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FTN – Frequent Transit Network: Transit Strategies towards Achieving Transit-Oriented Development in Alexandria City, Egypt

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1 ABSTRACT

Land use policy and transport policy are normally integrated through transit-oriented development (TOD) strategies. (TOD) is a "mixed-use community", that encourages people to live near transit services and to decrease dependence on their driving. Instead of requiring riders to consult a timetable or wait for extended periods of time, transit service is most appealing when it is frequent enough that riders can arrive at a stop knowing that a bus or train will arrive soon. Frequent Transit Networks (FTNs) aim to deliver services in high-demand areas in a convenient, connected, and memorable. (FTNs) are intended to serve the locations that the majority of people want to visit most frequently and to make service convenient by operating at least every 15 minutes from early morning until at least mid-afternoon. This paper discusses, evaluates, and looks into the possibility of implementing TOD and FTNs in Alexandria, Egypt. Alexandria is experiencing a sharp increase in transport demand as a result of its rapid urbanisation. With the narrow streets and limited spaces the rapid urbanisation process has led to a significant increase in traffic volume. This paper adopts the Frequent Transit Network (FTNs) strategies in identifying corridors linking the city's urban centers and the nodes where these corridors intersect. The main purpose is to direct growth , development and to create a proposal for a "System Backbone" that provides a structure for other services. Expected findings from this study is to perform a framework that identify potential (FTN) solutions for the city. It also proposes a "Key Corridor Network" for the bus routes and light rail transit, emphasising corridors in which combined transport services could provide a more efficient operation of the city's public transport.

Keywords: Key Corridor Network, Convenient, Frequent Transit Network, Mixed-Use Community, Transit Oriented Development

2 INTRODUCTION

2.1 A brief overview

Frequent Transit Networks (FTNs) and Transit-Oriented Development (TOD) are related ideas with the same goal of enhancing urban areas' liveability and sustainability of transportation. An FTN is a high-frequency bus, train, or metro network that puts accessibility and dependability first and makes it easy for people to get around the city. TOD is a land-use strategy that encourages mixed-use, pedestrian-friendly, and compact urban development around transit stations in order to maximise the potential of FTNs. By reducing reliance on automobiles and fostering sustainable mobility, FTNs and TOD provide an all-encompassing solution to urban transportation issues that also improves livability, economic vitality, and social equity. Therefore, any city seeking to create a more sustainable and equitable future should prioritise planning and implementing FTNs and TOD.

2.2 The Essential Elements of Frequent Transit Networks

Frequent Transit Networks are intended to deliver service in highly populated areas in a convenient, connected, and memorable way.

2.2.1 Convenient

Frequent Transit Networks operate at least every 15 minutes from early in the morning until at least mid-afternoon, making service more convenient. The most direct route possible is planned for each route.

For example: Seattle's Frequent Transit Network (FTN), which was first mentioned in the Transit Master Plan, offers a long-term vision of connected bus routes crisscrossing the city, offering high-quality and frequent transit service to all residents, employees, and visitors of Seattle. This network aids in directing the service investments made by (Stock Tank Barrel per Day) STBD.

Three categories of routes are established by Seattle's FTN: Local, Frequent, and Very Frequentas shown in Fig 1. The FTN emphasises frequent service that is available every day of the week (18 to 24 hours). All Seattle residents now have more transport options thanks to this interconnected network of routes. The FTN actively develops a transit network for the Seattle of the future while adjusting frequency around times of the day when transit demand is at its highest.

Fig. 1: FTN Frequency Targets.(Source: Seattle's Frequent Transit Network)

2.2.2 Connected

Frequent Transit Networks are made to take passengers to the places they want to go most frequently, including downtowns, urban neighbourhoods, mixed-use corridors, employment centres, and significant institutions like universities. Additionally, they can establish a de facto "system backbone" that acts as a framework for other services. Frequent Service Networks can offer a similar framework for smaller systems, with lower frequency routes and specialised services acting as connections to the Frequent Transit Network, much like how large urban systems are built around the backbone that their rapid transit systems provide.

2.2.3 Memorable

Four main strategies are used by frequent transit networks to make their services memorable: distinctive branding, frequent transit network maps, straightforward service models, and simple schedules.

Distinctive Branding: To increase awareness of the services offered, many transit systems brand their frequent transit networks. Unique branding and clever marketing can help bring new users into the system, decreasing reliance on cars overall.

Frequent Transit Network Maps: Numerous systems create unique Frequent Transit Network maps that are intended to draw attention to and distinguish frequent services from other services.

Straightforward Service Models: Frequent Transit Networks have straightforward service structures that are made to be simpler to remember. They usually travel as directly as possible along the main roads.

Simple Schedules: Frequent Transit Networks also frequently have simple schedules, with scheduled transit services operating at regular intervals (clockface headways) that are simple for passengers to remember.

3 LITERATURE REVIEW

By analysing related scientific studies to determine the research gap that is most likely to be true between them, a meta-analysis of the literature is used. It was determined that:

3.1 Problem definition

Planning guidelines for sustainable mobility have gaps from the perspective of sustainability principles. While issues like strategic land use and impacts on non-motorized travel are frequently overlooked unless they are a part of integrated land use and transportation studies (TOD) (Transit Oriented Development) or comprehensive urban development plans,transportation planning traditionally addresses various issues related to vehicles, safety, maintenanceand infrastructurerelated environmental impacts. Which led to the

observation that there is a general trend, “Modal shift from public transport to private transport” which is described below as shown in Fig 2. The challenge at the spot is to use a frequent transit network strategy to achieve transit-oriented development while directing the opposite “Modal shift from private to public transport” direction.

