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Role of Hubs in Resolving the Conflict between Transportation and Urban Dynamics in GCR: The case of Ramses square

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Abstract

Greater Cairo Region (GCR) is the largest metropolitan area on the African continent and the Arab world. It accommodates 16.1 million inhabitants representing 19% of Egypt's total population. Today, critical urban issues arise from the sheer size of the metropolis GCR and from its population density. Traffic congestion is on the top of these issues. This research focuses on the significant role that hubs (Multi Modal Platforms) can play in enhancing the GCR transportation infrastructure. Ramses square area in Cairo is selected to demonstrate a systematic solution to solve the problems resulted from the interference of multi uses activities and transportation modes in central areas of capital cities.

Keywords: Greater Cairo Region (GCR); hubs; urban dynamics; transportation

1. Introduction

Greater Cairo Region (GCR) is the largest metropolitan area on the African continent and the Arab world. Its past has been influenced by a rich confluence of world trade and cultures and it stands as a bridge between East and West. The GCR is today the beating heart of Egypt. Around 19% of the country's population is living within its boundaries. Today, critical urban issues arise from the sheer size of the metropolis GCR and from its population density that is unique among large cities in the world.

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Traffic congestion is on the top of these issues, which needs prompt intervention to prevent saturation of the metropolis and the deterioration of living conditions. Non conventional solutions are needed to deal with such a critical issue. This research focuses on the significant role that hubs can play, as a non conventional solution, in enhancing the GCR transportation infrastructure. The research deals with the interaction between the multiplicity of transportation modes and the urban dynamics related to the concentration of activities in the central districts in capitals. The relation between the transportation modes and the centralized activities leads to an accumulative problematic phenomena. It focuses on how to solve the problems resulted from such interfere of activities and transportation modes in an integrated way. The Hub (Multi Modal Platforms) as a way of integration between the numerous activities and transportation modes leads to a quick connection and easy joint between many poles and axes of movement needed in the central districts with its energetic movements. Ramses square area in Cairo is selected to demonstrate clearly the phenomena that the research addresses. The research structure is as follows: it starts with providing a background on the GCR, and then sheds light on the most significant urban challenges face the GCR, followed by an illustration of the conflict between urban dynamics & transportation. It then explains the importance of hubs and analyzes the case of Ramses square area with focus on how hubs can be used as a systematic solution to solve the problems resulted from the interference of multi uses activities and transportation modes in central areas of capital cities. It ends with concluding remarks.

2. Greater Cairo Region (GCR)

Greater Cairo Region (GCR) is the largest metropolitan area in Egypt and the third largest urban area in the Islamic World after Jakarta and Greater Istanbul. It is the largest urban area in Africa and the world's 16th largest metropolitan area (Demographia, 2012). The GCR is a vast agglomeration that comprises the urbanized area of the Governorates of Cairo, Giza, Qalyobiya, Helwan, Sixth October and the eight new urban communities that surround, as shown in Fig. 1 & Table 1 (GOPP & UN-Habitat, 2011). In population terms GCR, at 16.1 million inhabitants in 2006, represented 19% of Egypt's total population. GCR is considered the most important urban agglomeration in Egypt (Sims, 2012)

Table 1.Population in GCR scope

Population within GCR boundary (Million inhabitants)		Area within GCR (Km2)	% of Area within GCR
Total	16.1	3133	
Cairo Governorate	6.6	372	100%
Giza Governorate	3.3	119	100%
Helwan Governorate	2.5	1142	16%
6th of October Governorate	2.5	1352	4%
Qalyobeya Governorate	1.2	148	13%

(Source: Gopp estimates based on current CAPMAS, GOPP GIS databases)

To accommodate population growth, the urban area within the GCR has expanded constantly since the 1952 revolution, as shown in Fig. 2. Currently, it encompasses 736 sq. km (175,238 feddans), six times larger than it was in the 1950s and twice as big as in the 80's. It currently represents approximately 23% of the GCR total area. The main agglomeration is heavily over-concentrated, where it accommodates 12.6 million inhabitants, accounting for over 78% of the GCR's population (GOPP & UN-Habitat, 2011). The GCR is considered by many observers to be a "primate" city, given its weight of numbers and the

concentration of economic enterprises in it. It includes 55% of the nation's university places, 46% of total hospital beds, 40 % of pharmacies, 43% of public sector jobs and 40% of private sector jobs (Davis, 2006)

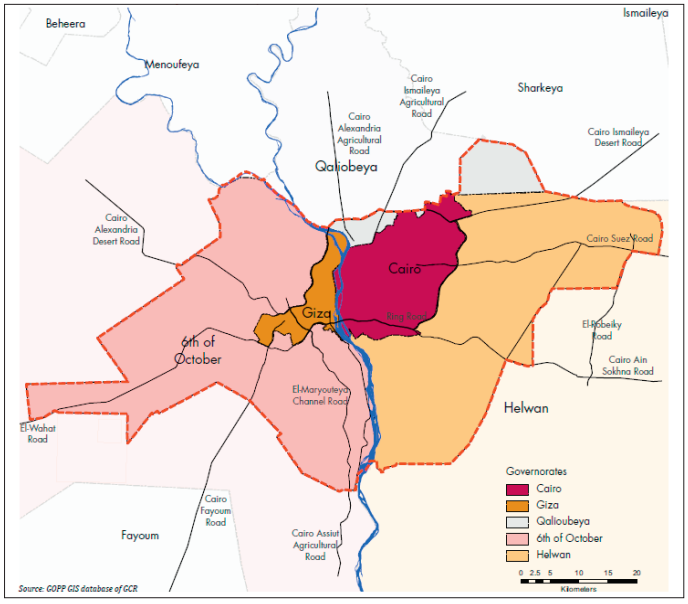


Fig. 1. Location map of Greater Cairo region (GCR)

