The Multiple Roles of Urban Affordability in Inclusive Smart Cities

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1 Introduction

The smart city concept, which relates to the application of advanced technology and data-driven solutions to meet increasingly complex urban service demands (Angelidou 2015), has become prominent in urban planning and management. However, the concept requires careful application in practice as smart cities could exacerbate urban exclusion, notably as a result of the digital divide (Caragliu & Del Bo 2023, Colding et al. 2024) and especially in developing countries (Indraprahasta & Alamsyah 2024). In such contexts, residents who are unable to access, utilise, or benefit from digital connections can be left out of smart city processes and outcomes (van Deursen & Helsper 2015). These tendencies were critiqued in early literature on smart cities, with concerns raised about their potential impacts on social equity and their disregard for the actual needs of citizens (Hollands 2008, Kitchin 2014). Scholars thus highlighted the need for a paradigm shift that centres citizens in the pursuit and objectives of smart cities, moving away from techno-centric conceptualisations (Echebarria et al. 2021, Kummitha & Crutzen 2017).

More recently, the concept has evolved to focus on inclusive outcomes, grounded on the smart city's primary objective of improving the quality of everyday urban life (Chang & Smith 2023, Paskaleva & Cooper 2022). Smart city efforts are now being evaluated in terms of how they benefit all citizens

regardless of their socio-economic conditions or intra-urban locations (Tekin & Dikmen 2024, Wang et al. 2021). As such, the smart city and the inclusive city have become intertwined concepts, birthing the smart-inclusive city where citizen-centred processes produce outcomes that are shared by all (Lee et al. 2024, Lee & Park 2025). Overall, this conceptual evolution has subjected the smart city to deeper investigation from the lens of inclusivity, drawing attention to factors such as urban affordability which is central to inclusive cities across spatial, social, and economic dimensions (Shah et al. 2015).

Urban affordability is vital for ensuring access to essential services such as housing, transportation, education, healthcare, and water and sanitation (United Nations 2015), all of which can be enhanced through smart city initiatives. It can be understood when economic interpretations of affordability such as the budget-shares ratio, potential affordability, or residual income (Kessides et al. 2009) are combined with broader social and environmental considerations in the urban context. This broad framing positions urban affordability as a human rights criterion (Hertel & Minkler 2007), which concerns the sustained capacity of all citizens to access essential services, in complementarity, so as to live a decent urban life (Baquero et al. 2017, Goddard et al. 2022, Mulliner et al. 2013). This implies that 1) the services should be consistently available and accessible for citizens to depend on at all times, 2) the affordability of one essential service should not be at the expense of another, and 3) the services should be quality enough to guarantee urban well-being.

Despite its significance, particularly in relation to the now inclusive-entangled smart city concept, urban affordability remains underexplored in smart city literature (Malhotra et al. 2021, Park & Yoo 2023). Smart city studies often make passing references to affordability within overarching notions such as sustainability (Sharifi et al. 2024), or approach affordability in terms of the high financial costs of providing or accessing smart services (Bello et al. 2024, Jonek-Kowalska & Wolniak 2021, Puron-Cid & Gil-Garcia 2022). However, limited studies have featured urban affordability as a central focus or methodically explored its broader implications for smart inclusive cities. To address these gaps, this research aims to systematically investigate how urban affordability can be positioned within the smart city context, and its implications for the provision of essential urban services to all. This extended abstract presents and discusses the preliminary findings from the overall research.

2 Methods

This research is conducted through a scoping review, which synthesizes fragmented references to affordability across smart city literature. Specifically due to the research's exploratory nature, the scoping review was employed as it is suited for mapping key concepts and examining the extent and nature of available research (Munn et al. 2018). The review incorporated recommended best practices for scoping review data extraction, analysis, and presentation (Pollock et al. 2023).

