Urban Transportation Planning Model for Long Term Refugee Camps Development: Case of Naher El Bared Camp in Lebanon

Nabil Nehme and Hani AlNaghi

Abstract This paper investigates the urban transportation planning framework related to long term refugee camps and their integration with the surrounding areas. The research considers the case of Naher El Bared Camp (NBC) in North Lebanon. First, the transport study for NBC before 2007 is analyzed via implementing the four steps model and performing a micro analysis using Emme regional transportation model linked with ArcGIS and Synchro software for signalized intersection traffic analysis. Then, a new transport model for the year 2030 is developed subject to several to social, economic, land use, and political constraints. This paper is the first documented study that investigates urban transportation planning for long term refugee camps in the Middle East region countries.

Keywords Four steps model · EMME · Urban transportation planning · Transport model camp · Long term refugee camp

Introduction

The Naher El Bared Camp (NBC) is one of the 58 recognized Palestinian refugee camps spread between Lebanon, Jordan, Syria, the West Bank, and the Gaza Strip. The area is known as the "Old Camp," has an area of approximately 0.2 km^2, and was first created in December 1949 by non-profit humanitarian organizations, such as the Red Cross, to host more than 5000 Palestinian refugees. However, the NBC has expanded over the years and transformed from a temporary 'tent-site' into a hyper-congested mass of multi-story buildings, characterized by concentrations of poverty and extreme overcrowding [1]. In the summer of 2007, a battle started between the Lebanese Armed Forces and an Islamist militia group called Fateh al-Islam and lasted

N. Nehme (✉)
School of Engineering, Lebanese American University, Byblos, Lebanon
e-mail: nabil.nehme01@lau.edu.lb

H. AlNaghi
Department of Civil and Environmental Engineering, American University of Beirut, Beirut, Lebanon

F. Calisir (ed.), *Industrial Engineering in the Internet-of-Things World*,
Lecture Notes in Management and Industrial Engineering,
https://doi.org/10.1007/978-3-030-76724-2_9

for three-and-a-half months inside NBC. During this battle, the majority of the camp was destroyed, and the adjacent municipalities were also affected. Before the battle, NBC was the second most populous Palestinian refugee camp in Lebanon, with a population of more than 30,000 persons [2–4].

In 2008, funded by the United Nations Development Programme (UNDP) and the United Nations Reliefs and Works Agency for Palestine in the Near East (UNRWA), an assessment and planning unit for the camp's reconstruction was established and has successfully guided the camp residents to develop a reconstruction plan [5–7]. This traffic impact assessment was required to assist the planning unit and to establish a satisfactory level of service in the proposed master plan for the horizon year of 2030. This assessment followed the procedure that is recommended by the Directorate General of Urban Planning in Lebanon. In some instances, information beyond the guidelines is provided in this study.

The NBC is located 16 km away from the city of Tripoli along the northern coast of Lebanon, in the Mhammara cadastral region of the Akkar Caza. It is bounded by the Bared River from the South, the Tripoli-Syria highway from the East, El Aabdeh junction from the North, and the Mediterranean Sea from the West [6, 8]. Figure 1 illustrates the general location map of Naher el-Bared and highlights the location of the new camp compared to the new camp. The NBC "Old Camp" is referred to as the geographical area before 2007, and the "New Camp" is composed of the "Old Camp" in addition to nine traffic zone sectors added after the expansion of the camp in 2007. The study area and the road network are represented in Fig. 2.

Prior to the 2007 war, the NBC site was a mixed-use development along a commercial spine, the main road extending from El-Minieh Sea Road to El-Aabdeh Roundabout. Two-third of the population were living in the dense "Old Camp" (population of 21,587 persons in a 0.2 km^2) while the "New Camp" included large areas of agricultural fields with a lower population density (population of 12,155 persons in a 1.13 km^2). In addition, the site included a total of 2741 non-residential units (commercial and institutional). Figure 3 illustrates sector divisions of the camp area, and Fig. 4 illustrates the spatial distribution of the non-residential units throughout the camp area. The total population reported was estimated to be 33,729 persons, with a total of 2,741 non-residential units. The detailed breakdown of residential populations and non-residential units for each of the sectors is presented in Table 1.

After the end of military operations, a preliminary master plan was developed to reconstruct NBC between the UNRWA and the community-based Nahr el-Bared Reconstruction Commission for Civil Action and Studies [5]. This preliminary master plan has six objectives. The first objective is to replicate the camp's landmarks. The second objective is to improve the camp's environment. The third objective is to enhance the urban infrastructure. The fourth objective is to improve the access by (i) establishing new pedestrian walkways, (ii) increasing the parking space outside the camp, and (iii) prohibiting vehicular access to residential blocks. The fifth objective is to expand the road and pedestrian networks by (i) reconstructing the road networks, (ii) widening the main road to 12 m and secondary roads to 6 m, (iv) widening alleyways to 4.5 m for pedestrian access to the residential building blocks, and (v) increasing parking capacity. The sixth objective is to enhance emergency

Fig. 1 General location of Naher El Bared camp

services by restricting specific roads to emergency services such as ambulances and fire trucks.

The reconstruction of the completely destroyed "Old Camp" consists of 4,705 residential units and 901 non-residential units (communal and commercial) in addition to the "New Camp" infrastructure, and related infrastructure works in the adjacent areas, including utility connections. The "Old Camp" reconstruction work was divided into eight packages. Figure 5 illustrates the "Old Camp" reconstruction plan layout and the corresponding blocks for each package.

The paper is structured as follows. Section 2 presents a brief review of the relevant literature. In Sect. 3, the current traffic conditions are generated and analyzed using the four steps model. In Sect. 4, the future traffic condition is forecasted, based on the four steps model generated in Sect. 3, using Emme/2 software. Section 5 concludes the paper and proposes future recommendations.

