Achieving Sustainable Urban Transport in New Cities

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Abstract— The sector of transport is considered one of the most significant and effective sectors in states; as it comes at the top of the sectors supporting the economic and social structure of each and every state. At the economic level, transport constitutes the means necessary to connect the elements and areas of production with each other through transporting individuals, goods and raw materials. At the social level, transport systems are regarded as the social link connecting the individulas in societies particualry with the great urban sprawl of cities. As for the urban level, the transportat network in cities can be viewed as the arteries and veins by which the regions and sectors of such cities are nourished. Therefore, transport sector with all the activities thereof are thought to be a basic pillar of progress; taking into account the impossibility of achieving the balanced growth among sectors of national ecnomy of any state without securing the needs of transport sector. The transport sector plays a very crucial role, nevertheless there are severe damages resulting from it, such as congestion, traffic accidents and the accompanied environmental problems; audiovisual problems and air pollution. Transport sector seems to hold a great responsibility of greenhouse gas emissions. Thereupon, a lot of global cities have recently moved towards the sustainability of the urban transport sector; as they have started in determining methodologies for tackling with the problems related to the unsustainable transport. Meanwhile, they have also begun applying sustainability strategies and policies in designing and planning urban transport networks.

This research paper aims to reduce the negative consequences of transport sector and to develop a vision towards the method of transport and access to urban areas by setting policies promoting the use of sustainable transport patterns.

Key words: susutainable urban transport- land use- population density**-GIS.**

INTRODUCTION

Transport systems are thought to be an influential element of national economy; since they directly contribute in building socities and improving quality of life. Consequently, the countries are supposed to provide transport systems that guarantee social equality among generations, and that are suitable for all social levels. Besides, the urban transport plays a dominant and pivotal role in the lives of urban city dwellers; however the increasing growth in the use of private vehicles negatively affects all social, environmental and economic aspects, in the view of the fact that the development of traditional transport systems is confined to expanding the already-existing transport networks, or building roads to address the urgent current problems only. Therefore, a lot of global cities have recently moved towards the sustainability of the urban transport sector; as they have started in determining methodologies for tackling with the problems related to the unsustainable transport, while applying sustainability strategies and policies in designning and planning urban transport networks, such as moving towards the mixed land use in urban areas, reducing the dependence on fossil fuels, incresing the awareness - of cities' dwellers- of the necessity and significance of using sustainable transport and of the damages arising from the excessive use of private vehicles; and enhancing sustainable transport through providing effective and safe infrastructure which is well connected to the city center. Furthermore, the technological and information revolution, which the world currently witnesses, has changed a lot of administrative concepts; the thing that requires the existance of effective information systems which meet the information needs for the institutions of transport.

The research paper ends with a comprehensive draft of policies and measures which can be applied in Egypt to achieve successful management of the sustainable urban transport sector in new cities.

1. SUSTAINABLE URBAN TRANSPORT

Sustainable transport is the ideal solution to mitigate the negative impacts of transport; since it takes into conhsideration the principles of sustainable development.

1-1 REASONS BEYOND THE GLOBAL MOVE TOWARDS THE SUSTAINABLE URBAN TRANSPORT IN CITIES:

The urban transport plays a substantial role in the lives of urban city dwellers; however the excessive use of private vehicles negatively affects all social, environmental and economic aspects, in the view of the fact that the development of traditional transport systems is confined to expanding the already existing transport networks, or building roads to address the current urgent problems only.

Yet, the effective urban transport needs a kind of improvement and development which don't cause any negative impacts on economic, social and environmental levels of the cities. Hereby, there's a necessity in modifying the approaches and strategies followed in designing and planning transport

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networks for the sake of managing city traffic, supporting mass transit, biking and walking (1).

Thus, a lot of global cities have recently moved towards the sustainability of urban transport sector; as they have started in determining methodologies for tackling with the problems related to the unsustainable transport, accompanied with applying sustainability strategies and policies in designning and planning urban transport networks.

1-2 Role of the sustainability of urban transport in improving and developing the public life in cities:

Sustainable urban transport systems have a great effect on polarizing and focusing development on the various hubs of mobility and transport, the things which help in improving the quality of life in cities through increasing various activities around road hubs. Subsequently, that will help in solving the problem of congestion, and reducing the travel time by assimilating a large number of passengers in a single trip, along with the provision of comfort and safety to them.

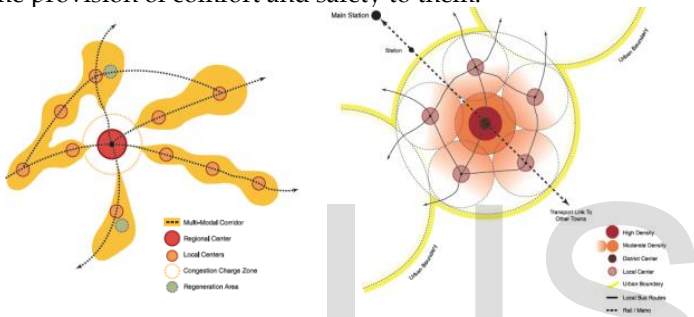

Figure (1): Development Focuses on Transport and Movement Hubs (2)

1-3 Concept of sustainable urban transport:

"Sustainable transport" refers to the mobility within patterns and mechaisim with low impact on the environment. It includes non-mechanical transport patterns such as walking and biking; and environmentally-friendly mass mechanical transport like directed transport, green vehicles and carpooling3. Moreover(3), The American Transportation Research Institute defined the sustaibable transport as the mobility for meeting the needs of development and daily requirements without affecting the quality of life of the future generations, and such kind of transport is supposed to be safe, healthy, inexpensive and specific in pollution production and the use of renewable and non-renewable resources. In other words, it's anticipated to meet the current daily needs without affecting the needs of the future generations.

