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Transit Oriented Development and Sustainable Land Use Theories Impacts on New Mega Transportation Projects in New Capital City in Egypt

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ABSTRACT

Transit-Oriented Development (TOD) land use theories have been applied in multiple countries both developed and developing areas of the globe. It has proven its strength in maintaining a more sustainable approach in both urban development and lifestyle. The greater Cairo Region is witnessing huge transportation projects such as Electric Elevated Train that connect old Cairo with the new Capital City in the Eastern desert of Egypt. The New electric Train line is foreseen as a major clean transportation for number of important areas in greater Cairo, nevertheless it lacks more broader urban planning vision to use the transit main spots as a potential of applying a land use planning approach to maximize the urban potentials of these sites. This paper is providing a land-uses planning approach to maximize the land uses around these transits stops by providing the theory of transit-oriented development and propose the suitable solution that TOD offer to create more comprehensive sustainable urban oasis. The paper theorizes TOD land use planning, and what suitable development could be provided for such spots. Analysis of the locations of main train stops are provided, recommendation for one stop TOD development as a replica for other main stops to create more sustainable urban oases in the eastern desert of Cairo New Capital.

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1. Introduction

Among the traits of metropolitan growth frequently associated with sprawl are unlimited outward extension of development, low-density housing and commercial development and fragmentation of land-use planning among multiple municipalities. In addition, there is reliance on private automobiles for transportation, segregation of types of land use; race and class-based exclusionary housing and employment; congestion and environmental damage; and a declining sense of community among area residents (Wheeler, 2004). This paper focuses on the problems related to the growth of cities and the concentration of human population in large metropolitan areas represents huge challenges for

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modern urban societies. Economic growth drives urban expansion in the form of construction of businesses, housing, roads, leisure centres, etc., and the metropolitan regions face the growing problems of urban growth, including a decline in natural vegetation, wildlife habitats and agricultural land.

2. Sustainable public transportation and land uses evolution

New development at the metropolitan edge creates transportation problems such as increased daily commutes in and out of the city due to the lack of job opportunities in these new developments, and the increasing rate of private transportation used due to the high- and medium-income target population (Camagni, Capello and Nijkamp 1998). These problems are challenges to sustainable communities that are meant to be self-sufficient, with decent places to live and work, low fuel consumption, and adequate public services. Ideas such as "smart growth" have grown in recent years in North America, which seeks to curb growth and shape it in a way that lessens the effects of sprawl, while in Egypt with its ambitious sustainable vision for 2030, many mega projects have been discussed to transform urban agglomeration of Greater Cairo Metropolitan region into new urban development towards the eastern Corridor. Creation of the new Capital City just 40 Miles away from Cairo, accompanied by Mega transportation Projects that connect the eastern corridor with the old capital raise many questions and opportunities to transform the Egyptian current land uses into more sustainable development driven by sustainable public transit. The paper focuses of taking advantage of public transit mega projects occurring in the last 3 years to replace the private car dependency land uses system with Transit Oriented Development TOD as a concept of mega public transit which had proven its sustainability and new land uses philosophy in international best practice which can improve the vast urban growth in the eastern corridor and provide healthy lifestyle to the Egyptian new generations.

3. Material and methods

The paper is applying the theoretical framework of sustainable communities and transit-oriented development land uses theory to the current public transportation mega projects in Egypt Eastern Corridor to frame a better sustainable urban future vision that could describe spatial characteristics of future Egyptian settlements allocation and new land uses theory. It can be summarized as follow:

1. Define Transit oriented Development TOD and illustrate its advantages in terms of land uses that fulfil small communities' development along Eastern Rail corridor as a smart growth policy that is suitable to expand urban growth towards undeveloped areas around the New Capital city.

2. Encapsulate the fundamentals of TOD land uses spatial distribution into new Egyptian land uses structure that is based on transit, sustainable and vibrant communities.

3. Weave the results in a pilot proposal of how develop TOD around the main Transit Terminals of the new rail line connecting New Capital city with Red Sea settlements.

3.1. What is Transit Oriented Development and smart growth

Transit-Oriented Development represented a rethinking of approach for the location of land uses or transportation strategies. To promote smart growth, TOD creates vitality and lifestyle choices in modern sustainable urban communities planning. Transit – Oriented Development emerged as a consequence tram evolution as a mass public transport into the 21st century urban sophistications. This transportation system is designed to separate people from private cars in the favour of public transport use. Meanwhile, a fundamental rethinking of the public transport surrounding area became a real concern. There is no general accepted definition of TOD, typically, the definition of TOD is the mix of uses, the densities and the vicinity of public transport. There are many ways to state the definition for TOD with

common elements though: a mix of uses at high densities within walking distances from public transport stations; but places that stand for this kind of development are sites with sophisticated and diverse characteristics (C.T.O.D, 2004). Therefore, a tendency to force a one-size-fits-all solution onto the different types of sites is not appropriate. The nature of mega cities urban issues is growth, in terms of land uses distribution, allocation and directions. The land uses model and spatial growth of mega cities focused on the form of polycentric growth due to many reasons, one reason is the social and economic characteristics of population spatial distribution and lack of developed lands for residents. Another reason is the high cost of residents in the inner city which why mega city like Greater Cairo planning the closest planning model to describe urban growth is the polycentric form. Figure 1 indicates the form of creating sustainable communities within the mega city's fringes. That takes to succeed an essential sustainable public transport to connect these nodes with each other's and with the mega city to maintain the job opportunities and more sustainable walkable nodes.

