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The Impact of Transit on Sustainable Urban Form

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Abstract

Cities suffer from many problems that have led to a decline in the quality of life. A large part of these problems is related to the relationship of the transportation system to the urban form of the city. This represents the research problem, As the study of the relationship between public transport and urban form implicitly deals with the relationship between land uses and transportation in general, as land uses are a generator of traffic and transport in the city. The importance of the research lies in the role of public transport as one of the mechanisms that contribute to directing the urban form towards sustainability. Therefore, the aim of the research tried to present an idea of the extent of support provided by public transport to the sustainability of the urban form of the city. The research assumed that public transport is affected by a set of factors that direct the urban form towards sustainability such as (density in development, diversity in land uses and urban design, and distance from urban centers), and that the urban form of the city can be directed towards sustainability by integrating with different land uses.

Key words: city form; urban development; transit; diversity of land uses; urban design

1. Introduction

Different factors have been affecting modern cities. These factors include climate change [1-3], freshwater sources [4-6], and it affected by pollution of the industries [7, 8]. Addition factor affected the modern city that is the transit. The idea of directing urban form by adopting public transport is consistent with modern ideas of transport planning, which adopt complementary models between land uses and transportation, these ideas that came as a result of the accumulation of transportation planning methods.

Ideas for transportation planning began in the fifth decade of the last century with models based on the socio-economic characteristics of families. These models alone are insufficient to explain the behavior of trips and choose the medium because they do not take into consideration the spatial differences in the assessment results. Urban development patterns have a direct effect on increasing the average number and distances of journeys. The indirect effect of public transport can be through stimulating land use patterns with more accessible characteristics of public transport and creating a more diversified system that leads to additional reductions in private transport trips and thus support sustainable urban development.

To understand the impact of transit on the sustainability of the city, it requires referring to the relationship between land use and transportation, and this relationship is called the cycle (transportation - land uses).

When transport routes reach a region, they become more attractive in most cases for urban use, as a developed land, after which the activity increases and leads to an increase in the number of trips, this increasing demand in turn causes an additional burden on transport services. Transport affects urban sustainability in two ways, figure (1). It affects, directly and indirectly, by directing city growth towards specific patterns that lead to achieving sustainable urban development. Because almost all urban environmental problems are caused by land use, such as lack of affordable housing, pollution from cars, abandoned buildings in city centers, in fact the urban form and land use patterns within the city are the decisive factors for the quality of the environment.



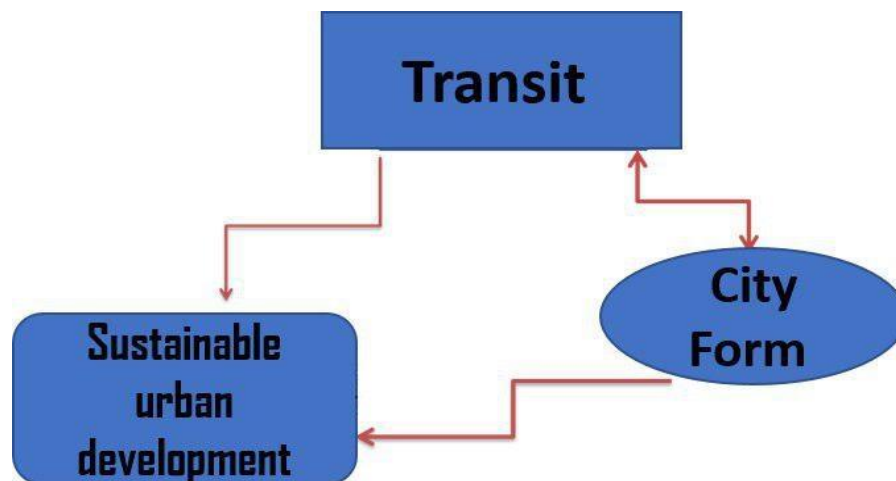


Figure 1. The impact of transit on sustainable urban development.

In recent studies, the relationship between the urban form and the type of trips has become one of the most important considerations for planners and decision-makers. There are many studies that have indicated that the change in the urban form is the most important indicator of the demand for urban transport, which in turn leads to a reduction in fuel consumption and an improvement in the quality of the environment. Recent studies have focused on reducing the number of trips by encouraging efficient land use patterns and a well-designed transportation system that is better managed.

