Impact of Automobility on Urban Sprawl

Subjects: Urban Studies

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Urban sprawl has become a controversial issue. Lines of thought among academics, practitioners, and local authorities have been diverse. Some academics advocate the compact city as an antidote to urban sprawl, some scholars doubt the ability of conventional notions of containments to create sustainability, and others are fascinated by urban technologies and believe in the feasibility of these technologies, whereas local authorities impose policies, one after the other, without effective results.

Keywords: car dependency ; automobility ; modern theories of city planning ; transportation policies ; compact city

1. Introduction

The rapid urban sprawl has led to numerous social and economic problems relevant to the environment. Therefore, long debates have been held over transitioning into sustainable cities; this has become an urgent matter since 1972 [1][2]. Many scholars have revived the old concept of the compact city; however, this trend has faced several criticisms despite its merits. The skeptics of the compact city state that urban containment is antithetical to sustainability in some aspects, such as livability. The conflict between urban sprawl and the compact city remains unresolved. Some countries such as the U.K., China, the U.A.E, and Korea have attempted to tackle the downsides of urban sprawl through technology [2]; they have established eco-carbon cities such as Masdar in the U.A.E. and ubiquitous cities, such as those in Korea. However, these kinds of cities are prohibitively expensive, were founded to serve the high-income classes, and increase social segregation. Low-income residents with low education cannot afford or deal with the services of such kinds of cities. Even if they have work in those cities, they will settle near cities. Then, the city loses its social coherence and one of the pillars of sustainability. Thus, this tendency is also equivocal. Local authorities all over the world have attempted to decrease urban sprawl and the congestion within cities by raising oil prices or imposing traffic taxes but these endeavors have not been effective enough to evolve into sustainability. Since the debates over versatility, the transition into a sustainable city seems fuzzy and needs more investigation.

2. Automobility and Modeling Modern City-Planning Theories

2.1. Pedigree between City-Planning Theories and Automobility

Since the invention of the automobile in the 1880s, city planners have been motivated to publish numerous theories on modern city planning, which has strongly relied on the potential of cars to overcome urban sprawl [3][4][5]. In 1894, for example, Soria Y. Mata would not have been able to link two existing cities, without evolution in the means of transportation. He coined his idea of the linear city in 1882, and implemented it in Spain twelve years after publishing it [6]. In 1898, E. Howard founded the garden city theory, in a publication entitled “Tomorrow: A peaceful path to real reform” and reissued it in 1902, under the title “Garden city of tomorrow”. The city was planned on a circular shape divided by radial boulevards [7], and was designed to be a utopia or ideal city, where the town met the countryside. Actually, Howard also would not have been able to build his theory, which advocates expanding horizontally, unless the potential of the car was taken into consideration [8][9][10][11]. The same applied to the Satellite cities theory that was put forth by Raymond Unwin in 1922, and the theory of the Broadacre City, a term coined by Frank Lloyd Wright ten years later [8][12][13]. The car had a vigorous impact on the horizontal city sprawl, as well as on its vertical growth. The radiant city, or “Ville Radieuse” embodied by Le Corbusier between 1922 and 1933, has wide thoroughfares and bridges (crossings) that were designed specifically because of the potential effect of cars [14][15][16], to the point where Le Corbusier noted in 1925 that “the corridor street must be killed” [17], indicating the wide streets and new urban systems that were imposed by the car. Theories oriented to neighborhood planning were also affected by cars, including Perry’s Neighborhood formulated by Perry in 1910, which has a hierarchical street pattern to help cars move smoothly [18][19][20][21][22]. Meanwhile, the superblock theory theorized by Wright and Stien in 1929, relied on cul-de-sac streets to secure settlers from the risks of vehicles [23]. Using a historic gaze, one can recognize the role of the car in formulating and crystallizing modern planning

theories. Therefore, the car provides a great opportunity for more urban sprawl and bigness—currently, and in the future. **Table 1** shows the chronological of city planning theories affected by automobility.