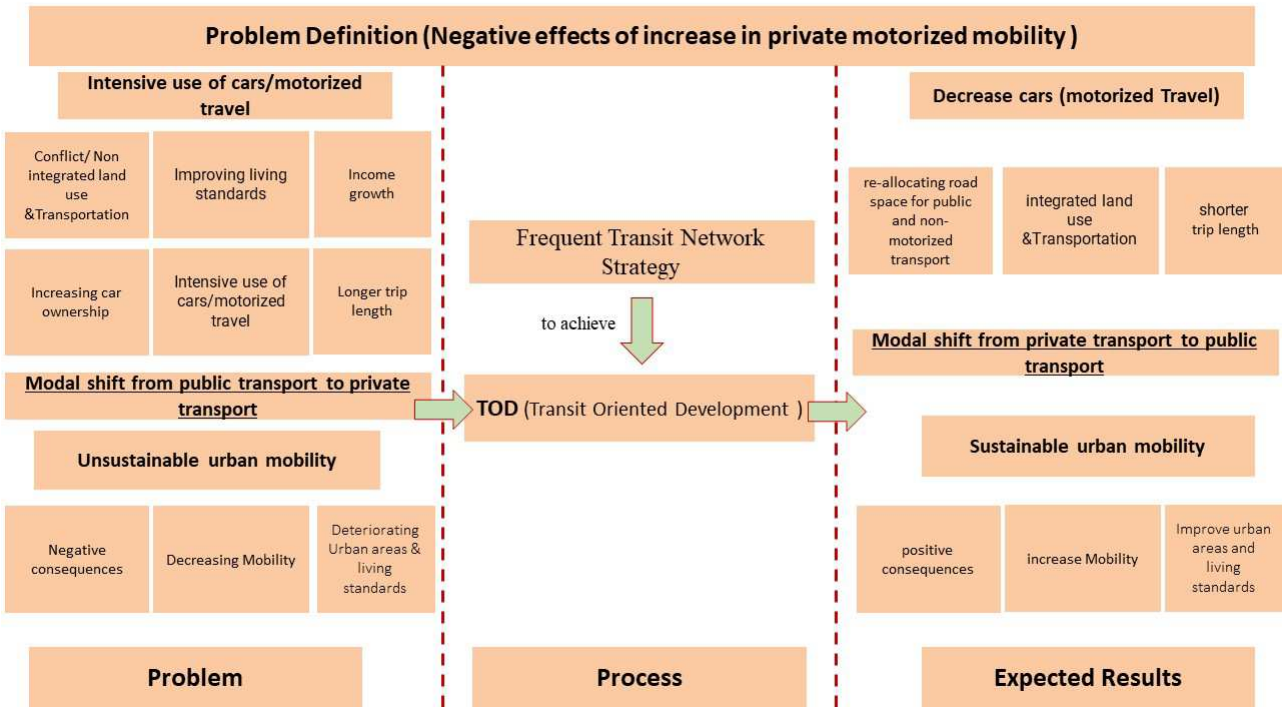

Fig. 2: Problem Definition (Negative effects of the increase in private motorized mobility). (Source:authers)

4 METHODS AND TOOLS

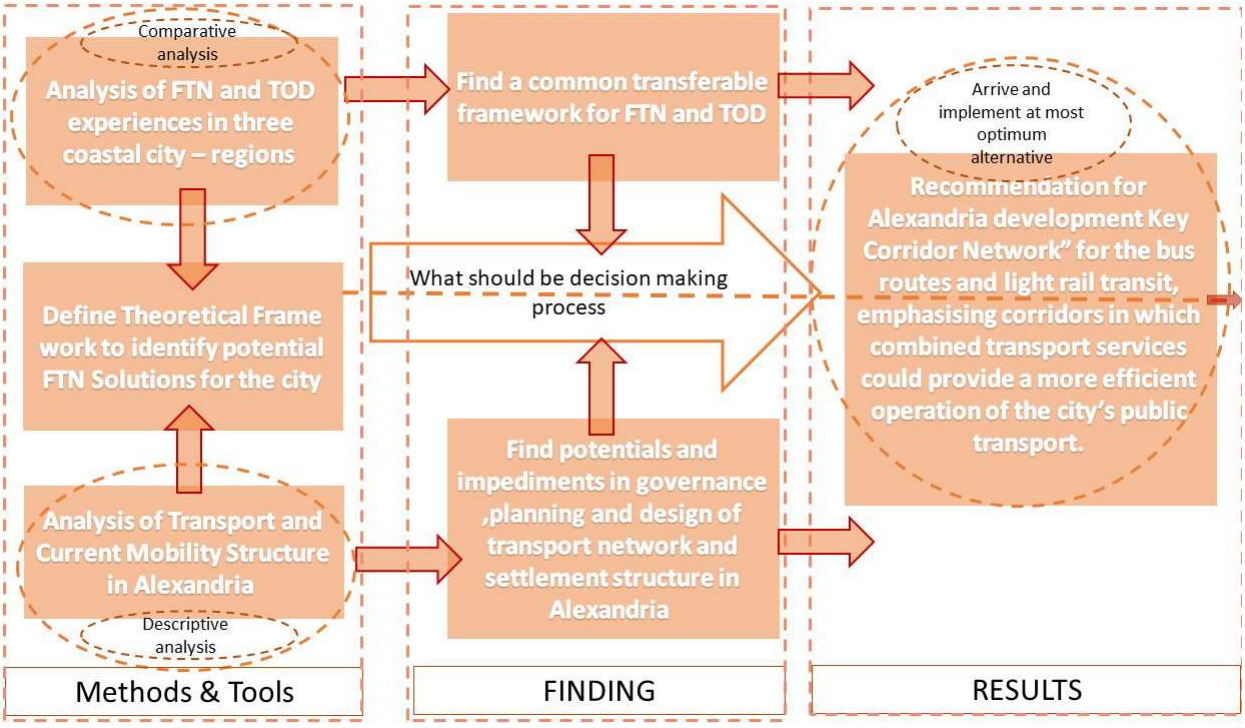

Fig. 3: Chart showing the sequence of work in paper (Methods &Tools – Finding – Results) constantly. (Source:authors)

4.1 Comparative analysis

Comparisons are made of the selected case studies through analysis of FTN and TOD experiences in three city regions.