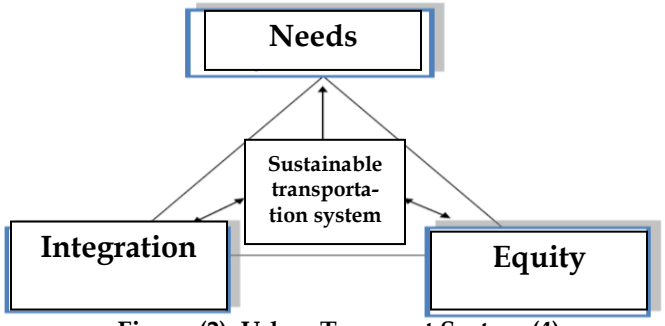

Figure (2): Urban Transport System (4)

1-4 Dimensions of sustainable urban transport:

The dimensions of transport are crystalized in the environmental, social, economic and urban areas(5), as shown in Figure (3).

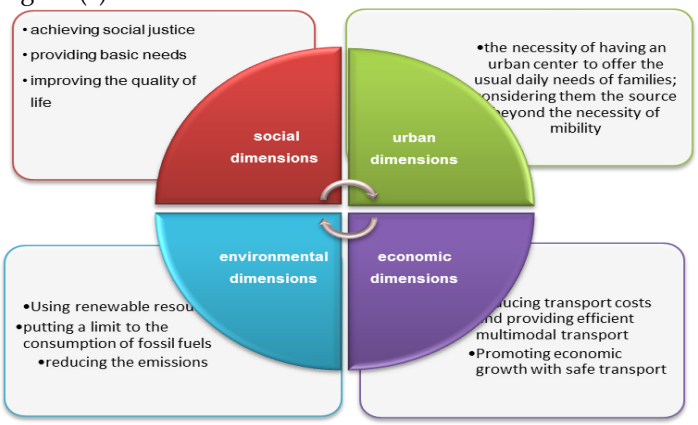

Figure (3) dimensions of sustainable urban transport- by researcher

1-5 Principles of the sustainability of urban transport

- **Achieving economic efficiency of transport**: by reducing transport costs, providing high-efficient and multimodal transport, reducing traffic congestion, along with the provision of a system of calculating the total costs, including costs in the long run, and the ability of the state and individuals to bear such costs. Opportunities and benefits which could be generated from reshaping transport systems should be taken into account (6).
- **Achieving social efficiency of transport:** by providing transport systems that boost creating attractive and lively urban communities, and a design that supports walking, biking and easy use of public transport; in addition to the provision of transport systems ensuring the realization of social justice among generations and all social classes.
- **Achieving environmental efficiency of transport**: by putting a limit to greenhouse gases emissions, reducing noise arising from traffic congestion, and decreasing fuel consumption for mobility.
- **Integrated planning of transport:** Both proper transport planning and building a comprehensive strategy depend on gathering information about the level of transport services currently available and the services expected to be provided in the future (7), in addition to the rate of population increase and the identification of transport networks, etc. Such process helps decision makers draw a plan including sustainable systems and integrative solutions not just temporary or partial ones.
- **Sustainability of the transport and mobility within the city:** by achieving street assimilation of people, vehicles and activities; and reaching a balance among different vehicles of transportation through executing separate paths for each kind; bearing in mind the el-

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derly and people with special needs (8). In addition, the pedestrians' walkability should be considered, which means the distance between stations should be moderate "not more than 500 m." Further, density and use sof land should be achieved for the purpose of less dependence on private vehicles. Ensuring the existance of parking lots shouldn't be neglected in order to avoid obstruction against pedestrians or cyclists.

- **Sustainability of pedestrians' paths:** by providing clean, safe and free of violations pedestrians' paths in favor of achieving continuity, communication and accessibility; without overlooking the standards of safety, security and the good linkage with various activities, commercial services, parking lots and transport stations. In addition to, a good linkage among reidential, commercial and entertaining zones - which are supposed to be well connected to public transport and pedestrians' paths- should be provided. Moreover, planning should support and enhance walkability and vibrant streets; and should achieve a mixed balance of different uses around neighborhood centers. It's also essential to pay attention to the provision of street furniture, proper views, appropriate lightening, protection of sunlight and designing adequate overpasses and underpasses with direct access with the other side of the street (9).
- **Sustainability of cycling networks:** by considering its width on the basis of the hierarchy of streets, traffic density and ensurance of safe transit. Plannig should also consider the linkage between cycling paths and public transport network, the continuity of safe cycling paths in crossroads, and liking such paths with commercial services and facilities without neglecting the implementation of bike parking lots in public transportation stations (10).