Table 1. The chronological of city planning theories affected by automobility.

Initiative/Theory	Theorist	Planning Level	Date
The linear city	• Soria Y. Mata	• City	• in 1882
The garden city theory and garden city of tomorrow	• Ebenezer Howard	• City	• In 1898 and 1902
The neighborhood Unit theory	• Clarence Arthur Perry	• Neighborhood	• 1910
The Satellite cities theory	• Raymond Unwin	• City	• in 1922
The radiant city, or "Ville Radieuse"	• Le Corbusier	• City	• 1922–1933
The superblock theory	• Clarence Stein	• Neighborhood	• 1929
The theory of the Broadacre City	• Frank Lloyd Wright	• City	• 1932

2.2. Criticism of City-Planning Theories Based on Zoning

The rapid urban sprawl that was derived from the sequenced, modern city-planning theories aroused some critics to attack those theories that had bad consequences. In 1913, Arthur T. Edward was one of the earliest who criticized the solitude of vigorous urban sprawl; he proclaimed that man likes to live closer to services and other facilities, and wants to live interactively with his neighbors instead of living as if in a fever hospital [17]. Jane Jacobs has also illustrated—in her book, "The death and life of great American cities"—that the trends adopted by Howard, Le Corbusier, and advocates of modern planning cities will produce unsafe, inhuman, uneconomic, and non-ecological cities [24]. Car ownership allowed the suburbs to double, causing social problems embedded in the segregation between the urban pattern of the mother city and the suburbs around it, the separation between social classes, and the increasing crime rate. Moreover, accident risks have increased, and the ratio of air pollution and noise has also been gradually rising owing to everyday travel. With the increase in the number of cars and car dependency, energy demand increases as well, and is considered a burden on the government's finances. Furthermore, the onus on the government has shifted toward the maintenance of the environment. Cities have become the habitat where all unsustainable actions arise and are exacerbated. However, they are also deemed to be the generators and hub for sustainable development [25], and they can afford to find a solution to the problems they encounter [26] if efforts are directed at the roots of the problem, rather than its manifestations.

3. Automobility as a Phenomenon

3.1. Private Car Dependency

The automotive industry may be the most invested among other industries according to different predictions by 2030. The car is an incredible phenomenon. It is the dream for both rich and poor. This dream is widespread and shared in all countries [27]. Among different kinds of vehicles available, the car is the most needed and, therefore, cars are dominant on the streets. In addition, they are considered a marker of personal identity, as well as an economic and social necessity [28]. Considering the traffic congestion in China [29], it was said that the Chinese would be happy with only rice, but this is not true; the minute people were given the opportunity to earn more money, the car became one of their priorities. In 1982, China produced 3428 cars. Now, China is deemed one of the greatest producers of cars in the world. In 2011, cars accounted for about 106 million vehicles, including around 78 million private cars [30]. Millions of Chinese obtained their first car during the last decade. Hence, China has become a country of new drivers. It only contains three percent of the vehicles cruising the world's streets, but the more bizarre fact is that Chinese vehicles are responsible for about 21 percent of road fatalities throughout the world [31]. In Africa, Luanda, among other cities, has chaotic traffic congestion;

every week another 2000 new vehicles hit the streets [32][33]. People of Luanda endure traffic congestion of up to three to four hours to go to work.

Notwithstanding the car's disadvantages, for the majority, it seems like a temporary dwelling inhabited for a short time (while commuting), and humans naturally attempt to maintain their privacy. Hence, everyone tries to possess a car, once they are able to afford its initial price and the associated running costs. In addition, car ownership has become a gauge of social status in most communities [34]. Thus, any solution aimed at decreasing the number of cars, without paying attention to the social and cultural issues related to car possession, will not be a realistic one.