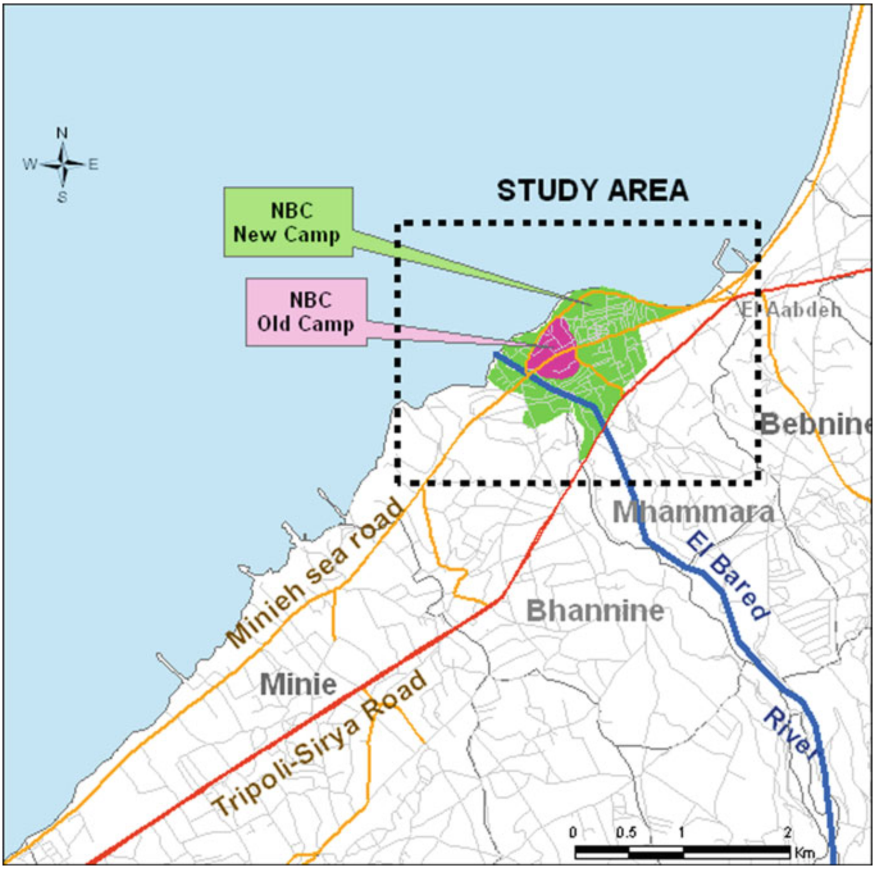

Fig. 2 Road network and the study area

Literature Review

Damme [9] discussed, for the first time, the transformation of refugee camps to permanent or long term camps, more than thirty years, by considering the cases of Goma and Guinea camps in Africa. Damme argued that the refugee, in this case, becomes completely dependent on outside help, and the cost per refugee is more than the gross national product per head of the host country. Damme differentiated between giant camps and small camps and discussed the high cost of operations and maintenance of long terms refugee camps. It is worth noting that in the literature, there is no documentation of any transportation planning study for refugee camps, especially for small permanent refugee camps such as Naher el-Bared refugee camp (NBC), where the population is less than 50,000. Therefore, this literature review is limited to transportation plans and mobility inside ‘small cities.’

Fig. 3 NBC sectors

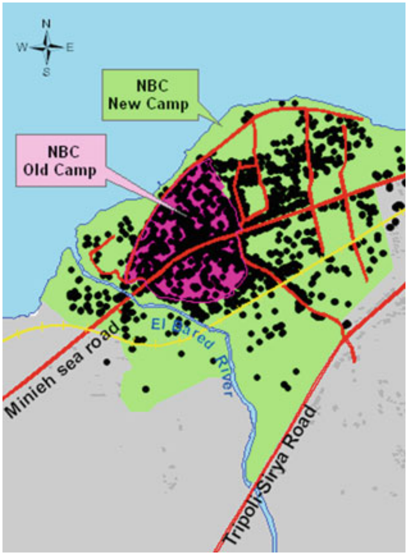

Fig. 4 Distribution of commercial units

Anderson et al. [10] developed a new methodology to predict external trip circulations in small cities. The authors identified the impact of roadway infrastructure and nearby cities on a small community traffic flow. They developed a statistical regression model using SPSS by taking as parameters: the origin and destination stations, the average daily traffic, the number of lanes, the nearby major city, the percent of trucks, the route continuity, and internal-external factors. First, they used a stepwise

Table 1 Breakdown of population and non-residential units

Sector		Population	Non-residential units
Old camp		21,578	898
New camp	*A'*	*820*	55
	B'	*1037*	280
	C'	*245*	103
	E'	*2523*	254
	A	*1273*	125
	B	*1101*	81
	C	*2441*	276
	D	*293*	122
	E	*2418*	514
	UNRWA compound	–	33
	Sub-total	12,151	1,843
GRAND total		33,729	2,741

regression model that included four variables: average daily traffic at the destination station, the nearby major city at the destination station, the route continuity between origin and destination stations, and internal-external factor for a condition when origin station is the same as the destination station. Then, a multiple regression analysis was performed using the four variables to determine the percent trip between every station. The proposed model was able to forecast 56% of the external trip data with an error of less than 20% compared to the National Cooperative Highway Research Program (NCHRP) model that predicted only 50% of the external trip data with the same error margin.

