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Evolution Towards Sustainable Urban Mobility: A Chronological Review

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Abstract

This paper traces the evolution of urban mobility in relation to the development of transport systems, examining different durations that coincide with technological advancements. Each era is characterized by the limitations of a particular transport technology, which are then overcome by the introduction of new technologies, leading to shifts in consumption patterns, geographies, and power dynamics. The study begins in the nineteenth century with the development of rail-based transport and explores its impacts on urban scale and form. The analysis extends to the present (2022/2023), with a brief acknowledgment of the Covid-19 pandemic's influence. The concept of "Sustainable Urban Mobility" is introduced as the culmination of this evolutionary process, with a discussion of its potential benefits for a better future. The paper also provides an overview of current urban mobility trends, anticipating their incorporation into the future body of literature and studies on the topic.

Keywords: History, Mobility, Smart, Sustainable, Urban.

1 Evolution of Urban Mobility in Modern History

In recent history, urban mobility clarifies the existing disparity between what we identify as developed cities, which successfully adapted to the evolution in transport infrastructure supply and technological advancements, and those developing cities that continue to grapple with upgrading their outdated or deteriorating transport systems and infrastructure. (Jones, 2014). This research studies three stages of cities development chronologically transitioning from walking to transit then transit to car (Newman, 2003) then from car to acknowledge significance of walking again.

1.1 1800s-1920s: Industrial Revolution and the Transition to Public Transit

During this period, significant demographic and economic changes extended in modern history. Although some cities prospered, others experienced a deterioration in significance. The industrial revolution emerged as a pivotal aspect during this period, introducing integral impacts on the mobility and transport sectors. Large distribution networks emerged, facilitating the transfer of raw materials, goods, and energy (Rodrigue, Comtois, & Slack, 2013). Moreover, it carried population migrations from rural to urban centers (Rodrigue, 1998-2022); towards improved job opportunities. The development of

the transport and construction industry played a crucial role in shaping urban form during this period. It influenced the construction of more densely populated urban agglomerations. Consequently, the urban form and infrastructure of cities during this time were shaped by joint influences between the development of urban-rural mobility and the evolution of urban mobility within the same city periphery. (Rodrigue, Comtois, & Slack, 2013).

Urban-rural mobility that started around 1814, when the first steam-engine railway appeared initially to haul coal (Linda Hall Library, 2012; Rodrigue, 1998-2022). The system's ability to carry heavy loads over long distances with less power made it advantageous, leading to its rapid and widespread adoption. In 1830, the first commercial rail line linked cities of Manchester and Liverpool (distance of 65 km) (Rodrigue, 1998-2022). Hence, railroads became a revolutionary inland transport system with long distance span that many canals were deteriorated and shut due to their inefficiency compared to the emerging new system at that time (Rodrigue, 1998-2022). The progress of railroads led to the emergence of suburbs located by the trackside, forming small nodes around the rail stations. These suburbs were not necessarily situated within the city itself but were typically around a 30-minute train ride from the nearest city. (Rodrigue, 1998-2022).

Impact of this revolution on the urban mobility across the city peripheries was not affected much at the beginning of the industrial revolution until the late nineteenth century (Rodrigue, 1998-2022). People remained still in cities lesser than 5-8 kilometers in diameter (Newman, 2003). Walking and horsecars were the typical transport modes, a person can walk from city center to city border in around 30 minutes. Cities were concentric and compact with relatively high density and land use was mixed accordingly (Rodrigue, Comtois, & Slack, 2013).

Horse-drawn omnibus services[1] were flourishing in the nineteenth century in the bigger and more advanced cities; during the 1800s, omnibuses were popular in England, France, and North America (London Transport Museum, n.d.). Horse-drawn omnibus service is recognized as the first public transit that stretched the city diameter; while it did not change the general urban form. Though, competing with steam buses and motor buses at the commencement of the twentieth century, the horse-drawn omnibus began to vanish, the last horse bus in London stopped operation in 1914 shadowed by its replacement from other cities around the world (ECLAC, 1994).

The development of the electric power motor marked a significant shift in urban form and commuting during the late nineteenth century. The establishment of electric trolley lines, which were three times faster than horse-drawn cars and buses, contributed to more efficient transportation with reduced environmental impact (ECLAC, 1994). The urban form expanded outwards up to 30 kilometers, and had irregular/star-like shapes (see Figure 1) with commercial linear corridors along the trolley lines (Rodrigue, 2020).

[1] The horse drawn bus is a French invention, first seen in the 1660's the original idea was to offer services to the rich; but then the rich didn't prefer it as they had their own carriages. In 1820 the horse drawn bus was reintroduced, again in Paris, and they coined the name omnibus. The horse drawn bus arrived in England in 1829 (petergould.co.uk, 2022).