Sustainable transport is one of the most influential and related elements of the urban form of cities. **"Transport, mobility, land uses and density"** are significant urban elements of sustainable city infrastructure; since the activities shaping life in any city depend upon the transportation services; in order to create a linkage among these activities. Therefore, it's a must to study the principles of land use sustainability and the relation thereof with transport.

2-5 Principles of the Sustainability of Land Use and its Relation with Transport:

- **Basic uses and open areas**: Planning should achieve a balance between land uses, and providing local service and facilities in accordance with the requirement and needs of population; along with the provision of enough green areas in cities for the purpose of realizing the effective use of land(11), in addition to setting priorities for allocating land uses to raise the efficiency of activities.
- **Connectivity & Walkability:** It's crucial to create a good connection among residential, entertaining and commercial areas; and give them access to public transportation. It's also critical to achieve the integration of land uses and density to boost walking, biking and using public transportation. Planning should consider achieving the minimum of street and sidewalk width to realize different land uses(12).
- **Integration of land uses:** It's significant to achieve the integration vertically and horizontally among the fuctions at the level of the building, block or the neighborhood. The balance among the various and incresed uses shouldn't be neglected.
- **Possibility and ease of access:** This can be achieved by centrality within networks, reducing the number of intersections at each path(13), and using new techniques and developed transportation to save time and effort, and to give access to facilities and public transportation.

Population density is an influential element in sustainable urban planning; as it plays a part in achieving the sustainable urban transport; since the **high density promotes walking and public transportation**. The lesser the population density is, the more dependence on private cars will be; as a result, the pollution rates increase. Hence, the poputaion density is supposed to be 15000 persons per sq, km built/ 150 persons per hectare/ **61 persons per acre**.

Analysis of City Models Applying Strategies Promoting Sustainable Urban Transport

items	Abu Dhabi (United Arab of Emirates UAE)
vision	Sustainable planning in favor of achieving a less harmful transport system, of higher quality and lower costs
strategy	Establishing a global city and a global transport system supporting economy and competitiveness through providing an efficient and high-quality transport system for the mobility of passengers and goods(14).
Area "hectare"	
67,340 km2 (26000 mile2)(15)	
Population	
2,908,173 (2017)	
Population Density "persons per hectare" (High densities in cities promote the public transport system)	
140	
Genera Outline(16)	

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Study of Transport Sector in the City

1- Economic efficiency of transport:

A variety of means at reasonable prices are available, in addition to the use of Geographic Information System GIS to ensure that all citizens of the Emirate of Abu Dhabi benefit from the capabilities provided by the system, such as locating trips from the starting point to the ending one with clarification of time and cost(17).

2- Social efficiency of transport:

There's a provision of distinguished & high-efficient public transport systems for a large segment of people, including those with low, middle and high incomes, as well as tourists and businessmen through a price structure suitable for different groups.

3- Environmental efficiency of transport:

There's a significant reduction in the use of private vehicles and a trend towards public transportation with cleaner fuel, and the use of electric power transport.

4- **Transport and mobility within the city:**

Abu Dhabi design considered improving accessibility to all sites; which means that transport system fully serves the urban area through providing transport facilities. In other words, reaching any of these facilities can be in not more than 5 minutes on foot "about 300 meters". Public transport services were also geographically distributed in proportion to the population density(17).

5- Movement of pedestrians and cyclists:

Abu Dhabi provides for the pedestrians a significant network connecting residential areas, urban centers of high density and public transport stations. It provides as well a tree line separarting transports paths and pedestrians' ones and granting the feeling of protection. Besides, it has connected biking lines and roads together, along with the provision of parking lots for bicycles in public transportation stations.

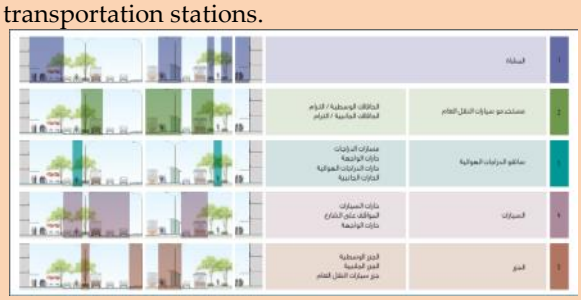

Figure (4):balance of all modes of transport
(17) Source
مجلس أبو ظبى للتخطيط العمراني " لمحة عن دليل تصميم الشوارع الحضرية – أبو ظبي " – إصدار .PDF 2016/1/1

Study of the sustainability of land use and its relation with transport

1- Main uses and open areas

The land use was planned by establishing two commercial centers, one in the capital district and the other in the Abu Dhabi Island Downtown area, as well as by providing shopping areas to meet daily needs. Plus, all services are linked to transport networks.

2- "Connectivity:"

All residential, entertaining and commercial areas were connected with each other, and linked to public transport, walkways and biking lanes(10).

3- Integration of land uses:

A vertical integration among land uses, residential areas and commercial centers was made(14).

4- Possibility and ease of access:

Services, central and commercial areas, and shopping areas were linked to a multimodal transport network, such as walking, bicycles and public transport of all kinds, accompanied with reducing the number of intersections.