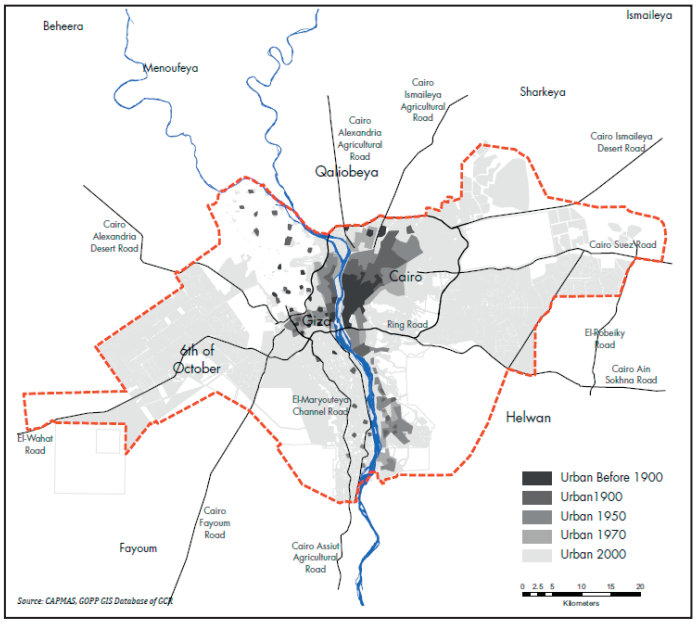


Fig. 2. Evolution of the Urban Mass

3. Urban Challenges in GCR

Such concentrations of population, economic activities, wealth, and power have led to serious urban problems, resulting in several attempts since 1960 to manage and reorganize the growth of the GCR and to decentralize population and activities. The main challenges facing the GCR due to the massive population increase can be summarized as follows (Elkouedi & Madbouly, 2007):

- The unplanned growth of the built-up area
- The excessive pressure on infrastructure
- Environmental degradation and high rates of pollution
- Major traffic and transportation problems within the region
- Lack of coherent institutional framework to manage the region
- Weak connectivity between existing built-up area and new urban communities
- The economic competitiveness of the region

The focus of this paper is on the transportation sector and how enhancing such crucial sector can prevent saturation of the metropolis and the deterioration of living conditions. According to statistic, if nothing were to be done to improve the transportation infrastructure of the GCR, by 2019 the average speed of travel will be reduced by 50%. This will definitely amplify the problems resulted from traffic congestion and inadequate services. Transportation and traffic issues principally result from two key factors (GOPP & UN-Habitat, 2011), as follows:

- Rapidly growing demand: An over concentrated population in the main strains all types of transportation within the GCR. The number of car owners jumped from 46 cars per 1,000 inhabitants to 76 between 1996 and 2006. The migration to New Urban Communities (NUCs) generated a large number of commuters -- 238,000 daily to 6th of October and Sheikh Zayed as of 2009.
- Inadequate supply, in particular public transportation: Remarkable efforts have been made to enhance road networks. However, the development of public transportation is crucial to solve traffic issues. The GCR has an acute lack of public transportation. It has only 4 km of metro line per one million inhabitants, compared to 20 km in Paris and 56 km in London. The GCR has only 3.4 buses per 10,000, compared to 10.6 in Greater London. Lack of public transportation is particularly sensitive to access and within the NUCs. The lack of public transportation supply is causing a shift to private modes of transportation. The percentage of passengers using public buses fell from 31% to 21% from 1996 to 2001, while the percentage of passengers using private microbuses increased from 15% to 25% in the same period. This is a clear threat to the GCR's development, since it will cause more congestion in the main agglomeration, hinder the development of NUCs and further deteriorate the environment through increased fuel consumption and air pollution.