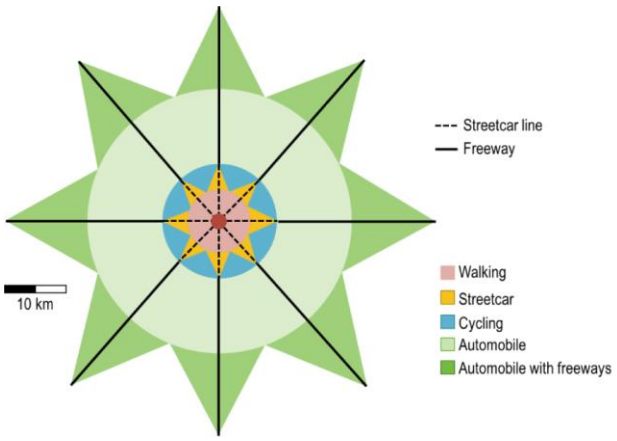

Figure 1 18th century producing the star shaped cities
Source (Rodrigue, 2020) adopted from (Hugill, 1995).

1.2 1920s- 1970s: Driving Cars and Cities' Enormous Expansions

Car ownership rates experienced a surge in the 1920s, driven by Henry Ford's low-price assembly-line production. The convenience of car mobility made suburbs increasingly attractive locations for development during this period (Rodrigue, Comtois, & Slack, 2013). Fast-forwarding to the mid-twentieth century, a significant dependence on motor vehicles became the norm and was seen as a future investment. This situation had a profound influence on the urban development of cities. (Jones, 2014). The urban fringes were more accessible areas along with extensive urban expansion, meanwhile cities' centers were branded as polluted and overcrowded places (Rodrigue, Comtois, & Slack, 2013). Simultaneously, the interest to maintain and repair electric trolleys declines because there was lack of profit (Rodrigue, 2020). Cars and motor buses dominated the streets and captivated the infrastructure investment; at that point the streetcar transit system or electric trolleys disappeared in the last part of the 20th century.

During this period, the concentric zone model or Burgess model was postulated in 1925 by sociologist Ernest Burgess. This model divided the city into sectoral rings (see Figure 2), each hosting a different social group and function (Quinn, 1940). It described American cities as a series of concentric rings, with each ring associated with a particular socioeconomic status (income) of families and distance from the Central Business District (CBD) (Quinn, 1940). According to this model, the quality of housing improves as one moves farther from the CBD, even though the commuting time increases (Malamis, et al., 2016).

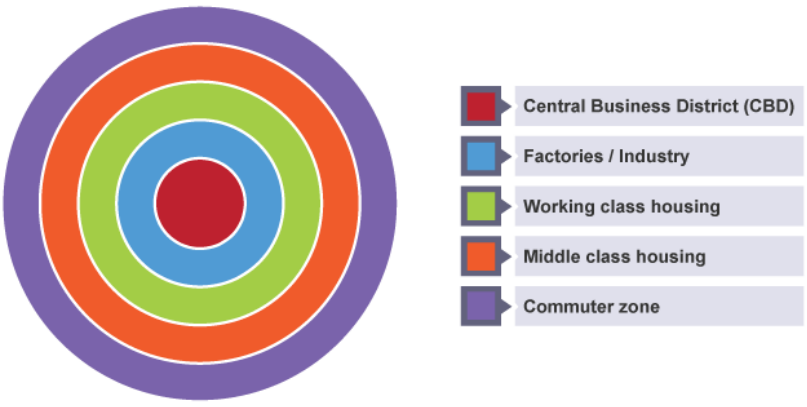

Figure 2 Burgess concentric zone model, first introduced in 1925, Source (BBC, 2022)

However, in terms of actual geography, these rings were criticized for being more conceptual, as the topography and continuous development of the transport system added irregularities to the urban

form rather than regular ring shapes. Subsequently, in 1939, the Hoyt model or sector theory emerged as an updated version of the Burgess concentric rings, proposed by the economist Homer Hoyt. (Malamis, et al., 2016). Hoyt altered the concentric ring model to suggest that cities should develop in radial-shaped sectors (BBC, 2022) in a pattern that resembles a wedge (see Figure 3)instead of rings (Malamis, et al., 2016); In this model, certain urban areas become more attractive for specific land uses, either due to contextual or geographic/environmental circumstances. The most attractive areas are occupied by various city activities or sectors that flourish and consequently expand outward. (BBC, 2022).

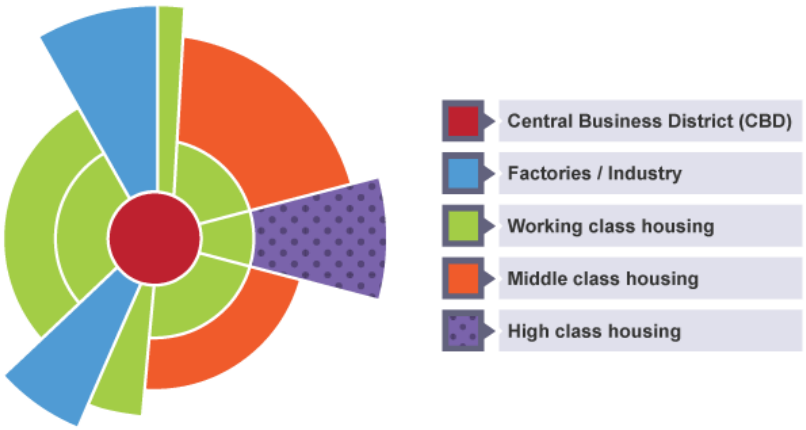

Figure 3 Hyot sector model, first introduced in 1939. Source (BBC, 2022)

Both the Burgess and Hoyt models reflected the reality of allocating the inner city to the poor, connected with public transit, while the suburbs became the residences of the wealthy, linked with cars (Malamis, et al., 2016). Additionally, the inner city was initially constructed for factory workers' residence, but with the closure of these factories, city centers have been impacted by modern planning factors like urban gentrification and globalization (BBC, 2022). This new urban phenomenon of Central Business Districts (CBDs) then underwent another stage of development known as the multiple nuclei model. This model, generated by Harris and Ullman in 1945, suggests that cities grow through the gradual integration of several separate nuclei (see Figure 4) distributed spatially across their fringes (Malamis, et al., 2016).

