American Journal of Environmental Protection
2015; 4(1): 1-16
Published online January 12, 2015 (http://www.sciencepublishinggroup.com/j/ajep)
doi: 10.11648/j.ajep.20150401.11
ISSN: 2328-5680 (Print); ISSN: 2328-5699 (Online)

A sustainable planning approach to resolving transportation hub problems in Egyptian cities “proposed measurement matrix”

Waleed Hussein Ali Hussein

Department of Architectural Engineering, Faculty of Engineering, Fayoum University, Fayoum, Egypt

Email address:
Waleed.a.hussien@gmail.com

To cite this article:
Waleed Hussein Ali Hussein. A Sustainable Planning Approach to Resolving Transportation Hub Problems in Egyptian Cities “Proposed Measurement Matrix”. *American Journal of Environmental Protection.* Vol. 4, No. 1, 2015, pp. 1-16. doi: 10.11648/j.ajep.20150401.11

Abstract: The research study discusses the environmental aspects of automated and pedestrian transport that need to be addressed when devising general and detailed urban plans, particularly for new urban conglomerations. It describes the adverse effects resulting from motor vehicles dominating roads and highways, including environmental hazards such as air and noise pollution, and identifies environmental concerns to be taken into account in the planning of automated and pedestrian traffic routes and parking spaces and underlines the need for upgrading transport and traffic policies in new urban conglomerates. The study focuses on environmental issues that can be resolved through the application of laws, policies and implementation mechanisms. It also identifies environmental considerations that should be included in all general urbanization plans, pointing out that the review of these issues by environment experts (before and during plan implementation) is a key developmental approach to resolving transportation hub problems in Egypt. In addition, the study presents an account of the components and basic principles of transportation hub design and the international criteria used in assessing the sustainability of transport routes. Local and international examples of sustainable transportation hubs are used as a reference to help in formulating the principal findings and conclusions that constitute the developmental approach to resolving this problem.

Keywords: Sustainable Planning, Road Networks, Pedestrian Traffic Hubs, Environmental Pollution, Traffic Hubs, Urban Development, Sustainable Development

1. Research Problem

The research problem concerns the obvious shortcomings in the development and resolution of transportation hub problems in Egypt, which necessitate the intensification of efforts and the use of analytical methods aimed at developing and upgrading this important component of urban planning for Egyptian cities.

2. Research Objective

The aim of this study is to formulate a developmental approach designed to reduce the adverse environmental effects (air and noise pollution) of transportation hubs, to identify the environmental aspects of transportation hub design and to benefit from international examples already in place, without losing sight of the aesthetic dimension.

3. Introduction Urban Transportation

Transportation and road networks today constitute a large part of any city’s area and vital facilities and they are the lifeline that provides it with the means for living. Additionally, the style and form of a city’s road network contribute to the shaping of its morphological identity.

The various components of a city’s transport sector account for approximately 32% of its total area. In Canada, the transport sector constitutes 37% of the country’s total inhabited area and, according to researcher Murphy’s estimation; the transport sector in the United States comprises 34% of the total area of the country’s cities1.

Pederson found that, on average, highways take up 15% to 20% of a city’s area and other transport facilities, including

1 Dr. Zein El Abedeen Ali, *Mabade’ takhteet al naql al 7adary*, p.30.

ports and airports, account for a further 5%2.

Figure 1. *High way Roads*

Source: www .ar.wikipedia.org/wiki,2011

4. Transport and Traffic Sector Problems in Egypt

4.1. Road Accidents

Accidents are among the traffic problems that affect human lives the most. The accident incidence rate increases with the growth of urbanization generally. In addition to environmental factors such as rain, wind and storms, road accidents are often the result of a disregard for traffic rules and regulations. Preventing road accidents completely is impossible, but sensible planning can certainly go a long way towards reducing their number and alleviating their gravity.

4.2. Congestion

Figure 2. *Traffic congestion in Eastern Cities.*

Source: www .ar.wikipedia.org/wiki,2010

Traffic congestion is the most widespread urban transport problem in Arab cities, especially during the peak hours of the day when people are going to work or heading home. In most cases, congestion is caused by the low absorptive capacity of road networks and by inadequate transportation systems that do not meet the needs of the size of traffic in the cities. During peak hours, travel speed often falls to 4 – 5 km / hour, leading to an extensive waste of time and energy. Long hours spent on congested roads also affect people emotionally, creating mental pressure that affects how they function at work and at home.

4.3. Respect for Traffic Rules

Traffic violations are a principal cause of the problems discussed in this paper. In addition to their social, psychological, educational and cultural connotations, they are one of the gauges that measure the behavior of motorists driving private and public vehicles.

4.4. Noise Pollution

Traffic sounds (automobile horns, braking, wheel friction etc) are a source of disturbance to building residents, people using public facilities and pedestrians on the roads, putting them under considerable mental strain.

4.5. Air Pollution

Traffic-related air pollution is one of the greatest environmental challenges of transportation in Arab cities. Air pollution increases with the increase of fuel (all varieties) combustion in all vehicle types and is very high because of the congested traffic conditions and low speeds mentioned above. This is the case particularly in densely populated urban areas, where large numbers of people are affected by high levels of traffic-related air pollution within a short time period - a very serious threat to public health and the environment.

"In his book on the relation between urbanization and the development of transport services, Dr. HaydarKamouna identifies some of the most important measures that should be taken to minimize transport and traffic problems in Arab cities"

Further research and additional field studies on the transport sector to obtain the information on actual urban developments in cities, (changes in population density and road accident statistics etc) required for planning3.

5. Factors and Variables Affecting Urban Transportation

Research on urban transportation and traffic planning reveals that many urban elements affect the generation of traffic mobility, and the transportation sector as a whole. In addition to factors related to land use in urban areas, these include urban development factors (horizontal extension of urbanization and the increased urban density in some areas or cities resulting from vertical construction expansion). Other elements that affect the transportation sector are related to the type of traffic (whether traffic is internal or external, locally generated or passing through), and its relationship to urban road network patterns, their absorptive capacity, and how effectively they meet existing traffic needs. The existence or absence of sufficient parking space in urban districts,

2 Pederson, E. O., *Transportation in Cities*, Pergamon Press, 1980, p. 14.

3 Dr. Haydar Kamouna, Al 3elaqa bayn al ta7adur watatawor al khadamat – A study published on the Magalet al 3ooloom al 'egtema3eya Forum

particularly in central areas, is another important factor.

All the above factors, however, are influenced by certain important variables that have the most impact on daily traffic mobility generation.

5.1. Population Growth

Population size is an important variable in the statistical analysis of transportation and traffic, and is one of the factors that influence total daily traffic mobility. The population factor is more dynamic than all the other variables, because there is a direct correlation between the number and density of an area's inhabitants and the number of road trips per day in that area. Furthermore, urban transport studies show a clear correlation between increases in the number of family members and increases in the number of road trips, finding that daily trips increase at the rate of 0.8 daily trips per additional family member. Studies also reveal that the number of road trips increases with the increase of the number of employed members in a single family4.