4. Conflict between Urban Dynamics and Transportation

The GCR is the preeminent transport center of Egypt accommodating over 20 million motorized person trips and 7 million non-motorized trips daily. Most of the transportation routes radiate from Cairo, connecting it with other major centers of the country and adding to its centrality. The lack of well-developed transportation and communication systems made it difficult to diffuse development from Cairo to other parts of the country, thus maintaining the primacy of Cairo (Rakodi, 1997). About 2/3 of all motorized trips are made by public transport through a combination of heavy rail, light rail, conventional buses, mini- and micro-buses, and taxis. It is, by any standards, overloaded. In response to this problem, privately owned passenger vans have begun to function all over the GCR. Although the road network represents nearly 25 percent of the total GCR area, its practical capacity is inadequate owing to many problems. Lack of maintenance, poor driving habits, low vehicle occupancy, bottlenecks, and lack of

parking lots and garages are among the major problems that decrease the efficiency of the network. Furthermore, problems of traffic congestion and inadequate services have combined to increase environmental pollution. High levels of air pollution, due to suspended particulate matter and lead generated by traffic and industry (especially cement manufacture), are exacerbated by wind-blown dust (WHO/UNEP, 1992). As a result of rapidly increasing population, and inadequate government responses, transportation conditions have deteriorated and the capacity of the GCR's transport systems to manage demand from the growing urban population is nearing the breaking point. The average travel speed in a business day does not exceed 10km/h, with many areas experiencing 5-6km/h during rush hours. The annual cost to the national economy due to congestion was estimated in 2000 at LE1.5 billion ($400 million). While the current car ownership rate is still low, it will only take a small increase to bring about a dramatic worsening of the traffic congestion that is amongst the worst in the world. Difficulties for users and operators alike are due to a number of factors (Elkouedi & Madbouly, 2007), including:

- Complex and fragmented institutional structures that lack clarity on roles and decision-making responsibilities;
- Serious traffic congestion (80% of intersections in center Cairo and Giza are saturated);
- Poor passenger transport system (only 4km of metro/1 million inhabitants [Bangkok=20, Sao Paolo= 31, Paris=150km of metro/1 million inhabitants];
- Severe shortage of high capacity bus supply: 300/1 million inhabitants [Bangkok=1737, Sao Paolo=1020, Paris=1800 high capacity buses /1 million inhabitants];
- High accident rate (more than 1000 deaths and 4000 injuries/year);
- Air and noise pollution (about 15 million tons of CO_2/year); and
- Inadequate and unsustainable financial arrangements.

5. Transportation Hubs

Transportation hub can be defined as a location which handles several transport modes. Transport modes can be of various types such as tramway, bus, automobile, ship, pedestrian, railway, metro or rapid transit, coach, truck, airplane and ferry. Thus, the term, transportation hub can be used for both the freight transfers and passenger transfers. Numerous advantages are expected from transportation hubs. They can offer high frequency of services in respect to other locations. The other advantage is the impressive development of an efficient distribution system simply because the transportation hubs can handle more traffic. Most of the transportation hubs make use of the shared transshipment facilities and so, the people can avail higher quality infrastructures at lower costs (Hubs.in, 2011). As Siemens (2011) argued, transport hubs are extremely important because the increasing flow of passengers and goods has to be managed within and between urban centers. As nodes, hubs must intelligently network various transportation systems so that people and goods can be transported in a safe, efficient, and environmentally sound manner. Hubs, as a network structure, allow a greater flexibility within the transport system, through a concentration of flows. The main advantages of hubs are (Siemens, 2011):

- Economies of scale on connections by offering a high frequency of services. For instance, instead of one service per day between any two pairs in a point-to-point network, four services per day could be possible.
- Economies of scale at the hubs, enabling the potential development of an efficient distribution system since the hubs handle larger quantities of traffic.
- Economies of scope in the use of shared transshipment facilities. This can take several dimensions such as lower costs for the users as well as higher quality infrastructures.

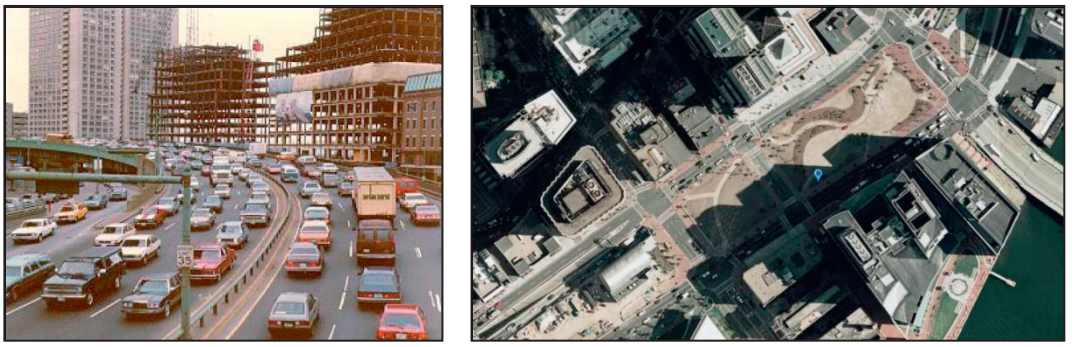


Fig. 3. Boston John Fitzgerald Expressway - Central Artery, before & after the project
(Source: BECT/AREP, 2009)