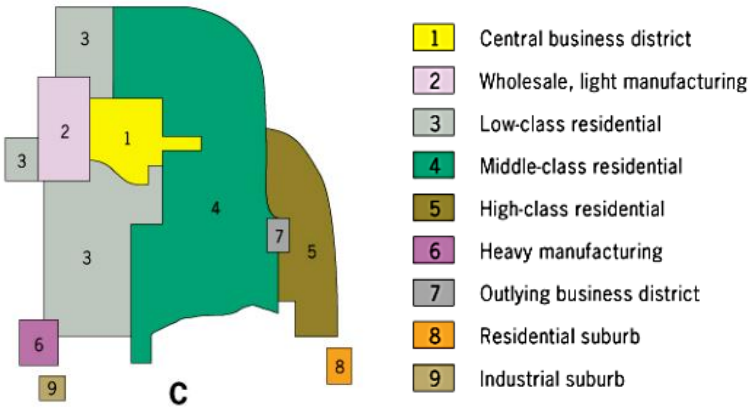

Figure 4 Harris and Ullman multiple nuclei model, first introduced in 1945. Source (Malamis, et al., 2016)

All previous models, which implied the presence of a Central Business District (CBD) at the core and outward expansions, demonstrate that urban morphologies during this study period were oriented according to urban

transport and car dependency, which is closely connected with Fordism or the influence of a Fordist city[2] (Roost & Jeckel, 2021). This influence appeared explicitly in the separation of uses and suburbanization (Roost & Jeckel, 2021). By the mid-20th century, communities were recovering from World Wars I and II, aspiring to a new lifestyle associated with owning a nice house and a fancy car. However, this pursuit of a higher standard of living was accompanied by increased consumption and pollution. As Fordism facilitated access to higher suburban housing for a large sector of the middle class, economic and technological changes ensued, leading to the transformation of the previously isolated CBD-suburban lifestyle (Roost & Jeckel, 2021).

During this era, accessibility was predominantly tied to the motorized transport system, prioritizing cars for both the wealthy and the lower income sectors. The evolution of this stage emphasized cars and resulted in extensive urban sprawl. Notably, a review of various references discussing urban models from this period reveals a lack of acknowledgment or consideration for individuals who couldn't drive due to physical, economic, or social constraints. Success or achievement during this time was often associated with the ability to drive cars, contributing to issues seen in today's cities, such as urban differentiation, segregation, social polarization, and social exclusion. These concerns remain significant in contemporary urban environments (Baum, 2006).

1.3 1970s- present: The Global Shift Back to Walking and Cycling

Over the last 50 years, particularly in Western countries, there has been a significant shift in urban mobility from a strong emphasis on increasing car dependency to limiting car use and avoiding road expansions that exclusively cater to cars. In the late 1960s to mid-1970s, researchers began examining the necessity of long and dense trips, exploring the potential for some of these trips to transition to non-car modes, and assessing the benefits of implementing policies to reduce car usage (Jones, 2014). This was a catalyst of sustainable commuting calls towards decarbonization and healthier cities (Jones *et al*, 1983; Jones, 2014).

The adoption of this approach stems from the vast expansion of cities into metropolitan areas, accommodating millions of daily commuters. In this context, trips have evolved into long, crowded, expensive, unpleasant, and, at times, unsafe experiences for citizens. (Rodrigue, Comtois, & Slack, 2013). Therefore, new agendas for urban mobility have emerged, emphasizing sustainable planning and transportation to ensure that all citizens have access to environmentally friendly, efficient, comfortable, and affordable trips throughout the city (Basiago, 1996). New visions for future cities have continually emerged, starting with the concept of the Compact City[3] in the 1970s, followed by the development of the Sustainable City[4] concept in the 1980s. Over the past 50 years, these concepts have evolved and branched out, leading to various interpretations and implementations such as: Eco City coined in the

[2] *"Fordism and post-Fordism are terms that each describe an economic form characterized by certain modes of production. These economic models have different effects on society, in the sense of its models of work, life, and consumption, as well as on space, in the sense of location decisions, flows of goods, and urban structures."* (Roost & Jeckel, 2021)

[3] The term *compact city* was first coined in 1973 by George Dantzig and Thomas L. Saaty that are two mathematicians of utopian vision; to describe compact urban forms that are dense, proximate , and connected by public transport systems; towards more efficient use of resources (Ahlfeldt & Pietrostefani, 2017). The term stems from the concepts of Jane Jacobs and her book The Death and Life of Great American Cities (1961), which provides a critical review of modernist planning for destroying the existing inner-city communities.