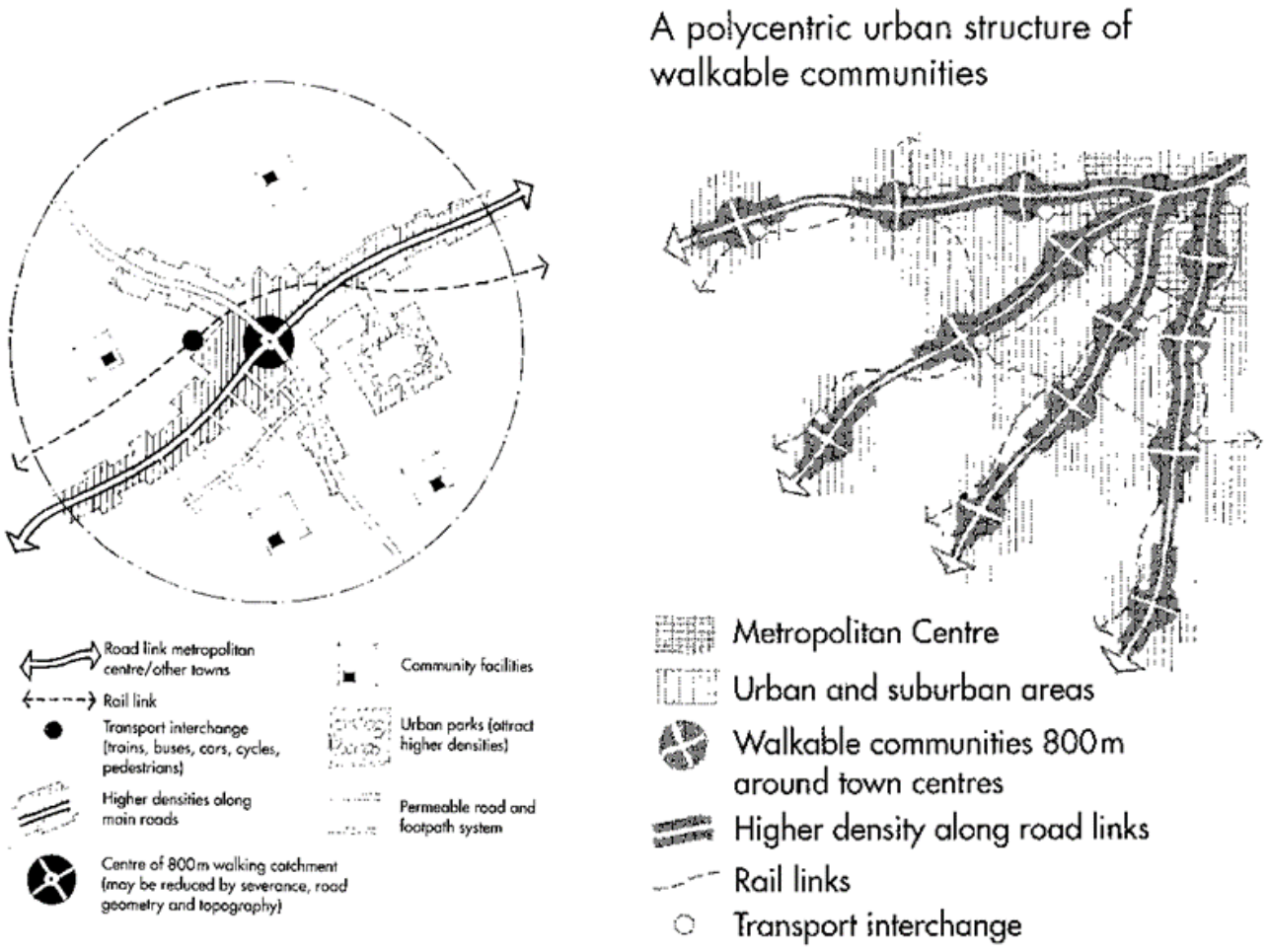

Figure 1. A polycentric urban structure of walkable communities and attributes of a walkable community (Source: Clarke, 2003)

3.2. Transit-oriented development TOD spatial land uses theory

The types of projects in the older parts of the city likely to be more different from the projects that are conducted in new development areas of city fringes, even with similar density goals (Youssef, M 2012).

We can categorize Transit – Oriented Development projects according to the project location of that depends upon the urban surrounding context, by analysing the level of densities, the level of land-use mixes and the public transport services (see figure 2). There has been, thus created a typology containing five categories. First mentioned in The New Transit Town: Best Practices in Transit Oriented Development (Gilbert and Ginn 2001), this delineation was further regarded as a starting point for defining TOD's typology.