Data was sourced from two reputable bibliographic databases, Scopus and Web of Science, according to four search queries that reflect the foundational concepts of the research. The first query featured commonly used smart city related terms (i.e., "smart cit" OR "technology cit" OR "intelligent cit" OR "connected cit" OR "digital cit"). The second ("smart govern" OR "e-govern") focused on governance as a facilitator of smart cities. The third included various essential smart services (i.e., "smart mobility" OR "smart transport" OR "smart energy" OR "smart water" OR "smart waste" OR "smart living" OR "smart home" OR "smart infrastructure" OR "smart econom"). The fourth incorporated conceptual terms now intertwined with the smart city concept ("smart inclusive cit" OR "smart sustainab cit"). Using the "AND" Boolean operator, each of these were paired with urban affordability related terms (i.e., "urban affordab" OR affordab OR access OR inclusiv*). The search queries were refined for quality, relevance, and minimised risk of misinterpretation according to three filters: publication type restricted to peer-reviewed journal articles, disciplinary scope limited to Social Sciences (for Scopus) and Urban Studies (for Web of Science), and publication language as English. Articles that matched the search filters and featured any combination of the search terms in their titles, abstracts, or keywords were retrieved.

In total, 2,075 articles were retrieved from the databases (1816 from Scopus and 259 from Web of Science) which were subjected to three levels of screening. The first level excluded duplicates within and across databases. The next levels of screening were conducted to retain only articles that sufficiently meet the criteria of making references to urban affordability and, at least, one essential service delivered through smart city initiatives. Accordingly, articles were screened after readings of their titles and abstracts, and then of the full text. Lastly, other relevant articles that were identified through background research and backward citation were included. The final review dataset consisted of 130 articles. Following the PRISMA statement recommendation (Moher et al. 2009), the dataset screening workflow is illustrated in Figure 1.

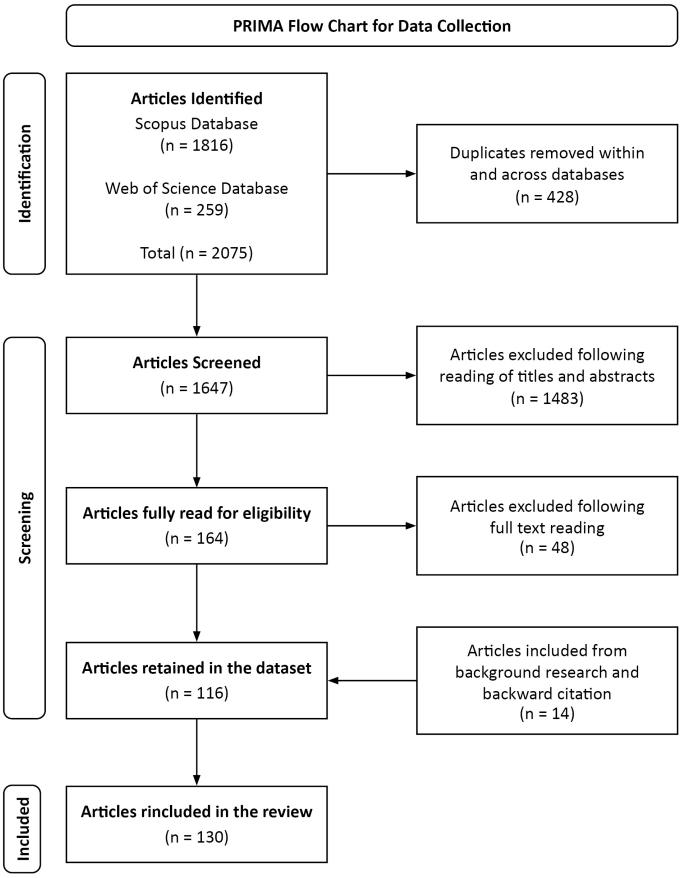

Figure 1: PRIMA Flowchart for Data Collection

Preliminary data analysis was conducted inductively, with identified recurring themes organised into different clusters. Among those clusters, this submission focuses specifically on the roles that urban affordability plays in the pursuit of smart inclusive cities.

3 Results

From the data set, it was observed that urban affordability plays multiple interconnected roles, serving as a condition, a means, and an outcome of smart service provision to all. Firstly, affordability serves as ***a critical condition for***

smart inclusive cities, relating to resources that must be deployed for the smart city concept to be practically realised. For cities to deliver smart services, certain 'contextual conditions' such as socio-economic and technology development inherently determine the effort and cost for accessing and deploying the required resources (Neirotti et al. 2014). In this sense, affordability is about the ease of deploying those resources towards: 1) the provision of basic urban infrastructure as a foundation for sociotechnical urban processes (Graham & Marvin 2001) and the physical medium for service delivery (Das 2024); 2) the integration of Internet-of-Things (IoT) technology into the urban system (Ciuffoletti 2018), which has become less cost-intensive due to innovations in artificial intelligence and data processes (Anjomshoaa et al. 2021, Radu 2020), and 3) digital connectivity for inclusive digital spaces which enables citizens fully participate in and benefit from smart cities (Graham 2002). Essentially, cities that are unable to afford these resources either fail to effectively implement smart city initiatives or exclusively direct services to specific social groups (Chakrabarty 2019, Tan & Taeihagh 2020).