[4] The abstract realization for sustainability appeared first in 1798, when Thomas Malthus published his ' *An Essay on the Principle of Population*' that introduced his famous 'theory of population'; which warned that population tends to grow quicker than resources (Sustainability for all , Acciona, 2019). The term 'sustainable development' also, first utilized officially in an official document signed by thirty-three African countries in 1969, whereas African countries realized the negative consequences for the fast degradation of their natural resources (IUCN, 2004). However, officially in 1987 was acknowledged as a global urban agenda when stated in 1987 in the famous Brundtland Report (also entitled 'Our Common Future') produced by several countries for the UN (Sustainability for all , Acciona, 2019).

late 80s (Ecocity Builders, 2022), Smart City that was introduced in the 1990s as virtual/ ICT/Digital city issues (GlobalData Thematic Research, 2020), Green City and Green Infrastructure introduced in the first decade of the 2000s (Breuste, 2020), and Walkable city that has been strongly promoted within the last decade (Speck, 2012).

It is crucial to emphasize that the transformations in urban mobility under the concept of sustainable cities have only begun as efforts to alleviate the adverse effects of urban expansion and excessive car dependence. Subsequent concepts have evolved, maintaining a focus on prioritizing human well-being and environmental sustainability, ultimately striving for greener and more convenient lifestyles. This transition has contributed to the increased value of city centers, emphasizing them as hubs for livable activities that necessitate human interaction (Jones, 2014); besides, many urban planning approaches were developed such as: car-free, bicycle friendly, and the 15-minute city[5]; in the advantage of public transit, walking, and cycling.

Understanding the profound impact of the information technology revolution is crucial to comprehend how developed cities have rapidly transitioned into smart or green cities. This transformation is evident in the enhanced efficiency of public transport and the regularization of carpooling and ride-hailing services through websites and applications (Fang, 2015) that utilize: interactive maps, comprehensive information on choice modes and cost, and real-time information (Berrone *et al*, 2016). The argument is still ongoing on whether people should ride their own cars, use ride hailing services, use public transit systems, or walk and cycle.

1.4 Covid-19 Outbreak

The global lockdown in 2020 prompted reflections on the necessity of all pre-Covid-19 trips, as people adapted to a new "stay at home" lifestyle and embraced alternative forms of communication and online activities. Notably, platforms like Amazon gained prominence, offering a global source for ordering various goods, even small essentials such as laundry detergent or soundproof headphones (Rapp & Harty, 2021). This shift to online shopping has contributed to reducing travel distances and times. The impact is evident in trip chaining, where the tendency to combine nearby shopping and non-shopping activities has changed with the rise of online shopping. If non-shopping activities are not a priority and were only planned alongside shopping destinations, entire trips may be eliminated (Le, Carrel, & Shah , 2021)..

In light of this perspective, technology has enabled effective online communication across various applications, encompassing the ordering of basic services or products, facilitating distant/non-physical learning and work, joining groups or discussion forums electronically, and exploring places and experiences through virtual reality. Notably, the advanced capabilities of younger generations in utilizing the vast horizon of information technology prompt speculation about the extent to which the future of urban mobility may become virtual.

1.5 Synthesis and Deliberations

The historical overview presented above suggests that the evolution of urban mobility has primarily aimed at progress, improved living conditions, and the integration of technology. An additional key takeaway is that for some individuals, achieving a better quality of life may not necessarily involve

[5] Mainly influenced by Jane Jacobs, and the theory was coined in 2016 by professor Carlos Moreno; to describe highly flexible urban model that ensures all citizens can access daily needs within a 15-minute distance; thus, countering the dominance of cars (Cutieru, 2021).

traditional mobility paradigms. Instead, the emphasis is on enabling people to participate and enjoy an enhanced quality of life, with physical movement being just one among several alternatives. This implies that urban mobility extends beyond motorized transport, catering to the holistic needs of individuals to access various urban services.

However, it is still too early to fully gauge the implications of substituting numerous physical activities with various online platforms for shopping, education, work, and leisure. The ultimate effects on pollution levels, social isolation, and exclusion remain unclear. Nevertheless, the research anticipates that the intersection of urban mobility, encompassing physical commuting and technology, will shape new urban forms in the future.

