		☑	☑			☑	☑	☑															8
	Bank	☑						☑		☑		☑		☑	☑	☑															7
	Police station		☑																												1
	Registry		☑																												1
	Laundry													☑	☑																2
	Bike shop														☑																1
	Hardware store														☑																2
	Hairstylist/barbershop													☑	☑																5
	Church	☑	☑				☑							☑	☑																8
	Services (general)	☑		☑									☑					☑							☑		☑	☑	☑	☑	5
Recreational	Sport facilities (swimming pool, gym, tennis court, etc.)		☑		☑		☑					☑			☑																3
	Playgrounds		☑		☑		☑																								11
	Green area/public space	☑	☑		☑	☑	☑					☑	☑	☑		☑							☑				☑				7
	Parks	☑			☑					☑		☑		☑					☑								☑				8
	Recreational (general)			☑					☑			☑						☑									☑	☑	☑	☑	4
Commercial	Bakery/Micellanus				☑										☑								☑			☑					6
	Restaurants	☑			☑				☑					☑	☑								☑								4
	Bars	☑			☑				☑														☑								3
	Cafes	☑			☑																	☑									11
	grocery shop				☑		☑	☑		☑		☑		☑	☑	☑						☑	☑			☑					10
	supermarket	☑						☑		☑	☑					☑	☑		☑			☑	☑			☑					4
	open air market		☑		☑					☑			☑																		4
	Malls	☑							☑			☑			☑																6
	Stores/shops	☑			☑				☑	☑		☑			☑																7
	Commercial (general)			☑		☑												☑							☑			☑	☑	☑	1
Public Transport	Collective mass transport (trains, metros, ferries, etc.)	☑																													2
	Day bus	☑			☑																										0
	Night bus																														2
	Shared bike station	☑			☑																										1
	Bike lane				☑																										3
	Public transport (general)						☑					☑		☑																	6
Work	Work (general)								☑			☑					☑			☑				☑	☑						3
Health	Hospitals	☑										☑					☑														7
	Primary health center/GP	☑	☑		☑		☑	☑								☑											☑				
	Counselling centers/social care	☑	☑																												2
	Pharmacy						☑	☑			☑				☑	☑			☑												6
	Day centers				☑																						☑				2
	Health (general)			☑					☑	☑		☑	☑	☑	☑			☑					☑		☑		☑	☑	☑	☑	14



Source: own elaboration.

Figure 13 Amenities and their importance mentioned on studies revised.



Source: own elaboration.

For the particular case of urban outskirtss, accessibility to public transport stops and infrastructure is considered relevant, as it is an essential service to reach jobs/education sites at the metropolitan level (Staricco, 2022; Staricco & Vitale Brovarone, 2022). This is the reason for many authors including public transport infrastructure as an opportunity to have nearby.

In the case of jobs, the literature is divided into the authors that include it as an essential amenity (Brookfield, 2017; Gaxiola-Beltrán et al., 2021; Knap et al., 2023; Ramírez Saiz et al., 2022) and the ones that considered this to be a regional issue (Birkenfeld et al., 2023; D. C. Da Silva et al., 2020; Guzman et al., 2024; Logan et al., 2022). On one side of the debate, jobs are included even in the definition of 15-minute city offered by (Moreno et al., 2021), and their supporters state that it does not matter if you have multiple and diverse amenities near your home if you still need to commute daily to another area where you will probably spend most of the time of your day. In this case, an analysis of proximity to services in the surrounding area within work locations could also be considered, as it may not be different for an individual to have the daycare or do shopping in the vicinity of the job place (within 15

minutes) instead of the place of residence. This could be changing according to (Di Marino et al., 2023) which support the creation of new working spaces to allow residents to stay in their neighbourhoods while having their work outside (mainly focused on jobs that allow telework).

On the other side of the debate, the supporters argue that from the planning perspective, access to jobs is more of a regional issue than a local issue. Jobs are dispersed throughout a metropolitan region and maintaining jobs-housing balance within individual cities may not be the most sustainable path forward. Job seekers are better off if they are able to access the largest number of jobs, which for most metro areas is by car. In car-oriented cities, that grew almost entirely in the post-war automobile era, limiting residents' ability to seek employment throughout the polycentric region would likely be economically harmful (D. C. Da Silva et al., 2020; Papadopoulos et al., 2023). However, more recent studies are proposing new office layouts with shared workstations, coworking spaces and innovative timetables (reducing peak hours) are essential to fulfil the vision of the 15mC (Abdelfattah et al., 2022).

From our point of view, this is a debate that still needs more research, specially through the development of surveys that consider residents' perceptions and preferences regarding job locations, and in general, all the types of amenities. Many studies have demonstrated that residents' perceptions may vary a lot according to their location and special needs (Guzman et al., 2024; Ramírez Saiz et al., 2022). This diversity aspect is one of the most complex of the 15-minute neighbourhood framework, as each area has specific needs and hence could prefer a specific set of functions. This is the reason why experts are recommending local-based or context-specific mindset when thinking about applying the principles of proximity for different urban settlements.

4.4.3. Design: spatial characteristics allowing people to reach amenities

From a broad point of view, after considering a neighbourhood's density (people) and its available amenities (activities), we understand design as what's left: the built environment characteristics (physical aspects) and connectivity (mobility network) that allow these people to reach different activities.

On the first hand, built environment characteristics has been considered by many authors as a relevant factor when applying the 15mC concept as seen in Table 7. The majority of studies used the road/pedestrian network variables to characterise the cities in terms of walkability. For example, Gaglione et al., (2022) considered network connectivity, slope, sidewalk width, cycling infrastructure, shaded paths, benches and other physical aspects to evaluate proximity to services by foot. Similarly, Di Marino et al., 2023) addressed accessibility to job sites by walking using pedestrian network variables. In Birkenfeld et al., (2023), they used two variables to measure built environment: 1) the Walk Score method (Duncan et al., 2011; WalkScore, 2024) to address walkability levels and 2) public transport accessibility to jobs. Their results showed that only few households in Montreal were able to conduct all their daily activities within a 15- or 30-minute travel radius using active modes of transport (walking, cycling, and public transport). Their study suggested that for some cities, especially car-oriented ones, applying 15 and 30-minute threshold could be challenging due to their existing urban layout, land use distribution and transport infrastructure.

Table 7 Built environment variables considered in studies reviewed.

	Study ID	Residential density	Building density	Land use	Building age	Street/road/pedestrian network									
						Intersections	Length	Slope	Stops	Sidewalk width	Pavement status	Cycling infra	Vehicle speed	Benches shaded paths	Noise
General	4			x (Shannon entropy)											
	6	x			x										
	7					x									
	8				x	x									
	10				x										
	15				x										
	22	x (compactness of urban fabric)	x		x	x	x	x		x	x	X	x	x	x
	26				x							X	x		
	27					x	x						x		
	31				x	x	x						x		
	35			x		x	x						x		
	42				x										
	44				x	x	x	x					x		
Outskirts	49				x	x			x	x					
	50		x		x	x	x	x		x	x		x	x	x
	51					x	x						x		
	52														
	54					x	x						x		
	57			x		x	x						x		
	62														
	63														
	64														
	65			x (Simpson's Diversity Index)		x	x	x	x	x	x	X	x	x	x
	66														
	67				x	x	x	x					x		
	68				x										
	69					x	x	x	x	x	x	X	x	x	x
	72		x												
	73		x												

Source: own elaboration.

These results are in tune with previous studies that suggest that population density might not be as important as urban structure. Some studies with a focus on small cities, showed that smaller cities can also achieve certain compliance with 15mC concept, especially if they have been developed before mass motorisation (Bartzokas-Tsiompras & Bakogiannis, 2023; Elldér, 2024). On these studies, urban development shows to be even more important that population size, stating the importance of what Newman et al., (2016) calls the "theory of urban fabrics". Based on this theory, walking cities are older, primarily planned over 150 years ago, before cars and railways led to urban sprawl and decentralisation, being characterised by dense and mixed-use. In contrast, car-oriented cities constitute those planned after 1950, when car access became massive and distances longer (urban sprawl).

In this sense, 13 out of 29 documents revised, considered *building age* as a key built environment variable to address this urban fabric differences. All findings point to the same takeaway message: ***it is very important to first understand the urban development model (walkable city vs car-oriented city) that guided the city planning of the tested location. Those car-oriented cities are going to struggle more to comply with the 15mC concept, and therefore the pace to comply with the set thresholds may be slower.*** To the best of our knowledge, no study systematically investigated a broader set of built environment factors and its relationship with the 15mC concept, but we do find references if we expand beyond 15mC topic studies. For example, Fonseca et al., (2022) reviewed 132 studies on the impact of built environment features on walkability, finding that "density" and "mixed land use" were the most important indicators. Mixed land use promotes proximity as it allows more people to visit amenities that are active throughout the day (Newman et al., 2016). The relevance of having mixed land uses has been extensively revised by previous works (Cervero & Kockelman, 1997; Ewing & Cervero, 2010).

On the other hand, connectivity aspects have shown to be highly relevant for the 15mC concept. Proximity is influenced by the spatial distribution and quantity of amenities in an area, but also the quality, quantity and type of transportation options (Handy & Niemeier, 1997; C. Silva & Pinho, 2010). For example, the Structural Accessibility Layer (SAL) considers both the quantity and variety of destinations (including employment) accessible within a set time limit by transport mode (C. Silva & Pinho, 2010), while the Metropolitan Accessibility Remoteness Index of Australia (METRO-ARIA) (Pitot et al., 2006), primarily focuses on transport accessibility to common destinations such as education, health, shopping, public transport, and financial and postal services. Other tools examining accessibility by public transit include the Spatial Network Analysis for Multimodal Urban Transport Systems (SNAMUTS) (Curtis, 2011). Measures of access to public transport (Both et al., 2022) and the numbers of jobs accessible within 30 min by different transport modes (Frank, 1994), are examples of accessibility indicators that combine transportation mode and employment availability that could inform city and economic planners.

Regarding the transport modes considered in the literature, Table 8 offers a general overview. As we can see, the majority of studies include walking and cycling in their 15mC concept definitions. Some studies emphasised the role of walking mode in their definitions as it is at the core of the concept (Aristizábal et al., 2023; Bartzokas-Tsiompras & Bakogiannis, 2023; Caselli et al., 2022; Ferrer-ortiz et al., 2022; Gaglione et al., 2022; Lima et al., 2022; Wu & Divigalpitiya, 2023) and others support the inclusion of public transport (Both et al., 2022; Graells-Garrido et al., 2021; Poorthuis & Zook, 2023). Even though most studies include walking and cycling in their definitions, when conducting the experiments, most authors stayed only with walking. In the particular case of (Knap et al., 2023), they evaluate only cycling as bikes are the most used mode in the Netherlands. Studies that involved walking and cycling in their methodologies are also scarce, with the few examples of (Gaxiola-Beltrán et al., 2021; Murgante, Patimisco, et al., 2024; Murgante, Valluzzi, et al., 2024).

