URBAN TRANSPORT SYSTEM ANALYSIS

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ABSTRACT
City center is exposed to many problems including the mixing uses, bottleneck in traffic and the inadequacy of the existing fabric for the current changes in the means of movement, therefore this paper studies the impact of the urban transportation system on the road network in the city center, in order to achieve a better environment. The paper focuses on analysis of the study area by making a comprehensive survey of quantification of trips generation as a result of these uses, and a survey of all the numbers of transport means and distribution to all regions of the study area, then the stage of traffic assignment to evaluate network connections to know the traffic level of service. Followed by a proposal for some alternatives can be applied to measure the impact on the road network as a result of buildings uses change and means of transport in the region. The paper is ended by recommendations that help to achieve the required balance resulting from the interactions between these uses and transport systems on the road network in the city center to reduce the pressure on them.
Keywords: city center, transport system, road network, buildings uses, urban transportation.

1 INTRODUCTION

Planning for sustainable land use and transport requires an integrated view of the two-way interaction between land use and transport. The challenges that cities are facing can no longer be dealt within the limited view of a single profession.

An interdisciplinary approach is needed which integrates land use policies with transport infrastructure development and traffic operation, as well as soft policies working with information or incentives. Only this integration will lead to a new, more balanced view of the entire urban planning process.

2 PROBLEM DEFINITION

The cities affected by the industrial revolution with the beginning of the nineteenth century and resulted in the proliferation of means of transportation and the multiplicity of ways of production and inflation in the number of population, which led to the inflation of cities, and the heart of the city areas most affected by this, which can be summarized as the following points:

- Mixing and overlapping uses.
- Opposes the bottleneck in the movement.
- Inadequacy of the existing fabric of the current changes in the modes of movement and communication.

3 THE GOAL OF THE RESEARCH

The study aims to achieve the desired results from the mutual interactions between land uses and traffic on the road network in the city center to reduce the pressure and achieve the balance.

In order to achieve this goal, it is a must to achieve several other objectives, including:

- Identify the trip rates from various districts of the city to the city center as a result of land use.

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- Evaluate the proper distribution of land uses, which achieves the highest efficiency of the traffic in the city center.
- Evaluate the efficiency of transportation systems used and proposed [1].

4 CASE STUDY

The case study is in the North-West part of the old city center of Alexandria city, Egypt (0.68 $KM^{2)}$, this area was chosen to be as a detailed study because of its special importance:
Moral importance:

- It is the node of the old city center and the part which is representing all the city.
- The area has a historical dimension because it contains many historical buildings have symbolic values reflect the spirit of the city.

Functional importance:

- This is the heart of the city containing many different functions and special activities.
- The node of the movement and communication.
- It is very important area for economic transactions [2].

5 ANALYSIS OF THE CURRENT STUDY AREA

The study area was analyzed as shown in Fig. 2.

Figure 1: Case study area. *(Source: Author.)*

Figure 2: Buildings uses survey. *(Source: Author.)*

5.1 Building uses survey

See Fig. 3.

5.2 Trip generation rates resulting from the building uses

From the previous building uses analysis the research calculated the traffic trip rates coming from the area of the uses by m^2 in each part in the case study [3].