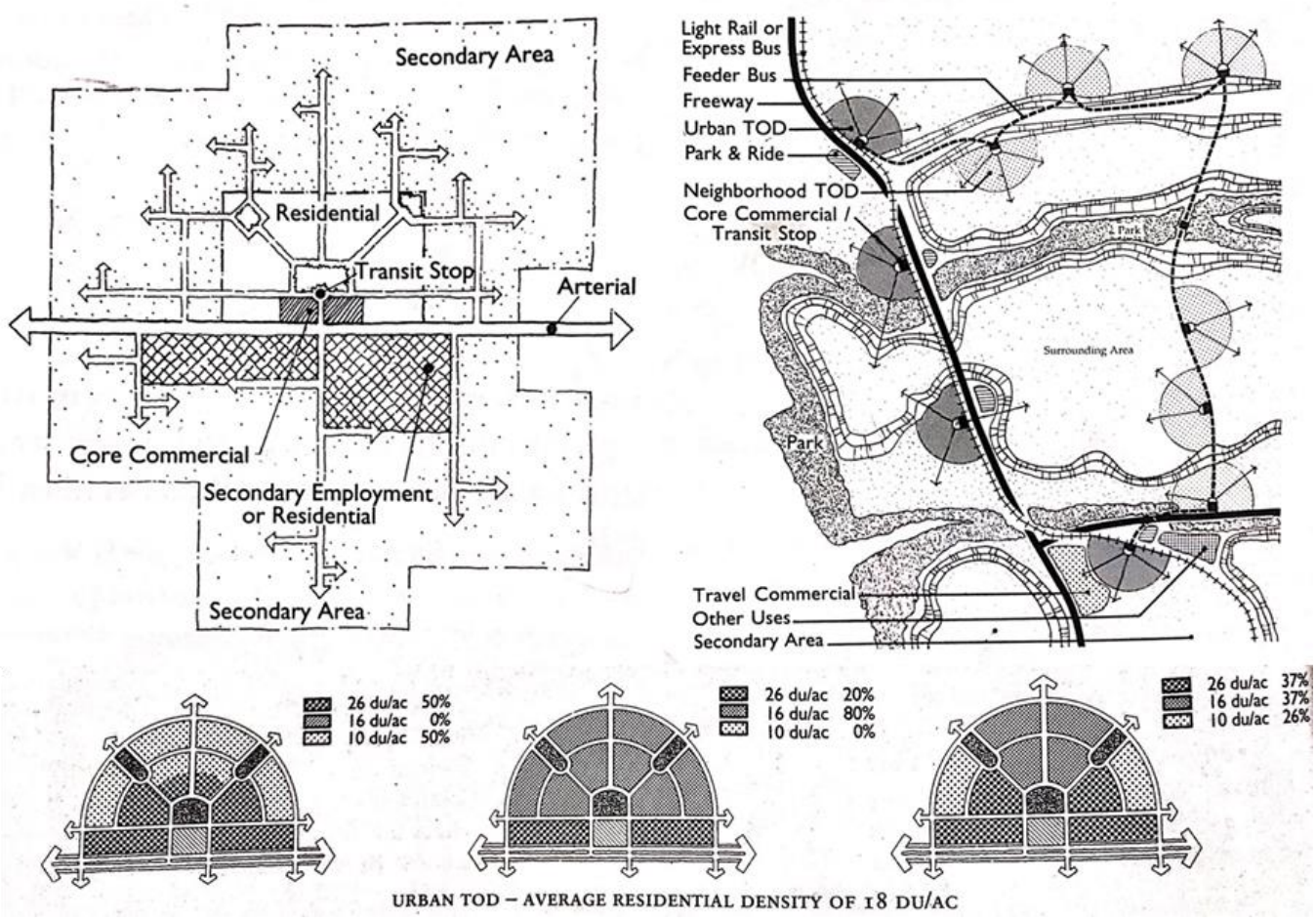

Figure 2. Transit oriented development TOD concept, land uses spatial distribution and building densities (Source: Calthorpe, 1993)

Land uses theories centralized around sustainability stated that, the urban form of a city is an important factor for achieving sustainability because the shape of the settlement pattern determines the patterns of private transport, fuel consumption and emission, and public transport. Breheny and Rookwood (1993) argued that the urban form might affect the rates of conversion of land from rural to urban. The urban form at all scales may be a significant determinant of sustainability. An environmentally desirable urban form may be seen as less desirable in economic and social terms, but Rogers (1998 p: 17) argues that mixed land uses can be acceptable within the successful sustainable urban neighbourhood. Adding to this, there is a conflict between high urban densities and the desire to green the city, therefore urban form and sustainability are linked in principle (Breheny and Rookwood, 1993).

It is possible to argue that some types of urban form are more sustainable than others. Thus, the urban form of the city will determine how successful sustainability will be in the city. It has already been

debated that compact cites have a big advantage in terms of saving energy and reducing automobile dependence by Elkin et al. (1991) and Breheny and Rookwood (1993), however, others argue that compact cities have their own downfalls, such as the acute impacts of pollution and other hazards on neighbouring activities (Ewing, 1997).

Beatley (2004) suggests three characteristics of urban form that make many other dimensions of local sustainability more feasible. These three aspects are public transit, walkable places and energy efficiency. However, these three policies are focused on the urban core and new development. In urban growth areas, he noticed that development studies always located these areas adjacent to existing developed areas. Cities such as Freiburg in Germany demonstrate the compact urban form, with a high density of new urban growth areas along the main corridors of its tram system (p: 250). In addition, urban growth should be planned in parallel with land uses. It is important to address land-use planning issues in relation to urban growth.