Moreover, Autunes et al. [11] discussed a new accessibility maximization approach to the inter-urban road network for long term planning. The authors developed a nonlinear combinatorial optimization model to minimize the travel time across the facilities by considering no action for the current connection, construction of new connection, and link improvement as decision variables. The traffic flows were estimated based on the four steps model, and the model considered accessibility and budget constraints. The authors used heuristic solutions, such as local search and simulated annealing to solve the model.

Drezner and Wesolowshy [12] analyzed the network design problem by formulating a multi-objective function model to minimize construction and transportation costs. The transportation cost was based on traffic and demand service generated. The authors did not consider the volume of traffic on each link. They used a descent algorithm, simulated annealing, tabu search, and a genetic algorithm as a solution methodology. In addition, Bigotte et al. [13] maximized the accessibility to facilities via promoting center and links to a higher hierarchy. They formulated an optimization model to minimize the overall summation for the movement of people in terms

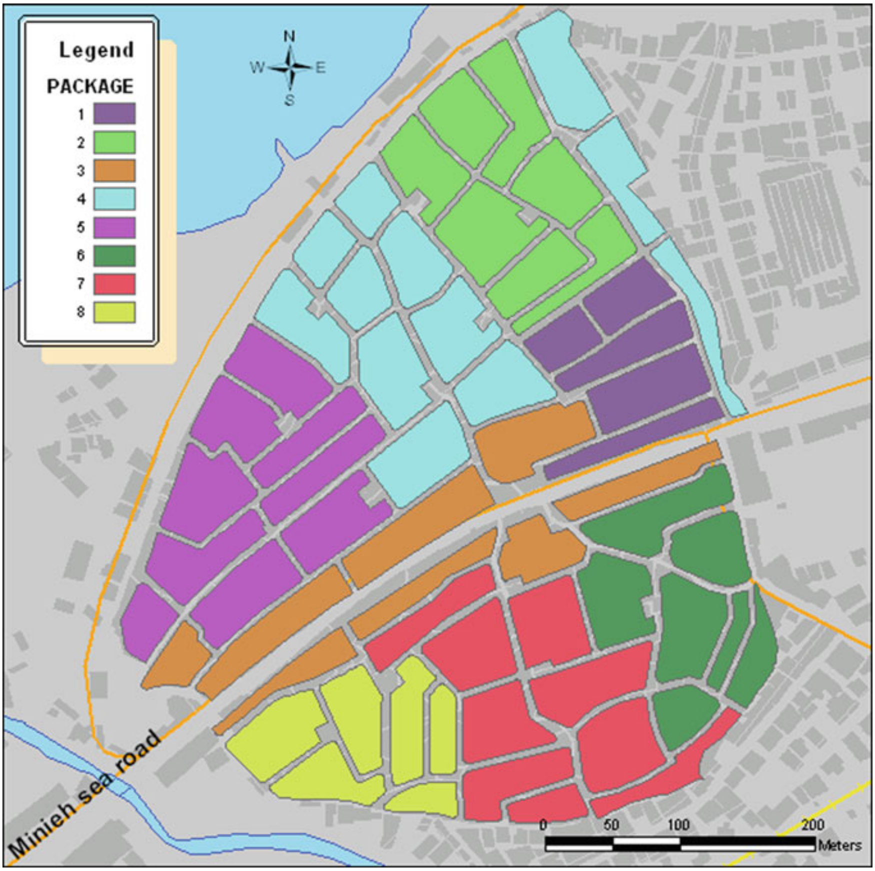

Fig. 5 Packages of the reconstruction of the old camp

of the total travel time. But the maximum capacity or the peak of the flow was not considered in the proposed model. The authors used a three-steps heuristic solution methodology similar to Nested Partition Algorithm.

Bose [14] studied the mobility for refugees settling in a non-traditional immigrant destination in Vermont, a state located in the northeastern side of the United States of America. The methodology used is based on a multi-year qualitative study of travel behavior preferences. The results of this study supported the hypothesis that lack of accessibility for refugees decreases their economic growth, deteriorates their medical health, and creates barriers to self-empowerment, acculturation, and integration within the new society.

Cetinkaya et al. [15] developed a Geographic Information System (GIS) based on a multi-criteria decision analysis model for refugee camps in southeastern Turkey to accommodate Syrian refugees. The authors used a fuzzy analytic hierarchy process to rank indicators generated from their developed GIS model. Fifteen new refugee camp locations are presented to replace the current camps allocated to Syrian refugees in southeastern Turkey. Gemenetzi [16] studied the evolution and the planning of Thessaloniki city in Greece after the Syrian refugee crisis in Europe. The author discussed the role of spatial planning in changing the geography of the city. According to Gemenetzi [16], Thessaloniki city has to adopt one of two options to respond to the Syrian refugee inflow in Greece. The first option is to follow passive pre-crisis strategies, which will transform Thessaloniki into an isolated city from geopolitical and economic perspectives. The second option is to adopt a radical resilience policy to frame the city's geography and ensures discursive narratives of strategic adaptability.

Current Traffic Conditions

Current Road Network

The Naher El Bared Camp (NBC) is adjacent to the Tripoli-Syrian Border highway, which is an international road with dual carriageway, two lanes per direction, and can be accessed through six access points as illustrated in Fig. 6. The six access points are (1) El-Aabdeh main entrance, (2) El-Mhammara entrance, (3) El-Minieh Sea Road entrance (bridge), (4) El-Mhammara minor and limited entrance, (5) Pedestrian Bridge on the Petrol Line and (6) Pedestrian Bridge on the Rail Line. The NBC internal road network is mainly the commercial spine (Camp Main Road connecting the Minieh Sea Road with El-Aabdeh interchange), which intersects several minor transverse roads and a narrow Sea Front Road that is poorly paved. In addition, the abandoned rail line and petrol line right of ways are paved with base coarse and are used as parking and internal access roads.