5.2. Family's Average Monthly Income

A relation exists between the socio-economic traits of a population and traffic movement in general. Most transport-related urban planning studies underline the correlation between a family's average monthly income and the number of road trips per day of its members. This is because the higher a family's income is, the greater its purchasing power and the more varied its needs; a greater of number of trips are required to satisfy family needs.

5.3. Vehicle Ownership

There is a marked increase in the use of private vehicles today. The ownership of private vehicles is one of the important factors affecting the generation of daily trips. It contributes to traffic congestion on urban roads and is the cause of many road accidents. In most countries, the per capita share of private vehicle ownership has increased. In Iraq, for example, statistics show that private automobile ownership rose from five vehicles for every 1000 persons in 1970 to 82 vehicles for every 1000 persons in 1995 (35 vehicles per 1000 persons in Baghdad in 1980). In Cairo, the ratio was 25 privately owned vehicles for every 1000 persons in 1980, a proportion that has almost doubled today. Private vehicle ownership is one of the indicators used in estimating future urban transport demand5.

5.4. Energy and Transportation

Energy consumption is a necessity of socio-economic development. Transport (the sector that consumes the most energy) constitutes one of the major challenges facing sustainable development because it is a source of pollution that is harmful to both the environment (at global, regional and local levels) and to human health. This dilemma has long baffled countries across the globe. The two principal challenges that face the transport and energy sectors are to insure a more widespread use of cleaner fuels and to convert existing modes of transport into cleaner and more efficient ones.

At the World Summit on Sustainable Development, the nations of the world agreed on the need for increased access to affordable energy resources. They decided to work towards enhancing energy efficiency, promoting the use of renewable energy resources, implementing advanced, cleaner, energy technologies, applying transport strategies that support sustainable development, limiting environmentally harmful energy subsidization policies and encouraging the use of cleaner fuels6.

Urban planning techniques, or methods, are among the most important factors affecting the urban transport system and the volume of its energy consumption. European urban plans are based on transport systems that depend largely on railway networks and urban developments concentrated around city centers, whereas urban plans in the U.S. depend on wide highways and horizontal urbanization.The planning of most U.S. cities makes automobiles indispensable to the life of their inhabitants, and these cities grow and expand horizontally for tens of miles.

A recent study by Dr. Edward Klisser of Harvard University found that only 22% of the inhabitants of the largest U.S. cities live within a three-mile radius from the city center (the principal commercial and industrial area), and almost 80% at distances of up to 30 miles outside the city borders. Obviously, this leads to a high rate of energy consumption.

In Europe, on the other hand, one can finish a day's work in Geneva, Switzerland and arrive in central Paris, France less than two hours later, getting off the train before the doorstep of the place of destination (hotel or company etc). This is because most European cities depend on a model rail network that connects all European city centers.

Some Arab countries, such as the U.A.E., Bahrain, Kuwait and Oman, have adopted the British urban planning system of narrow, winding roads but disregarded the most important factor; railway networks. As a result, these countries suffer from the narrow roads and vehicle parking shortages of the European urban planning system and are now moving towards the broad highways of the U.S. urban planning system. This is a noticeable tendency in the Arab world today. Note Dubai's initiative of building the first metro line in the Arab Gulf, which came into service in September 2009, and the adoption of the 2030 maritime transport plan in Abu Dhabi, which features the simultaneous construction of metro, tramway and railway lines. The above reveals the close relation between resolving energy problems, the control of a city's growth rate and public transport solutions (such as railway networks connecting large cities and ports)7.

4 Dr. Zein El Abedeen Ali, Mabade' takhteet al naql al 7adary, pp 82 - 84

5 Ibid.

6 World Summit on Sustainable Development (WSSD) publications – Johannesburg, South Africa, 26 August to 4 September 2002

7 Dr. Abdallah Ibrahim Al Fayez, *Takhteet al modon wa moshkelat al e3temad 3ala al taqasharl abodminho; Hansen, C.J. (2011) The role of policy-making and planning cultures for sustainable transport?. European Transport, 47 (2011), 89-108.*

Figure 3. *Train station in eastern cities*

Source: Green Transportation - powered by Feed Burner_files-O'flanerty, CA.: Highway Traffic,2009

6. Environmental Aspects of Traffic Mobility in the Thinking of the Pioneers of Urban Planning

Whereas the eighteenth century witnessed rapid progress and successful achievements in the manufacturing and construction sectors, the nineteenth century is characterized by the development and upgrading of scientific processes, sensible planning, economic reconstruction and the increase of population migration from rural to urban areas. This led to:

- Poor technical and architectural building specifications
- Inadequate infrastructure network planning
- Air, water and soil pollution

These factors led to the rise of a new generation of thinkers, writers, architects and other leading scholars whose objective was to re-plan and re-shape the modern city as follows:

Table 1. *Environmental Aspects of Traffic Mobility in the Thinking of the Pioneers of Urban Planning.*

Points of Comparison:	**Frank Lloyd Wright The Decentralized, Organic City**	**Le Corbusier1887 – 1965 The Raised City**	**Toni Garnier1909 The Industrial City8**	**Ebenezer Howard1889 The Garden City9**
Main Site:	A decentralized city integrated into the natural (organic) environment, where buildings are separated by large spaces and automobiles are needed to connect them. Decentralized services are spread across the surrounding countryside.	A city of high, geometrically-shaped buildings, surrounded by vast open spaces	Natural topography has a strong influence on the main site. City orientation depends on the direction of the wind - separation of industrial and residential areas	A ring road (beyond which is a greenbelt to cut back future urban spread) surrounds the city. Factories and warehouses are located beyond the ring road and farmland and pastures surround the city.
Roads:	Automobiles are used to connect the various parts of the city. There is no city center; public services are spread across the city.	A network of freeways (longitudinal design) ensures travel speed	Road orientation allows for the penetration of sun and air into homes	A railway line, bordered by gardens, surrounds the city. To reduce pollution, a large square separates residential areas from industrial zones.
City Center:	There is no city center. The city is not designed on a scale and land use is not planned. The size of public utility buildings is kept to a minimum to facilitate their distribution across the city, and long distances separate different elements of the city, and automobiles are the principal means of transportations.	City center of medium density –Road traffic speed promotes distances between public utility buildings	Topographic factors are used to separate the city center from industrial zones. Climate conditions affect the orientation of city elements.	Public utility buildings are located in the city center, surrounded by green spaces – a compact, mixed-use city
Mobility & Transportation:	Dependence on automobiles to link buildings and various services leads to long travel distances, resulting in a waste of time and energy on in-city transport.	Freeway network based on a longitudinal geometric pattern for automobile travel – Dependence on automobiles creates numerous environmental problems, from the use of green spaces to build roads, to air pollution, waste of energy resources, traffic congestion and a high incidence of road accidents	The plan depends chiefly on the railway line as a means of transport and travel. The railway passes between the industrial zone and the city.	Because the 'Garden City' plan was drawn up before the spread of automobiles as a means of transport and travel, the main plan depends on the railway as an ideal solution for pre-automobile industrial cities.
Energy Conservation:	Dependence on automobiles to connect different elements of the city led to wasting energy resources on roads and	Dependence on automobiles as a means of transport led to a considerable waste of energy resources.	The use of railway lines conserves energy resources.	Dependence on railway lines reduces energy consumption.