3.3. Land use planning and urban form to encourage public transit

The urban form of a city should be considered as an important factor in achieving sustainability. In fact, the shape of the settlement pattern determines the patterns of private transport, fuel consumption, emission and public transport. Breheny (1993) argued that urban form at all scales may be a significant determinant of the prospects for sustainability, Rogers (1998) argues that mixed land uses can be acceptable within the successful sustainable urban neighbourhood. It is possible to argue with some degree of certainty that some types of urban form are more sustainable than others. In that case, the urban form of the city will determine how successful sustainability will be.

3.4. Mega projects in greater Cairo metropolitan region and spatial land uses characteristics

The Egyptian urban context is strongly characterised by mixing of land uses within the community specially in older parts of greater Cairo, however new developments in greater fringes adopted more separation of housing areas and communities' services – surprisingly, the urban design characteristics of the elements of Islamic architecture encourage some of the current sustainability principles (Edward, 2006). In terms of mixed land use for instance, the Islamic urban form is characterised by mixing land uses at the neighbourhood design level, which reduces daily commuting to the city centre (Osman, 2006). It can be argued that the inner core of the greater Cairo Metropolitan region including low income and slum areas still preserve this concept. In the new development on the periphery of the city, the essence of Islamic architecture is still preserved, however, with more open and green spaces. As an example, the new development in the 6th of October, Elshrouq and New Cairo Projects represents these design characteristics.

However, mixed land use by itself does not provide sustainable urban development. Other aspects of urban development are crucial to the sustainability process at the neighbourhood level – aspects such as jobs, accessibility and environment protection. The existing urban development plans lack integration with other urban aspects. The crucial question is, with new transportation mega projects occurring by the government today; how far are they willing to restructure the planning regulations and procedures in order to achieve sustainable urban development? Aspects such as transportation planning, environmental protection and social aspects are still absent in the development process. Besides urban and landscape considerations in terms of open and green areas, Egyptian planners should focus more in the planning stages on issues such as mass transportation planning, providing job opportunities in the community, and decreasing the dependence on private automobiles. These planning considerations need solutions at different urban levels: regional, city and neighbourhood. Transportation mega projects which taking place in the Greater Cairo, new capital city and the eastern urban corridor are crucial for the land uses development of Egypt's future growth, although it lacks integrated vision with linking transport planning with land uses and urban growth.

The eastern corridor has a valued potential of being the future growth direction for Egypt's overpopulation issues. In order to face this problem, two of the major urban agglomerations area created, New Cairo City in the beginning of the nineties, and New Capital City in the new Melina. Both re located in the eastern urban corridor in order to link Greater Cairo with economic potentials and activities in located in the Red Sea region (Ain Sokhna Port City).

The main mega transportation projects currently running in New Capital City and Eastern corridor are consists of two major lines:

1. The elevated regional line which connects the Metro network lines within inner Cairo to the eastern border to expand public transport to new settlements in eastern Cairo which include Al Abour city, New Cairo City and New Capital City
2. The electric regional train which connects New Cairo City and New Capital City to reach the Red Sea for a distance of 100 kilometres to Ain Sokhna which is a major commercial port and an important node that connects Egypt with Asia and Europe.

These two lines is an ambitious project to provide connectivity and guide urban growth towards the eastern corridors. The advantage of creating these two lines should be maximised by creating number of urban nodes that can play a major rule in the new smart growth policy. Transit oriented development provides a planning model that can fit into these two transportation lines, TOD can be one of the methods of creating walkable sustainable urban communities along the 100 kilometres which can solve the over populated Cairo. Figure 3 indicates the new transportation mega projects and urban agglomerations in the Easter Corridor.