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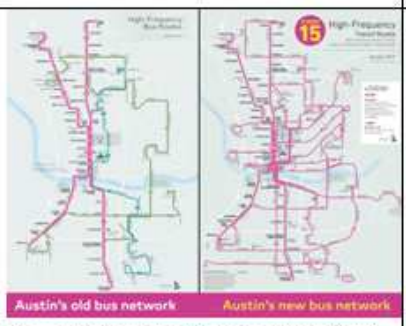
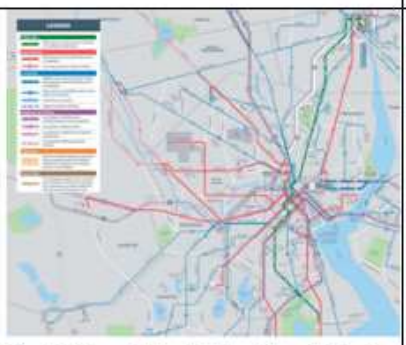
NO	Name/ Description	Map	Service /Used Techniques
	Portland, OR: By enhancing infrastructure and increasing frequencies, TriMet developed its frequent service network. The regional hubs where many riders live and work are intended to be connected by lines of the frequent service network. For transportation to and from Portland International Airport in the wee hours of the morning and late at night, TriMet is adding a new bus line. In order to reduce wait times, TriMet is also splitting its longest bus line and increasing frequency in East Portland. Increased access to dependable, safe transport throughout the region, better connections to jobs and other destinations, and more service are all benefits of the expansion.	 Fig. 3: Map of Trimet Frequent service (Portland ,OR)	**Services:** • Every 15 minutes or better most of the day, every day • five light rail lines • 24-hour service • Later trips on MAX and all-night bus service to PDX • A new frequent service line • Serving the suburbs • Splitting our longest bus line • A more comfortable ride **Used Techniques:** 1. New shelters and sign poles with service information a(nd stop identification numbers . 2. Bus stop re-spacing and curb extensions . 3.Better pedestrian access . 4.Traffic signal priority . 5.Bus-only lanes .
2	**Austin, TX:** Capital Metro's "High Frequency Transit Routes" network is brand-new, and it serves Austin. The bus system in Austin underwent a redesign in June 2018. Since then, Capital Metro has seen a 4.5% increase in ridership, making it one of the few transit systems in the country to see rising ridership. With a focus on frequent service, Capital Metro launched its Cap Remap bus network redesign in 2018. There are 15 routes in the new extensive transit system.	 Fig. 4: Map of Austin's bus network (old - New) (Austin ,TX)	**Services:** - every 15 minutes from 6:00 AM to 8:00 PM, seven days a week. - 13 metro bus routes - 15 routes -Thirteen MetroBus routes that run every 15 minutes from 6:00 AM to 8:00 PM, seven days a week. -Two MetroRapid BRT routes that operate every 10 minutes during peak hours on weekdays **Used Techniques:** •Prioritize transit and walking. •Redesigning of its bus network . •Transit Joint Development
3	**Rhode Island:** (Potential Rhode Island Frequent Transit System) A "Key Corridor Network" consisting of the Rapid Bus line (the R-Line), key corridor bus routes and transit emphasis corridors where combined services on multiple routes provide frequent service was created by RIPTA for the Providence Metro area as part of its 2013 system redesign.	 Fig. 5: Map of Rhode Island Transit Master Plan (Rhode Island)	**Services:** • every 15 minutes. • the Providence Metro area • Rapid Bus line (the R-Line), key corridor bus routes **Used Techniques:** •Developpinng a "Key Corridor Network" . •Crosstown routes that connect service outside of downtown . •Additional radial routes to provide frequent service to additional areas.

Table. 1: Comparison of strategies that were used in three cities to applyFrequent Transit Network (FTNs). Source: authors after Tri-Met's Frequent Service Network Capital Metro's new frequent transit network -RIPTA's Key Corridor service

4.2 Descriptive analysis:

Analysis of transport and current mobility structure in case study (Alexandria):

With 35% of trips and a portion of the 40% of trips that are internal to the East zone, the "east - city centre" represents the main ridership potentialwhich is described below as illustrated in Fig 6. The city center's north and south corridors exhibit a moderate flow that is clearly on a different scale from the "east-city centre" flow. Today, the "west - city centre" is less significant. It may change in line with anticipated western development, but most likely in the medium- to long-term..

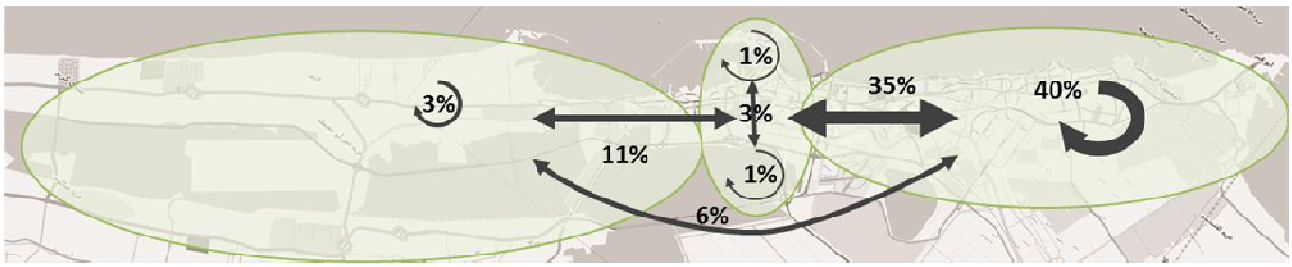


Fig. 6: Main public transport flows in Alexandria (Source: Egis 2014 surveys)

The sketch belowas illustrated in Fig 7 shows how the internal journeys of the eastern zone are represented. It demonstrates that the primary demand is also in an east-west direction there.This comprehensive analysis leads to the conclusion that the "East - City Centre" connection should be given priority (the scope of work) .