The capacity to move easily, which is offered by automobiles, has motivated people to possess them. Thus, the production of cars has been increasing annually, especially in the BRIC countries of Brazil, Russia, India, and China. The mass production of cars and their variety make them affordable for people all over the world. The average number of cars per 1000 inhabitants, and the high concentration of cars that exist in the USA, Canada, and Australia, whereas the lowest in Africa, as shown in **Figure 1** [35]. In Saudi Arabia, low car prices and inexpensive oil have inspired low-income Saudis to acquire cars. Currently, dependency on cars is a significant phenomenon in Saudi cities [36].

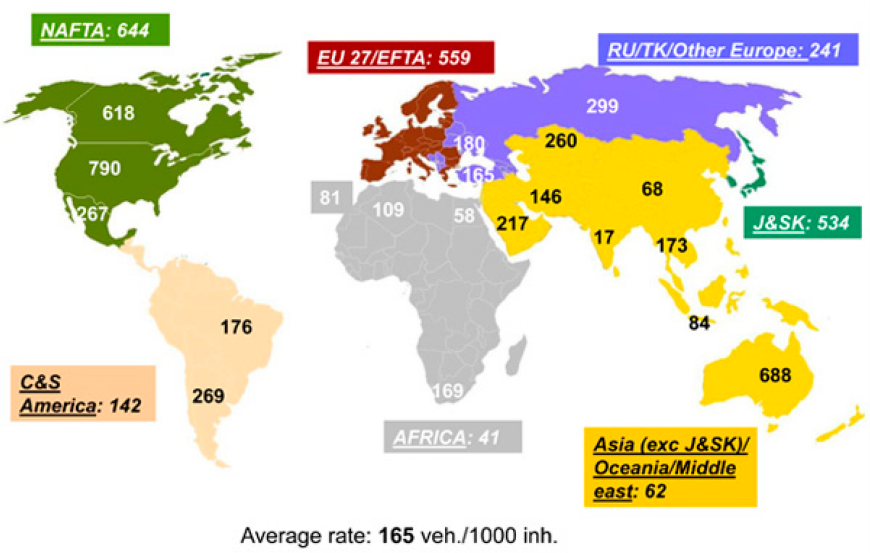

Figure 1. The average number of vehicles available per 1000 inhabitants throughout the world [35].

The rapid expansion of urban growth, increasing average human age, and increase in the affordability of automobiles has meant that automobiles are regarded as an essential tool for modern life, similar to the Internet; people cannot abandon them easily. In a survey of city dwellers, the extent to which people depend on their cars is shown in **Figure 2** [37].

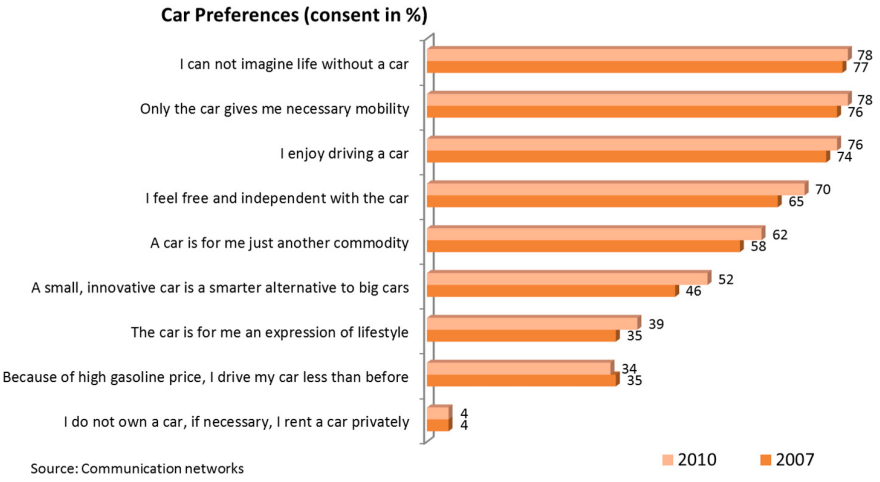

Figure 2. The average ratio of people who prefer cars, and their feelings toward them [37].