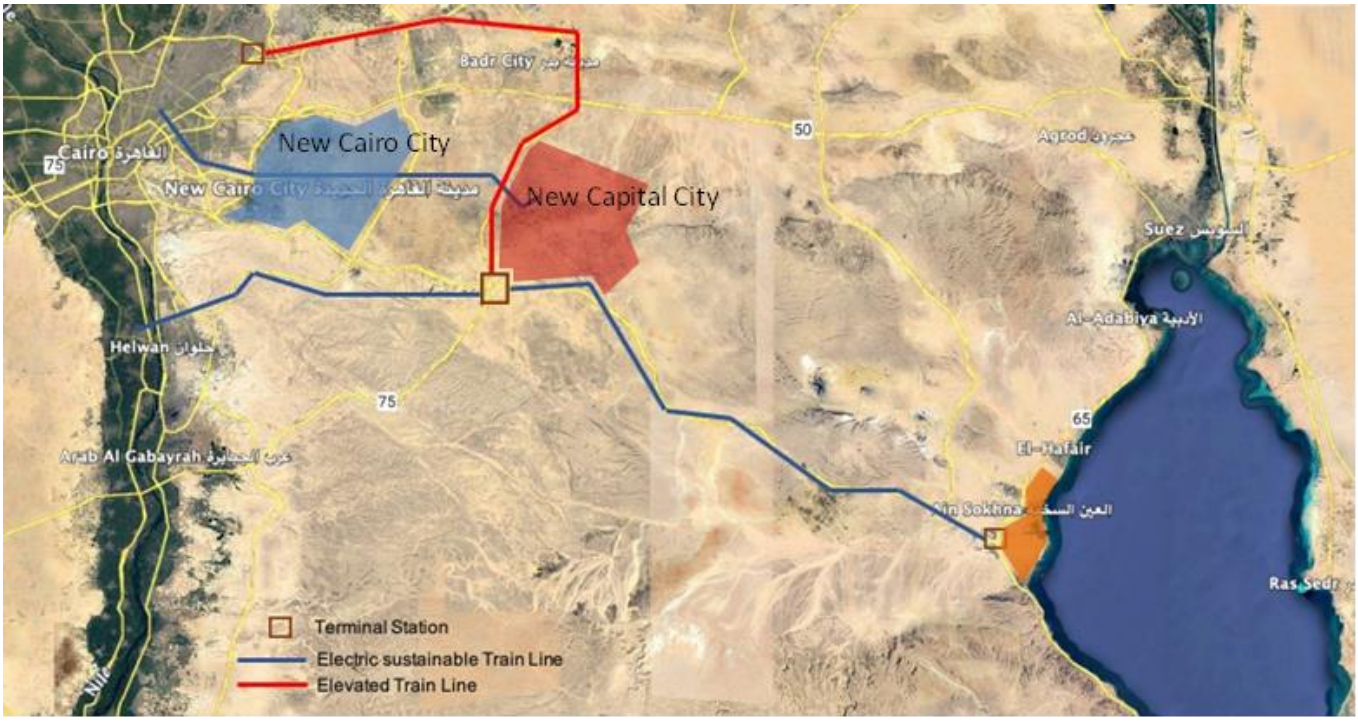

Figure 3. Mega transportation lines and urban settlements in Egypt eastern corridor

4. Discussion: Utilising transit-oriented development land uses theory in the Egyptian context

4.1. Transportation and land uses spatial distribution

Transportation systems have been a powerful force in determining the form of cities. Automobiles have accelerated the urban growth trend because they have allowed people to reach the city periphery in

a short time. Consequently, new towns and satellite communities have existed in metropolitan areas as an answer to the high density in the core city coupled with the availability of a good transportation network. However, later, conflicts became apparent between transportation growth and land use and the environment in the urban context. The city faced problems such as traffic congestion, air pollution due to daily car usage, daily commuting, generation of noise pollution, roads and parking area shortages, severe limitation of walking and cycling, public safety, etc.

In addition, evidence of urban growth should be planned in parallel with land uses are depicted in the last 10 years in such places like New Capital City, however comprehensive integration of land uses, and transportation is required for Greater Cairo region to make it more sustainable. In the 1970s Cairo Masterplan, zoning laws were set in place and Structural Avenues were designed to direct linear growth by attracting residential and commercial density along a mass transportation lane. In 1974, the main mass transit line began to operate along those avenues. This starts with a clear definition of the existing urban context assets and goes on to consider how they can be integrated into one holistic long-term framework (Youssef M., 2012). Transit-Oriented Development (TOD) advocates such as Peter Calthorpe (1993) describe TOD as consisting of residential and commercial Centres that are designed to maximise access by public transportation. A TOD neighbourhood has a centre with a rail or bus station, surrounded by relatively high-density development, becoming progressively less dense as it spreads outwards. For example, the neighbourhood centre may have a transit station and a few multi-storey commercial and residential buildings surrounded by several blocks of townhouses and small-lot single-family residential and larger-lot single-family housing farther away (Calthorpe, 1993): according to Calthorpe, the major TOD is characterized by these guidelines

- The neighbourhood is designed for cycling and walking, with adequate facilities and attractive street conditions.
- Streets have connectivity and traffic calming features to control vehicle traffic speeds.
- Mixed-use development that includes shops, schools and other public services, and a variety of housing types and prices, is a feature of each neighbourhood.
- Parking management is designed to reduce the amount of land devoted to parking compared with conventional development, and to take advantage of the parking cost savings associated with reduced automobile use (Calthorpe, 1993).

4.2. Urban growth policy and land uses international best practise

The international examples, especially those from North America, give much attention to smart growth. In addition, selection of best practise is carefully chosen to match the size and complexity of Mega cities that can be found in Greater Cairo, such as Portland, Greater Vancouver and Curitiba. The purpose of smart growth is not to curb the urban growth of the city, but rather to control this growth according to sustainable development principles by preserving the agricultural land, wilderness, important natural habitat and native species of fauna and flora (for Example Portland and Greater Vancouver). Urban growth is one of the most pressing challenges for sustainable urban development – cities cannot expand forever (Bell and Morse, 2003). However, the solution always has been to put into practice the regulations and management tools for controlling urban growth in the city. Uncontrolled growth causes many secondary problems such as private car use, congestion and pollution. Consequently, one of the policies for controlling urban growth is the "compact city". Advocates of the compact city, such as Breheny, suggest that the compact city can reduce automobile dependence and save energy through increasing the population density and mixed land use. The researcher agrees with Breheny, in the case of the Egyptian urban context, as the characteristics of the compact city exist in Cairo's urban core and part of the city periphery. The population density in these areas has reached

more than 1500 per square metre. In addition, daily commuting is generated because of a lack of job opportunities in these areas (Bell and Morse, 2005).

Apart from the compact city, urban growth policies suggest that land use and transport integration could control rapid urban growth. In Curitiba, Brazil, for instance, zoning laws were set in place and structural avenues were designed to direct linear growth by attracting residential and commercial density along a mass transportation lane. This allowed the city to meet strategic objectives that sought to minimise downtown traffic. In addition, the policy encourages social interaction by providing more leisure areas and pedestrian zones in the centre of the city. Also, the use of public transport and cycling is encouraged in order to achieve an environmentally healthy city.