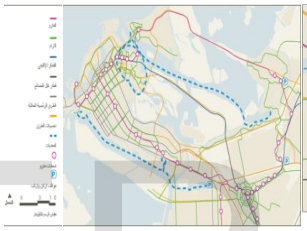

Figure (5):Multi-transport network.**Source**
https://www.econcil.ae/Publications/surface_transport_master_plan_ar.pdf/

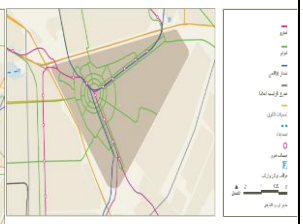

Figure (6):city centre and public transport link
Source
https://www.econcil.ae/Publications/surface_transport_master_plan_ar.pdf/

Lessons Learnt from the experience

- Integrating between both; land use planning and transport planning for the sake of achieving the maximum efficiency of the transport system, such as ease of access and changing people's behavior in mobility
- Using smart transport systems to inform drivers of spots with traffic congestions for avoiding them
- Following the design of compact urban communities of mixed uses to reduce the excessive use of private vehicles and to encourage multiple sustainable transport systems

In the theoretical part, I have viewed the motives beyond the global trend towards sustainable transport in cities, in addition to the concept of sustainable transport, its targets, perspectives and role in improving and developing the public life in cities. I have also viewed how urban transport sustainability can be achieved. Then, I have discussed methods and principles of the sustainability of land uses in an effort to achieve urban transport sustainability. On such basIs, I've analyzed Abu Dhabi experience that achieved successfully the implementation and effective management of urban transport.

In the following part, I'll analyze the current situation of the

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sustaibable uraban transport in El Shorouk City for the purpose of identifying the city problems and figuring out the best applicable solutions.

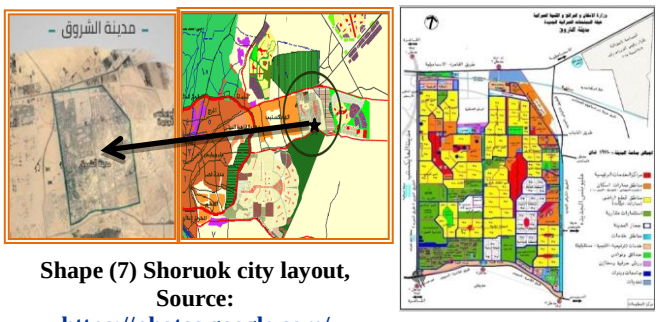
Urbanism and Planning of the City	
Country	**The Arab Republic of Egypt**
City	El Shorouk City (9)
Location	It lies at the northeast of Cairo, on Cairo-Ismailia Road at kilo 37 . Its width extends to the Cairo-Suez Road at a depth of 7 km, bordered to the east by Heliopolis. El Shorouk is one of the cities of the third generation which was established by the Presidential Devree **No. (326) of 1995.** The city consists of several residential neighborhoods covering all levels; from luxury and medium housing to above average and economic ones(18).
Area(18)	In accordance with the Presidential Decree No. **326 of 1995,** El Shorouk city was 10808 acres, but 5302,3 acres were added under the Cabinet Resolution No. **2119 of 2015**; making the total area 16110,3 acres. Resoultion No. **636 of 2017** was issued to increase the total cordon of the city to be **52991,83 acres.**
Population (19)	Current population (340 thousand persons) Targeted population by 2030 (estimated at 500 thousand persons)

A Brief on El Shorouk City

Residence (20): The residential are in El Shorouk is 6.9 thousand acres, divided into a number of neighborhoods, which include all levels of housing (luxury - above average - medium - economic).

The New Urban Communities Authority provides residential plots for individuals, investment companies and resorts. Moreover, pioneering projects such as the Future Society Housing Project, Mubarak Housing Project, Family Housing and Free Housing Projects, . ..etc also do.

The Authority also established 26,140 housing units, among them 13676 housing units for youth. As for the private sector, it established 25,147 housing units.



Shape (7) Shoruok city layout, Source: https://photos.google.com/

Services: The service activities cover 1500 acres; since the city urban planning provides plots for different services (health care- culture- education- religion- entertainment- commerce)

The most outstanding projects in the city:

In the educational sector (the British University- the French University- Shorouk Academy- the Open University)

In the entertaining sector (Green Hills Club- Heliopolis Club- the National Park- Shorouk Club)

1- Motives of choosing El Shorouk City

1- El Shorouk City was chosen as a study case for analysis with the aim of evaluating the city as a model for the new Egyptian cities, and to know how much compatible its urban transport system is with the principles of sustainability. This can be figured out by studying the outline and strategic planning, and the current situation.

2- The city road system has a proper hierarchy that provides accessibility and ease of transportation. Furthermore, the current road network scheme illustrates the integration of planning with the city road network, which promotes walking which is considered one of sustainable planning pillars. Sucsequently, that supports framing a sustaibale vision and strategy of the urban transport system in the city.

3- Currently, there is an interest by El Shorouk apparatus to keep pace with the global technological development in various fields.

4- The city transport system has been modernized by purchasing 20 buses with a cost estimated by 30 million Egyptian pounds. Each of the buses has the capacity of 26 passengers, and equipped by tracking system & WIFI.