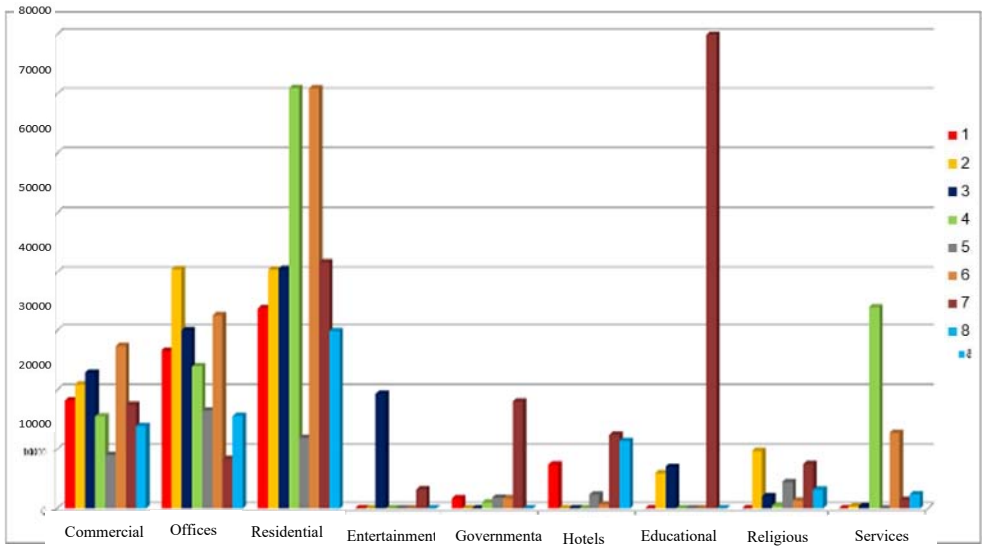


Figure 3: Total areas of building use in the study area. *(Source: Author.)*

Table 1: Trip generation rates in part 1. *(Source: Author.)*

OUT TRIP	IN TRIP	OUT %	IN %	trip rates	RATE	Unit No.	Unit	Area S.F.	Area m2	1
3459.31	3323.651	51%	49%	6782.962	34.57	196.2095	1000 S.F.	196209.5	18228.31	Comm.
355.0204	72.71503	83%	17%	427.7354	1.49	287.0708	1000 S.F.	287070.8	26669.53	Offi.
39.277	72.943	35%	65%	112.22	0.62	181	unit	363864.9	33803.87	Res.
0	0	36%	64%	0	4.91	0	1000 S.F.	0	0	Ent.
15.40115	6.919356	69%	31%	22.3205	1.21	18.4467	1000 S.F.	18446.7	1713.74	Gov.
31.3349	35.3351	47%	53%	66.67	0.59	113	Room	80100.09	7441.48	Hot.
0	0	55%	45%	0	1.21	0	1000 S.F.	0	0	Edu.
0	0	52%	48%	0	0.55	0	1000 S.F.	0	0	Rel
0	0	56%	44%	0	13.94	0	1000 S.F.	0	0	Ser.
3900.344	3511.564			7411.907						

Table 2: Trip generation rates in the study area. *(Source: Author.)*

% OUT	% IN	OUT TRIP	IN TRIP	%	Total Trips	Ser. Area m2	Rel. Area m2	Edu. Area m2	Hotel Area m2	Gov. Area m2	Ent. Area m2	Res. Area m2	Off. Area m2	Comm. Area m2	
10.7	10.7	3900.3	3511.6	10.7	7411.9	0.0	0.0	0.0	7441.5	1713.7	0.0	33803.9	26669.5	18228.3	1
12.9	12.5	4665.5	4103.8	12.7	8769.3	336.5	9752.4	5988.6	0.0	0.0	0.0	40504.4	40575.1	20958.8	2
14.5	15.5	5276.7	5098.6	15.0	10375.3	456.0	2060.4	7028.1	0.0	0.0	19324.6	40595.7	30149.2	22982.2	3
17.1	16.1	6212.4	5292.1	16.6	11504.5	33962.9	525.5	0.0	0.0	1070.1	0.0	70944.0	23948.5	15553.8	4
5.5	5.4	2002.4	1760.9	5.4	3763.3	0.0	4520.0	0.0	2320.4	1872.7	0.0	11955.5	16587.9	9107.3	5
18.8	18.5	6804.0	6083.2	18.7	12887.3	12739.1	1371.2	0.0	745.7	1724.7	0.0	70919.8	32577.2	27402.4	6
11.8	12.5	4287.4	4111.0	12.2	8398.4	1448.9	7484.1	79944.0	12446.1	18090.0	3208.1	41721.1	8335.4	17528.9	7
8.6	8.7	3133.9	2854.7	8.7	5988.6	2451.8	3162.5	0.0	11437.1	0.0	0.0	29942.6	15599.2	13858.0	8
100.0	100.0	36282.8	32815.8	100.0	69098.7	51395.3	28876.1	92960.7	34390.8	24471.2	22532.7	340387.0	194441.9	145619.7	

After that, the research put all the trip rates from the 8 parts in the case study in one schedule to calculate the total trip rates in the study area.