Urban form is the spatial pattern or arrangement of individual elements such as buildings and land uses, as well as social groups of economic activities and public institutions within the urban area and the distribution of the population and the networks that connect them. As for urban interaction, it is the set of mutual relations and the flow of activities to complement the patterns of behavior and individual and collective land uses in Functional entities. A job is an activity that is done and movement is the necessary flows to participate in that activity.

1.1. Spatial urban structure

Is a combination of form and function in a specific system, the shape refers to interconnected parts of the road network, homes, stores, parks, etc., and the function refers to the interrelationships? For example, how people and goods can move or flow between parts [9]. It is widely believed that the urban spatial structure is a composite of both the urban form with the superposition of patterns of behavior and interaction with subsystems with a set of organizational rules that bind these subsystems together in a city system.

The type and arrangement of the transportation system is the most important factor in the formation of the city. We see that the cities that arose during the period of reliance on public transport (before the invention and spread of the private car) have an urban shape different from the cities that were built on the basis of relying on the private car.

1.2. Public transportation and its impact on land uses.

There is a strong interrelation between land use planning and transportation in a large number of ways. These two elements are so interconnected that it is impossible to separate them [10]. There is also a wide range of solutions by adopting land use planning (urban area development) to activate public transport, limit car trips and restrict urban sprawl. These solutions must be integrated between workers, the most important of which is to increase the density and multiplicity of land uses to increase access to public transport, integrate land use with the efficiency of public transport networks to facilitate access and activate public transport, and improve the quality of urban design to encourage pedestrian trips.

The private car has little capacity, but it is fast and highly flexible. The public transportation means has a large capacity and fast, but its flexibility is little, while the means of walking has a high capacity and great flexibility, but its speed is limited. To find a competing vehicle for the private car, the links

between walking and public transport should be linked and strengthened. This is the essence of the idea of public transportation as a directive for urban development, as shown in figure (2) [11], by increasing the density around public transport routes to reduce the walking distance and thus increasing the destinations around these routes and increasing the flexibility that reduces public transport.

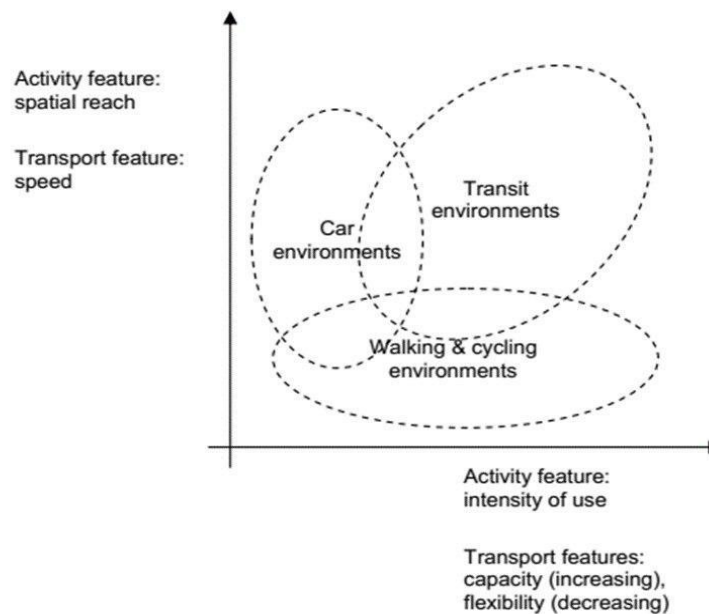


Figure 2. Public transport correlation with the form of land use.

The goals of transportation planning change constantly with city conditions. The current goals of transportation are to give priority to public transport, thus increasing ease of access, backing up, encouraging clustering of land use and calming traffic [12]. Public transport achieves sustainability goals, it is friendly to urban planning, encourages walking, is safer, and improves the environment. And it can reshape the city towards sustainable urban development through several methods.

2. Intensity of urban development

Public transport has a positive effect on increasing the intensity of urban development and mixed use of land, which in turn leads to the activation of public transport. The high density of residential and business areas necessarily leads to an increase in the use of public transport [13], as the intensity of development increases the number of potential passengers of the public transport route, and helps to provide more of the passengers, and with the increase in revenue, the public transport service is becoming more and more frequent [14]. Usually the density of urban development is measured in terms of population density or employment density. Much research focuses on the relationship between population density and travel patterns, raising four reasons for the relationship of population density with travel patterns [15].