Table 8 Transport modes included in studies reviewed

	Study ID	Modes on 15mC definition offered					Modes included on study					Threshold used on study					
		Only walking	Only cycling	Walking and cycling	Walking, cycling and Public Transport	Walking, cycling, Public Transport and Shared Mobility	Only walking	Only cycling	Walking and cycling	Walking, cycling and Public Transport	Walking, cycling, Public Transport and Shared Mobility	5	10	15	20	25	30
Urban	4				x		x							x			
	6			x			x					x	x	x			
	7	x					x							x			
	8	x					x					x	x	x			
	10	x					x					x	x	x			
	15			x			x					x	x	x			
	22	x					x							x			
	26			x				x						x			
	27			x			x							x			
	31			x			x							x			
	35	x					x							x			
	42			x			x										
	44			x			x										
Outskirts	49			x						x					x		
	50			x			x							x			
	51			x					x					x			
	52			x			x							x			
	54			x			x						x	x	x		
	57				x						x						x
	62			x							x			x			
	63				x					x				x			
	64	x					x							x			
	65			x			x						x	x			
	66			x						x				x			x
	67			x						x							
	68	x					x							x			
	69			x			x							x			
	72			x					x					x		x	
	73			x										x		x	

(*) shared bikes considered (**)Literature review study considered micromobility trail paths.

Source: own elaboration.

Fewer, but more relevant for the purpose of our project are the studies that involved active mobility (walking and cycling) but also public transport (Birkenfeld et al., 2023; D. C. Da Silva et al., 2020; Monteiro et al., 2023; Poorthuis & Zook, 2023)and even shared mobility services (Both et al., 2022; Vizmpa et al., 2023). In the case of a car-oriented cities, (D. C. Da Silva et al., 2020) assumed that a public transport trip of 30 minutes was compliant with the 20-minute city guidelines. They measured the number of destinations that can be reached from each parcel in Tempe, Arizona, within 20 minutes by walking (along both the all-roads and the sidewalk-only pedestrian networks), by cycling (along both the all-roads and the low-stress biking networks) and by public transport.

Moreover, Poorthuis & Zook, (2023) explored how the concept of 15mC might extend to suburban areas and even the countryside for the case of the Netherlands. They found both the city centres and non-urban areas maintain a rough average of 25 min per trip, but contrary to the ideal of the 15-minute city, non-urban residents use personal cars to compensate for the longer distances that they need to cover. The authors emphasised that car-dependence in urban cores are already relatively low. In this sense, there is much less to 'win' in these areas relative to the non-urban areas where reliance on cars is much higher. They recommend to extend research to non-urban areas, where people are more car-dependent to fight climate change.

In the case of Birkenfeld et al., (2023) that analysed Montreal city, they found that very few households, particularly 1.8%, conducted all their daily activities within 15 min from their home using active transport (walking, cycling, and/or public transport), and 6% within 30 min. A household that owns one or more vehicles was 78% less likely to be a 15-minute household, and 87% less likely to be a 30-minute household. On the case of studies that involved shared mobility modes, we can refer to Both et al., (2022) whom found that cycling showed the most potential for achieving the 30-min city, with an estimated 29.5% of workers able to reach their current workplace if they shifted to cycling, showing the potential that shared bike stations have close to worksites. Lastly, Vizmpa et al., (2023) did a literature review on the role of micromobility urban trail paths to promote proximity and 15mC principles. In summary, the way a city was planned and the mobility options that it offers are key elements to promote proximity-centred planning.

On Table 9 we offer an overview of the methodological approaches considered to evaluate the 15mC concept on the practical studies reviewed. As we can see, most of the studies rely on geospatial analysis and regression modelling to explore the influence of certain variables on the likelihood of the particular location to become a 15-minute city. Fewer studies used graph theory (Barbieri et al., 2023; Lima et al., 2022) or surveys (Basbas et al., 2023; Guzman et al., 2021). To calculate proximity metrics, most of the studies used Euclidean or network-based distances to draw isochrones (also called in some studies "service areas", "catchment areas", "buffers"). Some studies weighted this calculation using physical proximity index (Lima et al., 2022; Wu & Divigalpitiya, 2023)and distance-decay functions (Knap et al., 2023; Liu, Kwan, & Wang, 2024). In general, the walking speeds used to make the isochrones ranged between 3 and 5km/hr (with 4.24km/hr being the mean average speed) and for cycling 12km/hr (Gaxiola-Beltrán et al., 2021; Guzman et al., 2021) and 18km/hr and 24km/hr (for work commutes) used in Monteiro et al., (2023). Those studies that included lower speeds, usually analysed walkability measures for certain population like children's access to kindergartens in the case of (Caselli et al., 2022) or low-income woman access to healthcare services (Guzman et al., 2021). Finally, some interesting aspects are summarised in the observation column, for example, the use of not so common, but relevant variables in the analysis like rental prices of neighbourhoods used in (Graells-Garrido et al., 2021) or the particular focus on an specific population group: low-income and marginalised neighbourhoods (Aristizábal et al., 2023; Liu, Kwan, & Wang, 2024).

Table 9 Summary of methodological approaches to evaluate 15mC concept on studies reviewed.

	Study ID	Analysis conducted					Mapping strategy				Observations
		Geospatial analysis	Spatial statistics	Regression modelling	Other	Proximity (distance-based metrics)	Isochrones	Colour score maps	Walking speed	Cycling speed	
Urban	4			x		x		x			Rental prices included in analysis
	6	x				x	x		4,8km/hr		
	7				x (Graph theory)	x (Physical proximity index)					Pedestrian Infrastructure cost included in analysis
	8	x				x		x	4,5km/hr		
	10	x				x	x		3km/hr		
	15	x				x	x		4,8km/hr		
	22	x		x		x	x		4,8km/hr		
	26	x	x	x	x (building scenarios)	x (distance decay functions)		x			Only cycling was evaluated x-minute city score proposed
	27	x						x	5km/hr		
	31				x (Graph theory)		x		4,39km/hr		
	35			x			x				Focus on low-income and marginalised population
	42				x (online survey)						
	44	x				x (gaussian distance decay functions)		x			Focus on low-income and marginalised population
Outskirts	49	x			x (building scenarios)			x			PT included and non-work activities
	50	x	x	x			x				
	51	x				x		x	3,6km/hr	12km/hr	Work activities included
	52	x		x	x (online survey)		x		3,6km/hr	12km/hr	
	54	x	x			x	x				Large dataset of US cities (543)
	57	x		x							Only focused on work activities and 30-min
	62				x (literature review)						Micromobility considered
	63	x		x			x				
	64			x	x (Promethee II multicriteria approach)		x				
	65	x					x		4km/hr		Only focused on work activities
	66	x		x			x				PT included
	67	x				x	x		4,1km/hr	18km/hr and 21,64km/hr for work	Compared real city with a hypothetical compact city PT and car included
	68	x				x (Physical proximity index)					Focus on mid-sized cities
	69	x					x			4km/hr	
	72	x		x			x				
	73	x		x			x				

Source: own elaboration.

Thus, as a general conclusion of this section, we could state that density, diversity and design (proximity-centred planning) is key to implement 15mC in the outskirts. These are all exhaustively researched topics in the accessibility literature and explored issues on the 15mC general papers. However, fewer studies delve into the perceptions and needs of users and neighbours which is very relevant to design desired 15-minute neighbourhood or cities. In the next section we explore further this human component.

4.4.4. Human perspectives and needs

In the human component we delve further into the perceptions and preferences of people and particular target population groups which may desire different things. This section is the result from the analysis mainly of the 9 out of 74 papers that were focused on the human perspective of 15mC concept (see Table 3). There was a clear intention to create a separate component for the human needs as we think that the 15mC is a mainly user-centred approach, and thus, especial attention should be paid to people's desires. We intend to investigate what do vulnerable groups desire in their neighbourhoods and how can these desires vary from one population to another. Hence, this component involves considering any demands based on people's socioeconomic status on the one hand, and personal characteristics on the other.

When considering the human perspectives and user needs of 15mC, there are two main questions to be addressed: *who* are the people in the neighbourhood, and *where* do they want to go? The first question delves into user profiles, and considers characteristics such as gender, age, and socioeconomic status. The second dimension concerns the amenities that should be available within the neighbourhood (Allam, Bibri, Chabaud, et al., 2022b; Moreno et al., 2021; Pozoukidou & Angelidou, 2022).

The original diversity component proposed by Moreno includes mixed land use, but also different cultures and socio-economic levels. This inclusiveness dimension needs indicators such as safety levels, people's ability to move and affordability to be considered. The goal is to ensure access to essential services for ALL groups of society regardless of their abilities and socio-economic or cultural factors (Baquero-Larriva & Lámiquiz, 2024; Büttner et al., 2022). Disadvantaged groups based on age, gender, race, migration background, language, income, education level, employment status and disabilities need to be addressed. Therefore, proximity but also equity is to be achieved, as a neighbourhood should be not just accessible in terms of proximity, but it is accessible in terms of inclusiveness and design for all. Moreover, the study conducted by (SMALL, 2023) concluded that before convincing end-users for a mode shift to sustainable transport, policymakers need to change their perspective taking into account specific target groups' needs.

Therefore, we acknowledge that historical differences in urban planning in North-America and most Western-European countries (the two areas on which most studies focus) has led to two sets of starkly different case studies. For example, while most European cities have been developed with a walkable city centre, only adding suburban areas later, North American towns have been (re)constructed to favour car-centric mobility and urban sprawl. This also leads to differences when looking at which socioeconomic groups live or want to live in 15-minute city neighbourhoods: some studies in European contexts conclude that most walkable neighbourhoods are those of the working-class in the old centres with high population density, and that it is mostly the upper-classes that live in secluded suburban areas that are low in population density and have more greenery. On the other hand, there are indications that in the US, walkable neighbourhoods are considered quite a luxury and therefore mostly upper-class (although they are popular in other social groups as well) (Logan et al., 2022).

These differences will be addressed in the human component through two main dimensions: 1) socioeconomic characteristics that derived in users profiles and allow to target vulnerable groups and 2) citizens needs and preferences.

4.4.4.1.Socioeconomic characteristics: building profiles and targeting vulnerable groups

Socioeconomic characteristics are part of an individual's life that have to do with their social class and economic situation. This characteristics make up user profiles and allow planners to target specific vulnerable groups in their policies. The most common examples of socioeconomic variables are educational level and income, but also others that influence people's mobility behaviour and certain spatial elements, such as the neighbourhood and housing type in which they live, the mobility modes they can afford, and the level of care/work that they can afford to outsource to others (such as bringing children to a daycare or hiring a grocery delivery service). These elements play an important role in shaping people's needs in their neighbourhood, but so far, not much research has considered how these elements influence the needs of inhabitants of different neighbourhoods.

In the study of Brookfield, (2017), they assessed the support of residents' groups[1] of Southampton (UK) regarding walkable neighbourhoods through focus groups, concluding that while these groups were overall positive about the promotion of a neighbourhood scaled to walk and cycle, they were not necessarily on board with urban planning approaches meant to achieve this, such as neighbourhood densification through high-rise buildings. High-density building appears to be one of the main friction points of accessibility-based urban planning. While it makes sense to densify from a planning perspective, making services available to more people in the same radius, it is often cited as one of the negative aspects for inhabitants. As Brookfield, (2017) notes, high-density building is considered by participants to be at odds with other needs in their living environment, such as green spaces and quiet areas. On the other hand, such proximity-centred planning approaches have also been linked to neighbourhood gentrification: research from Gothenburg, Sweden, has concluded that as neighbourhoods become more attractive due to the enhanced proximity of services such as shops and care-related and leisure destinations, their popularity increases, and so does their demand and rent, which then drives out lower-income groups (Elldér, 2024).