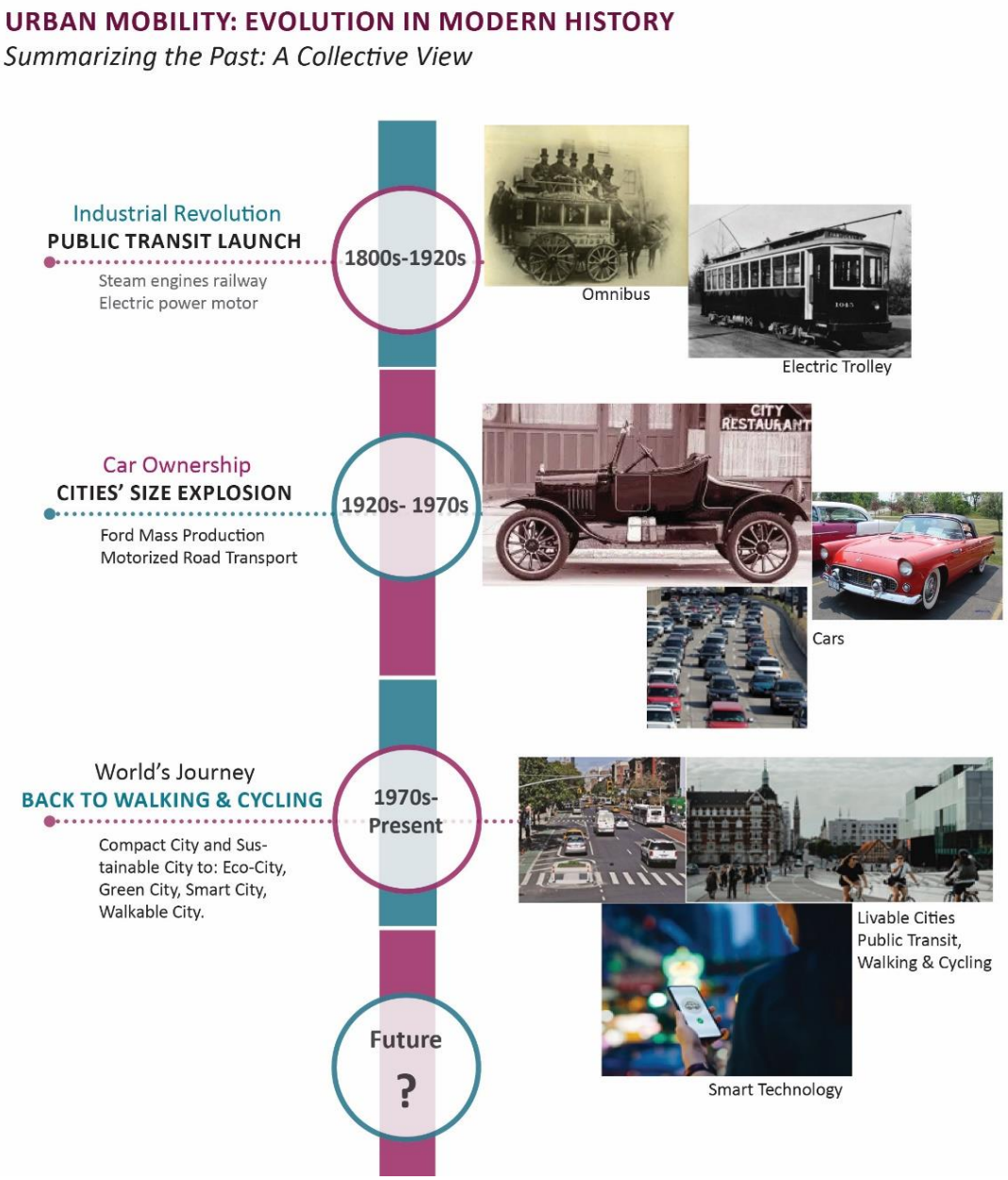

Figure 5 Evolution of urban mobility as per the evolution of transport in modern history. Source of analysis and graphics by author; the utilized pictures from miscellaneous references[6]

The future of urban mobility, as depicted in the analysis presented in figure 5, is shaped by the cumulative experiences of the past and present, giving rise to new business models driven by trends in

[6] Omnibus Picture (London Transport Museum, n.d.), Electric Trolley Picture (Britannica, n.d.), Old Ford Car Picture (I Drive Safely, n.d.), New 1955-1957 Ford Car Thunderbird Picture , Crowded Street with Cars Picture (The Dallas Morning News, 2018), Transit Assigned Street Lanes Picture (NACTO, n.d.), Cycling and Walking Picture (Hamza, 2021), Smart Phone Picture (Forbes, 2019).

connectivity, information, automation, and electrification. The manner in which people will navigate urban environments in the future hinges on the planning of cities and urban spaces. The researcher envisions a future of mobility that transcends traditional vehicle-centric approaches, opening up opportunities to enhance the lives of disadvantaged groups, particularly with the advancements in smart technologies. Consequently, the subsequent section provides a closer overview of current strategies aimed at improving urban mobility services, with a focus on the concepts of sustainable and smart urban mobility.

2 Sustainable to Smart Urban Mobility: A Close-Up View

This section provides an overview of sustainable urban mobility, aiming to comprehend its significance and its role in enhancing the overall performance of cities. It is essential to acknowledge recent literature that raises concerns about the effectiveness of current practices in sustainable urban mobility, especially in accommodating the growth in population and employment within cities. (Jones, 2014). On the other hand, the expanding influence of smart urban mobility plays a crucial role in alleviating the strain on road and public transport networks. Additionally, it addresses the escalating interest in developing walking and cycling networks. (Jones, 2014). Two primary investigations are examined in this context. The first delves into the benefits of transitioning from conventional urban transport to sustainable urban mobility. The second provides an overview of the era of smart cities and smart urban mobility, projecting its dominance in the future, and scrutinizing whether its impacts align with inclusive practices.