- High population densities broaden the opportunities available to develop local personal contacts and activities that can continue without resorting to automatic travel.
- The high population densities contribute to expanding the range of services that can be of support in the local area, reducing the need to travel long distances.
- The high density of development patterns indicates a reduction in average distances between homes, services, jobs, etc., which reduces journey distances.
- Higher densities support public transport and less use of private cars. In Young's study (1997) [16], the results of which were that doubling urban density reduces 25-30% of the motorized traffic per person. If the density of housing and jobs increases, the number of passengers per route will increase and lead to a higher level of public transport service. Also, improving the

comfort of the service will be positive for the number of passengers for public transport, which increases the revenue ratios and allows for better service levels.

Intensive urban development means that more people and activities can be concentrated in that area. As a result, the number of flights will be shorter distances than the low density urban dispersed areas [17].

By focusing development around public transportation paths, it can provide additional benefits to urban areas, as residential, commercial and industrial uses are closer together, thus encouraging people to walk more often, and there will be fewer uninhabited areas during long periods of the day. With the increase in pedestrian traffic along the main streets, walking around will become safer, especially in large urban areas. If there is a better mix and balance between housing and work in urban areas, it will increase the likelihood of using public transportation.

Nevertheless, increased density and mixed land uses, if applied randomly across the urban area, can exacerbate transportation problems [18]. Therefore, most efficient and efficient land use policies are those that require mixed use and high population densities that can be placed in areas with the highest levels of accessibility by public transport.

3. Diversity in activities (Mixed land uses)

Diversity in activities (mixed uses) in urban areas lead to achieving integration of land uses with each other functionally and increase economic savings by providing easy access. Diversity in activities (mixed uses) in urban areas lead to achieving integration of land uses with each other functionally and increase economic savings by providing easy access.

The presence of urban diversity leads to the creation of relatively self-contained societies, and reduces the need for internal urban mobility. It can be easily serviced by public transportation [19].

Diversity in land uses around public transport paths can lead to social diversity due to the presence of a percentage of representation for a variety of different population, social, economic, cultural and employment groups within the characteristics of society, and lead to living in a comprehensive, interactive and harmonious way. It is an essential part of social development requirements [20].

3.1. Urban design

Urban design is the composition or arrangement of city elements such as streets, buildings, open spaces, and the transportation system. Urban design can provide a suitable environment for public transportation at street level, which is a very important factor for pedestrian traffic. It helps to achieve easy pedestrian accessibility and thus increase the ease and efficiency of public transportation [21].

3.1.1. Street grid pattern. The pattern of the street network is the basic feature of the urban environment. The small, dense street network provides a more accessible environment for pedestrians in general. With high connectivity, the street network should provide an appropriate building environment. The streets are short, contribute to slowing down the speed of vehicles and reduce distances between land uses, and all of these factors are supposed to increase the attractiveness of walking [22]. Street patterns should be designed to minimize walking to public transport stations from either residential or business areas. Figure (3) shows the relationship between street pattern and traffic. It compares between the orthogonal pattern and the curved pattern. It shows that the two types require the same amounts of implementation, and provide similar intensity, but the uses of intersecting streets make walking trips easier. This can reduce congestion at the entrances to residential areas. As for the design that adopts curved streets, it will encourage the use of the private car [23], so the closer the street pattern is to the grid pattern, the higher its ranking and the better [24].

So, there should be a comprehensive approach to urban design. The grid system reduces distances and congestion by providing a more direct lane than the curved and non-perpendicular street system, which concentrates all traffic on a few lanes [24].

Rank	Description	
1	Low coverage for all roads	
2	Curved and closed roads. With a little Grid system	
3	An important proportion of the grid system. But there are closed ends	
4	Grid system s with little roads closed	
5	A complete grid system. No closed roads	

Figure 3. the street relational classification system.