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Study of Transport Sector in the City	Economic Efficiency of Transport	1	A new plan has been developed to restructure the tariff of public transportation buses in favor of reducing it. Thereupon, the ticket value has been linked to the number of the stations (granting an advantage to short trip passengers), while keeping the whole value for long trips (as currently applied L.E. 6) **<u>The plan proposed to be applied for El Shorouk bus lines(21):</u>** 1- Track (El Shorouk- El'asher bus stop- El Marg): - Ticket value of long distance L.E 7 (as currently applied), - Ticket value of middle-distance L.E 5 & - Ticket value of short distance L.E 3 (in stead of L.E 4 -currently applied) 2- Track (El Shorouk- El'asher bus stop- Rod Elfarag): - Ticket value of long-distance L.E 8 (as currently applied), - Ticket value of middle-distance L.E 5 & - Ticket value of short distance L.E 3 (in stead of L.E 4 -currently applied) 3- Track (El Shorouk- El'asher bus stop- Abulmon'em Riyadh bus stop): - Ticket value of long-distance L.E 8 (as currently applied), - Ticket value of middle-distance L.E 5 & - Ticket value of short distance L.E 3 (in stead of L.E 4 -currently applied).  **Shape (8): Offering public transportation in the city, Source: Captured by the Author.**

Study of Transport Sector in the City	Social Efficiency of Transport	0	<u>Walking</u>	At all the levels of the city, public transport systems were provided, howere they didn't plan for the bike lanes all over the city with the exception of the middle street. As for the pedestrians' paths, sidewalks with suitable width were provided on both sides of the road, yet most transport and pedestrians' paths were not separated with a tree line to give the feeling of protection from the nearby traffic. Further, both street design and transport service didn't take into account the elderly and people with special needs. Neverthless, all the city streets are currently being reformed in a way that will accommodate with people with special needs.  **Shape(9):Explains the city's public transportation routes**
		0	<u>cycling</u>	
		1	<u>Public Transportation</u>	
	Environmental efficiency of Transport	0	Using Public Transportation <u>with</u> cleaner fuel	 **Shape (10): 1st phase of the electric train, Source: Captured by the Author.** Right now, the electric train is being implemented in El Shorouk in two phases. The first phase includes the implementation of the northern platform and the administrative
		0	Using Electric Power Transportation	

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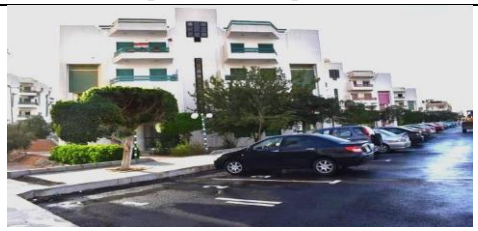
Study of Transport Sector in the City	Environmental efficiency of Transport	1	Reducing fuel consumption for mobility.	building, followed by the second phase including the implementation of the southern platform and a parking lot. The project is expected to be finished within a year and a half, starting from the date January 2020.
	Transport & Mobility Within the City	1	Street assimilation for people, vehicles and activities was achieved.	
		0	Separate paths for different means of sustainable transport weren't provided.	
		1	 **Shape (11): parking area availability, Source: Captured by the Author.** Enough parking lots were provided, so the mobility goes smoothly	
		0	On planning the locations of the stations, the pedestrians' walkability was not taken into account "500m."	
	Network of Pedestrians & Cyclists	1	Pedestrians' paths, that are clean, safe and free from any violation, were provided in order to achieve continuity, communication and accessibility.	
		0	Transport paths and walkways -in most of city streets - weren't separated by a tree line to give the feeling of protection from the near traffic.	
		1	Residential, entertaining and commercial areas were properly connected to each other; and all of such were linked to both public transport and pedestrians' paths.	
		1	 **Shape (12): hardscape and softscape availability Source: Captured by the Author.** There was a provision of street furniture, good views, appropriate lightening systems, and means of sun protection.	
		0	Except in the middle linking street, no bike lanes were designed.	

Study of the Sustainability of Land Use & its Relation with Transport	Main uses and Open areas	1	In accordance with the needs and requirements of population, the local services and facilities were provided.	 **Shape (13): green urban spaces availability, Source: Captured by the Author.**
		1	Enough green areas within the city were provided to ensure the effective use of lands.	
	Connection and Connectivity	1	Public transport successfully connected all residential, entertaining and commercial areas.	
		1	A special network for pedestrians -linked to public transport stations- was provided from residential areas to the urban centers of high density and shopping areas to meet the daily needs of the dwellers.	
	Integration of land uses	0	There was no integration among uses, residential areas and commercial centers.	
	Possibility and Ease of Access	1	A public transport network properly connected among services, central and commercial areas; and open areas	
		0	There was no use of technological and informatic techniques which provide trip time, duration, distance, cost…etc	

Having reviewd the abovementioned points in the study schedule of the current situation in El Shorouk City, some points of insufficiency have come up due to the following:

- On **street designing,** and providing transport services, **the elderly and people with special needs** weren't taken into account.
- There was clear negligence for designing **separate paths** for diverse **sustainable transport means**; such as walking, cycling and public transport; noting that such step is directly related to sustainable criteria.
- **Bike lanes weren't** palnned at the level of city streets (excepting the middle street). It's worth noting that such measure doesn't exist in the Egyptian legistations for building; however, that was implemented in some new cities, but wasn't approved by users because of the unorganized and unsafe design; subsequently, those lanes have been turned into car parking lots.