It has to be noted that some of the objectives of a 15mC can appear to be at odds with one another: on the one hand, there is a need for green spaces and leisure areas, while on the other hand, this becomes difficult to achieve when neighbourhoods are supposed to be compact. However, the opposite is also possible. Higher income may have the possibility to move around in a larger radius for their services, while those with lower incomes are confined to those services that they can access within 15 minutes of walking/cycling/PT ride. The authors in Pozoukidou & Chatziyiannaki, (2021) stated that it is relevant to avoid gentrification (socio-spatial segregation caused by people leaving their neighbourhoods because they can't afford to stay) and ghettoisation (concentrating similar sociodemographic population like rich-population areas and poor-population areas with low or inexistent mixture). Other studies considered different variables as ethnic minority groups as in Calafiore et al., (2022) or property ownership and its relationship with parks access like Olsen et al., (2022). In the study regarding ethnicity, their results showed it had almost no relationship with the level of accessibility, suggesting that the distribution of services do not disproportionately advantage or disadvantage any specific cultural group. In the case of Olsen et al., (2022), their findings revealed that 87% of respondents lived within 10 min-walk of a park/open space. Having a property reported as an important predictor for a park usage; homeowners declared higher use of parks than renters. Parks accessibility was also studied by Luo et al., (2022) whom proposed an indicator to measure exposure to green spaces and analysing this indicator with rental prices in Zhengzhou (China).

[1] "*Residents' groups can be defined as voluntary, non-party political, place-based organizations that profess to operate to protect and promote the perceived interests of their area of activity"* – (Brookfield, 2017, p. 47)

Research that analyses the feasibility of a 15-minute city in Hamilton (NZ) concluded that higher income groups had a much wider mobility radius than lower income groups (Wang et al., 2024). Traffic modelling research in Montréal reached similar conclusions, finding that lower income groups are more likely to live in a 15 or 30-minute neighbourhood, but that this has mostly to do with high-density building on the one hand, and car-centric city planning on the other (Birkenfeld et al., 2023). Critiques on the 15-minute city approach have highlighted that the approach can lead to unequal outcomes and how it is oftentimes only attainable for certain social groups. To this end, the authors proposed the provision of equal opportunities to employment, education, lifelong learning affordable housing, mobility options and financial resources also emphasised in Büttner et al., (2022). It is therefore important to look at the needs and perspectives of vulnerable population groups.

This brings us to the second dimension: building user profiles and targeting specific vulnerable groups. Generally, anyone living in a neighbourhood within the area of study can be considered the target population of the 15-minute city approach, as it is supposed to consider the basic needs of all inhabitants. In practice, this means that studies on the 15mC will need to focus on the needs of specific user groups, especially those identified as vulnerable[2] or marginalised groups, as the current strategies in urban and mobility planning do not sufficiently include the needs of these groups. Oftentimes, an 'average' person is considered, although the need to analyse personal circumstances to properly understand walkability factors has been emphasised since the 1970s (Miller, 2018; Willberg et al., 2023). The majority of studies considered focused on age, and primarily elderly people, in relation to walkability of their neighbourhood (see Table 10).

Many societies are facing population ageing, which brings along concerns of how to design cities for these people. Older people have different mobility patterns than younger people: they often have fewer physical capabilities than younger age groups, which can be an important barrier in their access to and use of transport modes, especially as older people become less likely to drive a car (Cheng et al., 2007). Some studies have noted the link between not owning a car and loneliness through social isolation and restricted access to services in older age groups *(Liu, Kwan, & Wang, 2024; Willberg et al., 2023)*. As such, it is important to adequately consider the needs and experiences of this group. Taking the example of the study by (Willberg et al., (2023), the authors analysed older access to services in the Helsinki Metropolitan area and how this access fluctuates due to seasonal change (weather conditions and daylight changes). Using a modelling approach to estimate differences in access to grocery stores, their findings concluded that daylight changes had a significant effect on elderly people's access to services, limiting them severely in the winter months.

A possible solution for this problem could be more flexible opening hours of stores, making it possible to spread trips over the day. Particularly on the case of food access, Hosford et al., (2022) analysed walking and cycling accessibility to grocery shops in Vancouver, with age as an indicator. Their results showed that when cycling is considered, only 1% of the city's population have no access to a grocery shop showing good accessibility levels. However, when considering a low walking speed (3,6km/hr as children and elderly people tend to walk), around one-fifth of the population did not have access to a grocery store, and this were mostly neighbourhoods with higher proportions of children, elderly and minorities

[2] *Vulnerable persons are people that encounter barriers and/or difficulties to accessing or using transportation services. This term refers to all people facing barriers due to similar personal characteristics (Martinez et al., 2022).*

Table 10 Target population, amenities and findings from humanistic studies reviewed.

	Study ID	Main target population	Main amenity of focus
General	1	General	Respondents prioritised: local amenities, social interaction, peaceful environments (no noise), green areas and lower densities.
	12	Children and elderly	The study analysed only food-related amenities accessibility.
	41	Elderly	Elderly population preferred calm places (mostly peripheral areas), well connected to the city centre. Most important amenities for this population: food, health and parks.
	38	Elderly, children, disabled	Food-related amenities as the most important and especially by low-income elderly population.
	36	Elderly	Accessibility to grocery shops not only spatial but temporal analysis is important (winter season).
Outskirts	59	Ethnic minorities and low-income	Food-related amenities are not accessible for almost one third of the population and ethic is not significant variable.
	60	Homeowners and low-income	Parks and open space are more used by homeowners compared to renters.
	61	General	Europe has inequality across cities and within cities, especially in the type and quality of amenities.
	71	Women with children and low-income	Low income woman in Colombia strive to find health centres, while high-income population needs retail.

Source: own elaboration.

From the practical set of studies (see Table 11), we can also grasp an overview of the most important socio-demographic variables considered when trying to apply 15mC principles. As we can see from the table, population (in terms of absolute number or density) is the most important factor, but also age and income. Vehicle ownership is also considered in several studies. For example, Birkenfeld et al., (2023) found that a household owning one or more vehicles was 78% less likely to be a 15-minute household, and 87% less likely to be a 30-minute household. Less common is to find documents that included gender, education level and migrant backgrounds (Bartzokas-Tsiompras & Bakogiannis, 2023; Graells-Garrido et al., 2021; Knap et al., 2023). Vehicle ownership (Aristizábal et al., 2023; Guzman et al., 2021), cyclist stress level (D. C. Da Silva et al., 2020) and job types (Both et al., 2022) are also considered as variables in the analysis for some studies. With respect to gender, authors like Aristizábal et al., (2023) have emphasised the importance to transform the so-called "dormitory neighbourhoods" into neighbourhoods with more significant urban activity and better service coverage, contributing to urban spatial justice. These authors highlight that spatial justice should promote better opportunities and accessibility for people, especially women, considering their diverse needs (caregivers) (Baguet, 2023; Martinez et al., 2022; SMALL, 2023).

Table 11 Socio-demographic variables considered in the practical studies

	Study ID	*Population*	*Population density*	*Age*	*Income*	*Gender*	*Education level*	*Migrant Background*	*Other variables*
Urban	4	x		x		x		x	x (Human Development Index)
	6	x							
	7								
	8								
	10	x							
	15	x							
	22		x	x					
	26		x	x	x			x	
	27								
	31								
	35			x	x		x		x (veh ownership)
	42			x		x	x		
	44	x	x		x				
Outskirts	49		x						x (cyclists stress level)
	50		x						
	51	x	x						
	52			x	x	x	x		x (occupation, veh ownership)
	54	x	x						
	57	x							x (job types)
	62								
	63	x		x	x			x	x (degree of urbanisation)
	64	x							
	65								
	66								
	67	x							
	68	x							
	69								
	72	x							
	73	x							

Source: own elaboration.

Generally, most studies on the topic of walkability and age have concluded that there are large differences in accessibility between city centres and suburban or urban outskirts areas. The study by Rhoads et al., (2023) focused on both elderly and younger people, the latter being another group that is often overlooked in urban planning studies yet makes up almost the majority of city dwellers. Using data on the sidewalk network of Barcelona, they concluded that for both the youngest and oldest groups in the city, access to vital services becomes limited not due to lack of the services themselves, but because of inadequate pedestrian infrastructure to reach these. This was a bigger problem in the city outskirts than in the centre, which is in line with other studies on similar topics.

A study in Santiago that also focused on the access of elderly residents to grocery stores showed that while the city centre was a promising accessible zone, the suburbs are still largely inaccessible by walking (Ulloa-Leon et al., 2023). Similarly, a study on access to grocery stores in Vancouver showed a great accessibility of grocery stores by bike, but 15-minute walking access was only possible in the central areas (Hosford et al., 2022).

In the case of Ulloa-Leon et al., (2023), the authors investigated the accessibility levels of elderly population in Santiago de Chile to different amenities. The authors prioritised the amenities based on trip frequency (previous studies and official data) around two levels: 1) basic amenities: food-related, healthcare and public space and 2) metropolitan amenities: hospitals, public services, banks, entertainment sites, worship places and public transport. They used a 2,4 km/hr speed and their results showed that the city did good in general, especially for low-mid income elder population that accounts for 70% of the city's older adults. Their findings also demonstrated that old population did not go to the city centre as much due to the low accessibility conditions and instead, they searched for peripheral areas with high levels of urban connectivity in order to retire.

From a built environment perspective, Vale & Lopes, (2023) analysed inequality issues across different European cities in terms of pedestrian accessibility. Their findings showed Germany had the most walkable cities against UK with the worst cases. Similarly, Brookfield, (2017) studied the elements that residents value the most when idealising a neighbourhood (by using focus groups). The results showed that local amenities, social interaction, noise (peaceful environments), green areas and lower densities were the most important to determine a neighbourhood's walkability. Even though some studies tangentially addressed gender-specific desired amenities like Guzman et al., 2024), there is, surprisingly, no specific study considering differences between desired amenities according to gender. Once we have delved into findings regarding socioeconomic characteristics, user profiles and vulnerable groups, the next section regards the studies on users 'preferences and their findings.

4.4.4.2.Individual's needs and preferences

As discussed above, it is important to focus on vulnerable groups. But what do these vulnerable groups desire? This dimension regards all the studies that investigate citizen's preferences and needs towards the 15mC concept. The majority of studies on the topic of equity in 15mC focuses on the variables of age and pedestrian access. This also shapes the focus on what services have been studied as important to access, with the primary focus being grocery stores. Additionally, studies considered schools, pharmacies, libraries, social services and access to public transport as vital services (Rhoads et al., 2023; Willberg et al., 2023). Some studies also point out the relevance that public transport has for low-income populations, as it does not simply connect origins and destinations, but structures social life (Vitale Brovarone, 2022). Consequently, social inequalities usually emerge, and those who for any reason cannot drive a car are seriously affected by the lack of accessibility and social interactions. Therefore, peripheral areas need specific strategies to overcome these inequalities even more than urban cores. Boosting first/last mile trips with energy-efficient mobility solutions to extend accessibility ranges are key to improve mobility in the urban outskirts as stated by Abdelfattah et al., 2022).

Key findings from Baguet, (2023) showed that men use micromobility much more frequently than women and that the transport system as a whole has predominantly been designed from a male perspective, inadvertently neglecting specific female needs. On the study Martinez et al., (2022) the authors focused on the needs of citizens when using a mobility hub. They found out that the benefits that vulnerable citizens may obtain from using mobility hubs will depend on how the facilities, services and vehicles are adapted to their needs. In this regard, a more inclusive design was recommended, with the possibility of being assisted by someone at the hub or having access to a how-to-use training of the hub. The procurement of security and feeling of safety was commonly stated as necessary by participants. Likewise, having the possibility to use the hub through non-digital channels, and the provision of simple and understandable information (e.g., boards, screens, signage, etc.) were also highlighted.