8 Catanese, Anthony J. & James C. Snyder, Introduction to Urban Planning, McGraw - Hill Book Company - New York, 1986

9 Burtenshaw, D. and Batenman, M. and Ashworth, G. J., *The City in The West Europe* - John Wiley & sons, UK, 1981

Points of Comparison:	Frank Lloyd Wright The Decentralized, Organic City	Le Corbusier1887 – 1965 The Raised City	Toni Garnier1909 The Industrial City8	Ebenezer Howard1889 The Garden City9
	transportation.			
Reducing Pollution:	Dependence on automobiles contributed to raising air pollution levels in cities.	Abundant use of automobiles raised the level of air pollution in cities.	Isolation of the industrial zone in the south at a lower land level limits the spread of air pollution in cities. Environmental home designs provide a healthy environment for inhabitants.	Positioning the industrial zone in a region separate from the residential area, and surrounding it with a greenbelt helped to minimize air pollution levels in cities; the urban greenbelt is considered the city's lungs.

Source: Catanese, Anthony J. & James C. Snyder, Introduction to Urban Planning: 1986, McGraw- Hill Book Company - New York

7. Environmental Considerations in the Planning of Motor Vehicle Travel Routes

- Choice of road type and network integration
- The role of laws and regulations in upgrading road environment

7.1. Choice of Road Type and Network Integration

The following considerations should be taken into consideration when selecting a model road network system as part of the overall plan:

- Prior to selecting the appropriate road network pattern or model, the primary function of the traffic hub and the secondary road functions must be identified, and the planners must have a correct estimation of the anticipated road traffic density of traffic. This will lead to the selection of the appropriate design and avoid future traffic congestion problems.
- Various types of road networks should complement one another. For example, automobile road networks do not do away with the need for pedestrian and cycling routes; indeed, neglecting to design pedestrian networks leads to increased pressure on automobile networks, multiplying the chances of road accidents and raising pollution levels.
- Sensible planning of secondary road functions, such as temporary parking space, pedestrian crossings and car parks. These should be the object of separate plans that are revised periodically.
- Public transport routes (railway lines, public busses etc) must be provided. Service stations and passenger waiting areas should be delineated in conjunction with the planning of traffic hubs or roads.

Table 2. *Types of Roads and Traffic Hubs and their Environmental Effects.*

Type of Road	Advantages	Environmental Problems	Solutions (if available)
Radial Roads	Link city centers to suburbs and constitute a major population attraction factor	The need for ring road and highway junctions; the insufficient number of these junctions leads to traffic congestion and higher pollution levels.	Building free ring roads to spread traffic flow around cities or city centers
Ring Roads	Considered an integral part of the radial road network – Despite being the longest road type, they reduce travel time, since most trips are outside of crowded cities and need not pass through city centers, thus avoiding highly congested roads	There are no environmental problems, except that the length of the road may necessitate additional lighting after dark as well as telephone and other services, while not encroaching upon ecological areas of a special nature.	
Gridiron Roads	Promote the homogeneousness of city and suburb traffic travelling over the network as a whole – The possibility of providing one-way lanes with a parallel lane in the opposite direction –Bridges and / or tunnels can be used as crossings	Gridiron road systems can result in very long roads that may lead to excessive speed and result in road accidents	Effective traffic management and speed control policies
Linear Pattern	Economic considerations may necessitate the use if this pattern in certain geographical locations	Traffic flows into a major linear road used for both inner city and outer city travel, resulting in a city that is divided in two and a high rate of traffic congestion	Building roads parallel to the principal linear road to spread traffic among the different roads

Source: Stones, Tabor R.: *Beyond the Automobile* - Prentice Hall, Inc., N. J., 1992; Commonwealth of Australia. (2011).Our Cities, Our Future: A national urban policy for a productive, sustainable and livable future. Canberra: Department of Infrastructure and Transport.

7.2. The Role of Laws and Regulations in Upgrading Road Environment

Laws and regulations play a leading role in influencing environmental considerations during the planning of traffic routes:

- They shape the environmental policies in cities and minimize negative environmental impact. By controlling speed limits, traffic laws and regulation promote safety and lower the incidence of road accidents, while laws prohibiting excessive use of automobile horns reduce noise pollution.
- Road management regulations establish stipulations, such prohibiting lorries inside cities and restricting their passage to perimeter roads outside city limits, or closing off certain roads to traffic and designating them for pedestrian use.
- To ensure that the road safety conditions are met, traffic laws set specific speed limits for vehicles travelling on bridges, through tunnels or in residential areas.

8. Environmental Considerations in the Planning of Automobile Parking Spaces

The planning of parking space is a key element of the transportation system, particularly in light of the huge increase in the number of automobiles in a city and the numerous environmental consequences, such as:

- Obstruction of automobile traffic flow on the roads
- Obstruction of pedestrian passage in front of building entrances
- The takeover of public squares, playgrounds and green spaces for use as parking space
- Increased air pollution from exhaust emitted when starting up the engines of parked vehicles
- Distortion of cities' aesthetic value (visual pollution)

Negative Environmental Impact of the High Number of Automobile Parking Spaces in New Cities:

- Loss of public spaces, squares and social meeting places that have been converted into parking space (a single automobile takes up $20m^2$ to 30 m^2 of parking space)
- Air and noise pollution: fuel combustion when starting up engines emits exhaust gas and is also noisy
- Blocking the entrances and disfiguring the facades of buildings: lines of parked cars in front of commercial outlet, public and private building entrances mar the city's appearance and increase traffic density in road lanes, resulting in crowded roads that do not perform their function.
- Impeding the passage of vehicles: sometimes, lines of parked vehicles in narrow side streets impede the passage of automobiles, which causes traffic problems and slows down mobility on the main roads into which these side streets lead
- Preoccupation with automobile-related problems led to the neglect of public transport development programs, resulting in increased dependence on automobiles and the environmental problems caused by them, at the expense of developing public transport needs, such as special public transport routes and adequate numbers of passenger waiting spots.