2.1 From Traditional to Sustainable Planning

The evolutionary pattern discussed in the preceding section guides the research away from an exclusive focus on traditional urban transport approaches toward a more integrated and sustainable urban mobility perspective. This is further elaborated in the definition of a Sustainable Urban Mobility Plan SUMP[7], which is stated by the European Union within the Urban Mobility Package of 2013 as: "*a strategic plan designed to satisfy the mobility needs of people and businesses in cities and their surroundings for a better quality of life. It builds on existing planning practices and takes due consideration of integration, participation, and evaluation principles*" (European Commission, 2013).

On the contrary, traditional transport planning regularizes the long distances that people travel regardless their limited time and cost (TADAMUN, 2016; European Commission, 2021), whereas the scope is to increase traffic flow capacity and speed (European Commission, 2021). A successful transport plan prioritizes the infrastructure's capacity to accommodate the convenience of motorized transport (TADAMUN, 2016). This clarifies the nature of traditional transport plans, which are initially sectoral. Consequently, various planning and transport-related sectors working in isolation have led to fragmented and short-term solutions that address one issue at a time. This has underscored the necessity for a new integrated approach aligned with the holistic concept of urban mobility. The figure below illustrates the distinctions between Traditional Transport Planning and Sustainable Urban Mobility Planning (SUMP).

[7] The Sustainable Urban Mobility Plan (SUMP) is a mobility planning approach introduced by the European Commission (concept introduced in 2009 and guidelines in 2013) (Rupprecht Consult, 2019), focusing on people. It moves from the vehicle-centric planning approach, maintaining effective participation of a diversity of stakeholders to compromise their different needs and priorities. It is applied in many European cities and internationally (Oyofo, 2019).

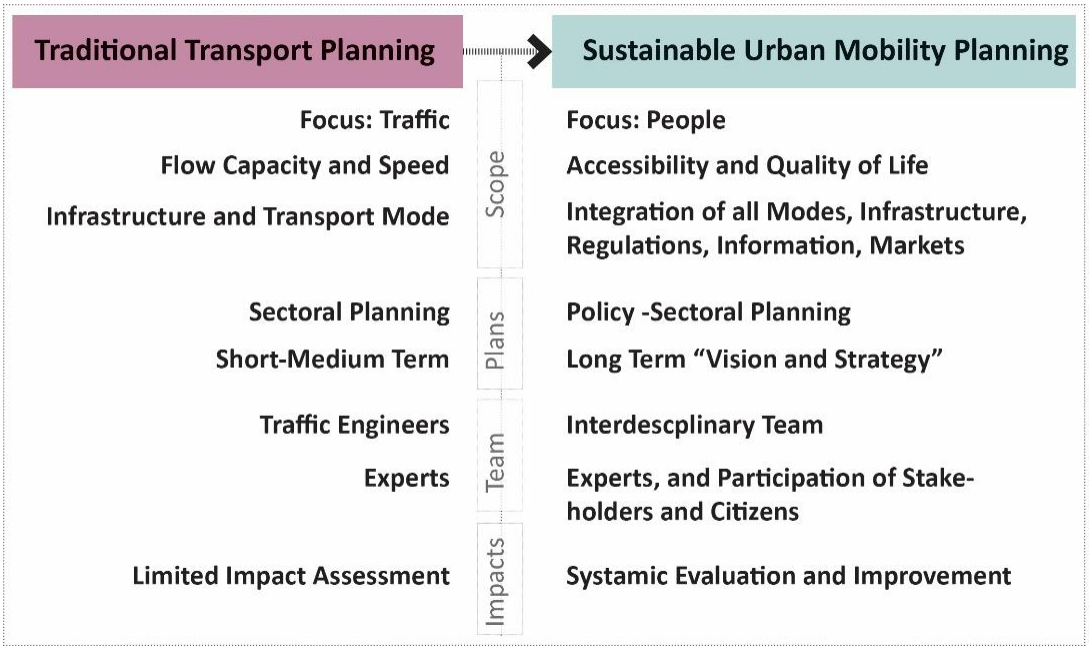

Figure 6 Shifts from Traditional Transport Planning to Sustainable Urban Mobility Planning SUMP.
Source of content of the comparison (European Commission, 2013); while the graphics and summarizing by author.

Therefore, SUMP represents a more strategic approach that comprehensively understands and integrates the complexities of mobility and transport. It places a high value on accessibility and the enhancement of the quality of life. SUMP adopts a long-term perspective, covering vision, implementation, post-implementation, continuous evaluation, monitoring, and updates based on technological advances and social trends (European Commission, 2013). The application of SUMP and similar participatory and inclusive approaches yields several benefits, including increased access to various mobility modes. This broadened access attracts qualified employees, and disadvantaged citizens, such as the mobility-impaired or urban poor, gain access to better job opportunities with the removal of travel barriers (Rupprecht Consult, 2019). The inclusive aspect of SUMP, along with other regulatory considerations, is encompassed in the Urban Mobility Package. This package is grounded in eight universally accepted guiding principles, as outlined in Figure 9.