5.3 Analysis of the transportation modes numbers in the study area

Table 3 shows the number of the main transportation modes in different points in the case study.

Table 3: Transportation modes No. in the study area. *(Source: Author.)*

Total	Serv.	bus	Micro bus	Taxi	Private	hour	Point No.
2976.9	138	20	32	1468	1242	9 → 10	1
2109.5	114	64	50	612	1142	2 → 3	
1830.3	62	18	24	604	1072	5 → 6	
1180.4	18	1	7	679	465	9 → 10	2
750.5	30	11	10	352	322	5 → 6	
1170	60	30	70	430	486	12 → 1	3
1989	96	56	90	814	790	9 → 10	4
1260.7	150	28	56	362	560	6 → 7	
711.9	36	3	27	395	220	9 → 10	5
619.8	72	0	14	200	306	12 → 1	
517	32	0	10	150	310	4 → 5	
1467.3	150	0	234	412	470	11 → 12	6
1503	120	30	230	406	496	11 → 12	
1037.3	102	0	134	312	370	5 → 6	
1158.3	90	24	174	306	396	5 → 6	
1289.6	24	1	8	884	360	9 → 10	7
1729.1	30	1	18	864	795	12 → 1	
1556.2	60	15	6	441	1000	4 → 5	
458.1	6	0	18	258	162	9 → 10	8
559.9	6	8	12	198	318	12 → 1	
515.5	20	5	5	100	372	4 → 5	
2168.9	78	8	2	942	1110	10 → 11	9
2055	60	0	0	984	996	12 → 1	
1643	36	4	0	744	846	6 → 7	
1660	72	8	0	672	882	11 → 12	10
1143	60	0	0	402	666	5 → 6	
1134.5	30	0	10	498	582	10 → 11	11
212.25	5	4	0	90	108	9 → 10	12
537	36	0	0	252	240	9 → 10	13
579	36	0	0	318	216	9 → 10	
161.65	5	1	2	48	102	9 → 10	14
1680	48	3	0	960	654	9 → 10	15
641.3	18	1	24	396	180	9 → 10	16
238.8	24	0	24	30	138	9 → 10	17

5.4 Traffic assignment on road network

This stage is the signing of trips size each way on the links of the proposed transport network, therefore can see the volume of traffic on each link in the network, using the program (Assign 14) to do this customization. Evaluate network connections to know the level of traffic service, the value of (volume/capacity) [4].

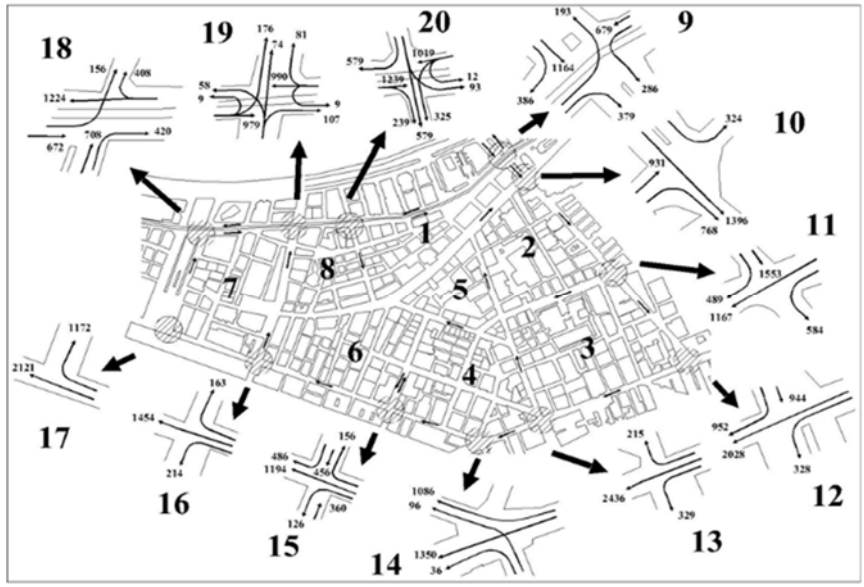


Figure 4: In and out trips in the main intersection points of the streets in the study area. *(Source: Author.)*