Table 3. *Methods Used to Provide Automobile Parking Space10.*

Method	Advantages	Environmental Problems
Grouped garages:	Accommodate large numbers of cars - free road space - creation of green spaces - city beautification	Crowding of garage entrances and roads when vehicles enter or leave grouped garages during rush hours
Parking space located in suburb & outlying areas:	This method entails leaving automobiles in parking spaces located on the outer perimeters of congested conglomerates and riding public transport from the stops surrounding the parking area. This is a partial solution to the problem of parking in crowded cities. It also promotes the use of public transport as a means of circulation.	None
Organizing on-road parking:		
Parking on narrow roads:		
One-way road:	Road must be at least 4 meters wide	Double parking may bring traffic flow on the road to a standstill
Two-way road:	Road must be at least 5.75 meters wide	
Building, garden and other entrances:	Parking in front of public and private service buildings is prohibited	Blocking the entrances and exits of public and private service buildings creates social problems
Pedestrian crossings:	Cars may not park on pedestrian crossings (which should be at least 8 meters wide)	Non-observance of traffic rules causes panic and confusion among pedestrians and endangers their lives
Bridges and tunnels:		Bridges and tunnels were designed to resolve traffic problems. Parking is only allowed in cases of emergency, such as sudden breakdowns or collisions
Special locations (hospital emergency centers, fire stations, bus stops etc)	Parking in front of bus stops, fire stations and hospital emergency centers is forbidden.	Inhibits the functioning of public services

Source: O'flanerty, C. A.: Highway Traffic Planning and Engineering, Volume 1; Commonwealth of Australia. (2011).Our Cities, Our Future: A national urban policy for a productive, sustainable and livable future.

10 O'flanerty, C. A.: *Highway Traffic Planning and Engineering*, Volume 1 - University of Leeds, UK

Canberra: Department of Infrastructure and Transport

Figure 4. *Parking types and spaces*

Source: http://en.wikipedia.org/wiki/Sustainable_transport, 2013

9. Environmental Considerations in the Planning of Pedestrian Traffic

The pedestrian traffic planning stage is a key element of a city's road and transport system. To identify the environmental problems related to this issue, we must first shed light on the issue of pedestrian traffic.

9.1. Pedestrian Paths

This is the place reserved for pedestrians on motorway sidewalks; paths reserved only for pedestrians where there are no trees, overhangs, pillars or dangerous obstructions. They should be fit for use by pedestrians as well as by the physically impaired. Pedestrian paths (sidewalks) must be at least 1.525 meters (60 inches) wide, to allow two people to walk side by side. Depending on population density, sidewalks in commercial sectors and similar places may be wider11.

Figure 5. *Pedstrian Paths.*

Source: http://en.wikipedia.org/wiki/Sustainable_transport, 2013

11 Daleel tasmeem al toroq – ketab tasmeem al toroq, 1-2, 2-2 (Ministry of Transport);Low, N. (2011).Australian Cities, Transport Integration and the Global Dilemma of Mobility. Retrieved April 2, 2012, from State of Australian Cities 2011: http://soac2011.com.au/full-papers-list.php

9.2. Pedestrian Problem

Beginning in the 1960's, and due to the enormous increase in the number of automobiles, conditions in cities (particularly for pedestrians and public transport passengers) began to deteriorate. This period witnessed an absence of:

Policies aimed at protecting pedestrians and cyclists

Construction of bridges and tunnels for pedestrian crossing of motorways

Investments in the development and upgrading of public transport systems

Policies aiming at encouraging the use of public transport over automobiles in congested areas

Figure 6. *Bike Lane.*

Source : http://en.wikipedia.org/wiki/Sustainable_transport, 2012

Some Proposed Solutions to the Pedestrian Problem:

- Converting one of the streets in the city center into a pedestrian street
- Using thick tree borders to separate motorways from pedestrian paths (sidewalks)
- Exploring possibilities for connecting the newly-converted pedestrian street to a public transport stop, and providing automobile parking space
- Creating special lanes for motorcycles (a non-polluting means of transport)
- The use of public transport and electric powered busses to reduce environmental pollution and congestion caused by automobiles.

10. The Aesthetic Dimension of Roads

10.1. Neglect of Aesthetic Standards in Cities (Visual Pollution)

The great effort expended on the construction of various types of roads and bridges in cities led to the neglect of many of the standards related to aesthetics and tranquility that characterized cities before the age of the automobile. Some important examples of this phenomenon are:

- Increasing the width of highways and city center streets at the expense of pedestrian paths, squares and meeting places

- Road and traffic hub construction has engulfed green spaces, which has had a huge negative impact on the natural and urban environment.

10.2. Aesthetic Elements of Pedestrian Passages and Transportation

The temptation to beautify pedestrian and automobile passages is important in the planning and design of pedestrian lanes. Great care must be taken in the positioning of plants and trees on roads; they must be planted in the right spots to perform the right function. Trees and bushes may be planted on passages that are largely reserved for pedestrian use. However, planting trees on the sides of highways or in the median strips separating two-way streets is not recommended. In fact, trees in the middle of highways can be the cause of some of the worst types of road accidents when automobiles crash into them12.

Figure 7. *internal pedestrian walk way.*

Source: http://en.wikipedia.org/wiki/Sustainable_transport, 2013

11. Standards and Parameters for the Design of Sustainable Transportation Hubs

11.1. Road Design Categories

This refers to the grading, for architectural design purposes, of a number of principal roads according to the level of traffic service they provide to users. Each of the four design urban road categories provides a particular level of traffic and other services to the area through which it passes. The architectural specifications and characteristics for each category are designed to match its particular conditions13.

11.1.1. Road Classification Factors

A number of factors and technical specifications serve as guidelines for the functional classification of road networks. These include anticipated size and quality of road traffic, average travel duration on a given road and the position of the road in relation to other roads on the road network.

11.1.2. Size and Quality of Road Traffic

Roads that accommodate heavy traffic naturally require appropriate architectural specifications and standards to provide an acceptable level of service that ensures the smooth flow of traffic while minimizing travel time and cost, thus ensuring suitable travel speeds and safeguarding security. Furthermore, traffic patterns (in addition to local traffic, traffic between far-flung destinations can be either passing through or long haul) directly affect the choice of a suitable category. In general, and depending on traffic size and quality, road networks can be classified into categories according to their needs, as follows:

Outer-City Roads:

- Highways and freeways: principally used by heavy traffic, they connect distant transport destinations and usually carry both uninterrupted and interrupted traffic flows. Highways are equipped with ramp intersections, while the intersections on freeways are all free.
- Side roads: these make up the road network that links highways or freeways to local roads. Medium category design elements, suitable to the size of traffic and allowing for the appropriate speed levels, are used for side roads.
- Local roads: these are roads that lead directly to nearby services. They must allow for acceptable traffic speeds that suit these services and the anticipated interference by other services

Urban Streets

In accordance with the above functional classification concepts for outer-city roads and in keeping with international and local classification concepts, urban roads are divided into the following categories:

- Highways and freeways: principally used by heavy traffic, they connect distant transport destinations and usually carry both uninterrupted and interrupted traffic flows. Highways are equipped with ramp intersections, while the intersections on freeways are all free.

Side roads:

Connect highways and freeways to local roads

11.1.3. Average Road Travel Distance

The design elements used for roads designated for long distance travel must allow for traffic speeds that are appropriate to long distances.

11.1.4. Position of the Road on the Network

The overall hierarchical categorization of road networks has a direct effect on the choice of road functions that are suitable to the road's position on the network. The function assigned to a road must be in keeping with the grading (categorization) sequence of roads on the network.