Many transportation services have adapted to include a hub-and-spoke structure. The most common examples involve air passenger and freight services which have developed such a structure at the global, national and regional levels, like those used by parcel carriers such as UPS, FedEx and DHL. However, potential disadvantages may also occur such as additional transshipment as less point-to-point services are offered, which for some connections may involve delays and potential congestion as the hub becomes the major point of transshipment. (Dr. Jean-Paul Rodrigue, 2012).Transportation hubs can also be airports; the top airline hubs of the world are Atlanta- Hartsfield, Chicago- O' Hare, London- Heathrow, Tokyo- Haneda, Los Angeles, Dallas, Charles de Gaulle- Paris, Frankfurt Main, Amsterdam (Hubs.in, 2011). There is a number of Best practice examples of transportation hubs worldwide, which worth to be mentioned. For example, the World Trade Center (WTC) Transportation Hub in Manhattan, designed by architect Santiago Calatrava. The transportation hub is designed to accommodate 250,000 pedestrians per day - which corresponds to projected ridership numbers for 2025, while the temporary station can accommodate up to 50,000 daily pedestrians (WTC, 2012). Another example of International best practices for similar areas that resemble the situation of Ramses square, with its problems, especially the traffic problems and the flyover placement status is BOSTON John Fitzgerald Expressway - Central Artery, as shown in Fig. 3.

The John F. Fitzgerald Expressway, known locally as the Central Artery, is a section of freeway in downtown Boston, Massachusetts, designated as Interstate 93, U.S. Route 1 and Route 3. It was initially constructed in the 1950s as a partly elevated and partly tunneled divided highway. Now, however, it is mostly made up of tunnels that were built during a ten-year period from the mid 1990s to the early 2000s as part of the Big Dig (Central Artery/Tunnel) project (Wikipedia, 2012).

6. The case of Ramses Square

Ramses square zone, as a case study example in the heart of the urban center of Cairo with a variety of transportation modes interacted with highly boiling over dynamic urban fabric is a greatly obvious sample for a multimodal nodal area, which can be a glary application as a hub solution example. It is located with a variety of means of transport, as shown in Fig. 4, such as:

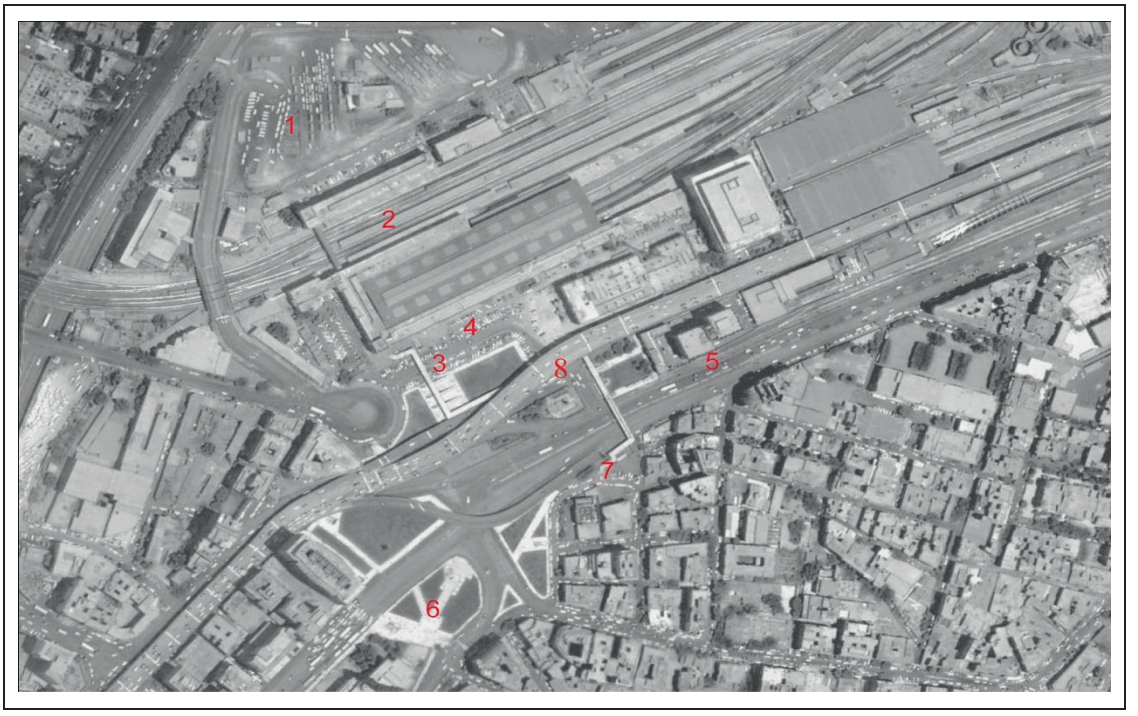
- National Station of train

- Regional Station of train
- A huge Metro station for two existing underground metro lines (line 1 and 2)
- Major road axes, such as the fly-over of 6th October and Ramses Street.
- Surface Tramway: linking this area with Heliopolis and Nasr city (Cairo east zone)
- Bus stops
- Minibus stops
- Microbus stops and terminals (Ahmed Helmi Microbus terminal)

This site has come to a saturation point today. Here are few numbers regarding the site (BECT/AREP, 2009):

- 30 000 Car figure per day
- 240 000 Passenger figure per day
- 23 000 Motion figure per day
- Hour of Traffic congestion

The following sections illustrate the adopted approach by an Egyptian and French Architectural offices/companies; BECT & AREP* for solving the problems of Ramses square zone using the concept of a transportation hub (Multi Modal Platform). This solution has won the first prize in the International competition for urban design and harmony, organized by the National Organization of Urban Harmony in Egypt, in 2009. It is worth mentioned that one of the authors of this research was the head of the planning team in the Egyptian counterpart.