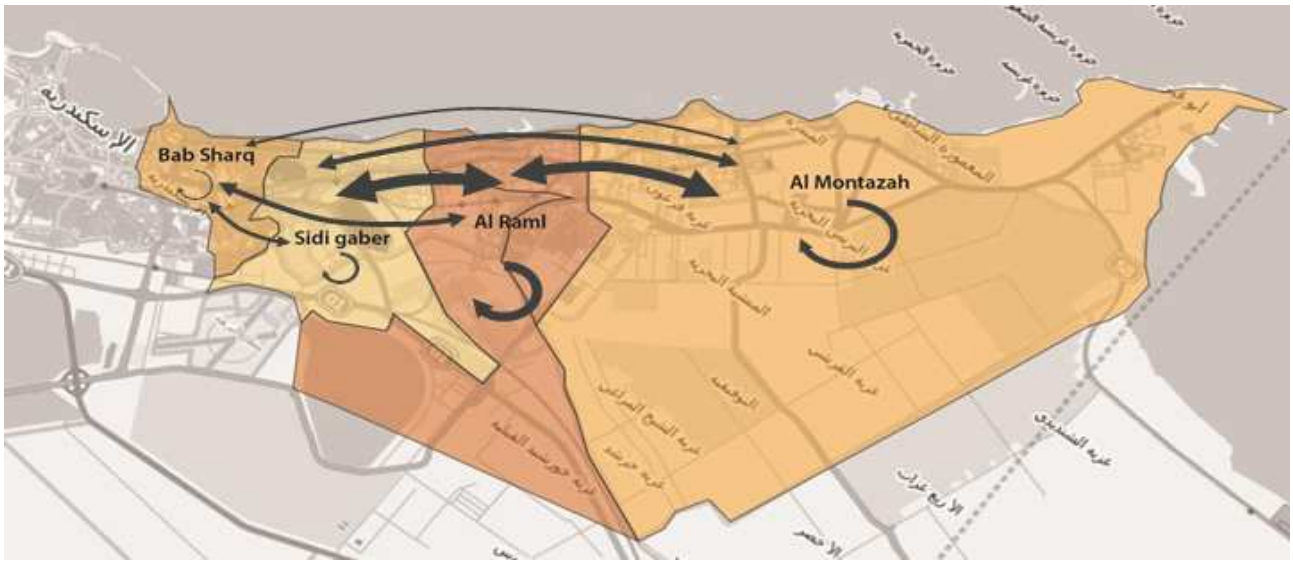


Fig. 7: Main public Transport flows in the east of Alexandria. Source: Egis 2014 Survey.

4.3 Define Theoretical frame work: to find potential FTN Solutions for the Alexandria case study

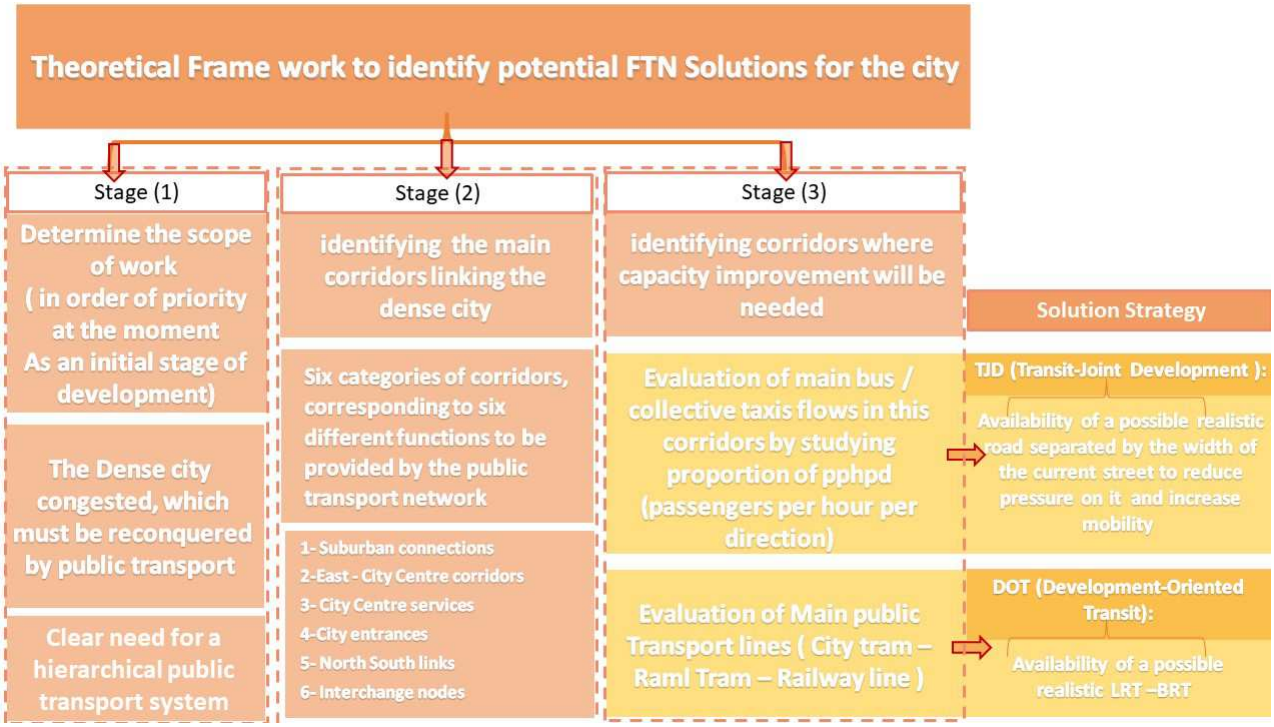


Fig. 8: Theoretical Frame work to identify potential FTN Solutions for the city (Source: authors)

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4.3.1 Determine the scope of work

Alexandria dense city : there is a clear need for a hierarchical public transport system. The dense City, congested, which must be reconquered by public transport.In Alexandria, due to the linear structure of the city, the structure will naturally be based on one or several east-west axis combined with south-north feeding lines.

1	Road to Rashyd	~ 17 000pphpd
2	Corniche Road	~ 15 000 to 20 000 pphpd
3	Al-Muhammadiyah Canal axis / Alexandria entrance road from Muharram Bey	~ 18 000 pphpd
4	Cairo-Alexandria Agricultural Road (regional road)	~ 10 000 pphpd
5	Suez Canal Street (main road)	~ 20 000 pphpd
6	Al-Max Street (Main Road)	~ 15 000 pphpd
7	Malak Hefni Road - Abu Qir Road	~ 18 000 pphpd

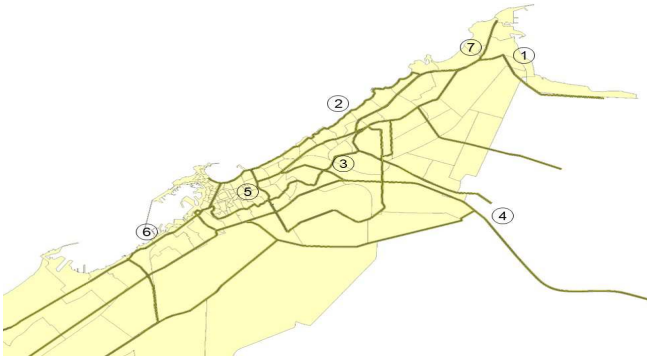


Fig. 9: Map of Alexandria dense cityMain bus/collective taxis flows (Current total publicridership-Passengers per hour per direction pphpd. Source: authors after French Development AgencyAlexandria Urban Transport StudyReport Phase 1.