11.1.5. Cycling Lanes

The design of cycling lanes on urban roads depends chiefly on the factors of comfort and security. Cycling lanes must be provided on urban roads where bicycle traffic size exceeds 500 bicycles a day.

12 Department of Transport and Main Roads (2011). Connecting SEQ 2031 – An Integrated Regional Transport Plan for South East Queensland. Brisbane: Queensland Government.

13 Ibid.

11.1.6. Space Requirements

A bicycle lane must have an empty space width of 1.10 meters (0.60 meters), the standard width of a bicycle, plus 0.25 meters of free space on either side to allow for the free flow of movement (other bicycles, pedestrians or vehicles).

11.2. Safety

The following points ensure safety on the road:

- Appropriate design factors (protective barriers – pedestrian paths – cycling lanes – lateral slopes – the number of lanes etc)
- Coordination between vertical and horizontal planning to ensure that drivers have a safe sight distance all along the road
- Making use of existing safety studies and expertise concerning road network components (vertical and horizontal planning – intersections – pedestrian and cycling lanes – railway crossings etc)
- Compatibility of road equipment (lighting – traffic lights and traffic signs – ground markings – traffic control equipment etc)

11.3. Environmental Issues

Transport and road network projects affect the environment, so it is crucial to identify and adopt transport design elements and factors that contribute to reducing negative environmental effects. For instance, careful note must be taken concerning a road's environmental impact regarding:

- Air pollution from exhaust fuel emitted by vehicles using the road, particularly in urban areas, and its effect on the public health of living creatures and plant life
- Noise emitted by vehicles on the road, lorries and large trucks in particular

11.4. Economic Factors

The study of economic considerations is one of the important elements that influence the choice of the foundations, design components and selected routes for road projects. Economics studies for roads comprise the following components:

- Road construction costs
- Road maintenance costs
- Vehicle running costs

11.4.1. Road Construction Costs

These include the cost of design studies and of expropriating any private property that may be located on the chosen route. Costs of similar road projects in the region may be used as a reference.

11.4.2. Road Maintenance Costs

Calculated according to the project's annual maintenance costs (includes the cost of routine and periodical maintenance)

11.4.3. Vehicle Running Costs

This is the cost of running vehicles on a road and is calculated per kilometer vehicle. Vehicle running costs depend on the model and average speed of each vehicle and it is also affected by the structural features of the road, such as horizontal curves, longitudinal slopes and the type and condition of road paving. Vehicle running costs include fuel, oil and tire consumption costs, servicing costs and vehicle depreciation resulting from mileage covered. The cost of time consumed on the road is also taken into account14.

12. Description and Analysis of International and Local Examples

12.1. London

Driving super personal electric transport pods to be installed near London

Milton Keynes, a small city north of London, has just announced plans to install one hundred automated "pod cars" to run between the city's central station and the city center. These ULTRA Personal Electric Transportation Pods will travel along the platforms, at speeds of up to 12 miles per hour. The project, which costs 104 million USD, is part of a five-year pilot plan expected to be completed in 201715.

Figure 8. *super personal electric transport pods.*

Source: Green Transportation - powered by Feed Burner_files-O'flanerty, C. A.: Highway Traffic, 2012

Figure 9. *super personal electric transport pods.*

Source: Green Transportation - powered by Feed Burner_files-O'flanerty, C. A.: Highway Traffic, 2012

14 Oglesby, Clarkson, H., *Highway Engineering*, (Arabic translation of third edition)

15 Newman, P., & Kenworthy, J. (2011, May 26). Peak car use: urban planning needs to change say Newman and Kenworthy. Retrieved April 10, 2012, from The Fifth Estate :http://www.thefifthestate.com.au/archives/24214

ULTRA Personal Electric Transportation Pods

Pedestrians will be able to get a taste of future centuries through smart mobility applications. This application was first used at London's Heathrow Airport in 2011, but the British government is now looking into applying it to public transport systems, in order to free the roads of pollution emitted by buses.

The pods are computer-driven vehicles and each can transport up to four passengers, along with their luggage. They are battery-operated, have rubber tires and can navigate complex routes with lightweight infrastructure. When running, the ULTRA Personal Electric Transportation Pods are silent, produce no noise, zero emissions and almost no external vibrations16.

Lessons learnt from the example

- Safety
- Use of electric energy
- Privacy
- Protecting the environment against pollution

12.2. New York City

Figure 10. *300 MPH Maglev Train*

Source: Green Transportation - powered by Feed Burner_file -O'flanerty, C. A.: Highway Traffic, 2012

Figure 11. *300 MPH Maglev Train.*

Source: Green Transportation - powered by Feed Burner files-O'flanerty, C. A.: Highway Traffic

300 MPH Maglev Train Could Carry Passengers from Washington D.C. to New York in 60 Minutes

Revised plans have recently been revealed concerning the 300 miles per hour Maglev bullet train that could transport passengers from Washington, D.C. to New York City in just 60 minutes. Driven by powerful electro-magnates, the train would be elevated, which would reduce friction and enable it to travel at high speeds with rapid acceleration. Growing interest in applying high-speed technologies to public transport (such as the Hyperloop) is behind the reinstatement of this project17.

Lessons Learnt from the Example

- Travel speed and resulting time savings
- Use of electro-magnetic energy

12.3. United Arab Emirates

The United Arab Emirates is a leading country in the field of sustainable transport. Examples of main streets where sustainable design standards have been applied are presented and examined below. The best urban streets are those that can easily accommodate a balanced mix of pedestrians, public transport passengers and drivers of motorcycles and other vehicles. Efficient and safe road networks necessarily depend on an integrated design process that takes into account different types of transport and the various users of a transport system. A number of variables must be considered before embarking on the process of urban road design. In the case of Abu Dhabi, it is very important for urban road design to consider climatic conditions and local context (in addition to standard design priorities and factors)18.

Example 1: Abu Dhabi: Al Moroor Street – Side Lane Added to a City Avenue

Al Moroor Street, located in the business center of the city of Abu Dhabi, is chosen as an example illustrating the methodology used in the three-step process of updating urban streets. The street's conditions are representative of the prevailing pattern existing in many of the city's streets:

- Chaotic advertisement billboards and signs
- Scarcity of seats and shade canopies at bus stops and in areas reserved for pedestrian use
- Narrow side barriers and passenger waiting areas at bus stops (2 meters)
- Wide (5 meters) one-way side barrier
- No safe pedestrian crossing at bus stops
- Perpendicular parking spaces, at a 5.6 meter angle
- Narrow, restricted pedestrian passages (2.65 meters wide)

Step One: Cleaning

Removal of unnecessary billboards and sign posts

Affixing signs unto multi-functional posts

Replacing damaged trash bins and fixing the new bins unto sign posts

Step Two: Upgrading Pedestrian Areas

Installing elevated crossings leading to bus stops

Repaving pedestrian passages using quality materials

Adding short pillars on the elevated crossings

16 Schiller, P., Bruun, E., & Kenworthy, J. (2010). An Introduction to Sustainable Transportation: Policy, Planning and Implementation. London: Earth scan.