In Vancouver Regional District, Canada, liveability remains the central guiding theme; this is embodied in its regional growth management strategy, the Liveable Region Strategic Plan (LRSP). This focuses on land use including the green zone, regional town centres and higher density centres including downtown Vancouver, and on transportation policies. Its aim is "to help the region develop in a way that maintains and protects the environment and at the same time guides the location of urban activities to create a high quality of community life" (GVRD, 2006 p: 15). The growth management focused on regional and municipal town centres. The policy's philosophy is that, by creating communities that are more complete, it would result in more jobs closer to where people live and accessible by public transport, and shops and services nearer to home. In addition, the policy advocates a compact metropolitan region, by increasing transportation choice through the use of public transport, walking or cycling. Another example is in Portland, United States: the strategy prepared for the region, referred to as region 2040, and developed through an extensive public process, is enabling the region to expand by encouraging urban form in the city. The policy is steering urban growth into a series of centres along the spine of the light rail system. The goal is for 85% of new residents to be within a five-minute walk of a public transport station.

4.3. Urban growth and land uses issues in Greater Cairo metropolitan region

With regard to mass transportation in the GCMR, both public transport and private vehicles are considered as vital means of transport in the Egyptian urban context. The excessive use of private vehicles is the result of the public transport system not being efficient enough to serve a large population such as Cairo has. Consequently, alternatives have been initiated to solve the need for daily transport such as private buses and mini buses. Yet the biggest project to have been conducted in the last 20 years is the GCMR underground with two lines connecting different parts of Cairo (apart from new towns). In addition, a third line is under construction. Although a large section of the population depends on the underground, the project itself did not prevent private automobile ownership increasing. This implies a critical question: is it a cultural issue and a matter of prestige in the GCMR to own a car or is there a lack of community education about how useful public transport is to protect the built environment? Actually, the answer to that question is complicated; it can be safely argued that: The notion of owning a car in Egyptian society is related to the concept "everyone is looking for prestigious social rank, and a car is one of the necessities, which is correlated to power, power in the sense of giving the impression of how important the citizen is in the society and how citizens are evaluated in Egyptian social life.

The concerns about mass transit transportation and Transit-Oriented Development, have been accepted within the Egyptian urban concept, and the starting point for this application should be the new towns and new development (Madbouly, 2006). The urban development characteristics of the new cities in terms of environment design, open spaces and mixed land match the principles of sustainable development, but still lack elements such as the connectivity in terms of public transportation. The current transportation system in the new towns is designed to encourage automobile dependence in these isolated areas (Fahim, S. 2006).

In addition, another reason that new towns are unsuccessful in attracting residents is the lack of job opportunities, as most of the jobs available are located in central Cairo. The urban policy fails to connect urban development in new towns with job opportunities and this creates a huge amount of daily commuting from new towns to the inner city. This discussion raises questions about the basic urban planning procedures that are followed when preparing master plans. The new urban planning movement is concentrating on action plans and small projects as a key for successful urban planning. This shift between master plans and action plans initiatives may be a step forward to achieve sustainable urban development in the GCMR. However, in order to achieve this, substantial changes need to be implemented in the old Urban Planning Law, as the Law has not been updated since 1982. The step towards changing the Law in a way to introduce sustainability is a first step; followed by specific, detailed regulations on how to alter the existing procedures and introduce a set of principles and tools to achieve sustainability, such as environmental planning, Strategic Environmental Assessment, ecological aspects. Box 1 indicates the 2030 Egypt sustainable vision objective regarding public transportation and sustainability, it depicts the government will to introduce clean and reliable public transportation means to the Egyptian by increasing the number of mass transport means to provide better life style to the Egyptians population.

Key Elements:

- Execute a project for increasing numbers of means of mass transportation in cities while increasing dependence on the private and non-governmental sector in provision of such services
-- Support roads with modern technological tools to monitor roads and traffic flow in order to enable responsible authorities to raise planning efficiency and manage traffic congestion in a better way.
- Adjust regulations and laws for increasing the quality requirements of means of mass transportation for private and non-governmental sectors
- Develop a national database to calculate numbers of users of modes of public transportation

Figure 4. Sustainable public transportation means objective in Egypt vision 2030

5. How TOD fits in with sustainable urban communities in the eastern corridor

Within the Egyptian urban context, many of the features of Transit-Oriented Development already exist in the new development projects in the GCMR, especially in the new settlements and towns, as a large section of private urban developers have recently become aware of the principles of environmentally oriented planning (Youssef, 2019). In addition, the government's biggest housing project "Youth housing project" is devoted to a healthy environment design. As part of an interview conducted with a number of government officials, one of interviewee pointed out that the missing ingredient of the TOD in the Egyptian urban context is "how to convince residents to alter private car usage and depend on public transportation alternatives when public transportation and connectivity is in urgent need of improvement first?".