Traffic Counts

In order to estimate traffic flows in and around the project site, previous traffic counts data that were collected at various locations for the years 1998, 2001, and 2005 were adopted in this study [8]. The traffic counts locations are illustrated in Fig. 7 and includes: (i) TMC (Turning Movement Counts) over 14 h at two intersections: El-Aabdeh Roundabout, and El Mhammara intersection, (ii) ATC (Automatic Traffic Counts) over a whole week on the highway adjacent to the CAMP, and (iii) MCC (Manual Classified Counts) at all TMC and ATC locations.

The automatic traffic counts ATC1 were collected during the years 1998, 2001, and 2005, using electronic counters that were installed for 7 days and provide hourly traffic variation for every day of the week. The average week's daily traffic (AWDT) was estimated to be 31,386 vehicles divided equally between the South Bound and

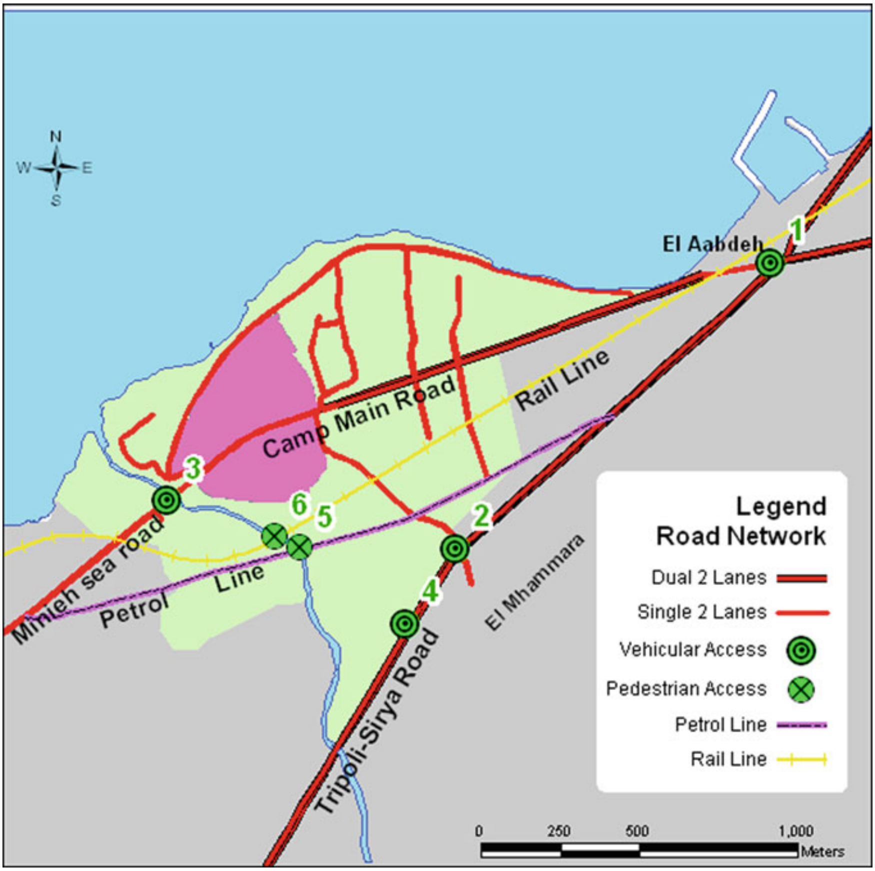

Fig. 6 Road network and site accessibility

the North Bound. The summary of the average daily traffic counts of the various years is presented in Table 2.

It can be noted that between the years 1998 and 2001, the yearly growth (around 9%) was higher than the years between 2001 and 2005 (around 2%). In fact, the Council of Development and Reconstruction report [17] has adopted a yearly growth factor of 2.5% for the forecast of the years 2010, 2015, and 2020. Therefore, the yearly growth factor of 2.5% was adopted in this study. Hourly traffic variation of the Tripoli-Syria Highway from the ATC1 counts for the year 2006 are presented in Fig. 8, showing the morning peak to be the highest (Total both directions of 2300 vehicles per hour being 10% of the total daily traffic). In addition, Fig. 9 represents hourly traffic variation of the camp-related traffic (from TMC1 and TMC2) indicates a noon peak hour of (approximately 8% of the total daily traffic).

Turning movement counts at TMC1, located at El- Aabdeh Intersection, are reported in Table 3. A total of 31,796 turning movements were reported at this TMC

Fig. 7 Locations of traffic counts

Table 2 ATC1-average week daily traffic

Year	SouthBound	NorthBound	TOTAL
1998	*11,410*	*11,053*	22,463
2001	*14,347*	*14,848*	29,195
2005	*15,693*	*15,693*	31,386

over the four different bounds (East, South, West and North) divided as follows. 18,552 for passenger car, 5,437 for Taxi, 4,128 for Van and Minibus, 162 for Bus, 2,517 for Light Truck, 233 for Medium Truck, 418 for Heavy Truck and 348 for other types of vehicles.