Using an inductive method, research by Brookfield, (2017) adds low-density building, green spaces and leisure areas as elements that respondents consider to be important in their neighbourhood. In Both et al., (2022), the authors reflected on the importance of creating new jobs in housing-rich areas and creating new housing in jobs-rich areas to achieve spatial justice. These authors delve into households' composition to see their relationship with 15-minute accessibility metrics. They concluded that the expectation that households will be able to perform all their trips in 15 min or less while only using active modes of transport was unrealistic, even if local accessibility was considerably increased. Their results showed that a household with employed members were much more likely to perform trips with a duration of more than 15 min, which shows the current incompatibility of the 15-minute city paradigm with the distribution of working activities. Moreover, a house with more than one person were less compatible with a 15-minute-city lifestyle and car owners also were found to struggle more with the

time thresholds. Regarding particular age groups, they found that students from 5–12 years of age positively impacted 15-minute households, and students over the age of 19 positively impacted 30-minute households, supporting that university students are likely to live in households that maintain a travel-time radius between 15- and 30-minutes.

As one of the main conclusions from this section, we can highlight an important gap found in the academic literature on 15mC, *which is:* ***the lack of studies that focus on people's preferences at a detailed level*** **(see Table 12)**. This concerns the services that people want to have access to, how they would prefer to go there, but also how much time they are willing to spend travelling there. From all the literature review conducted, only five studies conducted surveys to analyse citizen's perceptions. From the five studies, only four were academic papers (indexed) (Basbas et al., 2023; Dumedah et al., 2024; Guzman et al., 2021, 2024) while the last one is an official report (Hamersma & Roeleven, 2024). But if we look further to the topics of focus, detail level achieved with the survey and the spatial scale considered, ***we can conclude that no study was found that surveyed citizens to investigate their preferences for amenities in the context of 15mC topic, with a moderate-high detail on the questions and amenity types and specifically for the urban outskirts.*** Only one study conducted by Basbas et al., 2023) had a 44% sample coming from mid-sized cities (our urban outskirts) and analysing the topic of preferences for amenities. However, this analysis was done at a basic level of detail as they were asked to rank eight essential functions: health, social centres, local markets, libraries, schools, green spaces, entertainment and commercial shops. This study only considered general categories (not specific types of amenities) and only considered walking, not including cycling or public transport.

On the other hand, we find two studies that delved deeper into detailed type of amenities (Guzman et al., 2024; Hamersma & Roeleven, 2024) but they did not consider our spatial scale (urban outskirts) and one of then, as mentioned before, was an official report from a Dutch agency. First, Guzman et al., (2024) delved into perceptions of citizens but at the Metropolitan scale considering the entire city of Bogota. In this study the authors developed a standardised accessibility index and one of the components of this index was citizens' prisonisation of services. The level of detail for the specific type of amenities was high with six general functions and almost 24 specific amenities, but the survey was very general as it only asks respondents to rank the essential services (groceries, healthcare, education, recreation, services and public transport) and then within each category the specific types of amenities: groceries, hospitals, medical services, preschool, schools, university, technical institute, vocational training, cultural, sport venues, parks, restaurants, bars, commerce, banks, laundry, Hairdressing, veterinary, clothing store, pharmacy, BRT station, bus stop, cable car stations and bike sharing. Their results yielded that grocery stores and healthcare facilities hold paramount importance across all population. High-income population prioritised retail shops and commercial services, while in contrast, low-income population declared that healthcare facilities were the most important and scare at their neighbourhoods (especially women with children). The authors emphasised the importance to include surveys to ask residents what they need and their particular perceptions instead of imposing a one-size-fits-for all approach of an ideal 15-min city.

Secondly, on the report called "acceptable accessibility" from KiM (Knowledge Institute for Mobility Policy) (Hamersma & Roeleven, 2024), they analysed the preferences and needs of Dutch citizens regarding travel times and accessibility indicators to various amenities through a survey with 3.400 respondents. The most relevant amenities were supermarkets and health centres (GPs). Work was relevant especially for those with limited options for teleworking, while public transport was more valued for those living in urban areas without a private car. The authors also found that acceptable travel times for the most essential amenities (supermarket, GPs, and PT infrastructure) ranged from 9 to 18 minutes, while those less essential (hospitals, workplaces, universities) ranged from 30-50 minutes. Moreover, there was a strong correlation between car access and the preference to reach amenities by car, particularly in rural areas. This is the most detailed study as it involves many amenities, but also

modes of transport and perceptions regarding acceptable travel times, but as we mentioned before, it is not a academic paper and the scale was national (The Netherlands).

And finally, we have two papers that are not into the topic of 15mC preferences for amenities and also are out of the spatial scope of our analysis. On the one hand, we have the study by Dumedah et al., (2024) which addressed an informal community (rural scale) and they investigated how perceived or declared travel times differ from the actual (objective) travel time. They did this also at a very basic level considering six broad functions: work, healthcare, education, shopping, place of worship and family visit. On a similar note, Guzman et al., (2021) asked respondents to give their perceptions of the lockdown measures imposed in the context of 15mC, which is also out of our scope as it does not involves the ranking or preferences for amenities. Additionally, this study was also conducted at a metropolitan scale for the city of Bogota.

Table 12 Two studies that conducted surveys on citizens 'perceptions

ID	Scope	Objective	Year and motivation	Type	Questions	Scale	Results
71	Full 15mC amenities preferences at detailed level	To developed an standardised index based on the availability of essential urban functions within a 15-minute walking distance. The index integrated individual preferences, along with geographical attributes, and the quality of pedestrian infrastructure.	Conducted in 2023 Motive: people prioritise essential services differently and within each type of services, specific amenities may also be valued differently.	Online N=334	First part: rank essential category: which is more important to have close to your home? Second part: rank the 24 types of establishments. - Imagine your own situation and neighbourhood...which category of service is more important to have close by? rank - Which specific services are more important in this category? rank Third part: Sociodemographic and house location.	Urban (Bogota, Colombia)	Grocery stores and most relevant across all populations. High-incomers had preference for retail shops and commercial services. Low-incomers for healthcare.
52	Not 15mC amenities preferences	To evaluate COVID-19 lockdown measures' impacts on activity and travel behaviours across different income groups.	Conducted in 2021 Motive: people changed their behaviours after the pandemic and perceptions of the lockdown measures may differ.	Online N= 776	First part: sociodemographic Second part: travel decisions and time spent on specific activities (activity duration and possibility to perform online before, during and after COVID-19, trip mode, time and cost). Third part: perceptual and qualitative information about government's measures (respondents asked to express their level of agreement with four statements related to time use satisfaction, financial concerns, agreement with the government measures, and new technology adoption).	Urban (Bogota, Colombia)	Low-income people were more exposed to contagion being forced to go out to find their daily sustenance.
46	Full 15mC amenities preferences at basic level	To evaluate the differences between perceived and actual travel times to work, healthcare, education, shopping, place of worship and family visit on a suburban context.	Conducted in 2021 Motive: perceived and realised accessibility is different.	Distributed forms N=375	First part: sociodemographic Second part: travel times to different services, mode, cost and rank level of satisfaction with trip characteristics.	Rural- informal community (Ayigya, Ghana)	Respondents declared (perception) longer travel times that the actual trip time (realised) as expected. However, it was demonstrated that in an informal area, the 15mC principles complied as most walked less than 5minutes to amenities.
42	Full 15mC amenities preferences at basic level	To evaluate the opinions of citizens with regards to the concept of 15-minute city	Conducted in 2020 and 2022 Motive: opinions about the usefulness of the 15mC concept might be different. Biased sample: members of a social Facebook group of Sicilians who generally walk daily for both work and leisure.	Online N=700	First part: sociodemographic and car ownership Second part: do you consider walking as an anti-stress method? And what are the 8 most essential services for a neighbourhood to be within a 15 minute walking distance? Third part: How useful do you think the concept of 15mC is for Sicilian cities?	26% of sample from dense areas (300-700k pop). 44% of sample from mid-dense (urban outskirts) (60-300k pop.) 30% of sample from low-dense areas (less than 60k pop.) (Sicilian areas, Italy)	Residents thought the concept may be useful for Sicilian cities and 90% agreed that walking was an anti-stress method. Additionally, health services and green areas were ranked as the most important amenities.
Non	Full 15mC amenities preferences at detailed level	To investigate what citizens considered as "acceptable travel times" for different types of destinations, exploring the role of transport modes, and variations among different population groups.	Conducted in 2024	Online N= 3.468	The relevance of reaching 16 different types of destinations. Acceptable travel times to those destinations. The current travel times to the nearest and most frequently visited locations. The preferred modes of transportation for each destination. Acceptable travel costs and other comfort-related factors	National (urban and outskirts)	70% find access to supermarkets, healthcare (e.g., doctors, hospitals), and workplaces relevant. Education is also important for people with children. Supermarkets, daycare, metro stops 9-18min while work, university and hospital 30-50min.

Source: own elaboration.

In summary, this section explored human perspectives which are central to implement the 15mC concept. This section did so by exploring socioeconomic dimensions, user profiles, and user needs. While the 15-minute city model aims to promote equitable access to services and amenities, several challenges remain, particularly concerning socioeconomic disparities and the needs of vulnerable groups. The variabilities in accessibility point to a need for more research that addresses these inequities. Also, considering the preferences of people in terms of choice of transport mode, willingness to travel to reach destinations, preference towards specific types of destinations (e.g. a specific school or shop) and their perceptions concerning safety, security and how they feel in their neighbourhood are vital to better understand the feasibility and desirability of 15-minute neighbourhoods. Additionally, the predominant focus of existing studies on walking and, to a lesser extent, cycling or using PT, highlights a gap in the research concerning public transport access within 15-minute city frameworks. Lastly, despite most studies highlighting a difference in accessibility between centres and peripheries, research focusing on specifically the urban outskirts areas is still scarce.

4.4.5. Governance

The next section focuses on the policy and regulation in place to promote the 15mC concept. On Table 13 we offer an overview of the studies revised.

Table 13 Findings from governance studies.

	Study ID	Policy recommendations
General	2	Aim to achieve walk scores of 80-89 is good enough, as higher ones do not have necessarily have a higher impact. Moderate land use changes and transport strategies for lower scores. For higher scores just transport strategies. Transport strategies include: car-sharing, better public transport and unbundled parking.
	13	Statutory-backed document that outlines rights and responsibilities to deliver 20-min concept, or else the concept turns into just hollow city-branding device.
	16	Lack of specific indicators towards the promotion of proximity-centred planning and the inclusion of different target groups (for example disabled people).
	18	Apply context-based solutions with a bottom-up approach and involving as many stakeholders as possible.
	19	Promotion of tactical urbanism to increase co-creation processes with high citizen participation. Recommendations include: making telework as smart, flexible, hybrid working model and for those not teleworking increase job offer in housing-rich areas by public-private-partnerships. Repurposing of space to be all-day purpose, include green space, energy-efficient buildings, and turn redundant offices into housing. Citizen participation should be promoted to have clear governance frameworks, through surveys, public meetings and digital solutions and small scale experiments that could be replicated if successful.
	21	Financial challenges need to be taken in consideration especially in Global South. Fiscal policies must be included in the governance frameworks
	30	Adjust opening hours, apply crowd control and guiding public behaviour as measures to shift from a rigid one-size-fits-all lockdown scheme to a more precise, localised and adaptable governance framework to balance urban health and economic needs.
	39	Proposition of a four-layer model to guide policy: 1. Urban opportunities, 2. Mobility infrastructure, 3. Activity space and 4. Share of trips using sustainable travel modes
Outskirts	56	Legal backing for shared mobility services and personal mobility devices (PMDs) Expanding public transport Creating dedicated pedestrian and cycling paths Creating transit corridors Mixed-use developments
	58	Shift from 20-minute neighbourhood to 20-minute specific service to capture their unique complexities

Source: own elaboration.