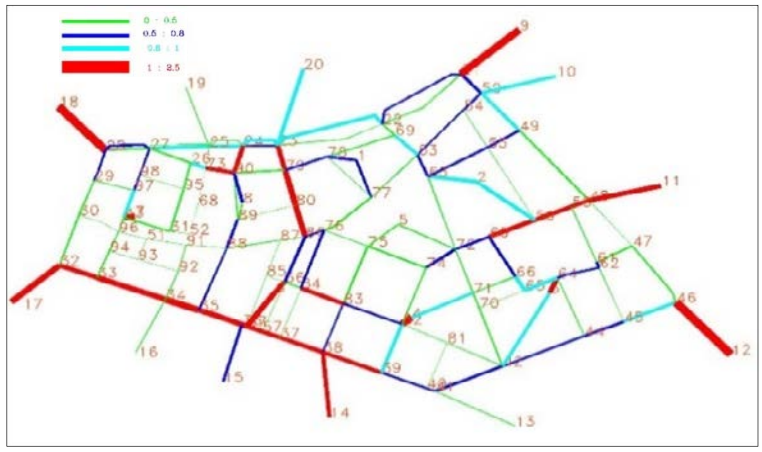


Figure 5: Current traffic Assignment. Show the volume of traffic on each link in the network. *(Source: Author.)*

6 FIRST PROPOSED ALTERNATIVE: THE IMPACT OF CHANGING BUILDINGS USES ON THE ROAD NETWORK

Increase office buildings and minimize housing in bad buildings for District No. 7, because this area is located on the main traffic hubs and next to places can be as a parking, either in the rest of the areas will increase housing, while maintaining the same total area for each use, as in Current situation.

7 INCREASING PUBLIC TRANSPORT ON THE ROAD NETWORK

7.1 Prevent the passage of private vehicles and provide parking areas

Prevent private cars in the internal streets of the city center at certain hours of the day and allow it only in the ring-road which surrounds the study area. Select parking areas places near the public transport stations to encourage citizens to leave their private cars and use public transportation [5].

Table 4: Trip generation rates depending on the proposed use. *(Source: Author.)*

% OUT	% IN	OUT TRIP	IN TRIP	%	total trips	Ser. Area	Rel. area	Edu. Area	Hot. Area	Gov. area	Ent. Area	Res. Area	Off. Area	Comm. Area	
10.6672	10.72089	3881.234	3520.199	10.69267	7401.434	0	0	0	7441.48	1713.74	0	40325.24	24663.46	18228.31	1
12.74903	12.75848	4638.702	4189.242	12.75351	8827.944	336.54	9752.4	5988.56	0	0	0	42809.23	29761.99	21562.46	2
14.39274	15.5477	5236.762	5105.082	14.94061	10341.84	455.96	2060.4	7028.12	0	0	19324.6	47651.64	26478.56	22982.23	3
16.95919	16.08271	6170.56	5280.751	16.54342	11451.31	33962.91	525.48	0	0	1070.1	0	68426.97	20842.82	15564.69	4
5.440123	5.394452	1979.375	1771.266	5.418459	3750.641	0	4520.04	0	2320.38	1872.72	0	20302.18	14172.1	9107.28	5
18.46326	18.44129	6717.812	6055.19	18.45284	12773	12739.1	1371.16	0	745.65	1724.67	0	65072.91	26573.18	27402.38	6
12.71717	12.35882	4627.111	4058.015	12.54719	8685.126	1448.92	7484.14	79944	12446.14	18090	0	26866.26	39643.54	17528.85	7
8.611276	8.69566	3133.191	2855.217	8.651305	5988.408	2451.84	3162.46	0	11437.14	0	0	30207.26	15510.99	13858.04	8
100	100	36384.75	32834.96	100	69219.71	51395.27	28876.08	92960.68	34390.79	24471.23	19324.6	341661.7	197646.6	146234.2	