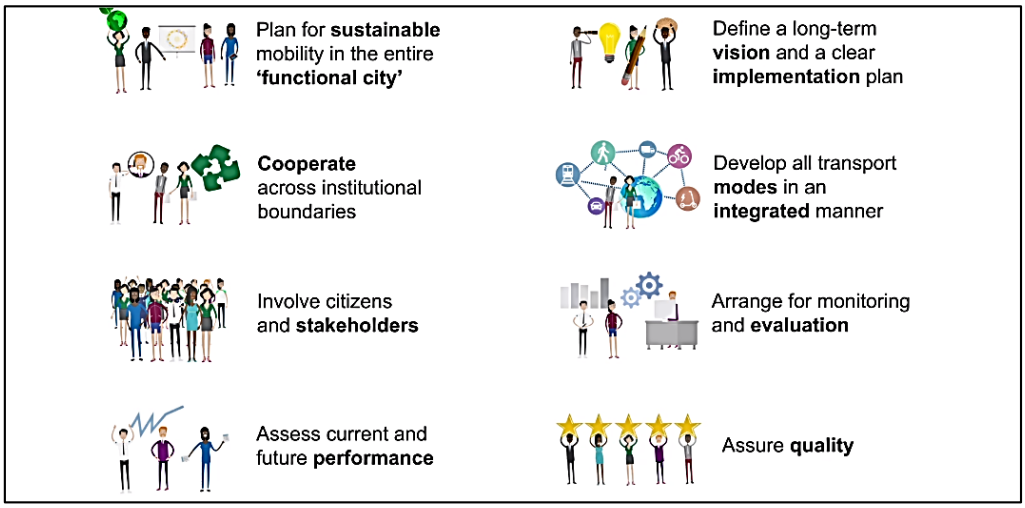

Figure 7 Eight crucial principles for successful Sustainable Urban Mobility Planning SUMP. Source (Rupprecht Consult, 2019) (Eltis, 2014-2023)

Subsequently, applying these fundamental 8 principles ensures that all citizens and stakeholders are involved across the influences of politics, economy, culture and technology through the different sectors of; transport, land use, environment, investments, social behaviors, health, safety, and energy

(Rupprecht Consult, 2019). This definition builds upon the introduced influences of politics, economy, culture, and technology (analyzed in figure 2), while focusing on factors that are related more to city and urban scale of recurrence, income, urban form, spatial accumulation, level of development and technology.

2.2 Smart Urban Mobility

Smart cities are often associated with advanced technology solutions in the favor of sustainability. Basically, "smart mobility" indicates the utilization of data advances and communications technology within the mobility services and transport; to increase the efficiency and convenience of city trips (UN ESCAP, 2022). Reviews of literature and recent reports categorize smart urban mobility either as a set of sustainable planning strategies and procedures or as transportation innovations. Nevertheless, all reviews concur that smart urban mobility aims to revolutionize everyday mobility by prioritizing user convenience and achieving zero emissions (The Department for Transport UK, 2019; Smart Nation Singapore, 2023). Interpretations in this regard incorporate smart mobility into demand-based transportation, green energy, and intelligent housing or shopping activities. This introduces new approaches to urban and city planning that take into account smart solutions for building construction, infrastructure, roads, parks, services, and activities (Ingwersen & Serrano-López, 2018). Moreover, the rapid advancement of transport innovations offers solutions for cleaner transportation, automation, and new business models, enabling more individuals to access barrier-free and convenient urban mobility.

While examining the current era of smart cities in which we live, it is evident that future aspirations go beyond basic digitalization procedures. This reality aligns with assertions that approximately 75% of the required infrastructure for the year 2050 is yet to be established (Guislain & Dasgupta, 2015). Thus, data science and internet are the steering gears of the next evolution stage of urban mobility (Berrone *et al*, 2016); where the world is exploring the unlimited horizons of Artificial Intelligence AI (Ingwersen & Serrano-López, 2018), and the arousing metaverse that implies technologies of virtual reality VR and augmented reality AR (O'Brien & Chan, 2021; Ball, 2022). Therefore, various applications of smart cities deviate from the conventional or singular perspectives on mobility, embracing a diverse array of forms and structures for connectivity and travel.

Consequently, the era of smart cities holds the promise of enhancing user experiences, ensuring a multitude of solutions for any desired service. These solutions may manifest through alterations such as introducing new land or building uses, enhancing transportation and infrastructure. In this envisioned future, obtaining a service could involve online ordering, taking an airbus, or a short walk to a satellite service office located in a nearby shopping mall rather than a distant headquarters. It is a time for governments, business owners, and communities to contemplate the ways in which people, goods, and services are transported, exploring the boundless opportunities offered by smart urban mobility (The Department for Transport UK, 2019).

This aligns with the current mobility plans of several cities that pursue applying and innovative transportation; for instance, the self-driving vehicles (The Department for Transport UK, 2019; Smart Nation Singapore, 2023); which will soon enable persons with disabilities and elderly populations to enjoy freedom of travel (The Department for Transport UK, 2019). Therefore, it is crucial for expertise and adaptability in urban mobility to be prioritized during the era of smart cities. This is necessary to

capitalize on the abundant opportunities presented by the smart city age, fostering improved functionality and equity in the planning and provision of diverse mobility services (UN ESCAP, 2022).