Regarding the general literature on governance issues about 15mC concept, we can highlight the study conducted by Boisjoly et al., (2018) whom explored the relationship between neighbourhood walkability and individuals' likeliness of walking in sessions of at least 10 minutes for the case of Montreal, Canada. Their findings showed that the influence of neighbourhood walkability on walking at least 10 minutes for shopping purposes increased up until Walk Score 80-89. The probability was then equally high in the 80-89 and 90-100 Walk Score neighbourhoods. In contrast, car access (as well as number of cars in a household) were strong predictors of walking, especially in higher Walk Score neighbourhoods. The authors emphasised the importance of combining land use and transport policies

to reduce car ownership. However, they demonstrated that while planners seek to achieve high Walk Score results, aiming for a 80-89 score would offer the same impact in terms of 10-minute walks requiring less substantial land use changes. Neighbourhoods with scores between 50-79 could achieve positive results just by applying moderate land use changes with complementary transport strategies to reduce car ownership, while those with high scores will just need car reduction strategies with no land use changes. Some of the recommended strategies to reduce car ownership included the expansion of car-sharing services and improving public transport especially in the outskirts and unbundled parking (buying a house without parking spot because it is bought separately).

On the case of Gower & Grodach, (2022) the authors reviewed planning documents for 33 cities worldwide to explore how the concept to 15-minute neighbourhoods have been implemented. Their results showed only two cities (Portland and Eugene) included specific, measurable benchmarks in their policy documents. ***The rest of the planning documents lacked measurable policy benchmarks, and no statutory weight was found, weakening the ability for planners to commit to the concept if there is no clear understanding of what is expected to be delivered.*** The authors showed that many of the cities used the concept in their general guidelines but do not specify how they are going to achieve this through policy, law and specific measures.

This general vision of 15mC without concrete, down-to-earth measures make the concept's implementation discretional and entirely reliant on the choice of the current planning team. Reliance on discretionary implementation for the 15-minute neighbourhood concept can consequently introduce spatial inequity and inconsistency as some local areas are able to deliver the concept, and others not. Finally, the authors state that without a statutory-backed document that outlines rights and responsibilities to deliver 15-min concept, the hollow policy becomes just a city-branding device as opposed to facilitating sustainable planning outcomes. This brand issue is also explored in Olivari et al., (2023) stating that x-minute cities has become a fashionable and even propagandistic element. Similarly, Ramírez Saiz et al., (2022) conducted a qualitative analysis of six different cities regarding their policies towards 15mC concept. Their results showed differences between each city's planning approach, but all of them coincide into one same weakness: ***the lack of measurable indicators and specific policies to promote proximity-centred planning through public transport and micromobility services***. In tune with previous mentioned studies, Papas et al., (2022) conducted a literature review to analyse the strategies implemented in French, Spanish and Italian cities to promote the 15mC concept. Their results yielded the need to make context-adapted strategies and solutions for the city that are an outcome of applying bottom-up approach while involving as many stakeholders as possible.

From a more policy-oriented focus, Pozoukidou & Angelidou, (2022) conducted a two-round Delphi survey with 120 European experts in the field of sustainable and smart cities, to explore the repercussions of the emerging 15mC in urban planning with a viewpoint in 2030. Their results were grouped around four different themes (proximity-centred planning, use of land and urban form, governance and citizen participation and inclusive digitalisation). Regarding proximity-centred planning, the experts point to the importance of jobs to create 15-minute neighbourhoods. They recommend to promote smart working (telework), but not fully home-based work model due to potential negative effects such as social polarisation and isolation. They advocate for smart, flexible and hybrid working modes that combine the benefits of organised workplaces with reduced commuting as also suggested in Di Marino et al., (2023). They also recommend to consider job as a basic function and to promote public-private partnerships (PPPs) to bring jobs to housing-rich areas.

We can also highlight the study by Di Marino et al., (2023) that delved into the job function to evaluate the possibility to include it as a basic function and at a metropolitan scale. The authors proposed flexible working stations or places that allow residents to stay in their neighbourhoods through telework. To

make this possible, in their study they considered coffee shops and libraries as workplaces. They mentioned that some of these places have adapted their business models to offer new facilities, such as several spaces for working, meeting rooms, Wi-Fi, video for videoconferences and other equipment/furniture, in addition to coffee and food, becoming authentic working hub locations. This adaptation allowed many residents to stayed in their neighbourhoods and be able to work at the same time. Similarly, in the study conducted by Allam, Bibri, Chabaud, et al., (2022a), the author recommended to create Special Economic Zones (SEZs) that could help attract investment, benefiting both public and private sectors and creating job opportunities at the local level.

On the topic of land use and urban form, the experts suggested to create liveable neighbourhoods within functional metropolitan areas as suggested by Graells-Garrido et al., (2021) with the phrase "a city of cities". They also promote the repurposing of spaces to be diverse and multitemporal, like for example using schools as community centres or playgrounds during off-hours, optimising space use while increasing social inclusion which is also supported by Li et al., (2023). Next, they also considered the integration of open space/green areas into the neighbourhood planning to increase urban health as well as energy-efficient buildings and converting redundant office space into affordable housing offer addressing the growing need for social housing.

Regarding citizen participation, the experts highlighted the importance of city planners to have clear business, governance, and operating models with a social and environmental mandate and that their staff receive proper training and incentivisation to apply those mandates, along with additional training in citizen-centric service design. According to the experts, when possible, citizens should be surveyed and engaged in the design and implementation of their neighbourhoods, which would thus allow genuine citizen-government relationships to be cultivated and support the transition to a more thoroughly interactive governance of the 15mC concept. Collaboration should always be sought not only through digital means but also by using the more traditional modes that have been used for decades in policymaking, such as public meetings. Self-organised bottom-up communities should be promoted and facilitated, through the offering of spaces and equipment to allow meetings and interaction to happen.

This participation can be incentivised, as is practiced in contemporary citizen science, through either non-monetary or monetary rewards in order to overcome the usual challenges related to attracting adequate participation. The governance framework for a 15mC concept to be implemented should include, according to their recommendations the following: 1. Vision and objectives of 15-minute neighbourhood, 2. Key facilities and infrastructures to achieve vision along with standards of operation, 3. Organisational structure roles, responsibilities of the multi-stakeholder team, 4. Procedures through which citizens and businesses will meet and work together for the vision, 5. Legal and ethics code for each stakeholder defining rights and obligations and 6. Method for assessing the performance and impact of 15-minute vision on social, economic and environmental aspects. And lastly on the topic of inclusive digitalisation, the experts recommend to use technology to facilitate citizen-driven small experiments with such applications, which could be scaled up to the neighbourhood and city level if they prove successful (Allam, Bibri, Chabaud, et al., 2022a).

Lastly, Tammaru et al., (2023) explored policy issues in the context of sustainable urban mobility, focusing on equity and inclusion. They proposed a four-layer model to guide equitable sustainable mobility considering: 1. Urban opportunities, 2. Mobility infrastructure, 3. Activity space and 4. Share of trips using sustainable travel modes. They proposed to introduce mixed-income housing policies at the neighbourhood level, reallocate road space from cars to public transport, cycling, and walking, consider metropolitan-wide strategies are also necessary to ensure equitable access to jobs and amenities that are not evenly distributed across all neighbourhoods, assuring that new shared mobility services are distributed throughout all neighbourhoods (low-income households included) and that public transport remains affordable.

Regarding the outskirts literature, we can highlight Renaningtyas Manifesty & Park, (2022) that discussed the implementation of the 15mC concept within the context of Singapore's 2040 Land Transport Master Plan, specifically through its adaptation into "20-Minute Towns and a 45-Minute City". They adapted the concept to provide residents with better access to local amenities within 20 minutes and ensure that most journeys across the city can be completed in 45 minutes using public transport or active mobility options. The authors described how regulations have been adapted, for example establishing legal backing for shared mobility services and personal mobility devices (PMDs), expanding public transport, creating dedicated pedestrian and cycling paths, transit corridors as well as moving away from rigid zoning laws to mixed-use developments that facilitate closer proximity between homes, workplaces, and essential services. Finally, Gilbert & Woodcock, (2022) compared local living policies from Australia, North America, China and South-East Asia in terms of their aims and relationship to planning practice. Their findings highlight the varying levels of maturity from different city planning documents both at the strategic and operational level. These authors also proposed a shift in focus from 20-minute neighbourhoods to 20-minute amenities: 20-minute schools, 20-minute health, etc., as this could help unpack the complex dynamics of each function. From this point of view, when analysing 20-minute schools, planners could grasp complexities like the parent/student attitudes towards walking/cycling, schools‘ policies for car usage and car parking, school events out of town or school zones.

One topic commonly found among literature is the issue of territorial boundaries. One key challenge could be extending the model beyond the municipal boundaries and aligning interests and objectives among different territorial units (Büttner et al., 2022). Where one municipal jurisdiction ends to make space for other municipal jurisdictions, one might ask whether it is desirable or not that all territorial units, regardless of their location, become hyper-local and take on a more urban character. On the other hand, from an economic-development perspective, streams of investments directed toward implementing 15mC in the main central city could lead to increased inequalities between the main city centre and the immediate suburbs. If not well coordinated with regional actors, core investments fuelling the 15mC could risk a decline in public transport infrastructure investments. If public transport is not sufficient and far-reaching throughout the city and its suburban borders there is the risk that commuters will resort to car usage in order to cover longer distances.

Other important issue is distrust of citizens. Marquet et al., (2024) emphasised that in order to successfully implement 15mC, it is important to understand and address people's concerns and distrust in authorities (as they might think government wants to achieve total population control). They point to ideological and political beliefs as being the basis of this opposition as supported by Rodríguez-Pose, (2018). The authors also recommend participatory workshops and co-design processes addressing rural or suburban concerns and democratising planning to focus on non-urban areas also. Available land and housing stock are relevant to reduce housing deficits and co-planning practices and participation in decision-making that include diverse cultural backgrounds, mobility difficulties, and the elderly, young people and students, in order to reduce their vulnerability through empowerment programs is key (Pozoukidou & Chatziyiannaki, 2021). More specifically, authors like Ferrer-ortiz et al., (2022) are proposing minute-based policies in which all these aspects are taken into consideration and policy becomes relevant for their target users.

On a similar note, other studies like the one conducted by Brown & Howell, (2024) analysed in a more specific way, the equity requirements in micromobility services across the US, highlighting the main barriers that make them inaccessible to vulnerable groups:

- Spatial limitations: Programs often concentrate in central urban areas, leaving peripheral neighbourhoods underserved.

- Economic barriers: Membership fees and lack of alternatives to credit/debit payments exclude low-income users.
- Technological barriers: Dependence on smartphones excludes individuals without mobile internet or smartphones.
- Lack of awareness: People may not know about micromobility services or find it difficult to access information due to language barriers or poor outreach.