Turning movement counts at TMC2, located at El-Mhammara Intersection, are reported in Table 4. A total of 26,621 turning movements were reported at this TMC over the four different bounds (East, South, West, and North) divided as follows. 14,182 for passenger car, 5387 for Taxi, 3780 for Van and Minibus, 195 for Bus,

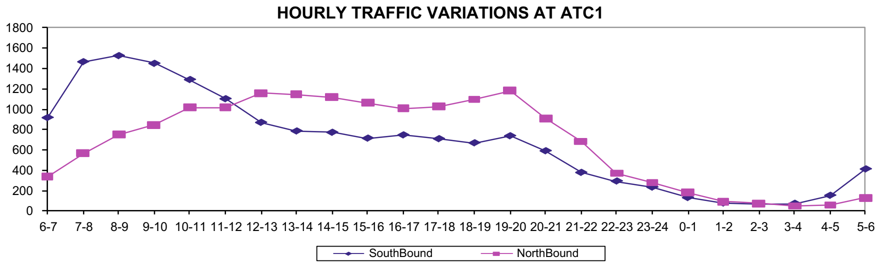

Fig. 8 Hourly variation of traffic flows on both the tripoli-sirya road

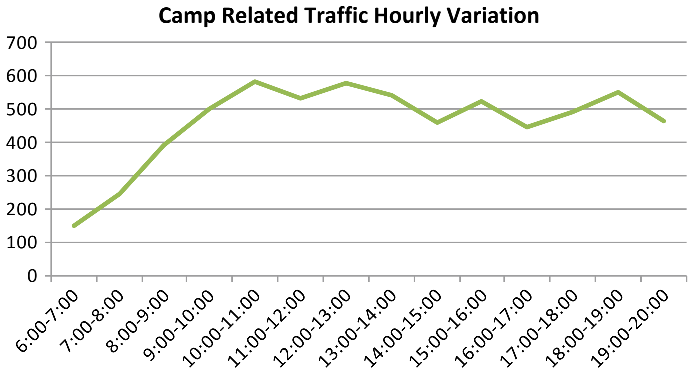

Fig. 9 Hourly variation of the camp-related traffic

Table 3 Turning movement counts at El-Aabdeh intersection (TMC1)

SouthBound	886 ↵	2,713 ↓	1,283 ↳	0 ↺
EastBound	0 ⮌	376 ⮥	1,974 →	1,162 ⮧
WestBound	1,126 ⮤	2,678 ←	8,033 ⮦	0 ⮎
NorthBound	0 ⮏	908 ↰	1,912 ↑	8,746 ↱

Table 4 Turning movement counts at El-Mhammara intersection (TMC2)

Approach				
SouthBound	191	11,835	174	16
EastBound	0	206	89	374
WestBound	266	101	274	0
NorthBound	128	375	12,228	365

2264 for Light Truck, 185 for Medium Truck, 482 for Heavy Truck and 146 for other types of vehicles.

Trip Generations

External traffic accessing the site from El-Aabdeh and El-Mhamara intersections (access points 1 and 2, respectively), as illustrated in Fig. 6 are available from the turning movement counts and are shown in Table 5. The Minieh Sea Road (access point 3) traffic was conservatively assumed to be equivalent to 20% of the total of both access points 1 and 2. The internal trips are mostly pedestrian trips due to low car ownership, parking constraints, and most destinations are within walking distance (schools and high density residential/commercial developments). Therefore, internal vehicular trips were conservatively estimated to be equivalent to 20% of the total external trips.

Table 5 Study area daily trip generations

Approach	Total	Ext. Split (%)
El Aabdeh approach	*9505*	*78*
El Mhammara approach	*1590*	*13*
Sea road approach	*1110*	*9*
Total external trips	12,205	100
Internal trips	2,441	
Total trip generation	14,645	

The total daily vehicular trip generation for the new and old camp area for the year 2006 is estimated to be 14,645 trips, assuming no additional through traffic due to the configuration of the road network. The population of this area is estimated to be around 33,000 persons and includes more than 2300 non-residential units (commercial and institutional). A daily vehicular person trip generation/attraction rate is estimated to be 0.44 trips/person/day for the NBC.

The total daily vehicular trip generation for the new and old camp area for the year 2006 is estimated to be 14,645 trips, assuming no additional through traffic due to the configuration of the road network. The population of this area is estimated to be around 33,000 persons and includes more than 2300 non-residential units (commercial and institutional). A daily vehicular person trip generation/attraction rate is estimated to be 0.44 trips/person/day for the NBC.

Trip Distributions

External trip distribution was generated using the results of the turning movement counts, while the internal trip distribution was estimated proportionally based on population densities of each sector and assuming negligible friction factor inside the camp for a gravity model. The peak hour trip distributions are illustrated in Fig. 10. The study area is then represented in 19 Traffic Analysis Zones (TAZ), being 14 internal TAZs for NBC and 5 external TAZs as illustrated in Fig. 11. The distribution of the 3,774 peak hour trip generations distributed as follows: 2346 trips external to external trips, and 1428 trips related to NBC internal as external as indicated in Fig. 1. Then, trip generations were expanded into a full Origin-Destination (OD) matrix based on the 19 TAZs, as shown in Table 6.

Mode Choice

Results generated from the manual classified counts on the roads entering/exiting the camp area from TMC1 and TMC2 are summarized in Table 7. The percentage of total vehicles traffic distributions were deduced as follows (1) Passenger Car: 61.8%, (2) Taxi and Service (Jetni): 14.7%, (3) Van and Minibus: 11.7%, (4) Bus: 0.3%, (5) Pickup and Light Truck: 8.5%, (5) Medium Truck: 1.1%, (6) Heavy Truck: 0.6% and (7) Other type of vehicles: 1.2%.