17 Schiller, P., Bruun, E., &Kenworthy, J. (2010). An Introduction to Sustainable Transportation: Policy, Planning and Implementation. London: Earth scan.

18 Daleel al shaware3 al7adareya – Abu Dhabi,2012

Providing new fixtures (such as seats) in pedestrian facility areas and sun protection canopies at bus stops, and providing a 2-meter wide free space around bus stops

Pavement extensions at elevated crossings, to reduce the length of the crossing

Providing additional space for street fixtures, then reducing the width of the side barrier to a distance of between five and three meters from the pavement

Figure 12. *Parking location, pedestrian crossing old statues.*

Source: Daleel al shaware3 al7adareya – Abu Dhabi, 2012

Figure 13. *Parking location, pedestrian crossing new.*

Source: Daleel al shaware3 al7adareya – Abu Dhabi,2012

Step Three: Street Reconstruction

- Consulting the Department of Transport about replacing the perpendicular parking spaces on the right side of the road with parallel parking spaces
- Narrowing the side barrier to a width of four meters in order to accommodate perpendicular parking , and to a width of three meters at pavements extensions to slow down vehicle speed
- Adding tiles all along passages in front of building facades to slow down traffic speed
- Planting new trees or installing sun canopies
- After consulting with the Department of Transport, widening the side barrier by narrowing perpendicular parking to 5.3 meters (on the left side of the street)

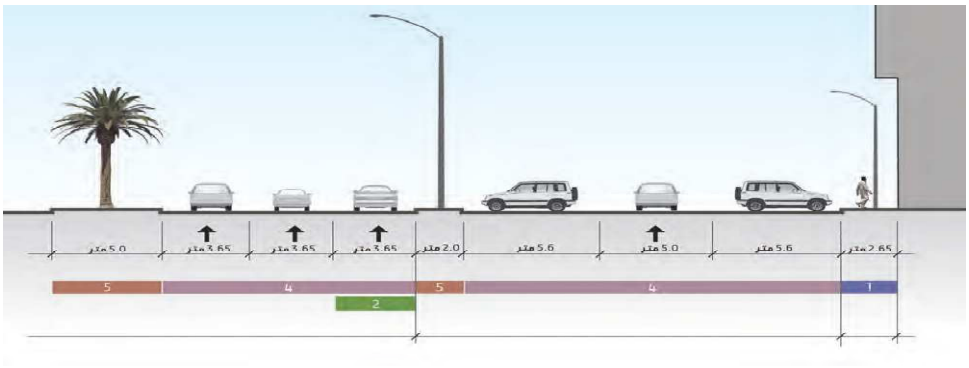


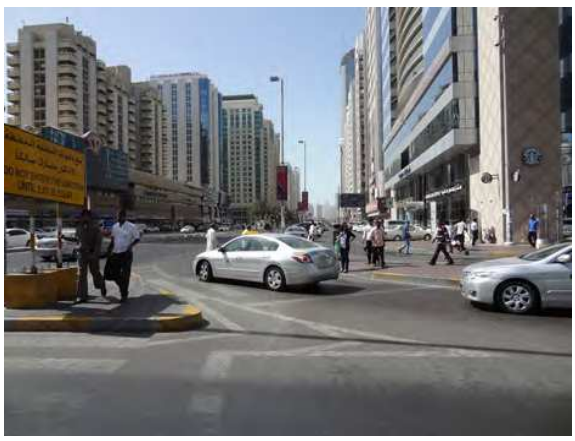
Figure 14. *proposed road cross section.*

Source: Daleel al shaware3 al7adareya – Abu Dhabi, 2012

Below are some examples of solutions applied to various streets in the U.A.E.:

The following figures show the differences between transport practices in Abu Dhabi before and after the application of urban street design standards and guidelines related to intersection design.

The elevated pedestrian crossings will encourage vehicles to give right-of-way to pedestrians.



(Before)

(After)

Figure 15. *Pedestrian crossing treatments.*

Source: www.monofeya.gov.eg, 2012

The broad median divider islands provide safe and comfortable waiting areas for pedestrians.

(Before)

(After)

Figure 16. *Pedestrian crossing treatments.*

Source: www.monofeya.gov.eg, 2013

Reducing traffic lane width contributes to slowing down vehicle speed at pedestrian crossings and decreases the distance pedestrians must walk to cross the street.

12.4. Applied Project in Shebeen El Kom, Egypt

The aim of the project is to promote the use of non-polluting, non-automotive means transportation (such as bicycle and pedestrian transportation) in certain traffic hubs of Shebeen El Kom. It also aims to provide bicycle parking space and to encourage the university and a number of companies to sell bicycles to students and employees at easy payment terms. Moreover, the project aims at encouraging university graduates to set up bicycle repair shops and at implementing some of the activities included in the National Campaign to Encourage Bicycle and Pedestrian Transport in Al Menoufeya Governorate, specifically in the city of Shebeen El Kom19.

Figure 17. *Shebeen El Kom, Egypt.*

Source: www.monofeya.gov.eg, 2012

Shebeen El Kom Project Implementation Objectives:

- To contribute to the amelioration of air quality and the reduction of noise levels
- Energy conservation
- To reduce greenhouse gas emissions, thus contributing to global efforts to combat climate change
- To keep pace with the global trend towards promoting bicycle transport, because of the significant health, economic, environmental and other benefits it provides

Shebeen El Kom Project Components:

Creating safe hubs for the use of bicycles in some of the city's transportation hubs

Creating safe bicycle parking space in selected locations

Creating a market selling bicycles at easy payment terms

Preliminary application of the National Campaign to Encourage Bicycle Use

First Component:

Creating Safe Hubs for the Use of Bicycles in some of the City's Transportation hubs

Facilitating bicycle circulation in the following selected transport hubs in Shebeen El Kom city: Gamal Abdel Nasser Street, Al Masna3 Street, a section of SabryAbouAlam Street and Tala3t Harb Street (dividers, road marks and signs will be

19 Ministry of Transport, Report on the Sustainable Transport in Shebeen El KomProject,2012

installed to mark the course of cycling lanes).

Second Component:

Creating Safe Bicycle Parking Space in Selected Locations

In coordination with the Governorate, bicycle parking space will be provided in certain central locations, such as the vicinity of various university faculties, a number of preparatory and secondary schools, government agencies and the factory, among others. Provision of special parking space for bicycles will encourage their use, reassure people about the safety of their bicycles and decrease the incidence of bicycle theft.