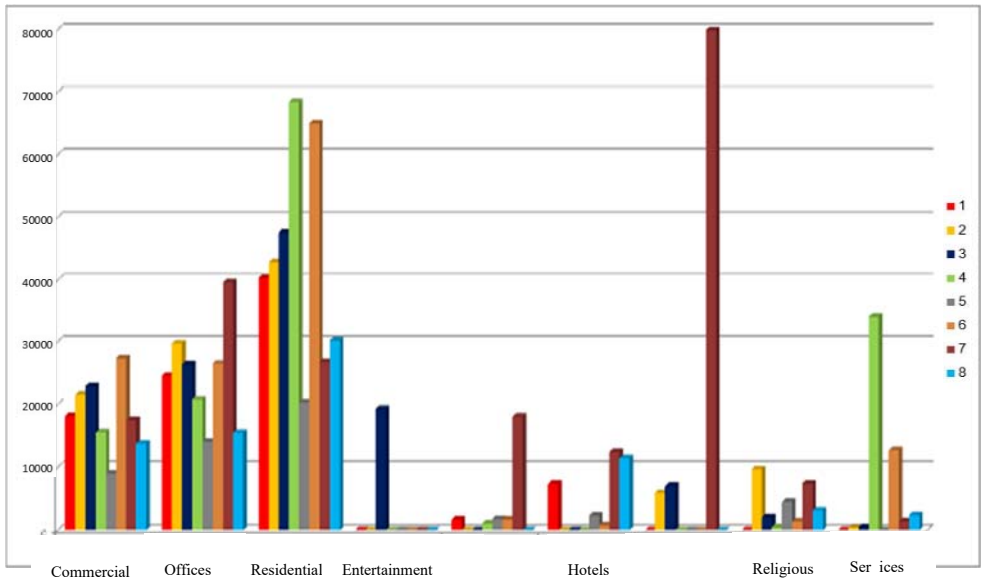


Figure 6: Total areas of building uses depending on the proposed use. *(Source: Author.)*

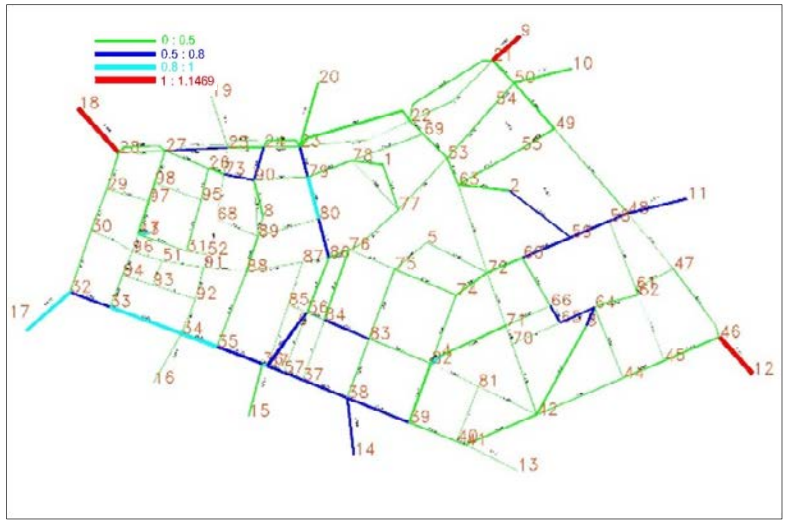


Figure 7: Traffic Assignment on road network depending on the proposed use. This minimizes the problems in the connections. *(Source: Author.)*