4.3.2 Identifying the main corridors linking the dense city:

Through the diagnosis, six categories of corridors were discovered, each of which corresponds to a different service that the public transport system will offer.

4.3.3 Identifying corridors where capacity improvement will be needed

Evaluation of main bus/collective taxis flows in this corridors by studying proportion of pphpd (passengers per hour per direction):

by layering mapon top of each other in order (Network of arterial ways and main roads + number of lanes of main roads + flow of main bus/collective taxis + interchange nodes) to produce a mapidentifying corridors where capacity improvement is required.

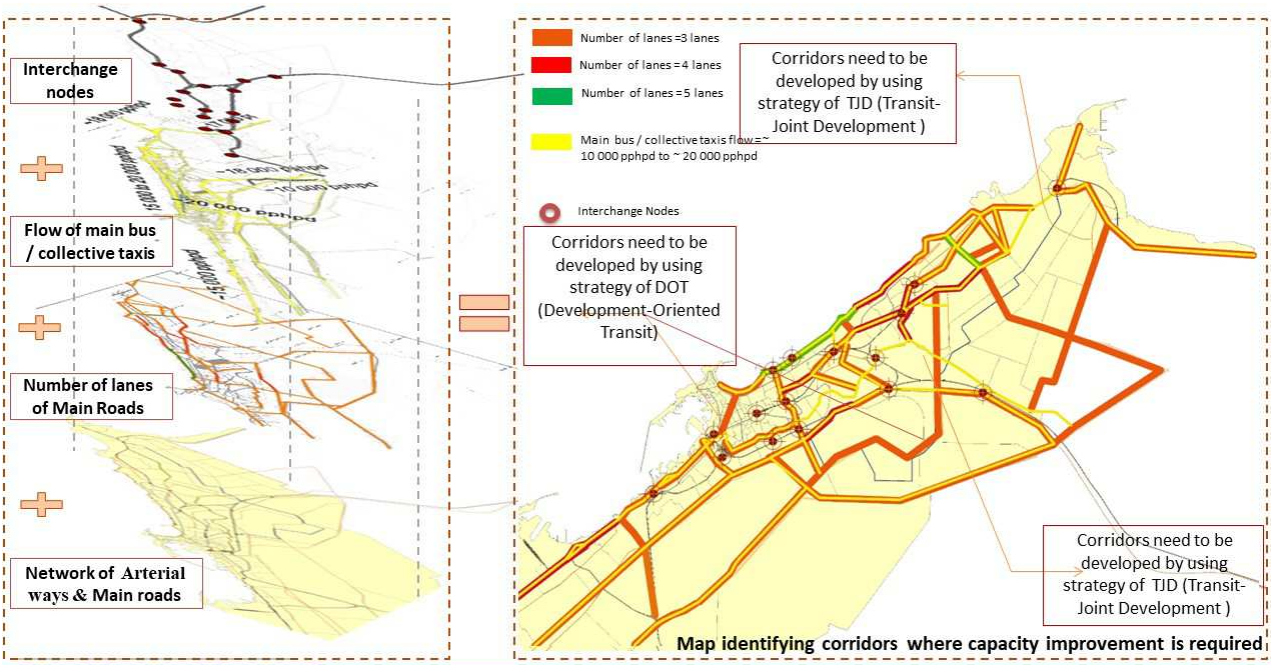


Fig.10: Proposed Digramatic Map of Alexandria dense city identifying corridors where capacity improvement is required. Source: authors.

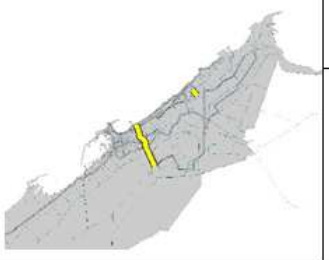
Function	Map	Road /Rail /Tunnel /Tram	Area Served	Current pphpd
1- Suburban connections		1- Abu Kir	City center, Sporting facilities, commercial centers	20 000pphpd
		2- Borg El Arab Rail line	City Centre, El Max, Almeriyah, Borg El Arab	7000pphpd
		3- North Costal Line	Dekheila port	15000pphpd
		4- Rail Connection from East to South		
		5- Abu Kir Line extention by Tunnel under city center	CityCenter	
2- East - City Centre corridors		6- Raml tram (existing right of way)	CityCentre,AlexandriaUniversity, tworailStations, Sportingfacilities, commercialcentre	12000pphpd
		7- Corniche	City centre, Alexandria University, Touristic Area (beach), commercial centres	20 000 pphpd
		8- Mahmoudeya Canal	Pharos University, Moharram bey, city centre	15000pphpd
		9- Mostafa Kamal to El Sa'aa	East New urbanized areas	8000pphpd
3- City Centre services		10- El sabaa Banat Road (Raml Tram extension or Corniche Line extension)	City centre	
		11- Sherif Street / Abdel Moneim Road	City centre	
		12- City Center North South tunnel	City centre, Misr Station	
		13- City Tram	City centre, Misr station, Alexandria Port, industrial Area	Vary from one line to the other
4- City Entraces		14- Road to Rashyd		17 000 pphpd
		15- Entrance of Alexandria from theAgricultural Road		18 000 pphpd
		16- City entrance through Moharram Bey		20 000 pphpd
5- North South links		17- Suez Canal Road	Citycenter	20 000 pphpd
		18- El Galaa – El Sa'aa	Victoria station, El Nokrashy	
6- Interchange nodes		19- Main interchange Nodes / P+R • El Max • Moharram Bek • Sidi Gaber • Victoria		

Table. 2: Identifying the main corridors linking the dense city. Source: authors after French Development AgencyAlexandria Urban Transport StudyReport Phase 1.

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Evaluation of Main public Transport lines (City tram – Raml Tram – Railway line)

(a) City Tram : is currently completely jammed in traffic, but could regain an important role if car traffic could be limited in the city center, and with an important renovation work. It could be the same also for walking, if increased space and safety was given to pedestrians.