In this context, the planning and implementation of smart mobility are discernible in trends like active mobility/travel, Mobility as a Service (MaaS) and Mobility on Demand (MoD), Micromobility, Ride-hailing and Ride-sharing applications, as well as Autonomous and Electric vehicles (The Department for Transport UK, 2019; EDP, 2022). Some of these concepts are further reflected in the coming section that delves into the planning and implementation of urban mobility, exploring various facets such as the types of city trips, an overview of urban mobility planning and delivery, and the applications of smart urban mobility. The discussion will revolve around the interplay between land uses and activity locations, influencing the distance, time, and energy expended in commuting. Additionally, the chapter will address the enhancement of both physical and digital transport infrastructure to facilitate more efficient and environmentally friendly city trips.

3 Insights into Today's Mobility Trends

Sustainable urban mobility introduces inclusive and people-oriented concepts, offering a variety of solutions at both macro and micro scales. Macro interventions focus on groundbreaking technologies like automated driving, while micro-scale trends, applicable at the neighborhood level, enhance the First/Last Mile experience for transit access. There's a growing integration of electric cars and eco-friendly modes such as electric scooters, attracting significant investments. The emergence of micromobility modes promises greater equity, particularly for disadvantaged groups like children, adolescents, the elderly, and persons with disabilities. However, the reliance on technology in these modes poses challenges for those without access to smartphones or online resources, limiting inclusivity. The following subsections provide a brief overview of active mobility, micromobility, ride-hailing and ride-sharing, and autonomous vehicles, highlighting current trends shaping urban mobility dynamics.

Active Mobility: Walking and cycling represent primary and convenient options for travel, yet they face challenges in the absence of accessible infrastructure and urban contexts lacking resilience to weather conditions. Safety is a crucial concern, encompassing the need to protect pedestrians and cyclists from accidents involving cars and instances of harassment (Biggar, 2020; Nyström *et al*, 2023). This trend has prompted policymakers and governments to recognize its significance, leading to efforts to enhance the design of street networks and city infrastructure to better accommodate active mobility. (Adriazola-Steil, Ohlund, & El-Samra, 2021).

Micromobility: This trend pertains to small mobility vehicles or devices designed to carry one or two passengers, primarily catering to the first or last mile of a trip (The Department for Transport UK, 2019). It intersects as well with active mobility modes that can be utilized for same purpose (Urbanism Next - University of Oregon, 2020). Illustrations of micromobility modes are electric scooters, electrically assisted pedal cycles (e-bikes) and e-cargo bikes (The Department for Transport UK, 2019) (Urbanism Next - University of Oregon, 2020). Similarly, there are light electric freight vehicles that has the capacity to substitute delivery vehicle in short-distance trips (The Department for Transport UK, 2019). Micromobility plays a crucial role in addressing the gap for trips that are too far to walk yet too close to justify the use of a car, considering the economic and environmental costs associated with car usage (Urbanism Next - University of Oregon, 2020).

Ride-hailing: This mode choice involves passengers using smartphone apps to book transportation services, typically provided by a professional driver using their own vehicle or one operated by a transportation network company.(Coherent Market Insights, 2022). Hence, it is a service that connects paying riders with licensed taxi drivers or hired drivers with private vehicles (The Department for Transport UK, 2019).

Ride-sharing: This trend involves a group of individuals, possibly strangers, traveling in the same direction and sharing a single vehicle while splitting the cost of the ride (Nourinejad & J. Roorda, 2015). Hence ride-sharing as carpooling can range from closed circles of friends and neighbors to dedicated websites and applications that connect people together with common trips (Najmi *et al*, 2020). Shared mobility in urban and suburban areas offers several benefits, including the reduction of carbon emissions, improved traffic conditions, decreased demand for parking spaces due to a lower number of individual cars, and increased affordability leading to reduced transportation-related costs (Fiedler *et al*, 2018; Behroozi, 2023).

Autonomous cars: They are also known as self-driving cars or driverless cars, are vehicles capable of operating and navigating without human involvement. They rely on a combination of sensors, cameras, radar, lidar, GPS, and advanced software algorithms to perceive their surroundings and navigate the roads. (Yurtseve et al, 2020; Lutkevich, 2023). Companies started to invest in developing such vehicle technology including Waymo (a subsidiary of Alphabet Inc.), Tesla, Ford, and General Motors. The challenges currently facing the development of autonomous vehicles include the need for regulatory adjustments, infrastructure modifications, and the establishment of a robust street network connectivity (Yurtseve et al, 2020). However, there are much concerns in the lack of ethical understanding in non-human operated vehicles; to realize situations that might arise and result into potential accident situations (Maki & Sage, 2018; Lutkevich, 2023).

4 Conclusion

In conclusion, this paper has meticulously traced the evolution of urban mobility, charting its course alongside the development of transport systems and aligning it with different historical periods marked by technological advancements. Each era has been characterized by the constraints of specific transport technologies, subsequently surpassed by the introduction of new innovations, leading to shifts in consumption patterns, geographies, and power dynamics. Commencing in the nineteenth century with the advent of rail-based transport, the analysis spans various durations, reaching the present (2022/2023) with a brief acknowledgment of the impact of the Covid-19 pandemic. The concept of "Sustainable Urban Mobility" is presented as the apex of this evolutionary journey, discussing its potential benefits for a more promising future. Additionally, the paper offers insights into current urban mobility trends, anticipating their integration into the future landscape of literature and studies on the subject.

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