Their results yielded the need for outcome-based evaluation of equity efforts, rather than just focusing on access as many services aim to increase the availability of their vehicles but failed to ensure that these are actually used by vulnerable groups; placing bikes in underserved areas but not taking care of other barriers (cost, lack of outreach). Their recommendations for an equity regulatory framework included:

- Policy Development: stating that Cities should establish clear equity policies that target vulnerable groups, focusing on affordability, accessibility (including non-smartphone access), and geographic distribution to underserved areas.
- Equity in Implementation: governance frameworks should mandate specific features like cash payment options and adaptive vehicles, which are critical for expanding access to a broader demographics.
- Evaluation: reporting needs to include evaluation mechanisms to ensure compliance and assess whether equity goals are being met. This includes requiring operators to report usage data disaggregated by income, race, gender, and neighbourhood.
- Incentivising compliance: operators should be incentive to link fleet sizes or permit renewals to the achievement of equity metrics.
- Comprehensive requirements: governance frameworks should adopt a multi-dimensional approach, including reduced fares, accessible payment systems, and targeted outreach.

Similarly, ITF, (2021) also recommends to have outcome-based regulations liked to specific performance criteria. For example, instead of vehicle fleet deployed, an authority could seek to evaluate number of trips per vehicle and per day according to different vulnerable or targeted group. They also recommend micromobility to be incentivised through subsidies and business models in the urban outskirts.

Therefore, citizen participation and the interdisciplinary planning process are key to build concrete human centre city policies and ensure their application. In this sense, authors like Abdelfattah et al., (2022) recommend sensitive, site-specific and participatory workshops that help create a shared vision of the 15mC. Governance component then plays a key role to guide policy to target specific vulnerable groups and to come up with creative innovative solutions to increase citizen engagement.

4.4.6. Business models

In regards to the 15mC, business models are needed where business (services) are needed and operated (involving cost). Hence, if we aim to implement interventions like shared mobility, on-demand public transit services, mobility or flexible activity hubs, and other measures that enabled proximity planning, then business models need to be considered. Having policy in place is relevant but also the mechanisms that allow this policy to become reality. This section delves into the existing business models studies and recommendations to guide cities towards a 15mC path. Firstly, we can highlight the lack of studies regarding business models in general, but specifically no study was found on the specific topic of business models for the 15mC.

From the shared mobility literature, we have learned that in general, all shared mobility services basically manage a fleet of vehicles and offer them to their subscribers as a rental service for a given

time (hours, minutes, etc.). They generally work through applications on smartphones, where clients access an interface with a city map and locate the closest vehicle (bike, moped or scooter). Once the vehicle is identified, they unlock it from the app and begin the journey. User data and bank information are saved when registering for the service in order to make payment for the use of their fleets. Once the user reaches their destination, they park and relock the vehicle from the app. All companies operate in a similar way with similar business models. In the particular case of car-sharing services, according to Münzel et al., (2019) there are mainly two types of car-sharing business models:

- Business-to-Consumer (B2C) Car Sharing: In this model, a company owns a fleet of cars that users can rent. The users typically pay for the car by the hour, day, or distance travelled. The service often includes insurance, maintenance, and repairs. These cars are commonly spread out across a city, and users can pick them up in a self-service fashion. There are two types within B2C: Roundtrip (RT): Users pick up and drop off the car at the same location and Free-Floating (FF): Users can drop off the car anywhere within a designated area, making it more flexible for short trips.
- Peer-to-Peer (P2P) Car Sharing: This model operates on a two-sided platform where private individuals rent out their personal vehicles to others. It is typically more cost-effective than B2C, and car owners can decide when to rent out their cars. This form of car-sharing has been growing due to the ease of online platforms and smartphone apps.

These models cater to different user needs, with B2C generally being used more frequently for recurring purposes, while P2P is often used for special occasions. A critical issue from the operational point of view is the need to redistribute vehicles since there is often an imbalance between the origins and destinations of trips according to hours of the day. Thus, for example, in early morning hours, most trips originate from residential zones, while they end at employment areas and the contrary tends to occur in the afternoon (commuting patterns). This causes vehicles to be concentrated in some neighbourhoods and scarce in others, forcing operators to redistribute vehicles in vans, with the consequent increase of operation costs, congestion and pollution.

In addition, dockless services require more operational logistics for maintenance and recharging tasks. In regard to the spatial distribution of these services, they are often offered mainly in the city centres, where operators find more profitability, as land uses are diverse, and a high concentration of public transport and activities offered. However, the concentration of shared services in the city centre may be competing with public transport and active mobility and hence, a more homogeneous distribution is desired reaching also peripheric areas, usually the most car-dependent ones, and where these services could be a solution to the last-mile trips.

In terms of funding, unlike public transport or the first emerging public bike-sharing systems that were mostly financed or promoted by public organisations with public money, the new shared mobility services are mostly incentivised by private initiatives. Large private companies are behind many of these initiatives (e.g., BMW with Car2Go, Renault with Zity or Kia with Wible). Hence, being a non-subsidised sector, makes it difficult to offer these services on low-income neighbourhoods or low-density areas. Hence, new social business models should be adapted or proposed to address this issue and increase social equity (Calafiore et al., 2022; Kelobonye et al., 2020; Tammaru et al., 2023).

Of particular interest is the study by Pozoukidou & Angelidou, (2022) which specifically addressed the governance and business model that needs to be in place to promote the development of the 15mC concept. The authors suggested that this business model should clearly define: 1. The mission of the 15-minute city, 2. The value proposition and the key activities, infrastructure, and resources required to generate that value, 3. the partners that are crucial to making the business model effective, 4. the cost structure and revenue streams of the 15-minute city, and 5. the social and environmental benefits, along with risks and costs. In order to come up with this business model, governance, operation and different

approaches must be discussed, co-created and regularly updated through the contributions of all stakeholders involved. They also mentioned the importance of funding as a critical aspect to achieve the mission in a sustainable manner. To this end, the authors proposed that 15-minute cities should take advantage of the numerous smart and sustainable city knowledge exchange networks and funding schemes offered by national and international authorities, such as the European Commission through the Climate-Neutral and Smart Cities Mission and the Circular Cities and Regions Initiative. Moreover, city planners and officials should be trained to carry out all the basic steps for participating in these networks and obtaining funds for which they are eligible. This will enhance their capacity to undertake smart city projects that can be sustained beyond the initial funding scope and period.

The study Allam, et al., (2022b) also recommends the introduction and institutionalisation of the fiscal incentives targeting funds that the private sector can align with public objectives. On their revision, they summarise that Cities have tried to address these barriers embedding equity requirements in permits and contracts for micromobility operators. On a similar note, Brown & Howell, (2024) recommends to include some requirements for operators before deploying vehicles and obtaining permits from Cities:

- Reduced fares for low-income users.
- Cash payment options for those without bank cards.
- Non-smartphone access.
- Multilingual services for diverse populations.
- Adaptive vehicles (e.g., seated scooters) for users with disabilities.
- Geographic distribution mandates to ensure vehicles are placed in underserved areas.

As a summary from the governance and business model component sections, we offered in Table 14 the most mentioned and frequently supported strategies to increase equity and enable 15mC concept in the outskirts neighbourhoods. most of the strategies are infrastructure-related, but also regulation that needs to be in place and citizen participation mechanisms that need to be activated to transition into a 15mC path.

Table 14 Strategies recommended or applied in cities from the literature

Topic	Strategies	Infrastructure	Equity-based regulation	Business models	Information and Citizen participation	Addressing issue
Mobility	Expansion of shared mobility	x				A
Mobility	Improving public transport	x				A
Mobility	Improving pedestrian infrastructure	x				A
Mobility	Improving cycling infrastructure	x				A
Mobility	Creating mobility hubs	x				A
Housing	Unbundled parking for new house developments		x			A
Housing	Convert redundant office space into affordable housing		x			A
Housing	Mixed-income housing development		x			A
Housing	Introducing superblocks (pedestrianise areas)	x				A
Amenities	Increasing amenities (number and quality)	x				A
Amenities	Street experiments/activity hubs (taking space from cars)	x				A
Work	Offering flexible working schemes (co-working spaces)	x				A
Co-creation	Citizen participation with co-creation process (not just surveys but public meetings, walk-along interviews)				x	B
Technology	Augmented Reality to show possible interventions				x	B
Incentives	Incentives (monetary/non-monetary) to participate			x		B
Incentives	Fiscal incentives for private funds to align with public objectives			x		B
Policy	Outcome-oriented planning documents with benchmarks/indicators/statuary (e.g. everyone should have a hospital within a 30minutes PT ride)		x			C
Policy	Shift from 20-minute city to x-minute amenity (for example 30-minute hospital, 5-minute daycare, 10-minute bakery, 15-minute PT stop, etc.)		x			C
Regulation	Multi-purpose and multi-temporal use of facilities		x			C
Regulation	Mixed land use promotion		x			C
Regulation	Promote city planners trainings on how to get funds for projects		x			C

A Spatial equity: "Those living in the urban cores are privileged and we in the outskirts are marginalised"

B Conspiracy Theories: "They want to bring back the ghetto or gentrify my neighbourhood…the government wants to take complete control and not allow me to move freely in my car"

C One-size-fits-all: "This concept risks to perceive all areas as similar when really each one of us needs different context-adapted measures and own speed rates"

Source: own elaboration.

5. THE DREAMS 15MN MIXER: THEORETICAL FRAMEWORK FOR 15MN TRANSOFRMATIONS

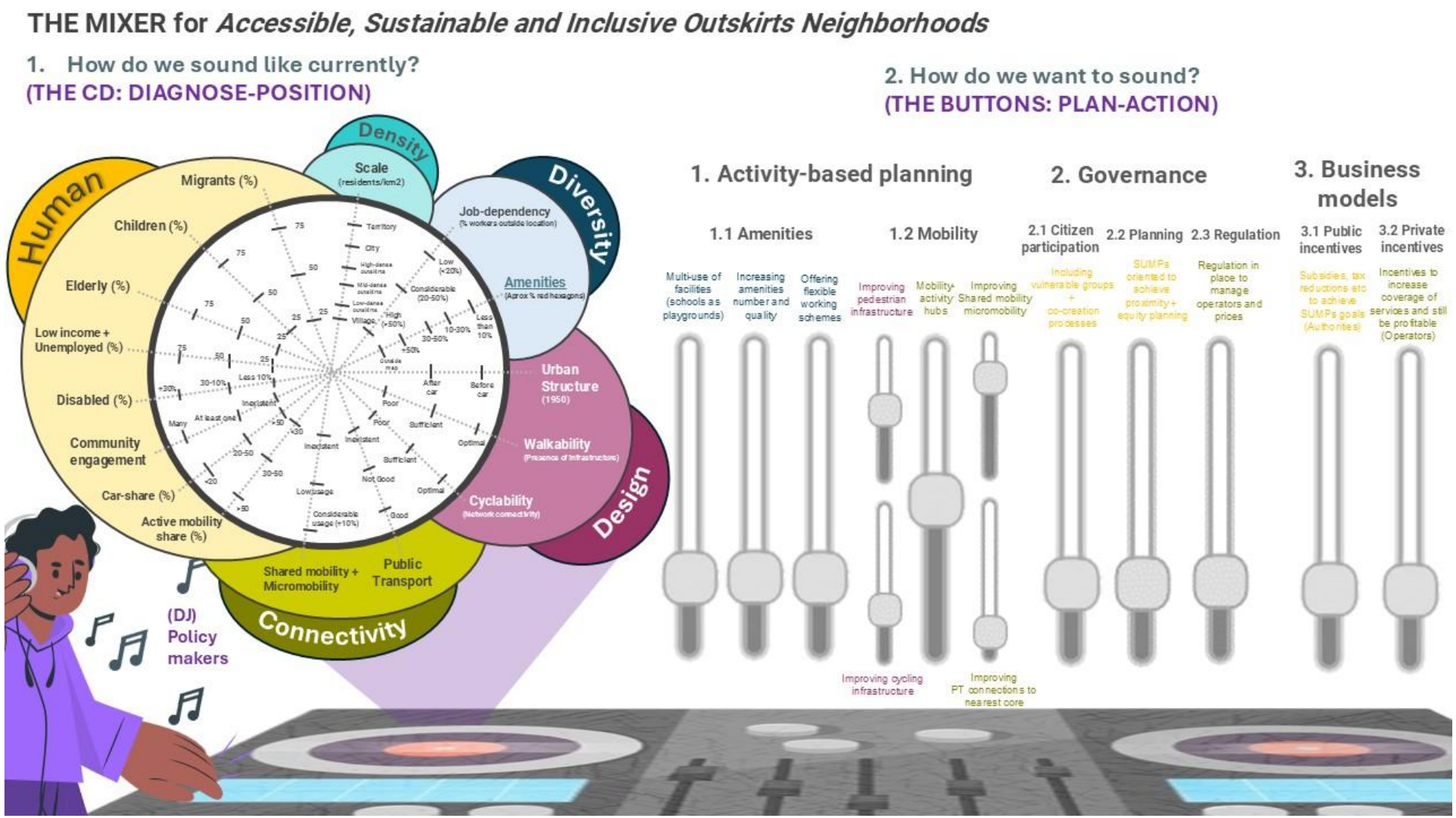
After describing the main components for our extended definition of 15mC for the urban outskirts neighbourhoods, this next section describes what we call, the DREAMS 15mN Mixer. The Mixer summarises findings from the conducted literature review, helping us to answer the question: *"What are the key components to be considered from the literature to define 15-minute neighbourhoods in the urban outskirts?"* The Mixer becomes our theoretical framework to address each of the living labs and position them according to these components (see Figure 14). First we want to clarify that the Mixer is not a tool per se (this will be delivered in WP3), but rather an illustration summarising findings from the literature review in a creative way.