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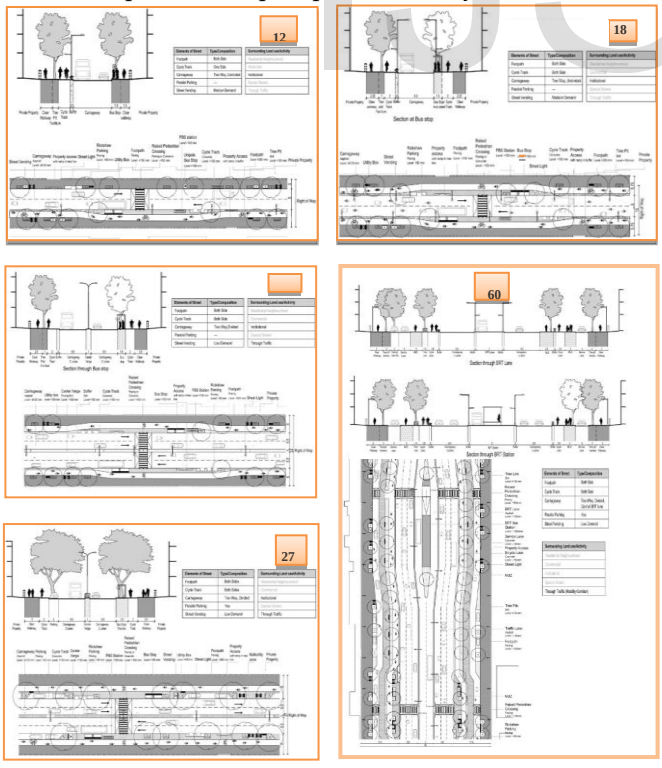
- Although sidewalks were built with proper width on both sides, most of transport paths and pedestrians' ones weren't separated with a tree line, depriving people from the feeling of protection from nearby traffic
- The current design overlooked the proper distribution of public transport stations.
- In spite of providing mass transit means, there was negligence of means of comfort – in both vehicles & stations. Additionally, there was no use of information technology which is supposed to offer basic information of the trip, spots of traffic congestions and other details that can encourage people to use public transportation.
- Till now, the population density targeted for the city hasn't been reached yet; which means, that will constitute a huge effect on achieving the sustainable dimension of planning; the thing that will have negative impacts on the transport system.

Therefore, the following proposal was put in place to avoid these shortcomings (This proposal is divided into three parts) and they are:

Infrastructure " Hard Ware "

❖ A proposal was made to design the different street sectors to achieve offers suitable for multiple sustainable transportation, including both pedestrian and public transport paths and bicycles.

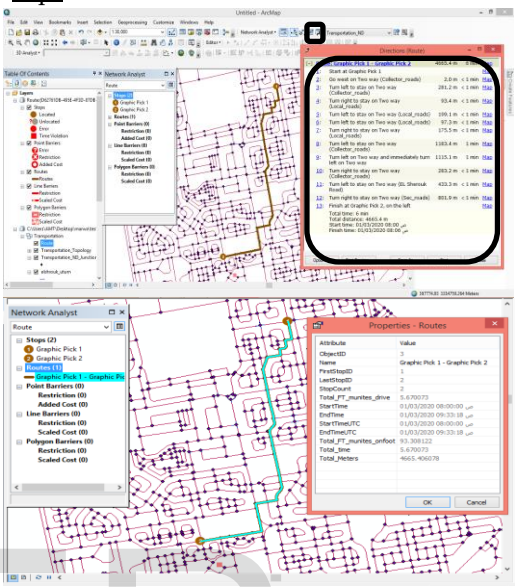


Shape(14): proposal for different road sectors.

Technology "Software"

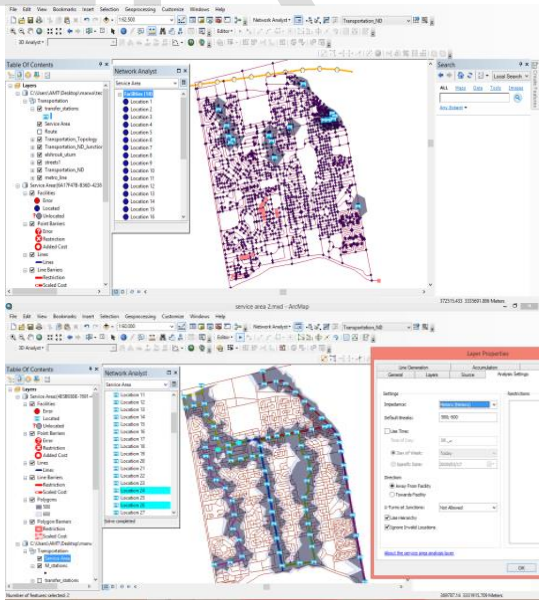
❖ **Using the (gis) program, you can analyze the city's traffic network:**

- **To reach the best route with the least time and distance possible "with a start and end date set for the trip"**



The shortest path between the two points is reached on the map, along with a report of the route directions and the start and end time of the trip in detail.

