MEASURING THE 15-MINUTE CITY A META-STUDY ON THE CONCEPTUAL OPERATIONALISATION AND TECHNICAL APPROACHES TOWARDS MEASURING PROXIMITY-BASED ACCESSIBILITY IN NEIGHBOURHOODS, CITIES AND URBAN REGIONS.

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1. Introduction

Since its introduction in 2016 [1], the 15-minute city (FMC) has become a popular model for urban planning and urban design [2]. The central idea is to provide people with all the essential amenities they need in their everyday-life within 15 minutes walking or cycling. This contributes to achieving several sustainability goals, especially *reducing greenhouse gas emissions, promoting active mobility and enhancing public life* [3].

As the concept aligns in many aspects with paradigms of contemporary and sustainable urban planning and urban design such as the *New Leipzig Charta, the C40 Cities Network* has declared the FMC concept a cornerstone for the sustainable transformation of urban regions according to United Nations' *Sustainable Development Goals* [4]. This raises the question how cities and urban regions can actually apply the concept or which policies they need to implement in order to become a 15-minute city or, more general speaking, a city of proximities.

Consequently, especially in recent years after COVID-19, numerous studies have been published investigating questions like *"Is [city] already a 15-minute city?" or "which parts of [city] can already be regarded as 15-minute neighbourhoods?"* or familiar questions. These studies assume that monitoring the alignment of urban regions, cities or neighbourhoods with the proximity-criteria of the FMC can be a first step towards its implementation into urban planning and urban design policies, as it can help to identify deficit areas which should be closer looked at or prioritised by further efforts.

It is important to notice that these studies interpret the FMC as a planning model pursuing proximity-centred accessibility [5] for active modes of mobility . For this reason several studies refer to the conceptual foundations as the 5 dimensions of accessibility introduced by Penchansky and Thomas [6]. However, when taking a closer look at these studies, it becomes obvious that, although continuously referring to Carlos Moreno's concept of the FMC, their operationalisations of the concept differ, as well as from the original concept as among each other substantially. That is why this meta-study compares the FMC definition and methodology of a random selection of 14 studies investigating the question if city X or neighbourhood Y already comply with the FMC concept.

2. Materials and methods

In this meta-study 14 studies (see Table 1) published in scientific journals between 2021 and 2024 on measuring compliance of cities and urban regions with the FMC concept have been analysed regarding their specific conceptual operationalisation of the FMC (definition of accessibility) concept as well as their technical approaches to evaluating proximity-centred accessibility (methodology).

AUTHOR(S), YEAR	SUBJECT
Noworól et al., 2022 [4]	Geographical proximity of Services in Krakow
Abbiasov et al., 2024 [7]	The 15-minute city quantified using human mobility data
Birkenfeld et al., 2023 [8]	Behavioural perspective on 15- / 30-minute city in Montréal
Knap et al., 2023 [9]	Development of a composite cycling accessibility metric demonstrated in case study in Utrecht
Gaxiola-Beltrán et al., 2021 [10]	Assessing urban accessibility in Monterrey (Mexico) at the metropolitan and local levels
Ferrer-Ortiz et al., 2022 [11]	Mapping pedestrian accessibility in Barcelona
Gaglione et al., 2021 [12]	Comparison between 15-minute neighbourhood accessibility in Naples and London
Olivari et al., 2023 [13]	Are Italian Cities already 15-minute? Presenting the Next Proximity Index (NEXI)
Vale & Soares Lopes, 2023 [14]	Comparison of 15-minute pedestrian accessibility in European cities with 100,000 inhabitant or more
Logan et al., 2022 [15]	Evaluating x-minute accessibility in 500 cities in the US and 43 urban regions in New Zealand
Nicoletti, Sirenko & Verma, 2023 [16]	Evaluating the nature and distribution of spatial accessibility among 54 urban communities
Starrico, 2022 [17]	Accessibility to services in Turin
Baletto et al., 2021 [18]	15-minute approach to transforming disused public properties in Cagliari

Table 1. List of the 14 studies from the sample for the meta-study.

2.1. Definition of accessibility

An important precondition for measuring accessibility is to present a definition which operationalises the term for measurement. Therefore, the studies of the sample have been analysed and compared regarding the following questions:

- definition of active mobility (walking, cycling, public transport)
- time threshold for accessibility (5, 10, 15, 20, 30 minutes)
- definition of essential functions, especially if working is considered an essential function
- does the same time threshold apply to all functions or are there different levels of importance or rather urgency resulting in differentiated time thresholds

2.2. Methodology

Regarding the technical details of measuring accessibility, all studies of the sample chose a methodology based on the use of GIS- and statistics software, e.g. *QGIS* and *R*. The following technical details are of importance:

- How is the location of origin defined (e.g. point data of post-addresses, centroids of parcels, building blocks or census blocks, nodes of the street network)
- How is the catchment- or service-area calculated (e.g. Euclidian distance, network distance)
- Which speeds are assigned to the different modes of active mobility (walking, cycling, public transport)

3. Results

Comparing the studies from the sample, two general approaches can be identified: The first approach is to measure accessibility by analysing actual mobility data (n=1) [7] or by analysing mobility surveys (n=2) [8, 9]. The second approach is to analyse the topological proximity of residents to essential amenities (n=13). These numbers do not add up to 14, because Abbiasov et al. (2024) [7] and Knap et al. (2023) [9] combined both approaches and thus were counted in both categories.