To illustrate more on the understanding of the framework, we invite the reader to think of a DJ gear or mixer. The DJ in this case, is the reader (students, researchers, policy planners, citizens, etc.) and we are about to address how a certain location named "A" (an urban outskirts) sounds like. The mixer has two elements: part I is the current sound (diagnosis) and is composed by those elements that cannot be changed or take too long to change and that, in general, characterise location A (scale, existing jobs and amenities, urban structure, walkability and cyclability, public transport, offered shared mobility and socioeconomic characteristics). Based on the knowledge of location A, the DJ positions it along these variables and levels like a CD and obtains the current music or current status. This part involves the diagnosis and positioning of a location with respect to others.

By listening closely, we introduced the reader into part II of the mixer where the DJ can actually play some buttons to improve this sound and make it more similar to an Equitable and Accessible 15-minute Outskirts Neighbourhood (DREAMS 15mN). These buttons represent the strategies, policies, recommendations and actions that could be taken into account for the outskirts. Based on the sound the DJ is hearing from the diagnosis, it is possible to make small/big changes to adequate policies to the particular location's sound and make it more in tune with the ideal 15-minute city song for the area. It is important to keep the *harmony* or mix of strategies by not putting all buttons up (trying to do everything with the same priority), as we will only get noise (too load sound). It is also important to not keep all buttons down (not doing anything at all) as then the result will be complete silence (turning the location's sound off). Therefore, we aim to have the optimal or feasible mix, which is the prioritisation topics that the certain location needs according to the current sound/status and based on their citizen's vision of the location (see Appendix 3 on a step-by-step guide of the DREAMS 15mN Mixer).

In this sense, our framework reflects how urban planners/policy makers (visualised as 'DJs') need to balance out various components in the quest to successfully implement the 15-minute neighbourhoods within the urban outskirts. Each element works on a spectrum, reflecting different intensities and qualities of urban development. It illustrates that a 15-minute neighbourhood is one achieved through careful adjustments and coordination across these multiple dimensions towards building a unified living environment that is sustainable and functional.

Figure 14 DREAMS Theoretical framework for 15mN transformations.



Source: own elaboration.

6. CONCLUSIONS

This report has described the main findings from a systematic literature review on academic papers that delve into the 15-minute neighbourhood and urban outskirts. As main conclusions we can withdraw that the 15mC concept is a new way of rephrasing previous concepts and that it has been successful in gaining momentum among researchers but also policy makers. The idea behind the concept is to have proximity to essential services using active mobility, public transport and shared mobility in order to reduce car dependency. Even though it was initially designed and applied to dense urban cores, the 15mC concept is being rethought for application in suburban settings or the urban outskirts. These less densely populated environments are generally characterised by sprawl and more intensive use of the private car, both of which would imply the rethinking of how proximity and accessibility could be delivered.

A key critical insight from this review is the need to adapt the main principles of 15mC to different spatial contexts. Hence, the short walking/cycling distances to amenities that we can achieve in the dense urban cores, need an adaptation for the urban outskirts, considering public transport, shared mobility solutions and innovative transport arrangements that could effectively connect more dispersed amenities. Such adaptations would need to consider that each area has its own pace to achieve 15mC goals, and at first a flexible timeframes could be proposed, recognising the greater distances often lying between home, services, and workplaces in these areas. This could also be adapted for different amenities/activity purposes with different timeframes.

Based on the literature, we propose the *"Equitable and Accessible 15-minute Outskirts Neighbourhoods (DREAMS 15mN) as an adapted version of the 15mC concept that focuses on the reduction of the need to use a private car in the urban outskirts allowing its residents to access their essential amenities and fulfilling daily needs through active mobility and local infrastructure (like public transport, shared mobility services, mobility/activity hubs among others), while also being well connected to other cores through regional infrastructure. This adaptation of the concept focuses on user's perceptions and preferences regarding acceptable travel costs to amenities".*

This extended concept involves at least the consideration of six components: density, diversity, design, human perspectives, governance and business models. Density, Diversity and Desing have been the most developed components in the literature while less documents are found for business models, governance and human perspectives. From the literature review, results yield an important research gap: the ***lack of studies regarding user's perceptions and preferences for different amenities and acceptable travel times.*** Studies which spatial scope goes beyond the urban cores to other urban settings. The lack of studies regarding equity-based regulatory and governance frameworks along innovative business models to enable 15mC in both, urban cores and urban outskirts.

Density refers to different outskirts scales based on their residential density. Diversity deals with the offer of amenities and services within a certain distance considering different modes. Finally, design involves physical elements like built environment variables (like cycling and pedestrian infrastructure) and connectivity (public transport and shared mobility options). The human perspectives and effective governance frameworks as well as innovative business models are also key to realising this vision in less dense settings. In doing so, co-creation, community involvement, and other such forms of participatory planning processes very much support the sensitivity towards the needs and preferences of residents. Other business models balancing economic viability and social equity enable the provision of both sustainable and inclusive mobility services that fit into the suburban setting where traditional urban models fall short. Moreover, inclusivity should emerge as one of the key elements of applying the 15mC concept to locations outside the very dense urban setting. In the outskirts, social and economic

diversity will mostly be much larger compared to urban settings; therefore, it would need to adapt to the various needs of different groups demographically. In areas where distance and connectivity are pronounced challenges, it becomes all the more important to reach out equitably to all citizens in the city, irrespective of their socio-economic backgrounds.

All these relevant components were summarised in a theoretical framework called the DREAMS 15mN mixer, which could help policy planners to diagnose and position locations, living lab areas or any place with respect to one another. Moreover, it helps then to take decision and to determine which components and aspects they can change to improve the current status and make neighbourhoods become more accessible and similar to a 15-minute neighbourhood ideal. Using the mixer, the DJ can listen to the current sound of an area and play with the buttons or strategies to achieve an improved sound. From this report we can highlight that this theoretical framework helps to address how a location is doing in terms of the most relevant variables for the 15-minute concept gathered from the literature review.

As a main limitation of the study we can highlight the time capacity to analyse not only scientific academic literature, but also other non-academic reports and grey literature that could complement this proposed framework. However, we wanted to focus mainly on the robust existing scientific literature in order to be able to grasp and summarised the discussions on the topic from the research community. Future research lines could delve into this non-scientific literature to complement findings and also get feedback on this framework from citizens living in the outskirts to see if something is missing.

Nevertheless, we acknowledge that the adaptation of such a concept in the urban outskirts is challenging. There are differences in accessibility, economic feasibility of providing extensive mobility service in low-density environments, and the task of fostering mixed-use development in car-dependent suburbs, among other challenges. These draw the need for creative strategies that go beyond conventional urban planning approaches toward a more inclusive and sustainable outskirts.

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APPENDIX

Appendix 1 Table of authors for general literature (48 studies) ordered and indexed by date of publication.

Study ID	Title	Year	Authors
1	Residents' preferences for walkable neighbourhoods	2017	(Brookfield, 2017)
2	How much is enough? Assessing the influence of neighbourhood walkability on undertaking 10-minute walks	2018	(Boisjoly et al., 2018)
3	15-Minute City: Decomposing the New Urban Planning Eutopia	2021	(Pozoukidou & Chatziyiannaki, 2021)
4	A city of cities: Measuring how 15-minutes urban accessibility shapes human mobility in Barcelona	2021	(Graells-Garrido et al., 2021)
5	Introducing the "15-Minute City": Sustainability, Resilience and Place Identity in Future Post-Pandemic Cities	2021	(Moreno et al., 2021)
6	15-, 10- or 5-minute city? A focus on accessibility to services in Turin, Italy	2022	(Staricco, 2022)
7	A Grammar-Based Optimization Approach for Designing Urban Fabrics and Locating Amenities for 15-Minute Cities	2022	(Lima et al., 2022)
8	Barcelona under the 15-Minute City Lens: Mapping the Accessibility and Proximity Potential Based on Pedestrian Travel Times	2022	(Ferrer-ortiz et al., 2022)
9	Circle of paradigms? Or '15-minute' neighbourhoods from the 1950s	2022	(Kissfazekas, 2022)
10	Exploring the 15-minute neighbourhoods. An evaluation based on the walkability performance to public facilities	2022	(Caselli et al., 2022)
11	Geospatial analysis framework for evaluating urban design typologies in relation with the 15-minute city standards	2022	(Burke et al., 2022)
12	is the 15-minute city within reach? Evaluating walking and cycling accessibility to grocery stores in Vancouver	2022	(Hosford et al., 2022)
13	Planning Innovation or City Branding? Exploring How Cities Operationalise the 20-Minute Neighbourhood Concept	2022	(Gower & Grodach, 2022)
14	The 15-minute city: interpreting the model to bring out urban resiliencies	2022	(Abdelfattah et al., 2022)
15	The 15-Minute City—The Geographical Proximity of Services in Krakow	2022	(Noworól et al., 2022)
16	The Level of Inclusiveness of Current 15-Minute City Models. A Qualitative Analysis on How Far City of Proximity Strategies and Design for All Are Merging	2022	(Ramírez Saiz et al., 2022)
17	Unpacking the '15-Minute City' via 6G, IoT, and Digital Twins: Towards a New Narrative for Increasing Urban Efficiency, Resilience, and Sustainability	2022	(Allam, Bibri, Jones, et al., 2022)
18	Urban mobility evolution and the 15-minute city model: from holistic to bottom-up approach	2022	(Papas et al., 2022)
19	Urban Planning in the 15-Minute City: Revisited under Sustainable and Smart City Developments until 2030	2022	(Pozoukidou & Angelidou, 2022)
20	Scenarios for a Post-Pandemic City: urban planning strategies and challenges of making "Milan 15-minutes city"	2022	(Pinto & Akhavan, 2022)
21	The '15-Minute City' concept can shape a net-zero urban future	2022	(Allam, Bibri, Chabaud, et al., 2022a)
22	Urban accessibility in a 15-minute city: a measure in the city of Naples, Italy	2022	(Gaglione et al., 2022)
23	Improving the Spatial Accessibility of Community-Level Healthcare Service toward the '15-Minute City' Goal in China	2022	(Song et al., 2022)
24	A civic and sustainable 15-minute campus? Universities should embrace the 15-minute city concept to help create vibrant sustainable communities	2022	(Barratt & Swetnam, 2022)
25	15-Minute City: Utopia or reality?	2023	(De Leániz & Lobo, 2023)
26	A composite X-minute city cycling accessibility metric and its role in assessing spatial and socio-economic inequalities –A case study in Utrecht, the Netherlands	2023	(Knap et al., 2023)
27	Are Italian cities already 15-minute? Presenting the Next Proximity Index: A novel and scalable way to measure it, based on open data	2023	(Olivari et al., 2023)
28	Assessing spatial equity in urban park accessibility: an improve two-step catchment area method from the perspective of 15-mintue city concept	2023	(Zhang et al., 2023)
29	Community gardens and the 15-minute city: Scenario analysis of garden access in New York City	2023	(Limerick et al., 2023)
30	From lockdown to precise prevention: Adjusting epidemic-related spatial regulations from the perspectives of the 15-minute city and spatiotemporal planning	2023	(Li et al., 2023)
31	Graph Representation of the 15-Minute City: A Comparison between Rome, London, and Paris	2023	(Barbieri et al., 2023)
32	Materials for a debate on the 15-minute city: Public transportation's effect on urban space and time in two Asia-based alternative	2023	(D. M. Bruno et al., 2023)
33	Measuring compliance with the 15-minute city concept: State-of-the-art, major components and further requirements	2023	(Papadopoulos et al., 2023)