Trip Assignment

The traffic assignment model developed in this study takes into account the urban specifications of the Naher El-Bared Camp, including trip generation, internal road

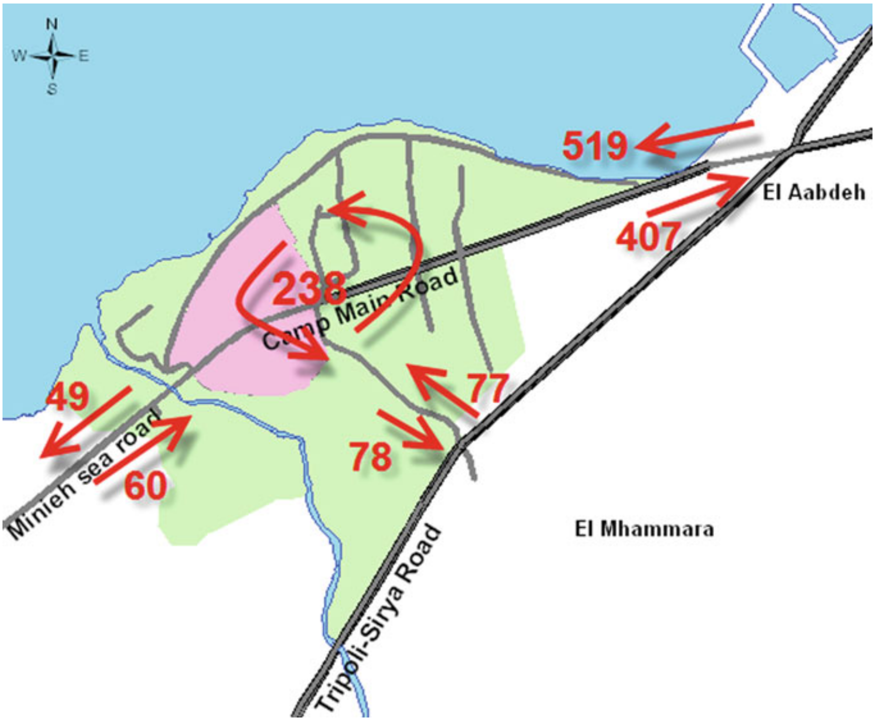

Fig. 10 NBC peak hour trip distribution

	ID	SECTOR
INTERNAL	1	Old Camp A
	2	Old Camp B
	3	Old Camp C
	4	Old Camp D
	5	New Camp A'
	6	New Camp B'
	7	New Camp C'
	8	New Camp E'
	9	New Camp A
	10	New Camp B
	11	New Camp C
	12	New Camp D
	13	New Camp E
	14	UNRWA Compound
EXTERNAL	15	Sea Road
	16	Tripoli Road
	17	El Mhammara
	18	Halba Road
	19	Syrian Road

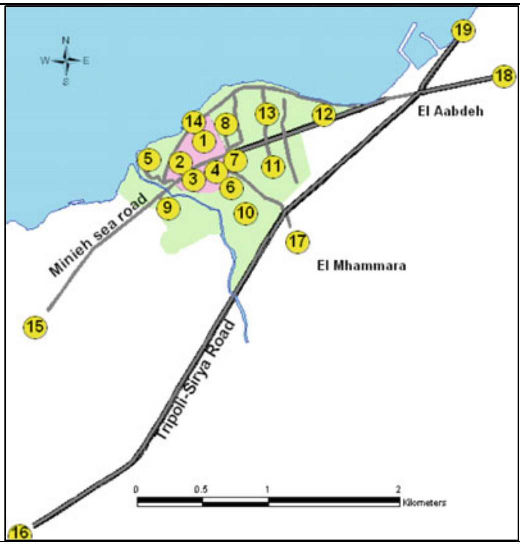

Fig. 11 Traffic analysis zones

Table 6 Expanded OD matrix

O/D	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	TOTAL
1		7.38	4.56	5.32	0.98	1.25	0.27	3.04	1.52	1.30	2.93	0.33	2.88	1.19	3.26	68.44	3.42	65.13	18.50	192
2	7.38		3.95	4.61	0.85	1.08	0.23	2.63	1.32	1.13	2.54	0.28	2.49	1.03	2.82	59.28	2.96	56.42	16.04	167
3	4.56	3.95		2.85	0.52	0.67	0.14	1.63	0.81	0.70	1.57	0.17	1.54	0.64	1.74	36.61	1.83	34.85	9.90	105
4	5.32	4.61	2.85		0.61	0.78	0.17	1.90	0.95	0.81	1.83	0.20	1.80	0.75	2.03	42.73	2.13	40.65	11.55	122
5	0.98	0.85	0.52	0.61		0.14	0.03	0.35	0.17	0.15	0.34	0.04	0.33	0.14	0.37	7.85	0.39	7.47	2.12	23
6	1.25	1.08	0.67	0.78	0.14		0.04	0.44	0.22	0.19	0.43	0.05	0.42	0.17	0.48	10.03	0.50	9.54	2.71	29
7	0.27	0.23	0.14	0.17	0.03	0.04		0.10	0.05	0.04	0.09	0.01	0.09	0.04	0.10	2.18	0.11	2.07	0.59	6
8	3.04	2.63	1.63	1.90	0.35	0.44	0.10		0.54	0.46	1.05	0.12	1.03	0.43	1.16	24.41	1.22	23.23	6.60	70
9	1.52	1.32	0.81	0.95	0.17	0.22	0.05	0.54		0.23	0.52	0.06	0.51	0.21	0.58	12.21	0.61	11.62	3.30	35
10	1.30	1.13	0.70	0.81	0.15	0.19	0.04	0.46	0.23		0.45	0.05	0.44	0.18	0.50	10.46	0.52	9.96	2.83	30
11	2.93	2.54	1.57	1.83	0.34	0.43	0.09	1.05	0.52	0.45		0.11	0.99	0.41	1.12	23.53	1.18	22.40	6.37	68
12	0.33	0.28	0.17	0.20	0.04	0.05	0.01	0.12	0.06	0.05	0.11		0.11	0.05	0.12	2.62	0.13	2.49	0.71	8
13	2.88	2.49	1.54	1.80	0.33	0.42	0.09	1.03	0.51	0.44	0.99	0.11		0.40	1.10	23.10	1.15	21.98	6.25	67
14	1.19	1.03	0.64	0.75	0.14	0.17	0.04	0.43	0.21	0.18	0.41	0.05	0.40		0.46	9.59	0.48	9.13	2.59	28
15	2.66	2.30	1.42	1.66	0.31	0.39	0.08	0.95	0.47	0.41	0.92	0.10	0.90	0.37		21.36	1.07	20.33	5.78	61
16	71.04	61.54	38.01	44.34	8.14	10.41	2.26	25.35	12.67	10.86	24.43	2.71	23.98	9.95	27.15		28.51	543.04	154.24	1,099
17	3.47	3.01	1.86	2.17	0.40	0.51	0.11	1.24	0.62	0.53	1.19	0.13	1.17	0.49	1.33	27.90		26.55	7.54	80
18	64.26	55.66	34.38	40.11	7.37	9.41	2.05	22.92	11.46	9.82	22.10	2.46	21.70	9.00	24.56	516.18	25.79		139.51	1,019
19	26.48	22.95	14.17	16.53	3.04	3.88	0.84	9.45	4.72	4.05	9.11	1.01	8.94	3.71	10.12	212.78	10.63	202.48		565
TOTAL	201	175	110	127	24	30	7	74	37	32	71	8	70	29	79	1,111	83	1,109	397	3,774