(b) Raml Tram : where demand is high (more than 10 000 pphpd) and where the existing tramway could be upgraded into a modern tramway system with an improved right of way segregation. The existing line could be extended towards Mansheya Square or even Kabbary if it is possible to cross the city center.

(c) Railway Line / Regional lines : will also be the main structure for the public transport network and offer a possibility for quick move inside the city.)Jérémie Simon et al. , 2015(

5 RESEARCH FRAMEWORK

Common transferable framework for applying FTN Strategies towards achieving Transit-Oriented Development as shown in fig. 11.

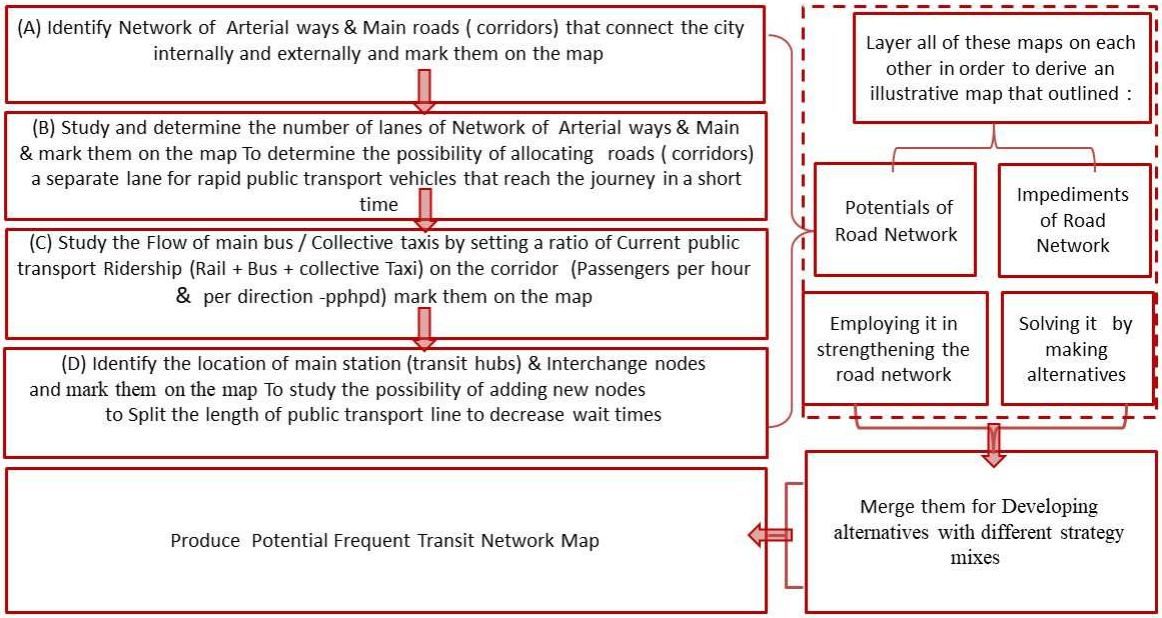
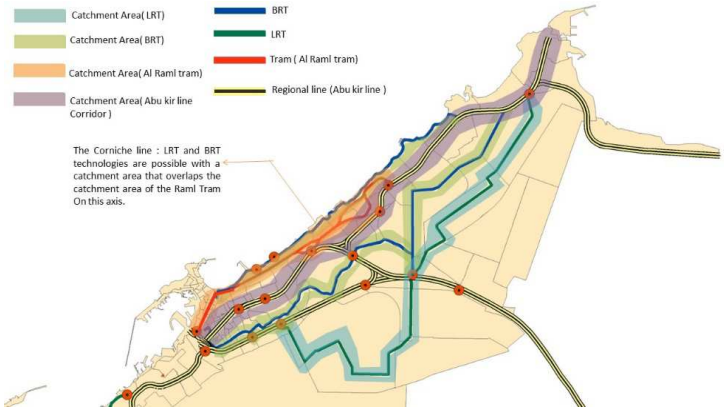


Fig. 11: diagram show Common transferable framework for applying FTN (Source: authors)

5.1 Results

Recommendation for Alexandria development Key Corridor Network" for the bus routes and light rail transit, emphasising corridors in which combined transport services could provide a more efficient operation of the city's public transport as shown in fig. 12.



Five other suitable corridors to increase catchment area for the main east west corridor are¶
1- The Raml tram : The existing line could be extended towards Mansheya Square or even Kabbary if it is possible to cross the city center.¶
2- The Corniche line : LRT and BRT technologies are possible with a catchment area that overlaps the catchment area of the Raml Tram On this axis.¶
3- The Mahmoudeya Canal: BRT should be sufficient in terms of capacity. The Mahmoudeya Canal line will provide a south bypass of the city center.¶
4- Tram Al Nouza: LRT should be sufficient in terms of capacity.¶
5- Tram Al Montazah: LRT should be sufficient in terms of capacity.¶

Fig. 12: Proposed Digramatic Map of Alexandria dense city framework development Key Corridor Network. Source: authors after French Development Agency Alexandria Urban Transport StudyReport Phase 1.

The main east west corridor: a mass public transport line such as a heavy metro or a LRT with high capacity to implement such a line is on the Abu Kir line corridor will operate as the backbone of public transport on the area; its stations will be fed by bus and collective taxis to improve the accessibility of the line and the attractivity of the whole public transport network. Those stations could also be used as nodal points for transport oriented development.