3.2. Economic and Environmental Problems of the Automobile

The economic growth of cities has opened the door to more ownership of motorized vehicles, such as the private cars that are distributed throughout Eastern European cities, the microbuses that have spread in Latin American and African cities, or even the 2–3 wheelers in Asia cities [38].

Cars in general, and the cheaper models such as Tata Nano and Bajaj produced by India in particular, have facilitated rapid urbanization and the inflation of cities, and caused land erosion. Urbanization consumes around 75 percent of global energy. Hence, cities emit about 80 percent of global greenhouse gas [39][40], in addition to various social and economic problems [41][42]. The transportation sector (road and air transportation) consumes the largest share of oil globally; it alone consumes about 47 percent of oil production, equivalent to 34.5 million barrels per day according to 2001 statistics; road transportation consumes around 80 percent of total oil consumed by the transportation sector [43]. It is worth mentioning that the oil consumed by the transportation sector in total differs from country to country; the Organization for Economic Co-operation and Development (OECD) countries accounted for 55% as an average rate; whereas the non-OECD countries consume below 40 percent of oil purchased for transportation purposes. The difference in consumption between OECD and non-OCED countries took place because of the activity gap between them in terms of industrial and commercial transportation demands. The high oil demand needed to cater for transportation increases carbon dioxide levels, which are responsible for roughly 80 percent of global warming and climate change. Road transportation is responsible for about 20 percent of total carbon dioxide emissions [44][45]. In April 2007, automobiles emitted around 17 percent of total U.S. carbon dioxide emissions [46]. So, cars are a greater source of carbon dioxide [47], compared to other means of transportation, such as vans, trucks, buses, and motorcycles.

3.3. The Automobile and City Sprawl

Earle Draper is one of the pioneers of city planning in the U.S., who coined the term “urban sprawl” in 1937; the British planner F. G. Osborn followed him, by summarizing the relationship between urban sprawl and transportation in the 1940s [48]. The first national conference on city planning took place in Washington DC in 1909, where planners discussed the impact of automobiles on urban sprawl. The conference attendees pointed out that the transportation means did not merely facilitate movement, they reshaped urban patterns. Thus, they recommended that the city and the automobile must adapt to each other [49]. In the 1970s, the impact of automobiles on American life was clear, and a book entitled, “The architecture of four ecologies”, was authored by Reyner Banham in 1971. A year later, a film entitled, “Reyner Banham loves Los Angeles”, presented a picture of modern American life from inside a car [50]. Private cars were the most important component of the transportation system.

4. Tackling Automobility

As a result of car dominance, some initiatives have emerged to regain the street for its first function as a place serving people, rather than cars. “Reclaim the street” is one of the protesters’ initiatives against the dominance of cars on the streets.

4.1. Sustainable Urban Approaches: The Compact City, Free-Carbon Eco-City, and the Ubiquitous City

4.1.1. Compact City

In the last quarter of the Twenty century (1973), G. Dantzig and T. Saaty rooted the term “compact city” in academia. The concept of a compact city has been published widely, especially since the beginning of the 1980s. The notion of the compact city was a correction path against urban sprawl resulting from repercussions of the world wars causing setbacks to environmental, economic, and socio-cultural values. The compact city has been oriented to raise urban density with mixed land use and simultaneously shorten automobile trips [1][51]. The open spaces providing from car-independency and minimizing parking spaces would contribute to creating vibrant spaces where residents’ socio-cultural dimensions can be boosted. Frankly, the notion of a compact city is old; it is traced back to the medieval city, when the streets were for pedestrians rather than automobiles [52].