* BECT; Bureau Egyptien de Conseil Techniques is a consulting firm in Egypt, represented in the competition by Omar El Hussieny, Principal partner. And AREP is a public limited company in France represented in the competition by Etienne Tricaud, CEO.

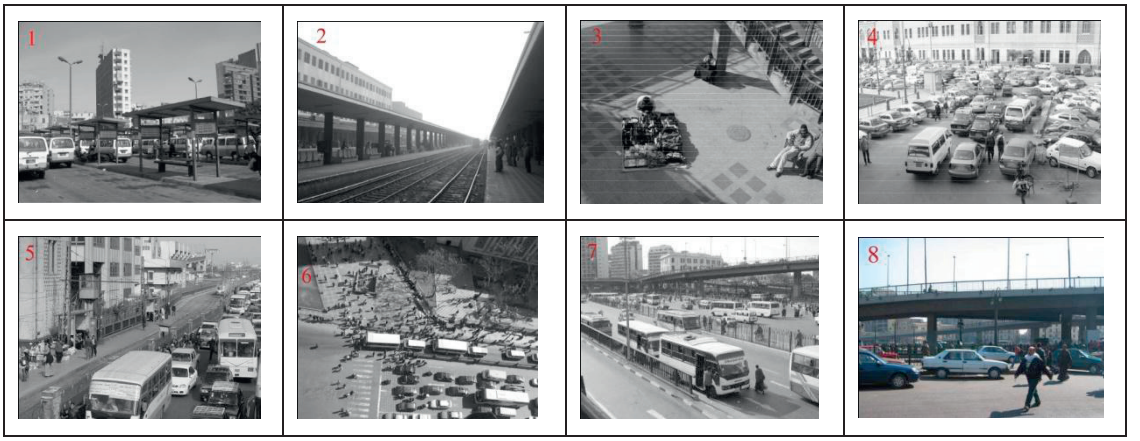


Fig. 4. Ramses sq. zone (Google earth map), 8 photos for different means of transport
(Source: BECT/AREP, 2009

6.1. Methodology

This research adopted a combination between theoretical and applied approach. It reviewed literature on current challenges facing GCR, then it dealt with the interaction between transportation modes and the urban dynamics related to the concentration of activities generally and that in capitals, and the conflict generated due to such interaction. Afterward, it investigated its main topic which is the "Transportation Hubs" in terms of concept and practice. The applied part of this research focused on the case of Ramses square in Cairo, where the concept of Hubs has been applied to solve the problems resulted from the interference of multi uses activities and transportation modes in this central area. It showed a multimodal transportation hub project with complete illustration with plans, sections, perspectives and sketchy analysis drawings to summarize the collective solution theme. Application of such solution faced many limitations to reach its final phase of evolution, which can be summarized in the following:

- Removal of 6th October flyover, which was an intrepid decision
- Dealing with the complicated underground metro station was a dangerous field to walk through, and the most challenge was to solve the new underground metro station, with its platforms and railways lines – two lines, integrating with the new car tunnel (instead of 6th October flyover) and with the underground car parking.

Additionally, this research faced another limitation through the rare sources of literature that tackle Hubs issue. For this topic – transportation hubs – is discussed as a way of organization of transportation modes or logistics hubs, not related to the interaction with the urban dynamics. Therefore, this paper is an attempt to tackle such issue.

6.2. Reveal the urban central aspect of the site: a door to the city

The area of Ramses square was the entrance of the city in the ancient periods. It was considered as Fluvial harbor in Fatimid times, before diverting Nile course; the river used to extend far more inside the land at the very place of the actual station. In the beginning of the 12th century, Salah el Din built a wall that extended until the harbor where it ended by the well-known “Bâb el Hadid” door. Then a park is developed. The Nile diversion and swamp drying out allowed the city to expand gradually until the great

wall. This area became then a resort place. In the 19th century, Mohammed Ali Pasha destroyed the famous door, and then allows new territories to become urbanized in the north and north-east, as shown in Fig. 5. Ramses square is a core for transports: tramway was built at the end of the 19th century, metro in the 80s and the construction 6th October flyover. They all exacerbated the strategic position of the station being at the crossroads of important structuring axes. The site is nowadays the city nerve centre with articulations between different historic areas and most recent ones at the cross of few main city roads: Ghamra, Ramses, Faggalal, Clout Bek, Gomhurieh, Sabtieh, Galaa, and Shubra.