6 DISCUSSION

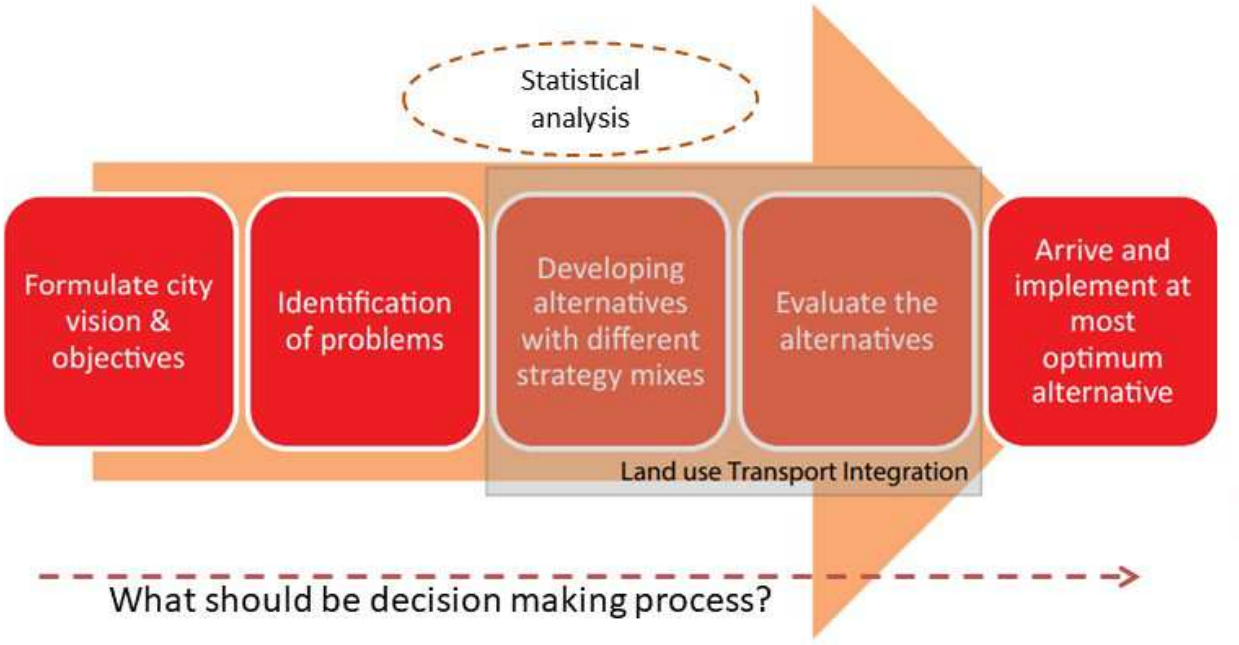


Fig. 12: Diagram show steps of decision making process as part of fig. 3.

6.1 Formualte city vision and objectives

6.1.1 City Vision

The strategic Urban Plan 2032 describes the "city vision" in six modules:

Each of these modules has been translated in five technical objectives:

a. Support decentralized concentration
b. Improve quality of life and environmental quality
c. Simulate successful socio-economic development
d. Promote cultural and architectural heritage
e. Support planning policies for implementation

6.1.2 Objectives

the Strategic Urban Plan 2032 identifies some priority objectives to improve the existing public transport system, which is currently not sufficient to deal with the large demand. These objectives are:

(a) Expand capacity: provide public mass transit along the primary communication axes.

(b) Prioritize public transport: in terms of space (dedicated lanes, priority at crossings) or finances, to show that public transport is faster and more convenient than driving.

(c) Connect subsystems and form a hierarchic public transport system.

(d) Make heavy maintenance on existing network: Raml tram line and Abu Kir railway line.

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6.2 Identification of problems

No	Diagnosis	Problem	Strategic tools to be a dopted
1	Transportation	overall congestion; un-attractive public transport; limited catchment area	Limit car congestion, with higher performances of public transport lines increase catchment areas
2	Urban and economic development	un-sustainable urban development	develop a consistent planning between urban planning and transport Improve economic and touristic attractivity of the city – example of the Corniche
3	Environmental and social	there are major disturbances due to heavy traffic: air pollution, noise, unsafety.	Improve the quality of life, safety in the dense city
4	Financial	funds are lacking to develop and even maintain the public transport system	enhance the financial sustainability of new projects
5	Institutional diagnosis	coordination between public transport stakeholders is lacking	Integration, or at least coordination, between stakeholders in Alexandria

Developing alternatives with different strategy mixes: Strategy used: (1) Employment of potentials of existing road network, (2) Developing solutions for Impediments of existing road network.