Another interviewee stressed of an urgent need to update the Terms of References (TOR) and building regulations of urban housing projects is required from the Greater Cairo Region Authority to achieve sustainable urban form and to maintain a level of urban environment that is suitable for living (Youssef, 2019). In addition, the government should seek improvements to the public transportation network not only in terms of traffic management but also in terms of transportation planning of the existing

transportation network, to achieve connectivity of the different parts of the city and convince the residents to use public transportation (Youssef, 2019). The sustainable vision of Egypt 2030 has a great deal concerning public transportation, one of the major objectives of Egypt government must achieve is to Increase the capacity and quality of means of public transportation in cities: The 2017 Government Electric Mass Train proposal program aims to improve the quality of the urban environment in governorates through increasing citizen dependence on modes of public transportation (see Figure 4).

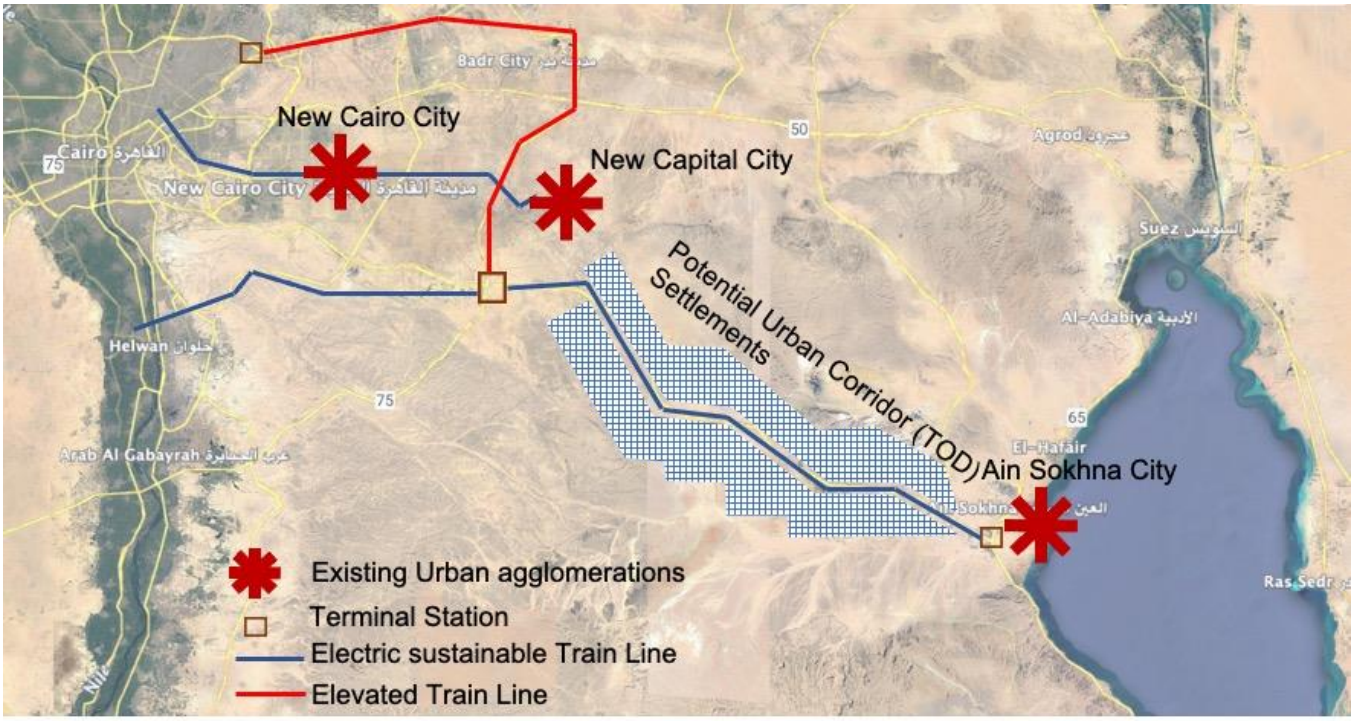

Figure 5. Proposed smart growth transit oriented development in Egypt eastern corridor (source: Government Development Vision, 2017)

6. Proposed land use model for Transit Oriented Development TOD in new capital transit corridor

Figure 6 describes the Author planning concept for each transit nodes inspired its shape of the human DNA which provide potentials in planning land uses and green industrial areas in a way each node contain a transit stop that works as a central area, followed by residential areas that will be walkable from transit stop and on the fringe of each node clean industrial parks are located.

The transit system proposed, above left connecting each land use with other areas with tow sub systems major transit line that connect each node with the other node and public transit with connect various land uses in each node. Each node can major a different economic base that allow multiplication of nodes with various planning economy that depends on each node's function in the transit system.