- **Calculation of service areas:**



Where you can know the range of services for public transport stations in the city and determine the area to be served on the map underserved areas, this helps decision-makers to solve various problems related to this service, so that all stations serve the public transportation path and the service range is 500 meters.

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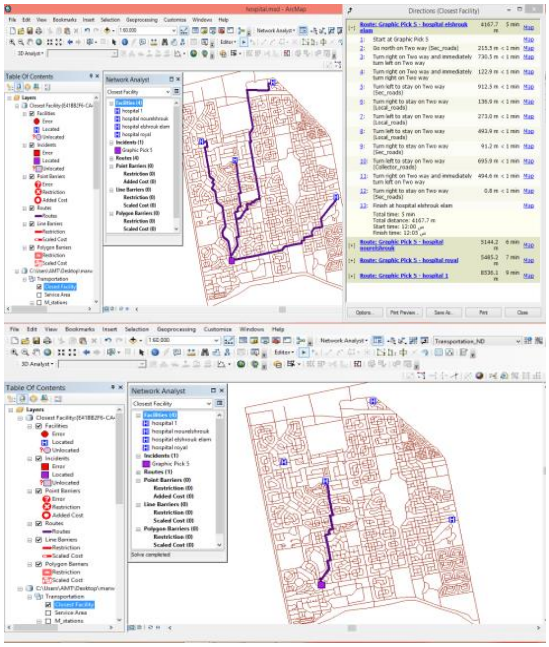
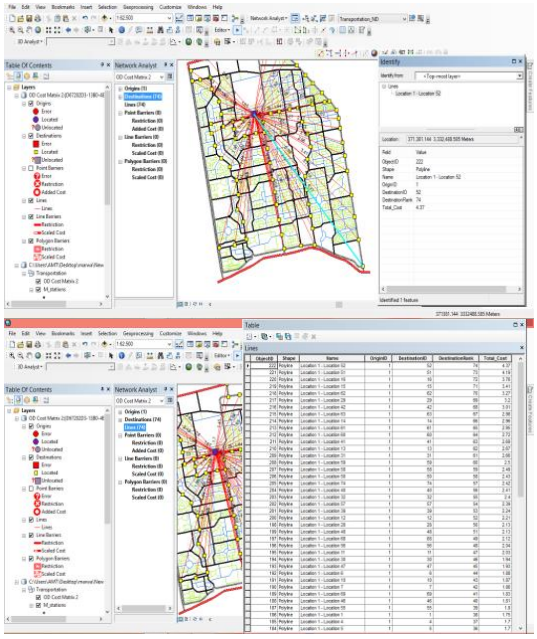
- **Get the best route to the closst service:**



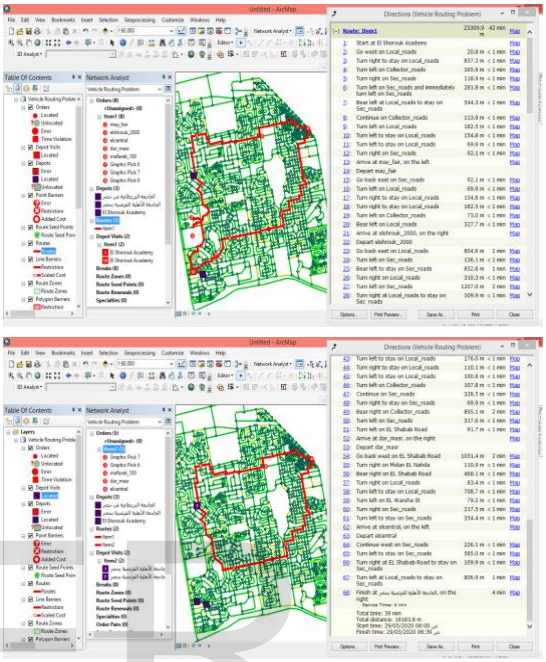
The access path to the nearest hospital is shown, It is also possible to control the number of proposed routes for more than one service point (hospitals), With a table showing directions for each path, with the shortest path in time and distance determined.

- **Create a schedule or matrix to determine the time, distance, and cost between each source and destination.**



It is possible to know the travel time, the traveled distance and the cost between the main station of public transport and the substations of the sustainable transportation system, and from it the exit cost matrix can be produced according to the places of distribution of the stations, "as they differ according to the distance and proximity of the substation to the main".

- **Vehicle Routing Problems:**



Among the advantages of this system: It reduces both "operating costs and fuel consumption". It was used to find the best way to connect students from Al Shorouk Academy, and the French University into a set of points (Students' riding stations near their homes) It is also possible to know the directions of traffic with the calculation of the total time and the total distance taken from the beginning of the journey to the end of it.

Human Ware (Institutions)

- Integration between land use planning transport planning to maximize the efficiency of the transportation system like ease of access and changing the behavior of people on the move.
- Create an attractive urban environment for walking and cycling.
- Use smart transportation systems to notify drivers of traffic jams to avoid them.
- The necessity of providing public transportation for people with special needs and the elderly by providing elevators for wheelchairs and low transport vehicles, while providing seats for the elderly and other facilities to facilitate accessibility.