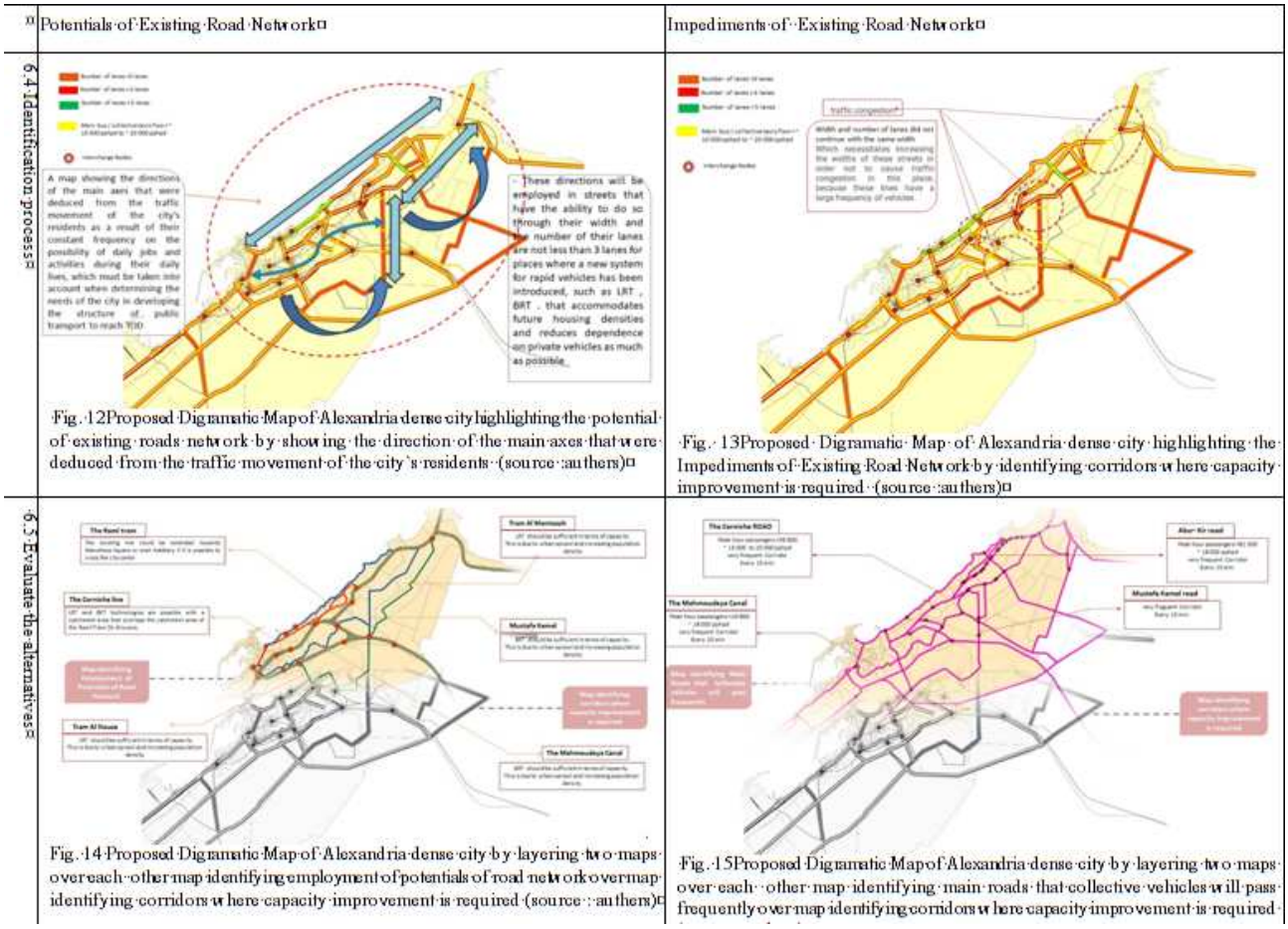

Fig. 12 Proposed Digramatic Map of Alexandria dense city highlighting the potential of existing roads network by showing the direction of the main axes that were deduced from the traffic movement of the city's residents (source :authers)

Fig. 13 Proposed Digramatic Map of Alexandria dense city highlighting the Impediments of Existing Road Network by identifying corridors where capacity improvement is required (source :authers)

Fig. 14 Proposed Digramatic Map of Alexandria dense city by layering two maps over each other map identifying employment of potentials of road network over map identifying corridors where capacity improvement is required (source :authers)

Fig. 15 Proposed Digramatic Map of Alexandria dense city by layering two maps over each other map identifying main roads that collective vehicles will pass frequently over map identifying corridors where capacity improvement is required

7 CONCLUSION

The research deal with the problem of "Modal shift from public transport to private transport" and how to apply a Transit Strategies towards achieving Transit-Oriented Development .The challenge here is to steer the opposite "Modal shift from private transport to public transport direction" by using a strategy of Frequent Transit Network through Comparative analysis of (FTNs) and (TOD) experiences in three city – regions & Analysis of Transport and Current Mobility Structure in Alexandria conclude from it Theoretical Frame work to identify potential (FTNs) Solutions for the city. The research has finally arrived Recommendation for Alexandria development " Key Corridor Network" for the bus routes and light rail transit, emphasising corridors in which combined transport services could provide a more efficient operation of the city's public transport.

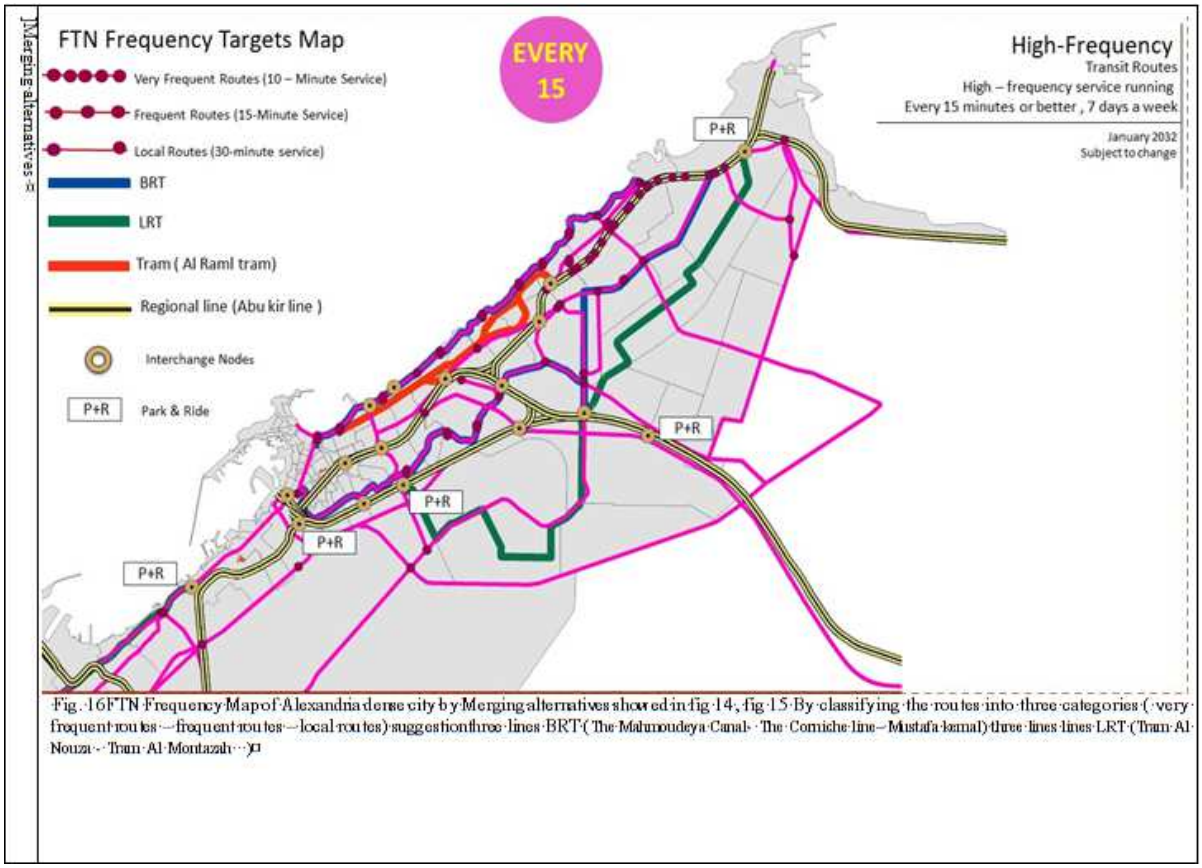

Fig. 16 FTN Frequency Map of Alexandria dense city by Merging alternatives showed in fig 14, fig 15 By classifying the routes into three categories (very frequent routes —frequent routes —local routes) suggestion three lines BRT (The Mahmoudeya Canal- The Corniche line – Mustafa kamal) three lines lines LRT (Tram Al-Nouzi - Tram Al Montazah ...)

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