Secondly, affordability serves as ***a means for smart service delivery***, whereby minimised cost in the processes of delivering services render it a more feasible endeavour for service providers. In the smart city context, studies highlight two dominant pathways to such affordability. The first is the adoption of technology in service delivery which can optimise associated processes and lead to long-term savings (Silva et al. 2018). Innovations like smart meters applied to energy and water supply systems (Grigg 2020, Shafiullah et al. 2023, Yi et al. 2011), IoT and machine learning in waste management processes (from collection to recycling) (Gopikumar et al. 2021, Lella et al. 2017), and use of big data and GIS for mobility service optimisation (Aqib et al. 2019, Aquilué Junyent et al. 2024) offer some exemplary applications of technology that can minimise cost (money, time, effort, etc.) and improve output. The second pathway is the involvement of citizens in the service delivery processes which can be facilitated through open city platforms (Barns 2018). This allows residents contribute in governance by reporting incidences, communicating service demands, and influencing proposed interventions (Hansen et al. 2025, Lee et al. 2023, Torabi Moghadam et al. 2024). These help to ensure that resources are directed towards actual needs, reducing the overall cost of urban governance and service delivery.

Thirdly, affordability serves as ***an inclusion-enabling outcome of smart city initiatives***, as smart cities ideally support the socio-economic development of citizens and offer them increased capacity to afford essential services. This aligns with Sen's (1999) capability approach (Sen 1999), which stipulates that people's rights are only as meaningful as their ability to benefit from them. In this sense, services enhanced in smart cities are meaningless if the end-users

are unable to interact with them in fulfilment of their urban rights (Harvey 2008). Therefore, technology interventions in education that enhance access to quality informational resources and improve learning outcomes (Revak & Gren 2022, Sahlaoui et al. 2024), as well as those that expand income generation opportunities by opening up employment streams in the digital economy (Alfaro-Navarro et al. 2024, Jabeen et al. 2024, Mossberger & Tolbert 2021) are critical. Such initiatives facilitate human capital development and set citizens on a path to socio-economic prosperity (Becker 1964). This strengthens their capacity to utilise and benefit from essential services for quality urban life, and ultimately fosters smart urban inclusion.

4 Discussion and Conclusion

By synthesising the literature, this study systematically highlights how urban affordability contributes to the pursuit of inclusive smart cities. The preliminary analysis of the literature, which forms the basis of this submission, helps to organise multiple roles of urban affordability into a more apparent and comprehensive framing. It indicates that urban affordability is a consistent factor that emerges even before the process of service provision is initiated, as it impacts the pre-requisite deployment of resources. In addition, it aligns with both the technological and human dimensions of smart cities (Nam & Pardo 2011) throughout the process of service delivery, as it is facilitated by technology adoption and citizen involvement. Lastly, it emphasises inclusive outcomes for all citizens, aligning with the current evolved state of the smart city concept. Overall, this framing advances current fragmented research that engages with urban affordability with a narrow focus on financial resources, or from analytical vantage points of either the service provider (city government, private institutions, or citizens themselves) or the end-user.

A more systematic organisation of the findings is expected as the dataset is being subjected to in-depth analysis, with the objective of a conceptual framework that appropriately positions urban affordability in the smart city discourse. The Input-Process-Output (IPO) model, which offers a lens for understanding the systematic processes of planning and service delivery (Chadwick 2013) is being considered as a tool for further analysis and presentation. This will help to illustrate the relationships between the roles discussed herein, the stakeholders involved in delivering affordable smart services, and other identified thematic clusters. Such future outputs will bring this research closer to uncovering how urban affordability can foster truly inclusive smart cities where all citizens can access the services necessary for quality life.

This extended abstract is drawn from preliminary analysis of a more comprehensive scoping review research, which forms the literature review section of my PhD. A literature review paper that features more in-depth and structured findings is being co-authored by myself (Mohammed Lawal Shaibu) and my PhD supervisors (Juhyun Lee and Joon Sik Kim).

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