Table 7 Results of the manual classified counts

Vehicle type	%
Passenger Car	61.8
Taxi/Service	14.7
Van/Minibus	11.7
Bus	0.3
Pickup/light truck	
Medium truck	1.1
Heavy truck	0.6
Other vehicles	1.2
Total	100

network, and connections with the external area-wide road network. The modeling framework and software used are Emme/2 regional transportation model linked with ArcGIS and Synchro7 for signalized intersection traffic analysis. The analysis was performed for the year 2006, before the war, noon peak hour period, and the Emme/2 assignment output is presented in Fig. 12.

Traffic Analysis

Results of the 2006 assignment revealed that road links were operating with a low to moderate Volume-to-Capacity (V/C) ratio. The highest ratio reported was 500 vehicles per direction on the Camp Main Road, and congestions were observed on junctions, namely the major junction, as shown in Fig. 14. This junction is a four-way unsignalized intersection with the north-south approaches staggered at a distance. Then, Synchro software was used to analyze this junction, and the output is presented

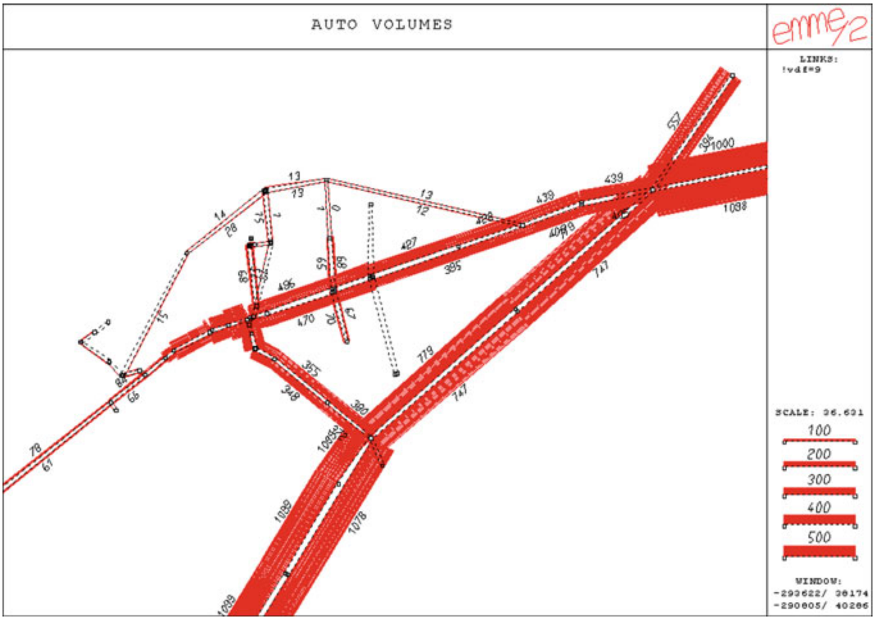

Fig. 12 Emme/2 assignment output

in Fig. 13. This junction was modeled as two 3-way intersections, and the LOS (level of service) was deduced to be F.

Fig. 13 Synchro output for the main camp junction

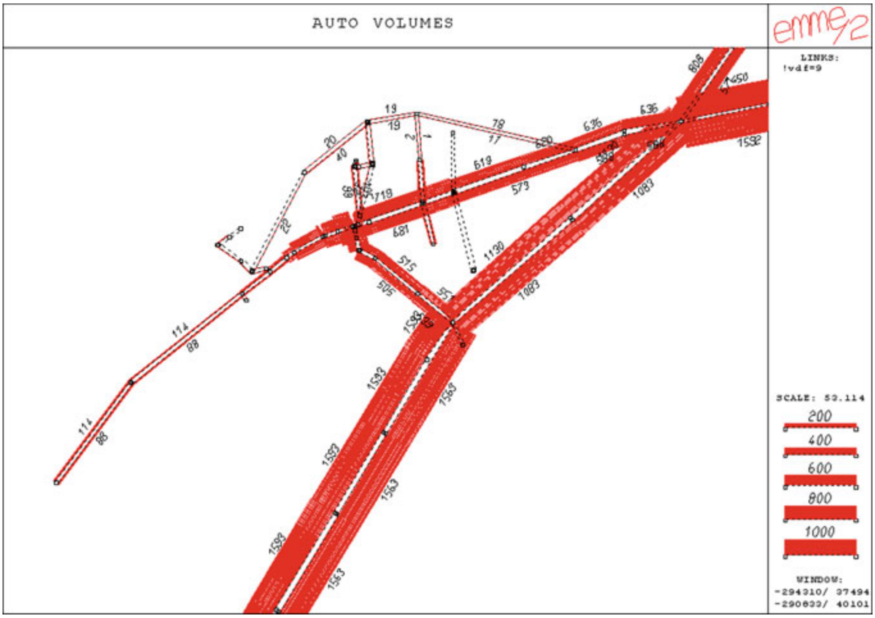

Fig. 14 Emme/2 assignment output (year 2030)