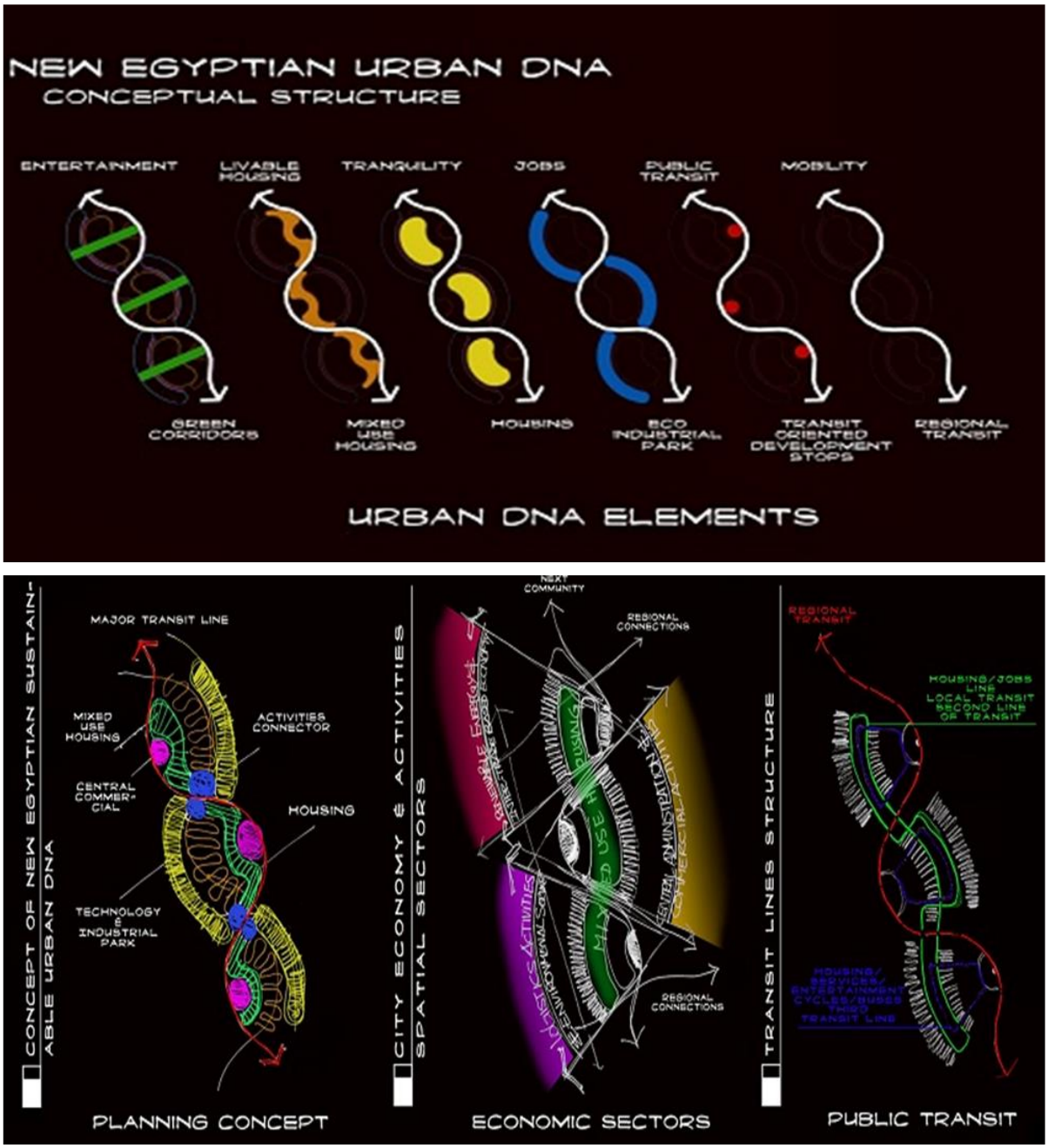

Figure 6. Proposed urban planning concept and design in one TOD in Egypt eastern corridor

The starting point of transit system is shown in figure below left close to Suez Canal and acts as ignition points for the proposed new sustainable urbanism that may suite the Egyptian urban growth model in the future. The spatial concept demonstrates the elements of new urban design DNA proposed for new Egyptian transit-oriented development system in Sinai, it shows the central area of major transit terminal surrounded by first ring of mixed use and commercial activities, the second ring contains the residential areas and the third rings shows the green industrial areas. The node centralized by green corridor integrates land uses together and creating major Green Park that utilized as a transition point for public transport system that divided the node to major previous mentioned land uses.

7. Conclusions

- Smart growth is the key element to create more sustainable new communities, it should be coupled with land uses management
- Transportation planning is essential when managing urban growth, public transit and alternative solutions should be introduced as an incentive for population to move to new communities
- Egypt 2030 in need of a smart growth management and TOD such in the case of connecting Cairo with new capital but in the same time cautions should be taken of a big agglomeration, in that case transit-oriented development could be one solution to avoid vast urban growth
- No clear adaptation of sustainable urban development policies and instruments to face transportation problems in both existing cities and new proposed cities. The 2030 vision is ambitious and has a good intentions of better urban development future but lacks integration with an overall systematic long term urban policy. The concept of public transit is introduced which is a further step for creating sustainable means of transportation in the near future which will help of targeting sustainability principles. Smart growth and transit-oriented development proved to be sound policies and instruments to achieve sustainable communities. providing these settlements with jobs and activities can achieve the spread of urban population from the 10% concentration of land to the 90 % vacant land. The 2030 strategy is very ambitious and full of good intentions, but reformulation of the strategy is essential in terms of settlements population size and urban planning spatial configuration. It should have a very realistic urban strategy that can achieve more sustainable new communities rather than big agglomeration media propaganda new communities. It should concentrate creating a small size new communities' network and connected with the right public transit.

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The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

Ethics statements
Studies involving animal subjects: No animal studies are presented in this manuscript.
Studies involving human subjects: No human studies are presented in this manuscript.
Inclusion of identifiable human data: No potentially identifiable human images or data is presented in this study.

Conflict of Interests
The author declares no conflict of interest.

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