4.1.2. Free-Carbon City

Almost in conjunction with the date of propagation of the compact city, another approach to urban sustainability was launched in 1987 by Richard Register who published his book, “Eco-city Berkeley: Building cities for a healthy future” [53]. This notion stemmed from environmental motivations depending on the mitigation of carbon dioxide emissions, and the uses of eco-friendly energy. A few models of this type of city have been designed throughout the world. Masdar City, located in Abu Dhabi, is considered one of the prominent innovative models of such a notion [54][55][56][57], where the inner transportation depends on electric personal rapid transit [58]. Underground tunnels have been developed to allow personal rapid transit to navigate through the city, avoiding traffic congestion and keeping traffic safe [59]. The benefits obtained by Masdar city are questionable compared to the USD 24 billion [34][60] cost of the construction of Masdar. This critical point will be discussed broadly in the Challenges section.

4.1.3. The Ubiquitous Eco-City

Undoubtedly, the rapid development of communication technologies has a remarkable effect on our lifestyle. Urban life is considered a melting pot where cutting-edge technologies of communication are interrelated in various urban activities. Thus, not far from the emerging notion of a Zero-Carbon city, Mark Weiser launched his notion about “ubiquitous” depending on Information and Communication Technologies ICT to connect people with goods and services wherever they are and whenever they need them. Weiser presented his computational project to the Xerox Palo Alto Research Center in the US in the 1990s [61] in order to improve the urban quality of life within the city or even on a regional scale.

By 1997, when the Asian financial crisis occurred, the vision of South Korea toward a sustainable urban life had provoked a new paradigm based on ubiquitous computing, whereby residents can access services and goods where they are and whenever they need them, through the ICT embedded in the urban infrastructure [62][63]. A decade later, South Korea launched the Korean U-eco-cities project. In 2008, the Hwaseong Dongtan was an exploratory project [64][65][66], and the number of such projects has reached more than 64 projects nowadays in South Korea. One of the attributes of these projects applied by the Korean Ministry of Environment is the utilization of green cards, which invite people to obtain credits for buying hybrid cars and eco-friendly equipment when they save energy consumption in their homes. This initiative was sponsored by some Korean companies such as Hyundai Motors and Samsung Electronics [62].

Another project was oriented toward an eco-friendly transportation system. In Yeosu city, the domestic authorities supplied residents with U-bikes, whereby the ICT-embedded bicycles are employed to support green transport within the city. Moreover, U-bikes could prevent bike theft cases because of the tracing-back smart system. Electric cars have also been adopted for transport in Jeju city so as to create a cleaner environment. After the COVID-19 pandemic, televideo-based conferences such as Zoom, Skype, and FaceTime can ensure affordable remote communications for groups and businessmen. Therefore, they save time and decrease carbon emissions and commuting costs. The U-eco-technologies can navigate the visitors to find their destinations easily and confidently. These technologies also offer a credible service for those who are responsible for elderly people suffering from Alzheimer’s disease. These technologies have made some Korean cities, such as Seoul, Busan, and Incheon, into smart and ubiquitous cities and helped them to overcome the challenge of COVID-19.

The markets also have turned to be ubiquitous. A virtual store has been established by Homeplus (a Korean discount store retail chain) in Jamsil subway station in Seoul, which is deemed a creative idea, utilizing Ubiquitous and ICT technologies. The columns and walls of the Jamsil subway station are covered by virtual Homeplus products—digital advertising columns and walls—similar to what customers would see in real shops. This type of shop could significantly minimize the physical space of the traditional shop, and avoid shopping trips, unnecessary freight, and further car dependency.

4.2. Public and Governmental Policies Relevant to Traffic

4.2.1. Policies Interrelated to Traffic Congestion

Local interests have tried to address the negative outcomes that derive from automobiles. In 1925, McClintock assumed in his work, “Street Traffic Control”, that the organization of car movement is essential for eliminating accidents and traffic congestion. Thereafter, some urban consultants attempted to make streets wider and more accessible, and less close-ended; they recommended the provision of traffic signs and focused on a hierarchical street system, in addition to separating paths for various types of vehicles to enhance movement flow [49]. The Vietnamese prefer to use motorcycles in commuting rather than cars, because of the motorcycle’s ease of movement and its affordability in terms of oil provision and price, while the car consumes more urban area, both in cruising the street and in parking [67]. In 2000, the motorcycles on Hanoi’s streets numbered 953,087 whereas cars numbered 130,746. It seems that reliance on motorcycles is a suitable alternative for cars in some Asian cities, such as Jakarta and Kuala Lumpur, as shown in **Figure 3** [68].