Third Component:

Creating a Market Selling Bicycles at Easy Payment Terms

- Preparing an implementation program for selling bicycles at easy payment terms to students and employees (reduced prices or long-term installment payment plans)
- Working with the Environmental Protection Fund (EPF) of the Egyptian Environmental Affairs Agency (EEAA) and the Social Fund for Development (SFD) to assist young people to set up bicycle rental and maintenance projects in Shebeen El Kom, providing maintenance and rental services to bicycles users in the city20

This project is a *preliminary application of the* National Campaign to Encourage Bicycle Use. After evaluation, the project will be implemented in other medium-size cities.

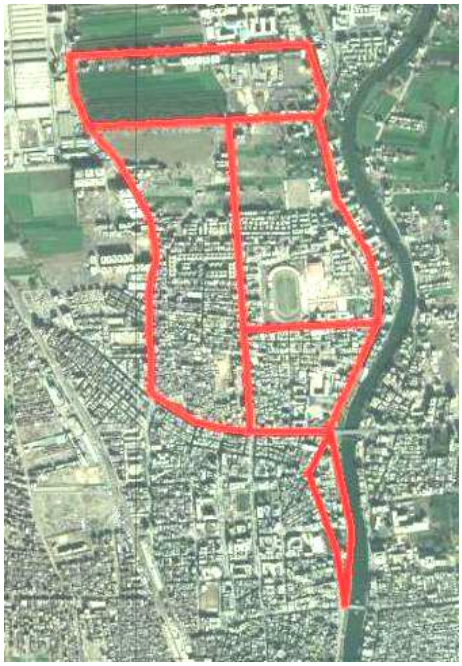


Figure18. *a preliminary application of the National Campaign to Encourage Bicycle Use.*

Source: www.monofeya.gov.eg,2012

Figure 19. *Using a Bike Lane with the road design.*

Source: www.monofeya.gov.eg, 2012

Figure 20. *Bike lane as a majore transport facility.*

Source: www.monofeya.gov.eg, 2012

Based on the above presentation and analysis, proposed design approach components and the relevant inventory of tests can be formulated as follows:

"To facilitate the process of drawing conclusions, care has been taken to ensure that the measurements used in the inventory of tests are applicable, testable and falsifiable."

Conclusions and Recommandations

- Length of travel time that contributes to increasing fuel consumption and higher carbon monoxide emissions, calling for devising sensible environmental plans to reduce travel times.
- Below average fuel combustion rates in engines are caused by the quality of fuel and the manner of driving.
- Size and density of traffic require appropriate transport hub planning
- Pollution levels vary according to the type of vehicle (automobile, railway, lorry)
- Road topography (mountain roads, desert roads, coastal roads, roads passing through plains): flat roads consume less energy than mountainous or rough roads
- Trees and vegetation on the sides of the road contribute significantly to reducing the negative effects of car exhaust on urban structures and the environment generally
- By using local construction methods, combined with a little technology, it is possible to implement sustainable urban transport plans in Egyptian cities at reasonable cost
- It is important to benefit from Arab and international sustainable transport planning examples while preserving national and economic features that are in line with both the

20 Ibid.

Egyptian architectural environment and modern technical and architectural techniques, particular green architecture

- Sustainable transport is an integral part of green architecture (a comprehensive concept whose components must be applied together and not separately). Green architecture is in harmony with the environment and seeks to limit adverse environmental effects, promote efficient energy use, to encourage the use of renewable energy resources and the efficient use and recycling of materials and resources. It respects and interacts with the site, while adapting to climatic conditions and ensuring the comfort of users.
- Upgrading the present standards for the design and planning of automated traffic routes and pedestrian areas in urban contexts will contribute significantly to reducing the incidence of road accidents.

Table 4.*proposed measurement matrix for sustainable roads design.*

NO.	ITEMS DESCRIPTION	CHECK				remarks
		Yes		No	N/A	
		Full	Partial			
1.0	Suitability of roads to site topography and minimization of digging and backfilling					
1.1	Appropriateness of road network design to contour lines					
1.2	Digging and excavation works do not exceed the volume allowed by the owner					
1.3	The excavation methods selected, and the use of environmentally friendly material in backfilling					
2.0	Regulation of traffic hub movement and ease and safety of movement					
2.1	The proposed design facilitates transportation to and from the various site sections					
2.2	The design ensures prevention of present and future traffic congestion					
2.3	The design ensures that pedestrian and automated traffic are separate and that there is no discordance between them					
2.4	The design ensures that pedestrian networks, crossings and traffic are clearly marked, particularly for the disabled					
3.0	Promoting pollution reduction in traffic hub design					
3.1	The design includes natural vegetation elements that promote pollution reduction					
3.2	The design designates specific garbage collection areas according to modern environmental specifications					
3.3	The design includes notification methods to minimize environmental, noise and visual pollution					
4.0	Incorporation of road gradation and integrated networks					
4.1	Existence of a clear hierarchy of traffic hub networks					
4.2	The design ensures the complementarity of traffic hub networks and traffic flow from and to all service sectors					
4.3	The design ensures that infrastructure and electricity networks are interconnected					
5.0	Provision of optimal methods and systems for automobile parking space					
5.1	The design provides automobile parking space that is appropriate to site conditions					
5.2	The design provides for the required number of automobile parking spaces					
5.3	The design provides appropriate solutions for indicating parking space locations and facilitating pedestrian movement from and to parking spaces					
6	Taking the aesthetic dimension into account in traffic hub planning and design					
6.1	The aesthetic dimension is considered in the layout of the area surrounding roads					
6.2	The design encourages walking and cycling					
7.0	Observing traffic hub sustainable design standards and components					
8.0	Using suitable technologies to monitor and improve traffic hub performance					
9.0	Provision of mechanisms to ensure the continuity of periodic maintenance and development works necessary for preserving traffic hub conditions					

Recommendations

Advising state institutions and agencies of the need to update laws related to transport design by adding stipulations concerning environmental protection and the prevention of environmental infringements.

Likewise, advising educational and academic institutions of the need to raise awareness concerning the importance of maintaining favorable road conditions and abstaining from behavior that could adversely affect them in order to resolve the problems that threaten society. It is therefore necessary to develop educational curriculums that explain environmental conservation theories and their relation to green transport and to organize public awareness conferences, seminars and lectures concerning the environmental effects of personal decisions and actions.

In addition, the study recommends taking immediate steps to identify special design standards for pedestrian areas and to apply the principles of road network planning and design that aim to guarantee pedestrian comfort in places where pedestrian and automated traffic meet. Above surface solutions should be used first, followed by tunneling systems, while the safety and comfort of users should be a priority at all times. The next step should be to build bridges with gradient ascents and descents, rather than steps. Pedestrian traffic is one of the essential components of a city's structure, and priority must be given to planning pedestrian crossings of automated traffic roads. The above recommendations should be the subject of clear plans that are integrated into overall city plans. These plans should include the creation of pedestrian passages, since it is necessary to provide streets for automated

traffic and separate places for pedestrians that are safe, functional and aesthetically attractive. The study focuses on the importance of separating pedestrian and automated traffic by creating underground paths, pedestrian bridges etc to keep the movement of city inhabitants away from road traffic. It further recommends investigating possibilities for installing underground or aboveground trains to encourage the use of public transport, similarly to modern cities all over the world.