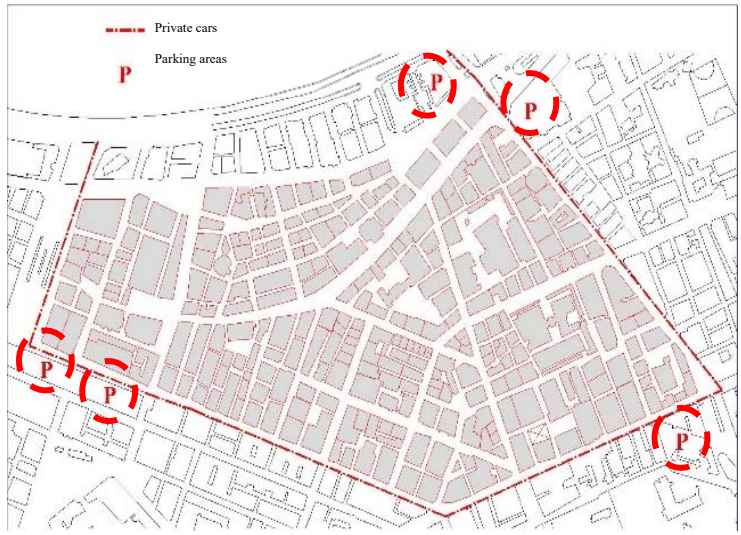


Figure 8: Roads for private cars and parking areas. *(Source: Author.)*

7.2 Increase public transport systems

Buses: Give priority to public buses on the roads and allocate a fixed path to use it.
Electric car: Provides a high-level and environmentally friendly system. It is small in size, do not take a big space and save time in searching for the traditional position of the car, especially in the city center [6].

Tram: It is one of the most important means of transport that can accommodate a large number of passengers, therefore it is very important develop the tram path and the stations to provide passenger comfort and quick accessibility [7].

Bikes: Providing many of the bikes that operate by rental system, this system helps to reduce traffic congestion and purify the city's air. It is a must to ensure the safe ways for bicycles, through the re-planning of road networks.

Street design: Increasing public transport systems in the road network in the study area need to have a good design to the streets with separate lanes for cars, buses, bikes, tram and pedestrian. Also choosing a best location for pedestrian crossing [8].

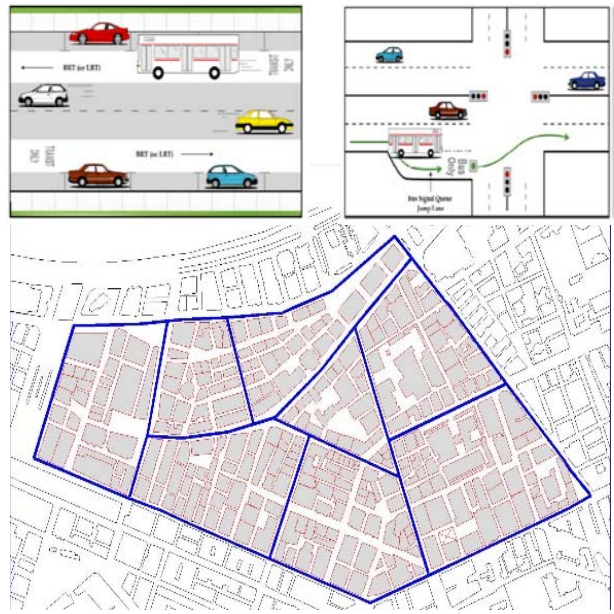


Figure 9: Increase public buses in certain roads. *(Source: Author).*

Figure 10: Using environmental electric car in internal streets of the study area. *(Source: Inderwildi & David, 2012.)*