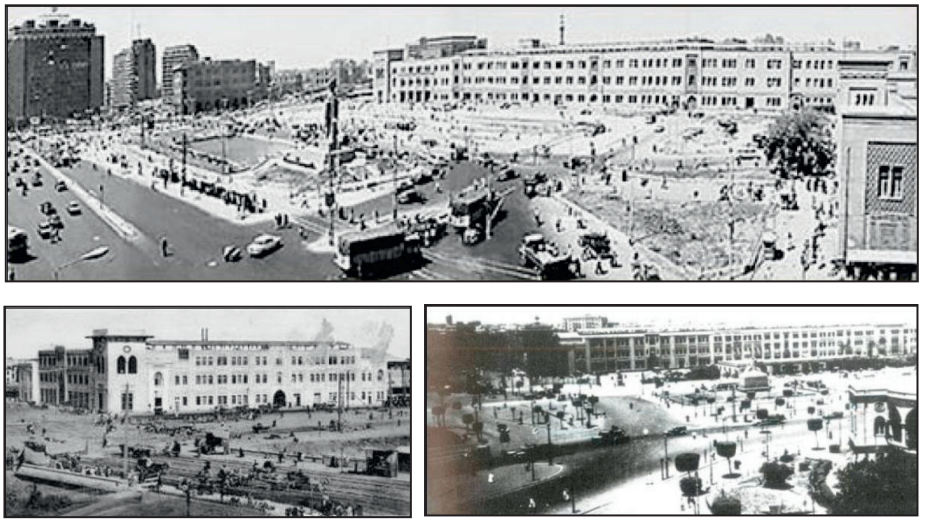


Fig. 5. Ancient photos for Ramses square area
(Source: BECT/AREP, 2009)

6.3. Relieve downtown congestion

Traffic overload is a major problem in Cairo city. A holistic vision of city transport system and services will contribute to problem solving. Resolving the conflict between urban dynamics and transportation of this site requires a development strategy of actions that implies evolution of each of the transportation modes in the city generally and in Ramses square specially. So, it is crucial to rethink of the functionality and transport services in the city in addition to rethink of a development strategy of railway transports at regional level, and then the role and position of Ramses station. This can be realized through the following:

6.3.1. Train stations

Limitation of streamlining numbers of regional lines servicing Ramses station. By collecting the two stations in one place and decrease the number of trips servicing the suburban. To develop new station in the suburban such as Shubra el Kheima Station (for Delta and Alexandria lines), Ain Shams Station (for Suez Canal cities' lines) and Giza (for the Higher Egypt lines) with the point of view of decentralization (BECT/AREP, 2009), as shown in Fig. 6.

Fig. 6. Decentralization of Ramses station, by developing new stations in suburban
(Source: BECT/AREP, 2009)

6.3.2. Metro network

As it is the most important means of transportation, with its currently operational overloaded two lines, added to it the 3rd line (nearly developed). Furthermore, an additional 3 more lines are under study. Similar to international capitals (New York, London, Paris.) transport system can strength Cairo regarding its size as a Metropolis and offer an indisputable alternative to road transports assuring efficient connection from CBD to new suburban (Shubra elKeima, Ain Shams, Giza). Sections located between Ramses metro station and intermediary suburb stations could then evolve quicker transport, higher capacity of wagons and adapted in step demand (BECT/AREP, 2009), as shown in Fig. 7.

Fig. 7. Example of Cairo Metro station, 3 photos of proposed developed Metro lines
(Source: BECT/AREP, 2009)

6.3.3. Tramway network

This network is old in Cairo, but now it is deteriorated – as service and running quality. However, this mean of public transport is highly recommended; trustworthy it attracts lots of people in big cities such as Paris or Barcelona. (BECT/AREP, 2009), as shown in Fig. 8.

Fig. 8. Example of proposed developed tramway lines
(Source: BECT/AREP, 2009)

6.3.4. Road network

This network is highly overloaded congested routes connected with 6th October fly-over needed to be reorganized to avoid entering downtown as a through pass during trips from west to east and vice versa, this is assuring traffic fluidity in the area. Adding to this, increasing the transit capacity in the tunnel by increasing the lanes from 2 or 3 lanes to 3 or 4 lanes (BECT/AREP, 2009), as shown in Fig. 9. Concluding, the integration between the previously illustrated means of transportation; train stations, Metro stations, tramway and road network (including the flyover) will give the optimum initial solution for the problem of traffic congestion in parallel with a number of suggested actions that will be illustrated in the next section

Fig. 9. 6th October flyover and roads network
(Source: BECT/AREP, 2009)

6.4. Reveal the central midpoint of this site

Given the importance of Ramses square location, it is suggested to promote the central midpoint of the site to accommodate motion, living, entertainment and restful spaces. Therefore, the following actions should be taken into consideration:

- Limit roads impact
- Optimize motions linked to transport centers
- Reveal existing usages
- Free public space and create central place to pedestrian
- Accompany movements for a new trading offer

Finally, reconsidering the site inter-modality is highly recommended. This can be realized by optimizing the station performance and the interconnection between different means of transportation.