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- The need to improve the ease of access to all places, so that the transportation system serves the entire urban area, by providing public transportation facilities so that one of the facilities can be reached within a time of no more than nine minutes on foot, i.e. about 500 meters.

Results:

- It's significant to integrate the land uses, considering that a basic means for achieving the sustainable development and less independence on private vehicles. Mixed uses promte less planning for the transport needs.
- Management transportation demand is achieved by integrating the urban transport planning with land uses, and by pricing policies
- Transport, mobility, land uses and density are influential urban elements of the infrastructure of the sustainable city.
- The excessive use of private vehicles negatively affects all the social, environmental and economic aspects.
- Sustainable urban transport systems greatly affect on polarizing and focusing the development on diverse mobility and transport hubs.
- High density promotes the principles of walking, cycling and public transport.
- Abu Dhabi has re-drawn the future of public transport in the world; through introducing a new concept of integration among entertainment, transport efficiency and various services around centers; and through mixed land uses. All that combined to shed lights on the city as one of the most poneering tourist cities around the world. That was – in the first place- achieved by developing a comprehensive urban plan, with the cooperation of an international urban planning team, included the international elite of distinguished experts.
- Analyzing the current situation of urban transport system in El Shorouk, some problemscam up to the surface:

- The population density hasn't reached yet to the target.
- Integration between uses, and residential and commercial areas was overlooked.
- With the exception of the middle linking street, bike lanes weren't a part of design of the city.
- While planning station locations, pedestrians' walkability wasn't considered. "500 m."
- Separated paths for each kind of sustainable transport-like walking, cycling and public transport) were disregarded.

- **Therefore, the following proposal was developed to address these deficiencies:** to take advantage of the city's large streets, a proposal was developed to redesign the various street sectors to offer sustainable multiple transport. Technology applications and smart systems, such as computing, communications, control, and electronics, have been used to confront many of the challenges and problems facing urban transport. Gis have been used to find the best and fastest way to travel from one location to another, as well as to determine the range of services of the city's public transport stations, map user areas, and unserved areas, which help decision makers solve various problems related to this service. The best route to the nearest service has been identified as all service informations has been provided, such as access to the nearest hospital at a given accident site and other services. In additional to this, A matrix has been created to determine the time, distance and cost between each source and destination. A range of vehicles were rerouted to deliver a particular service in the best possible way and at the least time as the best route was found to connect students from the British university, the shorouk academy, and the French university to a number of points (the student riding stations near their homes).

Recommendations at different levels:

- **At the environmental development level:**
  - Moving towards the application of sustainability principle in managing reources
  - Controlling environment quality at all levels in the city; e.g. air, noise and green areas.
  - Providing green and open areas, and connecting them with sidewalks
  - Promoting the use of public transpotation, walking and cycling in view of reducing the use of private vehicles, the issue that will lead to eliminating gas emissions resulting from the excessive use of private vehicles
- **At the infrastructural level (upgrading the infrastructure level to achieve sustainability):**
  - Implementing separated paths for diverse means of sustainable transportation "public transport- cycling-walking"; accompanied with achieving the minimum width of each path
  - Achieving safety and security in the bike lanes and crossroads
  - The necessity of providing clean and safe pedestrians' paths to guarantee continuity, communicaton and easy access, while implementing a tree line between vehicles

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roads and pedestrians' paths; as long as it provides the feeling of protection and enhances walking.

- **At the transport level: (developing sustainable transport to create a system that could meet the current and expected mobility requirements)**
  - It's important to develop all the elements of road network and transport facilities in the city.
  - The diversity of the options of sustainable transport is a central point. Such can be realized by providng alternatives of transport for all social groups through developing public transportation system in the city and improving the environment of cycling and walking.
  - It's greatly advisable to use wide streets in the city in redesigning the different street sections to have the peoper width for the various sustainable transport means.
  - Setting the required standards to achieve balance between urban activities and land uses to shorten mobility distances and lessen the number of trips
- **At the governmental and institutional level:**
  - It's very essential to set pricing policies for the purpose of enhancing public transportation, to apply reasonable tariffs for low-income segments in order to achieve social justice for such segments, and to activate e-payments by smart cards.
  - It's necessary to provide high-efficient, air-conditioned and safe buses for passengers, in addition to supplying the stations with air conditioners to afford suitable waiting environment; along with the use of smart information systems to provide the trip basic details; duration, cost & track.
  - It's a priority to have places for renting bikes near main public transport crossroads, in order to ease moving to areas of high activity density; and access to the nearest public transport station. Such could be achieved through the availability of bike stations and parking lots in certain points.
  - It's advisable to follow the designing patterns of integrated urban communities of mixed uses to eliminate the excessive use of private vehicles and to encourage several sustainable transport systems.
  - It's crucial for the institutions in new cities to seek to offer the ideal solutions whether on the level of administrative and technological systems, or on the level of the developmemt of services. In addition, they should pay attention to the improvement and development of infrastructure to achieve the optimum efficiency of transport system; such as easy access and changing people's behavior in dealing with mobility.

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