Figure 11: Develop tram path and the stations. *(Source: Suzuki & Luchi, 2013.)*

Figure 12: Provide lanes for bikes. *(Source: Suzuki & Luchi, 2013.)*

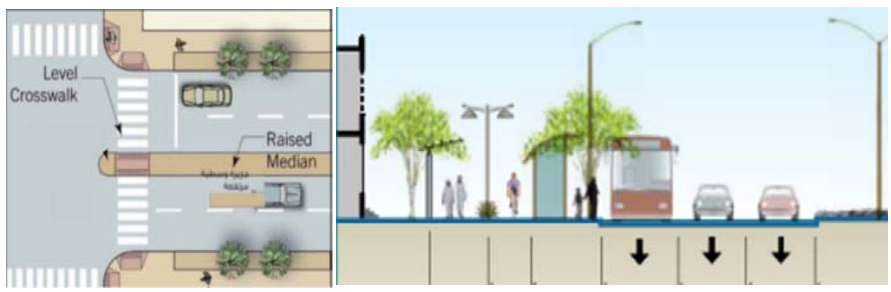


Figure 13: Street Design. *(Source: Golem & Smith, 2010.)*

8 SECOND PROPOSED ALTERNATIVE: THE IMPACT OF INCREASING PUBLIC TRANSPORT ON THE ROAD NETWORK

8.1 Stage of division of trips to various means of transport (*Modal Split)*:

- Calculate numbers of transport means in the main intersection points of the streets in the study area, in the rush hour with classification into types of methods.
- Calculate the averages for all the points.
- Find a ride equivalent unit.
- Calculate the number of users for each type of transportation then transferred to percentage.

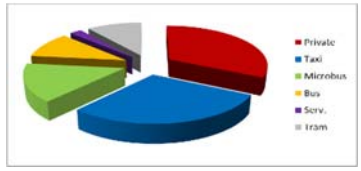
- Propose new percentage of the number of users and therefore know the numbers of new users in the proposed situation.
- Calculate the new averages and find equivalent of the proposed riding unit.
- By knowing equivalent in the current situation and the proposed equivalent and rate used in the current situation thus find a rate that should be used in the proposed situation.
- Compensation occurs in the following tables to calculate the number of trips in and out of each region of the study area as a result of the proposed situation.
- Calculate OD of the proposed situation and applied to the assignment program to see impact on the road network [4].

Table 5: Proposed modal split. *(Source: Author)*

Total	Tram	Serv.	Bus	Microbus	Taxi	Private	Pick hour	Point
2976.9	0	138	20	32	1468	1242	9 → 10	1
2109.5	0	114	64	50	612	1142	2 → 3	
1830.3	0	62	18	24	604	1072	5 → 6	
1180.4	0	18	1	7	679	465	9 → 10	2
750.5	0	30	11	10	352	322	5 → 6	
1170	0	60	30	70	430	486	12 → 1	3
1989	0	96	56	90	814	790	9 → 10	4
1260.7	0	150	28	56	362	560	6 → 7	
711.9	0	36	3	27	395	220	9 → 10	5
619.8	0	72	0	14	200	306	12 → 1	
517	0	32	0	10	150	310	4 → 5	
1467.3	4	150	0	234	412	470	11 → 12	6
1503	5	120	30	230	406	496	11 → 12	
1037.3	7	102	0	134	312	370	5 → 6	
1158.3	5	90	24	174	306	396	5 → 6	
1289.6	0	24	1	8	884	360	9 → 10	7
1729.1	0	30	1	18	864	795	12 → 1	
1556.2	0	60	15	6	441	1000	4 → 5	
458.1	0	6	0	18	258	162	9 → 10	8
559.9	0	6	8	12	198	318	12 → 1	
515.5	0	20	5	5	100	372	4 → 5	
2168.9	0	78	8	2	942	1110	10 → 11	9
2055	0	60	0	0	984	996	12 → 1	
1643	0	36	4	0	744	846	6 → 7	
1660	0	72	8	0	672	882	11 → 12	10
1143	0	60	0	0	402	666	5 → 6	
1134.5	0	30	0	10	498	582	10 → 11	11
212.25	0	5	4	0	90	108	9 → 10	12
537	0	36	0	0	252	240	9 → 10	13
579	0	36	0	0	318	216	9 → 10	
161.65	0	5	1	2	48	102	9 → 10	14
1680	0	48	3	0	960	654	9 → 10	15
641.3	0	18	1	24	396	180	9 → 10	16
238.8	0	24	0	24	30	138	9 → 10	17
	5	56.6	10.1	38	487.7	540.4	av.	current situation
1203.65	20	70.75	20.2	64.6	487.7	540.4	equivelant	
100	1.66	5.88	1.68	5.37	40.52	44.90	%	
2501.35	260	56.6	262.6	380	731.55	810.6	pers.	
100	10.39	2.26	10.50	15.19	29.25	32.41	%	
100	15.39	2.26	22.91	20.19	39.25	0	%new	alternative
2501.438	385.07	56.60	573.02	505.07	981.69	0	new pers.	
783.6026	7.405144	56.6	22.03914	50.50675	654.4567	0	new av.	
884.767	29.62058	70.75	44.07827	85.86148	654.4567	0	new equivelant	