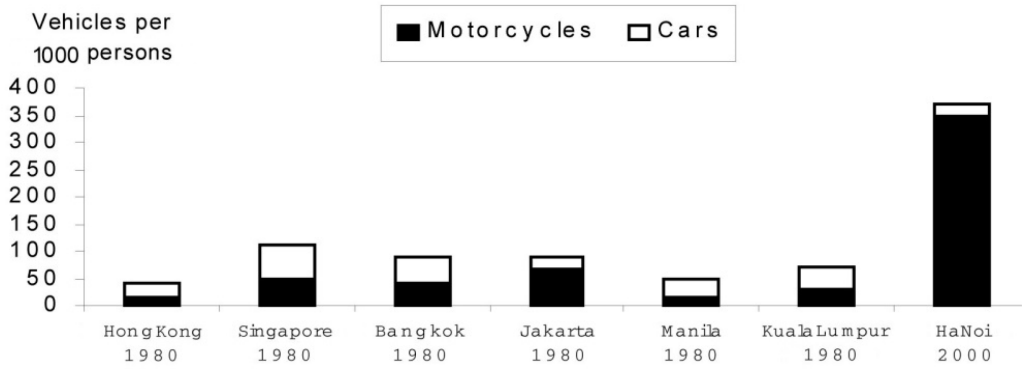

Figure 3. The ratio between automobiles and motorcycles in South East Asian capitals 1980 and Hanoi 2000 [68].

4.2.2. Policies Aimed at Improving the Environment

Air pollution increases the rate of fatalities among humans. In Serbia, for example, about 5000–7000 persons die annually, owing to air pollution and poor air quality [69]. These consequences motivated the Copenhagen authorities to reduce carbon dioxide by providing electric and hydrogen-run cars. This type of pilot scheme has also been carried out in Spain, where the use of electric vehicles, buses, and taxis to reduce air pollution has become a necessity [43]. The exacerbated air pollution resulted in the emergence of absolutely green vehicles, which produce zero pollutants while operating or cruising and use renewable energy resources, such as solar energy. Moreover, the use of vehicles with low greenhouse gas emissions, such as those that are operated by electricity derived from biodiesel or natural gas, produces a limited amount of pollutants. Thus, Al-Hinti et al. (2007) recommended using diesel cars to mitigate carbon dioxide emissions and save on energy consumption in order to achieve progress toward sustainability in Jordan [44]. Shared autonomous electric vehicles may replace about four automobiles less than the non-electric shared independent vehicle, which replaces seven cars. One of the challenges to electric cars is the availability of charging infrastructure [70]. Thus, it is probable that electric shared cars are still underused in Poland compared to other European countries [71].

The share mobility contributes to creating social equity and hence sustainable cities [72]. The Copenhagen government encouraged people to use car-share schemes, and made reserved parking spaces for licensed shared cars. Poland also is witnessing remarkable progress in the use of car-sharing [71]. A study conducted in Austin, Texas, concluded that a non-electric shared independent vehicle can replace about seven automobiles [70]. Similar to Stockholm, taxes on car congestion have been imposed to eliminate the problem [73][74][75]. In addition to raising fuel prices, this measure was an effective tool for decreasing private car dependency and promoting public transportation in oil-rich countries such as Iran [76]. In the U.S. and U.K., planners have changed the regulations on minimum parking limits to the maximum parking limit, in order to shorten automobile trips, and thus support sustainable development and the vitality of the city center [36]. Since 2002, an initiative known as CIVITAS has emerged in Europe, which is co-financed by the European Commission (EC) and CIVITAS cities; it aims to create vital and sustainable cities, with an evaluation approach based on collecting and analyzing survey and interview data, in order to improve the transportation system [77].

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