3.1. Definition of accessibility

The majority of studies from the sample (11/14) considered only walking as active mobility and defined a 15 minutes time-threshold for their analysis (9/14). Only three studies considered working an essential amenity [8, 9, 10]. That is noteworthy, because in Moreno's original FMC concept working is one of the essential social urban functions. Concerning the other functions the picture is quite diverse. However there seems to be a broad consensus on the point, that supermarkets, primary schools, primary health facilities (11/14) and parks (10/14), kindergartens and playgrounds as well as pharmacies (9/14) are essential social urban functions whereas the status of sports facilities, places of worship and stops or stations of public transport (4/14) as wells as secondary schools (6/14) is more disputed. This is astonishing as the accessibility to public transport is a key issue of reaching destinations beyond the neighbourhood-scale without the use of a private car. Almost all studies applied the same accessibility threshold to all POIs. Only Ferrer Ortiz et al. (2022) [11] developed a more sophisticated model in which different amenities from one category have been assigned different time thresholds, for example five minutes for kindergartens and primary schools and ten minutes for secondary schools. Such differentiations can be an efficient way to mapping the complexity of mobility decisions and considering differing catchment areas of amenities.

3.2. Methodology

In general, two approaches can be distinguished whose methodology will be explained below: First, a supply-based approach (n=5) and, second, a demand-based approach (n=11). These numbers add up to more than fourteen, because some studies [9, 11] combined both approaches. Out of nine studies which applied a strictly demand-based approach – Knap et al. (2023) [9] and Gaglione et al. (2021) [11] excluded – six used centroids of cadastral parcels, urban blocks or census blocks as origins points for the calculation of their service areas, whereas two studies [13, 14] used the nodes of the pedestrian network. Only one study calculated the catchment-area of its service based on the Euclidian distance [4]. The overwhelming majority (13/14) calculated the catchment-area based on the pedestrian- or cycling-network assuming speeds between 3.6 and 5.0 km/h for walking and between 12 and 15 km/h for cycling.

3.2.1. Supply-based approach

Based on the locations of the amenities which shall be accessible within the time threshold using active mobility, the catchment areas of POIs (amenities considered essential by the specific definition of accessibility) are calculated. Depending on the definition of active mobility, only those areas where the catchment areas of all functions overlap are considered accessible or *proximity areas*. This methodology is for example used by Noworól et al. [4] to measure the accessibility in Krakow trying to find correlations with morphological features of different morphogenetic zones of the city.

3.2.2. Demand-based approach

Based on people's places of residence (origin), distances to POIs (destinations) are calculated (O-D). For each category only the distance to the nearest POI is relevant. Depending on the specific definition of active mobility, the largest value among the different POI-categories like, e.g. *education, healthcare, provisioning*, defines the accessibility value for this specific point. For example and according to Logan et al. (2022) [15], if accessibility is defined as being able to reach at least one kindergarten, one supermarket and one public park within 15 minutes walking from home and the next kindergarten is 8 minutes away, the nearest supermarket 14 minutes and the nearest public park only 5 minutes, then the value for this point is 14 minutes, because all needed amenities can be reached within 14 minutes walking from home.

Those accessibility values can then be aggregated to produce an accessibility index for a certain area, e.g. a city, a neighbourhood, or a census block. Depending on the research question it might be useful, if these areas matched with the spatial units in which other necessary data is provided, e.g. statistic cells or census blocks.

4. Conclusions

The meta-study shows that the when measuring the FMC it is generally operationalised as proximity-centred accessibility which can be measured by analysing real mobility behaviour or topological proximity of residents to services in a certain area. The absolute majority of studies from the sample measure accessibility as proximity of services defined as within 15 minutes walking from home, according to the original FMC concept. Whereas the list of amenities considered essential differs significantly among the studies, there is stark agreement on the significance of supermarkets, primary schools, primary health facilities, parks, kindergartens and playgrounds as well as pharmacies. Regarding the technical details of evaluating accessibility most studies opted for a demand-based approach measuring the network-distance from the centroids of census blocks to essential destinations. Several studies have combined their x-minute statistics with other information such as urban morphology, demographics or socio-economic data in order to identify possible correlations and approaches for development, transformation or intervention.

List of symbols

FMC 15-minute city

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