The importance of improving air quality and reducing noise levels is stressed. In keeping with the global trend towards encouraging cycling as a mode of transport, the study highlights the example of the executive program facilitating the sale of bicycles to students and employees at reduced prices or in easy installments, due to the health, economic, environmental and other benefits of this mode of transport. Finally, the study recommends that utmost importance be accorded to sustainable transport planning in Egypt.

References

[1] Schiller, P., Bruun, E., & Kenworthy, J. (2010). An Introduction to Sustainable Transportation: Policy, Planning and Implementation. London: Earth scan.

[2] Commonwealth of Australia. (2011).Our Cities, Our Future: A national urban policy for a productive, sustainable and livable future.Canberra: Department of Infrastructure and Transport.

[3] Department of Transport and Main Roads (2011). Connecting SEQ 2031 – An Integrated Regional Transport Plan for South East Queensland. Brisbane: Queensland Government.

[4] Hansen, C.J. (2011) The role of policy-making and planning cultures for sustainable transport?. European Transport, 47 (2011), 89-108.

[5] Low, N. (2011). Australian Cities, Transport Integration and the Global Dilemma of Mobility. Retrieved April 2, 2012, from State of Australian Cities 2011: http://soac2011.com.au/full-papers-list.php

[6] Newman, P., & Kenworthy, J. (2011, May 26).Peak car use: urban planning needs to change say Newman and Kenworthy. Retrieved April 10, 2012, from The Fifth Estate :http://www.thefifthestate.com.au/archives/24214

[7] Hay, William, W. An Introduction to Transportation Engineering (translated by Drs. Saeed Abdel Rahman Al Qadi and Anis Abdallah Al Taneer, King Saud University Publications, 1999

[8] Dr. Mohamed Tewfiq Salem, Handasset al naqlwa al moroor – Dar al rateb al game3eya, 1985

[9] Oglesby, Clarkson, H., Highway Engineering (Translated by Dr. Ali Suleiman Huzayn and others, Dr. Tarek Youssef Al Ridi, Dr. Mohamed Salah Al Din Al Howary) - John Wiley & Sons, New York

[10] Burtenshaw, D. and Batenman, M. and Ashworth, G. J., The City in The West Europe - John Wiley & sons, UK, 1981

[11] Catanese, Anthony J. & James C. Snyder, Introduction to Urban Planning: 1986, McGraw- Hill Book Company - New York

[12] Dr. Ali Mohamed Abdel Moneim Hassan, Handassat al naqlwa al moroor (mabade' takhteet al naqlwa al moroor dakhel al modon) - Dar al rateb al game3eya, 1994

[13] Dr. Khaleel Ahmed Abou Ahmed, Al tasmeem wa al takhteet al handasee leltoroq al 7adareya wa al khalaweya– Dar al rateb al game3eya

[14] Dr. Zein El Abedeen Ali, Mabade' takhteet al naql al 7adary – Dar safa'alelnashrwa al tawzee3, Amman, Jordan, 2000

[15] Dr. Sabah Mahmoud Mohamed, Al madkhal fi takhteet al naql al 7adari – Mo'assaset al waraqlelnashrwa al tawzee3, Amman, Jordan, 2002

[16] Al e3tebarat al bee'eya fi takhteet ma7awer al 7araka belmodon al gadeeda fi misr

[17] Mohamed Abdel Ba'I Mohamed Ibrahim, Daleel tasmeem al toroq, Ketab tasmeem al toroq 1-2, 2-2 (Ministry of Transport, Egypt)

[18] Al tasmeem al handassi leltoroq (General Authority for Roads and Bridges - Ministry of Transport, Egypt)

[19] Oglesby, Clarkson, H., Highway Engineering, (Arabic translation of third edition)

[20] Report on the Sustainable Transport in Shebeen El Kom Project (Ministry of Transport, Egypt)

[21] "Tatawor wasa'el al naql wa almowassalat", published on Sciences Way website (http://www.sciencesway.com/vb/showthread.php?t=5839)

[22] Fahd Ben Khaled Al Fawzan, "Qeta3 al naql wa dawroh fi al tanmeya al eqtessadeya" (http://www.suhuf.net.sa/2001jazhd/jun/26/ec.htm)

[23] Haydar Kamouna, "Ahameyat qeta3 al naqlwa al morror fi al tanmeya al eqtesadeyawa al egtema3eya" (http://www.almadapaper.com/sub/06-405/p19.htm)

[24] World Summit on Sustainable Development (WSSD) publications – Johannesburg, South Africa, 26 August to 4 September 2002 (http://www.un.org/arabic/esa/desa/aboutus/keyissues.html)

[25] Engineer Mohamed Hassan Sayed, "Ba3d semat 7arakat al moroor wa athareha", Arab Urban Network website (http://www.araburban.net/author/muhammed.html)

[26] Adel Hamoud, "Al naql/ tareekhoh, wasaeloh, tataworoh (http://www.alsabah.com/paper.php?source=akbar&mlf=copy &sid=37221

[27] Dr. Abdallah Ibrahim Al Fayez, "Takhteet al modon wa moshkelat al e3temad 3ala altaqa sharlabodminho" (http://www.aleqt.com/2207/01/28/article_7726.html)

[28] "Al mawsoo3a al goghrapheya / derassat al naqlwa al moroor medaneyan" (http://www.4geography.com/vb/showthread.php?p=2782)

[29] Dr. Haydar Kamouna, "Al 3elaqa bayn al ta7adur wa tatawor al khadamat", Magalet al 3ooloom al 'egtema3eya Forum (http://swmsa.net/forum/archive/index.php/t-10193.html)

[30] Pederson, E.O., Transportation in Cities, Pergamon Press Offices, New York, USA, 1980

[31] Litman, Todd, "Introduction to Multi-Modal Transportation Planning Principles and Practices", 18 November 2008, Victoria Transport Policy Institute

[32] Federal Highway Administration, Federal Transit Administration, "The Transportation Planning Process: Key Issues – Part-1", updated September 2007, Publication Number: FHWA-HEP-07-039

[33] "Guiding Principles for Sustainable Transportation" – The Global Development Research Center – Conference organized by the Organization of Economic and Social Development (OECD), Vancouver, Canada, 24 – 27 March 1996

[34] Bradley, Bradley M.J. & Associates - Comparison of Energy Use & CO2 Emissions From Different Transportation Modes - Submitted to American Bus Association, Washington, D.C., May 2007

[35] Green Transportation - powered by Feed Burner_files-O'flanerty, C. A.: Highway Traffic

[36] Planning and Engineering, Volume 1 - University of Leeds, UK—Stones

[37] Tabor R. Stone, Beyond the Automobile; reshaping the transportation environment, Prentice Hall, Inc., N. J., 1992

[38] AASHTO, A Policy on Geometric Design of Highways and Streets, 1994

[39] http://en.wikipedia.org/wiki/Sustainable_transport