3.1.2. Development site. To take advantage of the scope of impact of public transport, development should be focused heavily around public transport routes. The location of common and integrated uses together around a public transport nodes has positive results in improving pedestrian accessibility, as Figure (4) shows, the extent of public transport is graded according to the distance from the public transport position [25], the first part is the center of the parking station, and passengers have direct access to it, and the majority of public transport passengers are from this area, and after that comes the secondary area and it is located within the available walking distance to the parking areas, and the planning can provide direct access to it. The last area is the secondary, and the distance is farther and using public transportation is more difficult. Focusing development at the center of influence ensures multi-purpose flights, and generally reduces flight distances.

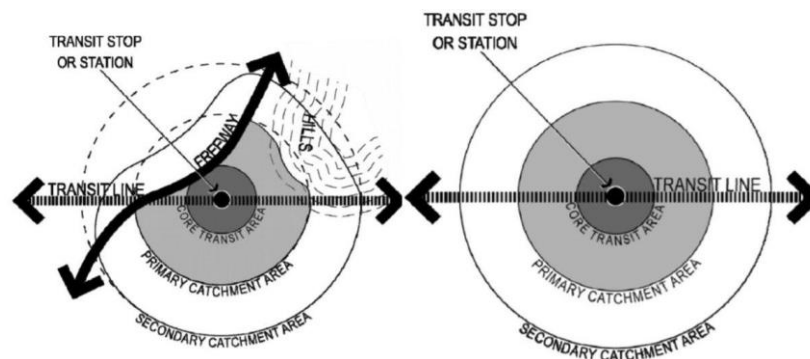


Figure 4. Public Transportation Impact Zone.

The best mix of land uses should be encouraged along major public transport routes, in order to develop an urban environment supportive of public transport. The density can be high or medium next to the public traffic lanes [26], and this will enable a large number of passengers to have direct access to the public transport service. The concentration of mixed uses in the nodes leads to the concentration of end-of-flights in several separate locations. This will make it more suitable for public transport use, as a single public transport trip can serve a wide range of destinations. This variety includes employment opportunities, retail, entertainment, entertainment and cultural purposes that some of these residents will move to other locations for shopping or work, which will help balance passenger levels in both directions. Secondly, it will ensure that nodes activity is published on a 24-hour basis and create a safer environment.

The centers of high density in the urban area, which include a mixture of different housing units inhabited by residents of different income, constitute nodes, intersections and public transport stations that should be within the current or proposed activity nodes when the new public transport routes are planned, Figure (5), and coordination the size of the nodes activity with the existing or planned levels of public transport, and the advanced busy activity nodes located in the traffic system centers of public transport in small urban areas, and this usually occurs in the business district in the city center [27]. To achieve maximum convenience for public transportation users, effective nodes should be user-intensive, and activities should be within walking distance. Activity nodes should be designed so that they are readily available to pedestrians who live in residential neighborhoods.



Figure 5. locating of high density in the activity nodes.

3.1.3. Design of neighborhoods and public spaces. Developing the urban design of the neighborhood can encourage public transportation and reduce the use of private cars if the pedestrian needs are fulfilled. Internal streets should be designed to provide walking directly to public transport stops. In order to improve the attractiveness of public transportation, lanes should be designed to provide as direct a route as possible to reduce the length and time of journeys.

The users' need for public transportation is sensitive to the distance to be traveled to public transport stops. Long or winding roads discourage people, even if public transport is good. The maximum walking distance to a public transport service that users are willing to walk depends on many factors such as terrain, sidewalks, weather and age. To help achieve these standard characteristics, it requires the creation of a high density of development in the vicinity of public transport and the provision of sidewalks along public traffic routes and on both sides of public transport roads and adjacent side roads. The comfort and safety of public transportation users and those who are able to work, which is vital for the elderly, families with children and the handicapped, and pushchairs for children, to facilitate access for all groups [28].

3.1.4. Designing public transport lanes. If the activity lanes and lanes are safe and attractive to pedestrians, cyclists and travelers, then public transportation will become more enjoyable and comfortable. There are many measures by which street spaces can be supported to be walkable. Locating retail stores, and serving stores and restaurants on public streets will help revitalize the street and encourage more activities. Interesting architectural interfaces can be added, and another important factor to encourage walking is to increase a sense of safety, as it is an important factor in choosing a mode of transportation.