6.5. The final solution of the square as a multimodal transportation hub project

The final suggested solution of Ramses square aims to optimize the interconnection that take place at network level. It is principally based on benefiting from the tramway line modernization to bring its end closer to the square, modifying the main metro access entrance and position it as close as possible to the conveying point of the whole flows and restructuring connections with coach station around a trading arcade. Reconsider station transport services so as to position back pedestrians in the heart of public space which is underpinned by the following:

6.5.1. Accessibility and quick car drop off

In order to allow a huge part of square space to be freed and thus to give back a genuine place in the very heart of the place, the suggested solution aims at the following:

- - Develop an underground drop off for the station with access from Ramses Street through an inclined section. This accessibility process intervene thus directly on Ramses Street functioning in order not to alter transit flow from this street to control road access to the station, and to secure pedestrian crossways.
- Use the under construction current parking and by creating drop off a level -1 (-2.50m). This embanked drop off allows the Square to be isolated from all flows as well as offering a pleasant place with easy access as close as possible to the station.
- Dedicate part of the drop off to delivery and post sorting.
- Increase the parking hold to create a parking extension on two levels.

6.5.2. Bus and minibus accessibility

- Identify and organize a coach station for buses and minibuses in the north of the station. The coach station is divided into two main functionalities: on one side significant needs for microbuses 140 parking places and on the other side regional buses with less significant needs 15 parking places.
- To create pedestrian connections that allows easy access to platforms from the coach station. To create a footbridge on the east of the exchange centre heart and to pedestrianism the road bridge in connecting again the station on both sides. To place along Ramses Street a drop off for minibuses.

In Figs. (10-13), it is clearly shown how the rearrangement of multi transportation modes is studied and collected from diffused unorganized to a multimodal exchange point hub concentrated in the middle of the square and strongly linked with all modes of transportation from all directions, after redesigning most of them, train station, metro station, buses, minibuses, microbuses stops and terminals, car parking, tramway and roads network (including the flyover that is converted to tunnel).

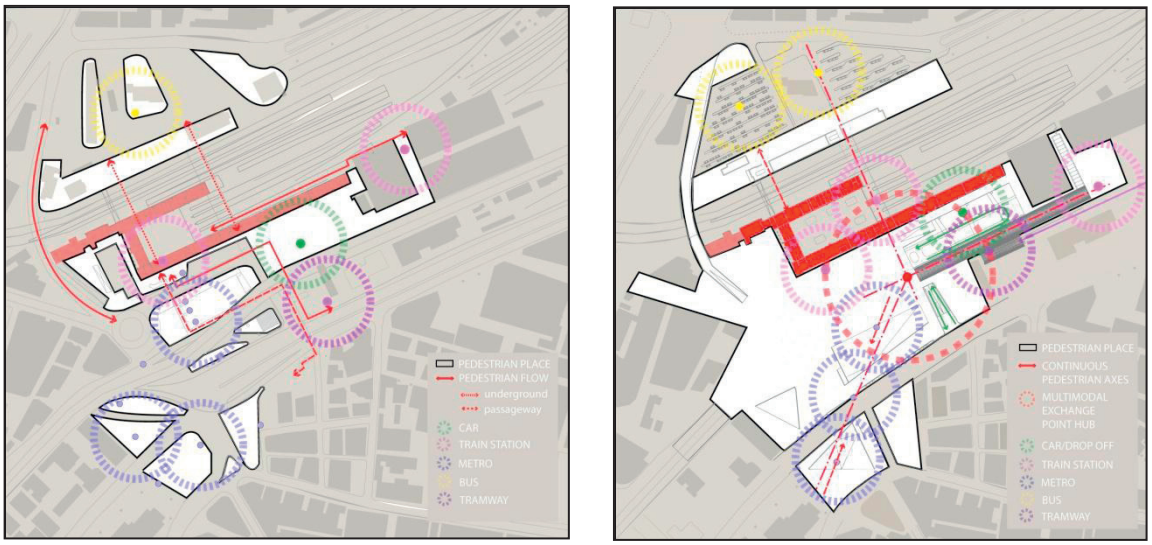


Fig. 10. Ramses square analyses before and after the solution development
(Source: BECT/AREP, 2009)