Future Traffic Condition

Currently, the old camp is closed by the Lebanese army for security reasons; only construction workers with special permits are allowed into the site. With more than 70% of the camp residents being displaced, traffic operations in the year 2010 are considered temporary. Therefore, the population of the camp for the year 2015, at the full reconstruction of the old camp, was expected to be equal to the year 2006. Therefore, a future scenario for the year 2030 (forecasted at 2.5% yearly growth) was evaluated in Emme/2. Figure 14 showed the results, where the Volume-to-Capacity (V/C) ratios are still acceptable (the highest ratio on the camp main road reached 700 vehicles per direction with a capacity of 1200 vehicles per lane, V/C is equal to 0.58). The main junction continues to operate at a level of service F and is recommended to be converted into a roundabout which can accommodate higher traffic volumes with the minimal conflicting points.

Conclusion and Recommendations

This paper analyzed the urban transportation planning framework related to long term refugee camps, specifically the case of Naher El Bared Camp in North Lebanon. A transport study was conducted using a combination of the four steps model and a micro-analysis approach using Synchro software. A new transport model was developed to forecast demand in the year 2030, taking into consideration land use and political constraints, and implemented using Emme/2 software. Several insights were deduced from the developed model.

First, despite the high-density population inside the long term refugee camp, a low trip generation was recorded, approximately 0.44 trips/person/day. To the best of our knowledge, none of the previous research conducted in the literature recorded any value for trip generating in a long term refugee camp. Second, congestions were mainly on junctions due to the absence of proper geometry and traffic law enforcement. Therefore, roundabouts are recommended since the accommodated capacities are higher for unsignalized intersections, simulating the level of service of any future intersection, as performed by [18], is a worthwhile direction for future research. It is also recommended to increase parking widening and sidewalks to facilitate and enhance mobility inside the refugee camp. Thus, Analysis of vehicle ownership and operating costs inside the camp is a potential venue for future research, as illustrated by Mansour et al. [19].

This study is a first step toward documenting and formulating urban transport studies for long term refugee camps in the Middle East.

References

1. United Nations High Commissioner for Refugees (UNHCR) (2016) The situation of palestinian refugees in lebanon
2. Ramadan A (2009) Destroying Naher el-bared: sovereignty and urbicide in the space of exception. Political Geography 28:153–163
3. Ramadan A (2010) In the ruins of Naher al-Barid: understanding the meaning of the camp. J Palestine Stud 40:49–62
4. Ramadan A (2013) Spatialising the refugee camp. Trans Inst Br Geogr 38:65–77
5. Naher el-Bared reconstruction commission for civil action and studies (2008) Preliminary Master Plan and Guidelines for the Reconstruction of Naher el-Bared Palestine Refugee Camp. United Nations Relief and Works Agency, Lebanon
6. United Nations relief and works agency for palestine refugees in the near east (UNRWA) (2012) Reconstruction of Naher El-bared camp and UNRWA compound
7. United Nations development programme (UNDP) (2008) The contribution of UNDP to the early recovery process of Palestinian and Lebanese populations affected by Naher El Bared Crisis. United Nations Development Programme, Lebanon
8. Government of Lebanon (2008) A common challenge: a shared responsibility. Report of the international donor conference for the recovery and reconstruction of the Naher el-Bared palestinian refugee camp and conflict-affected areas of North Lebanon. Vienna
9. Damme WV (1995) Do refugees belong in camps? experiences from Goma and Guinea. The Lancet 346:360–362
10. Anderson MD, Abdullah YM, Gholston SE, Jones SL (2006) Development of a methodology to predict through-trip rates for small communities. J Urban Planning Dev 132:112–114
11. Antunes A, Seco A, Pinto N (2003) An accessibility-maximization approach to road network planning. Comput-Aided Civil Infrastruct Eng 18:224–240
12. Drezner Z, Wesolowsky G (2003) Network design: selection and design of links and facility location. Transp Res Part A Policy Pract 37:241–256

13. Bigotte JF, Krass D, Antunes A, Berman O (2010) Integrated modeling of urban hierarchy and transportation network planning. Transp Res Part A Policy Pract 44(3):506–522
14. Bose P (2014) Refugees in Vermont: mobility and acculturation in a new immigrant destination. J Transp Geogr 36:151–159
15. Çetinkaya C, Özceylan E, Erbaş Kabak M (2016) GIS-based fuzzy MCDA approach for siting refugee camp: a case study for southeastern Turkey. Int J Disaster Risk Reduction 18:218–231
16. Gemenetzi G (2017) Thessaloniki: the changing geography of the city and the role of spatial planning. Cities 64:88–97
17. Council of Development and Reconstruction (2001) Traffic study for the feasibility of the deir-ammar-el aabdeh corridor. http://www.cdr.gov.lb
18. Fawaz W, El Khoury J (2016) An exact modelling of the uniform control traffic delay in undersaturated signalized intersections. J Adv Transp 50:918–932
19. Mansour C, Haddad M, Zgheib E (2018) Assessing consumption, emissions and costs of electrified vehicles under real driving conditions in a developing country with an inadequate road transport system. Trans Res Part D Transp Environ 63:498–513