The availability of climate-mitigating means along the street helps to protect pedestrians from wind, cold, high heat and sunlight. It can be provided by planting shade trees that provide protection from

the weather and contribute to an attractive pedestrian environment. The sidewalks should be wide enough to accommodate bus parking, pedestrian traffic, and an area adjacent to the buildings to allow for shopping. And facilitate access to all groups.

3.1.5. Distance site from urban centers. The limits of concentration and spread of the urban spatial structure can be clearly seen through the distance of the journey to obtain a specific service [29], as we find that the services are distributed within the urban structure in proportion to the importance of those services that they provide, so the higher its importance that service, we find that it takes our place more centrally, this, in turn, leads to an increase in population density within the limits of the services provided and shows a strong impact on the amount of trips by private car. Residents who live near the city center tend to use automatic means of travel to a lesser extent than residents of the periphery who have the same socio-economic characteristics, as shown in the figure (6) [30]. Thus, residents of areas far from the city center use public transportation more than residents who live near the city center [31].

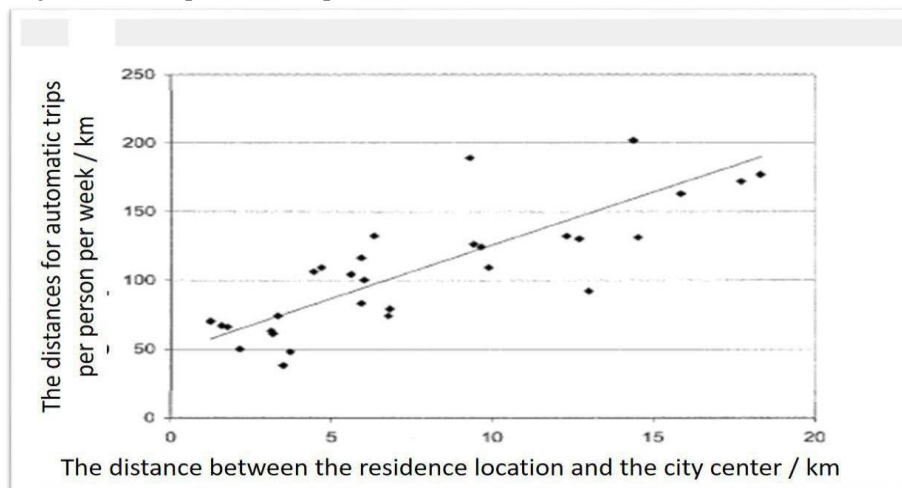


Figure 6. The relationship between the motorized trip and the distance from the city center.

4. Conclusion

According to the analysis of previous studies and the ideas put forward, the following conclusions were reached:

- Good and efficient public transportation supports high densities in development and thus greater diversification of uses and solidarity in development. It also reduces the need for land provided with additional services such as developing cities and other benefits resulting from density and increasing development, including protection of allocated agricultural lands and other uses, and the protection of environmentally sensitive areas.
- The urban patterns supported by public transportation are livable and more humane patterns. They do not address transportation problems, but rather prevent their occurrence in the first place, in addition to the aesthetic aspect that it provides to encourage people to walk.
- The factors of the urban form that have been dealt with affect in different ways the activation of public transport and increase the sustainability in cities in different ways, as density increases the number of public transport users, while the diversity in activities as well as its effect on public transport reduces the use of the private car, while the urban design helps to ease of movement and accessibility, so it is an excellent tool to help achieve sustainable development and improvement of the urban environment.

- The urban patterns promoted by public transportation lead to a compact city and smart growth and are in harmony with the ideas of new urbanization, these trends that verified at the end of the twentieth century and whose goal is sustainable urban development.
- Finally, it can be said that technological determinism through transportation has shaped cities towards expansion, as a result of dependence on private cars. But environmental determinism forces us to confront the control of the private car to enhance public transport to reshape cities towards sustainability after the environmental consideration has become a priority in planning.

Therefore, the research recommends the need to look at public transport not as a transportation service, but as an effective and powerful tool to direct the city towards sustainability, taking into account the reconsideration of the urban planning process, and government intervention must be effective through increasing investments and supporting public transport on the one hand. And the adoption of urban planning supported by public transportation.

Taking into account that land uses are designed in an integrated manner with the public transport system in general, to reduce mechanical movement, increase the contribution of public transport, and limit the use of private cars to a limited extent.

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