Current case study					
Tram	Serv.	Bus	Microbus	Taxi	Private
10.39	2.26	10.50	15.19	29.25	32.41

Proposed alternative					
Tram	Serv.	Bus	Microbus	Taxi	Private
15.39	2.26	22.91	20.19	39.25	0.00



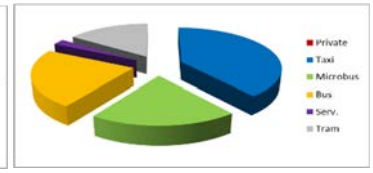


Figure 14: Percentage of users for each type of transportation modes. *(Source: Author)*

8.2 Traffic assignment stage

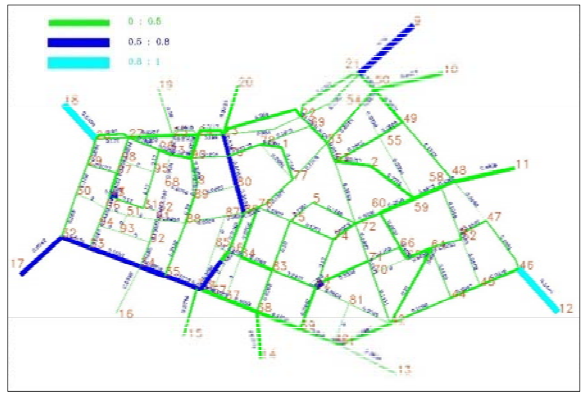


Figure 15: Proposed Traffic Assignment show the impact on the road network. *(Source: Author.)*

9 CONCLUSIONS

There is a relation between land use and road network. Any land use will attract trips from residents of the city and this applies when changing uses the trips are changing accordingly.

- Accessibility plays an important role in changing land use patterns and the higher degree of accessibility leads to higher value of the land.
- The absence of laws and legislation governing land use structure has contributed greatly to the deterioration of many of the central areas.
- Interfere a lot of activities in the city center of Alexandria affect the movement of internal traffic and road network.
- There is shortage in the current policies of transport within the cities, resulting large increase in the consumption of fuel and energy and the highest consumption rates come from using of the car as the primary means of transport and not focusing on public transport.
- Public transportation reduces traffic pressure on the road network.
- There are many parts of the road network in the current situation have bad level of service as the result of v/c is greater than 1 and this shows the pressure on the existing road network.

10 RECOMMENDATIONS

Set land use regulations, which aim to reduce the use of the private cars and reduce conflict between different uses.

- Give license for establishing an activity after the study of its impact on traffic and noise level in the area.
- Commercial use preferred to be present on main roads network of the city center and reduces in the secondary roads to decrease the pressure and increase the level of service within it.

- Administrative and service buildings when planning their places, it is preferred that be near to parking and public transport stations so users reduce the pressure on the internal roads of the city center network.
- The transportation must be planned according to stages and steps, including short-term plans and long-term part of the overall development process of the state.
- Enhance traffic flow and thus relieve traffic congestion to reduce trip time and facilitate access to all land use and reducing different types of environmental pollution.
- Review traffic laws and analyze the strengths and weaknesses in order to develop them.
- Provide numbers of multi-story parking in the city center where the citizen leaves the car and uses means of public transport from the stations located near them and this can help to restore the importance of public transportation.
- Change the priorities of the street design of the current situation where the focus is on the movement of vehicles only to an integrated process that takes into account the needs of pedestrians, cyclists and public transport movement.
- Prevent private cars in the city center traffic at certain hours of the day.
- Providing many of the bikes that operate by subscription and rental system with saving their own stations , this system helps to reduce traffic congestion and purify the city's air.
- Provide high-level electric cars with environment-friendly system in the internal road network of the city center.

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