34	Rethinking urban utopianism: The fallacy of social mix in the 15-minute city	2023	(Casarin et al., 2023)
35	Spatial regression model of urban walkability under the 15-minute city approach	2023	(Aristizábal et al., 2023)
36	The 15-minute city for all? – Measuring individual and temporal variations in walking accessibility	2023	(Willberg et al., 2023)
37	The 15-minute city: Urban planning and design efforts toward creating sustainable neighbourhoods	2023	(Khavarian-Garmsir, Sharifi, & Sadeghi, 2023)
38	The inclusive 15-minute city: Walkability analysis with sidewalk networks	2023	(Rhoads et al., 2023)
39	Towards an equity-centred model of sustainable mobility: Integrating inequality and segregation challenges in the green mobility transition	2023	(Tammaru et al., 2023)
40	From Garden City to 15-Minute City: A Historical Perspective and Critical Assessment	2023	(Khavarian-Garmsir, Sharifi, Hajian Hossein Abadi, et al., 2023)
41	"15-Minute City" and Elderly People: Thinking about Healthy Cities	2023	(Ulloa-Leon et al., 2023)
42	The 15-minute city model: the case of Sicily during and after covid-19	2023	(Basbas et al., 2023)
43	Mosques pedestrian accessibility analysis under the 15 min cities concept	2023	(Harroucha & Chaouni, 2023)
44	Developing the 15-Minute City: A comprehensive assessment of the status in Hong Kong	2024	(Liu, Kwan, & Wang, 2024)
45	Development of a Chrono-Urbanism Status Composite Index under the 5/10/15-Minute City Concept Using Social Media Big Data	2024	(Liu, Kwan, Wang, et al., 2024)
46	Do informal urban communities in Ghana qualify as a 15-Minute City based on access to socioeconomic activities?	2024	(Dumedah et al., 2024)
47	Reconceptualizing Proximity Measurement Approaches through the Urban Discourse on the X-Minute City	2024	(Megahed et al., 2024)
48	Spatial Equity of Urban Park Distribution: Examining the Floating Population within Urban Park Catchment Areas in the Context of the 15-Minute City	2024	(Jeon & Jung, 2024)

Source: own elaboration.

Appendix 2 Table of authors for outskirts literature (26 studies) ordered and indexed by date of publication.

Study ID	Title	Year	Authors
49	Accessibility in Practice: 20-Minute City as a Sustainability Planning Goal	2020	(D. C. Da Silva et al., 2020)
50	15-minute neighbourhood accessibility: A comparison between Naples and London	2021	(Gaglione et al., 2021)
51	Assessing Urban Accessibility in Monterrey, Mexico: A Transferable Approach to Evaluate Access to Main Destinations at the Metropolitan and Local Levels	2021	(Gaxiola-Beltrán et al., 2021)
52	COVID-19, activity and mobility patterns in Bogota. Are we ready for a '15-minute city'?	2021	(Guzman et al., 2021)
53	The Theoretical, Practical, and Technological Foundations of the 15 Minute City Model: Proximity and Its Environmental, Social and Economic Benefits for Sustainability	2022	(Allam, Bibri, Chabaud, et al., 2022b)
54	The x-minute city: Measuring the 10, 15, 20-minute city and an evaluation of its use for sustainable urban design	2022	(Logan et al., 2022)
55	Urban Transition and the Return of Neighbourhood Planning. Questioning the Proximity Syndrome and the 15-Minute City	2022	(Marchigiani & Bonfantini, 2022)
56	A Case Study of a 15-Minute City Concept in Singapore's 2040 Land Transport Master Plan: 20-Minute Towns and a 45-Minute City	2022	(Renaningtyas Manifesty & Park, 2022)
57	Achieving 'Active' 30 Minute Cities: How Feasible Is It to Reach Work within 30 Minutes Using Active Transport Modes?	2022	(Both et al., 2022)
58	Local Living and Travel Time based Urbanism	2022	(Gilbert & Woodcock, 2022)
59	The 20-minute city: An equity analysis of Liverpool City Region	2022	(Calafiore et al., 2022)
60	Trends and inequalities in distance to and use of nearest natural space in the context of the 20-min neighbourhood: A 4-wave national repeat cross-sectional study, 2013 to 2019	2022	(Olsen et al., 2022)
61	Accessibility inequality across Europe: a comparison of 15-minute pedestrian accessibility in cities with 100,000 or more inhabitants	2023	(Vale & Lopes, 2023)
62	Micromobility in Urban Trail Paths: Expanding and Strengthening the Planning of 15-Minute Cities	2023	(Vizmpa et al., 2023)
63	Moving the 15-minute city beyond the urban core: The role of accessibility and public transport in the Netherlands	2023	(Poorthuis & Zook, 2023)
64	Quantifying and visualizing the 15-Minute walkable city concept across Europe: a multicriteria approach	2023	(Bartzokas-Tsiompras & Bakogiannis, 2023)
65	The 15-minute city concept and new working spaces: a planning perspective from Oslo and Lisbon	2023	(Di Marino et al., 2023)
66	Who is living a local lifestyle? Towards a better understanding of the 15-minute-city and 30-minute-city concepts from a behavioural perspective in Montréal, Canada	2023	(Birkenfeld et al., 2023)
67	Filling in the Spaces: Compactifying Cities towards Accessibility and Active Transport	2023	(Monteiro et al., 2023)
68	Availability and Adequacy of Facilities in 15 Minute Community Life Circle Located in Old and New Communities	2023	(Wu & Divigalpitiya, 2023)
69	The "15-minutes station": a case study to evaluate the pedestrian accessibility of railway transport in Southern Italy	2023	(Fazio et al., 2023)
70	The Potential Role of Railway Stations and Public Transport Nodes in the Development of "15-Minute Cities"	2023	(Wolański, 2023)
71	Is proximity enough? A critical analysis of a 15-minute city considering individual perceptions	2024	(Guzman et al., 2024)
72	Developing a 15-minute city: A comparative study of four Italian Cities-Cagliari, Perugia, Pisa, and Trieste	2024	(Murgante, Patimisco, et al., 2024)
73	Developing a 15-minute city: Evaluating urban quality using configurational analysis. The case study of Terni and Matera, Italy	2024	(Murgante, Valluzzi, et al., 2024)
74	Built environment and the evolution of the "15-minute city": A 25-year longitudinal study of 200 Swedish cities	2024	(Elldér, 2024)

Source: own elaboration.

Appendix 3 Step-by-step guide of how to use The Mixer

PART I: DIAGNOSIS OR CURRENT SOUND

1. Density-scale: what is the residential density at the location? Take into account urbanised area (without green open space).
    a. Neighbourhood (unit scale): 0-300 people/km2
    b. Village: 301-650 people/km2
    c. Low-dense Outskirts: 651-2.500 people/km2
    d. Mid-dense Outskirts: 2.501-3.500 people/km2
    e. High-dense Outskirts: 3.501-7.500 people/km2
    f. City: 7.501-25.000 people/km2
    g. Territory: more than 25.000 people/km2
2. Diversity- job-dependency: what is the percentage of residents that work outside the location?
    a. Low percentage: less than 20% of residents go outside for work reasons.
    b. Considerable percentage: from 20 until 50% of residents work outside.
    c. High percentage: more than 50% of residents go outside for work.
3. Diversity-amenities: what is the current situation of the location in terms of amenities? First visit this link, then write the name of the main city in which your location is at and based on the map showed…classify approximately how much hexagons of your location are in red (areas in which people have low accessibility to amenities):
    a. Less than 10% are red
    b. From 10-30% are red
    c. From 30-50% are red
    d. More than half are red
    e. The location is outside the hexagons map
4. Design-Urban structure: was the location planned before or after the car became massive (year of reference 1950)?
    a. Before 1950
    b. After 1950
5. Design- walkability: in terms of presence of pedestrian infrastructure how is the location doing?
    a. Optimal
    b. Sufficient
    c. Poor
6. Design-cyclability: in terms of cycling network connectivity how is the location doing?
    a. Optimal
    b. Sufficient
    c. Poor
7. Connectivity-public transport: in terms of presence, travel times to city centre and frequency of public transport…based on your knowledge of the location…how is the situation?
    a. Good…there is public transport (train, metro, buses, etc.) and it has high frequency.
    b. Not good...there is public transport but low frequency.
    c. Inexistent…people depend on their cars and taxi services.
8. Connectivity-shared mobility/micromobility: in terms of presence and general usage of micromobility and/or shared mobility services… based on your knowledge of the location…how is the situation?

    a. There is shared mobility/micromobility services and a considerable usage by the population (10% or more).
    b. There is some shared mobility/micromobility services but its usage ir very low (less than 10%).
    c. There is no shared mobility/micromobility services.
9. Human-active mobility share: If you add walking and cycling together in the location…what will be the approximate mode share?
    a. More than 50%
    b. From 30-50%
    c. Less than 30%.
10. Human-car share: what is the car share in the location approximately?
    a. More than 50%
    b. From 20-50%
    c. Less than 20%.
11. Human-Community engagement: based on the knowledge of the location…how are people organised?
    a. There are many citizen organisations (community centres, groups, etc.) and at least one of them focuses on vulnerable groups.
    b. At least one organisation is found.
    c. No organisation is found.
12. Human-disabled population: approximately what is the percentage of disabled population in the location?
13. Human-low income and unemployed population: approximately what is the percentage of low income and unemployed population in the location?
14. Human-elderly population: approximately what is the percentage of elder population in the location? (above 65 years).
15. Human-children: approximately what is the percentage of children in the location? (under 18 years).
16. Human-migrant population: approximately what is the percentage of migrant population in the location? (born abroad and/or with parents born abroad).

PART II: IMPROVEMENTS WITH BUTTONS

Now we intend to prioritise the different strategies and propose new ones (that have not been considered) to improve the sound of the location.