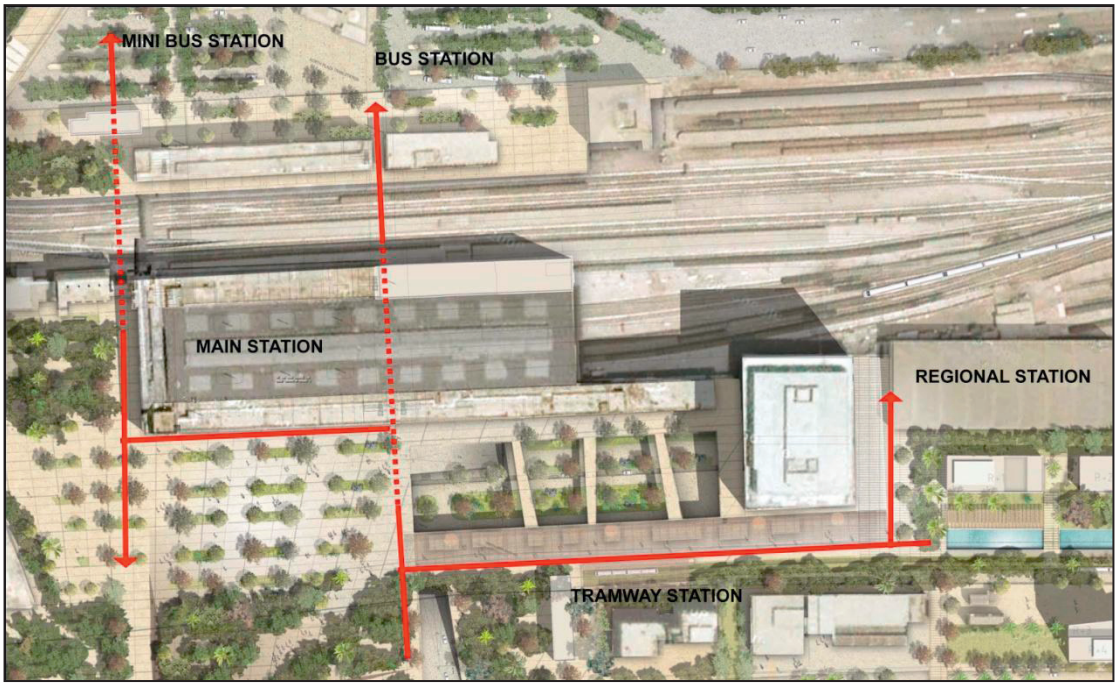


Fig. 11. The final design for the square area
(Source: BECT/AREP, 2009)

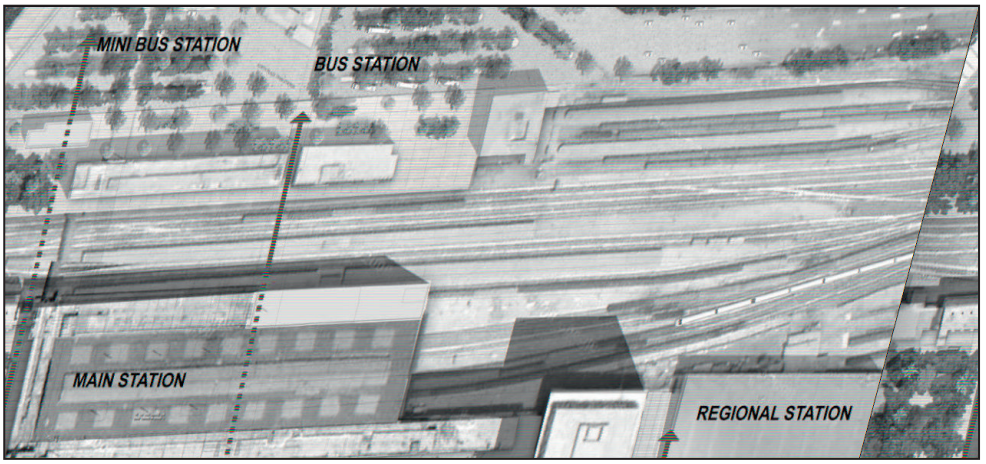


Fig. 12. Perspective shot and transversal section for the final design for the square area
(Source: BECT/AREP, 2009)

Fig. 13 General Perspective shot for the final design for the square area
(Source: BECT/AREP, 2009)

7. Findings and Discussions

Findings of this research were clearly remarked in the solution of Hubs, that it is highly needed to integrate multi modal transportation modes in central locations with numerous uses and activities. Within the case of Ramses square the use of the concept of Hubs crystallizes the organized layers of different modes of transportation to avoid congestion nodes at the squares that boiles with flow of traffic jams. In further research, it is highly recommended to study how to use Hubs on a grid of cental locations to form absorbtion nodes for traffic congestions and multi modes of transportation in a balanced way allover the highly denisity city and capitals – as Cairo. The use of "Hubs network" can articulate a civilized way of traffic movement through peaceful routes of mobility over all the city sides.

8. Concluding Remarks

The main agglomeration of GCR is currently subject to strong congestion and high density. The transportation network of the GCR is today well below international comparisons. It is saturated; congestion is common on the roads and the capacity and coverage of the public transportation network are insufficient to cope with the ever increasing demand. This results in congestion, traffic jams and wasted time and productivity for millions of Cairenes. Looking for non conventional solutions to resolve the conflict between transportation and urban dynamic of CGR was indispensable. This research focused on transportation hubs (Multi Modal Platforms), as a nodal that can handle several transport modes and more traffic, particularly in busy cities. It then illustrated the case of Ramses square which is located in the centre of Cairo, as an example of a multimodal nodal area, which can be a glary application as a hub solution example. Ramses square is a core for transports; railway, underground metro, surface tramway, major road axis, bus stops, minibus stops, microbus stops and terminals. The illustrated solution is principally based on the integration between several means of transportation; train stations, metro stations, tramway and road network (including the flyover) in order to give the optimum initial solution for the problem of traffic congestion in parallel with a number of complementary suggested actions. It is clearly shown how the rearrangement of multi transportation modes is studied and collected from diffused unorganized to a multimodal exchange point hub. The adopted methodology can be replicated in similar context either in Egypt or in other countries that face same problems of traffic congestion and conflict between urban dynamics and transportation, particularly in central centres of city capitals. It is suggested for further research to study the field of "Hubs networks", where the Hub can be the unit or prototype which be repeated to form a network. This opens the door for a new perspective to deal with the critical problems resulted from traffic congestion in urban agglomeration (city or capital).

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