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## **Traffic Management in Residential Areas: Case Study the South District of Luxor City, Egypt**

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### **Abstract**

Traffic management includes the implementation of a wide range of measures, devices and techniques based on a combination of parallel strategies, to improve safety and livability on streets by reducing the effect of vehicular traffic.

The local residential streets have the intended traffic function of providing access to limited numbers of local residents. Traffic management for residential streets helps to preserve and enhance streets by minimizing the negative impacts of traffic and seeks to improve safety for pedestrians, cyclists, motorists and all other road users.

The problem is that the planning of Egypt's existing cities depended on grid and linear network streets without separation land-use. Where the residential areas are always mixed land-use, (residential and commercial uses). This situation reflects on congestion residential areas; noisy, Traffic confusion, . . . . . etc. So, the author aimed to create the traffic methodological for existing residential areas.

This paper is applied in the south district of Luxor city, where the city's authorities took some procedures for managing traffic to no avail.

This practical study includes: designing the traffic methodological framework, applying the framework at case study, and comparing the designed model with the current state of case study. The software programs used are SPSS and excel.

The results show that the current state ignores some principles in comparison to the designed model. The important recommendations of research are: the designed model should be applied at case study, and the framework of traffic methodological for existing residential areas is applicable in different areas.

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### **Keywords**

Traffic management; critical point; commercial density; Streets' characteristics; one-way street; two-way street

## **1. Introduction**

The street has long been studied by many authors such as Kevin Lynch, Jane Jacobs and J.B. Jackson. They discussed the street as a physical and social part of the living environment, as a place used for vehicular movement, social contacts and civic activities. In particular, the role of street in living environment is more effective in the local residential streets, where they are central to the feeling of "community" and "belonging" within a neighborhood.

Street layout is the key to controlling the form of the movement network and influences several key features (Mc-

Cotter, Consulting, Group, & Services, 2000). Donald Appleyard hypothesized that when traffic volume increases beyond normal local residents, or vehicle speeds increase as the cause of street design, then social street activities are greatly reduced, and the feeling of wellbeing in the affected residential area is threatened (A. Donald, 1981). In order to protect livability as well as to provide for efficient movement of motor vehicles streets are designed and traffic is managed.

Colin Davis debated his views on how to improve the main street. He suggested enhancing' pavements quality and reducing the street furniture clutter created by signs and guard rails (Mike, Paul, & Peter, 2005), while Akinori Morimoto confirms that understanding the relationship between land-use and traffic is extremely important for designing a safe society (Akinori, 2015).

Land use and traffic are interdependent. For example, the residential use of land requires easy arrival to each house without encouraging transit traffic, while the commercial use needs easy shipping and transportation and reduction of the maneuverable during movements. The movement from one place to another place is called the transportation system (Edward, 1991), so, the transportation system in urban areas is related to the concentration of people and socioeconomic activities of the population (Becky & Chow, 2006).

## 2. Literature reviews: Traffic management overview

The dictionary describes 'traffic' as the transportation of goods, coming and going of persons or goods by road, rail, air, etc. Often in common usage traffic is defined as the movement of pedestrians and goods along a route. In the 21st century the biggest problem and challenge for the traffic engineer is often the imbalance between the amount of traffic and the capacity of the route, leading to congestion (Mike et al., 2005).

Traffic management describes a wide range of technical practices undertaken to manage traffic across networks, which includes prioritization and slowing down (Harsha, Shankar, Prasad, & Reddy, 2013), so, its policies aim to improve traffic flow by influencing the route choice of drivers, therefore preventing traffic jams in crowded cities (Madlen & Mark, 2018).

Moreover, the rationale for traffic management lies in the recognition of the intended function of roads, for example, the traffic management of the smallest residential area focuses on local streets, which are predominantly residential in character and the intended traffic function is accessibility to limited numbers of local residents. Where traffic management improves the safety and the liveability of residential area: for pedestrians, cyclists, motorists and all other road users, by minimizing negative impacts of traffic, such as noise, pollution, . . . and so on.

Traffic and transport routes are shaped by urban physical structure, economic factors and cultural factors (Peter & Jeff, 2007). The components of urban physical structure factors are:

- Urban pattern (street network; grid, linear, organic,. . . and so on).
- Streets' characteristics; width, length, junction, and end type -closed or opened-.
- Land-use; residential, commercial, industrial, educational, administrative . . . . . and so on.

Manfred and Vu Anh confirm that traffic design requires short-distance trips connecting places of human activities, and the characteristics of traffic including its capacity is affected by surrounding land-use (Manfred & Anh, 2016). This paper presents the traffic management methodological for existing residential areas to be more comfortable for users by studying streets' traffic type (one-way or two-way) and the traffic direction for the one-way streets.

## 3. Empirical study methodology

The local authorities of Egyptian cities took some procedures for managing traffic, which focused on determining the traffic type of street; one or two-way and the traffic direction for the one-way streets. For example; in Cairo

city there are many main streets one-way as Corniche Elnile street front of Maspero and the Ministry of Foreign Affairs, Ahmed Helmy street at Ramses area, Al-Qasr Al-Aini Street at Altahrir area, and . . .so on. Most of these streets have the large governmental and administrative institutions and huge companies and also the few of residential buildings, which explained the acceptance of fixing the direction of these streets traffic.

Another example; in Elmina city, there are two main parallel streets at Sultan's land area, Taha Hussien and Adnan al-Maliki streets these two streets are linked with many horizontal local streets. Generally, Sultan's land area has mixed-use; residential and commercial use. The both of two main streets were designed and planned as two-way streets, at the begging of 2018 year the local authorities decided to convert each of these main streets as one-way street, and their direction reverse each other. Recently, many of traffic problems appeared which caused cancellation the decision.

So, the empirical study methodology concentrates on design a new applicable traffic methodological.

Design traffic methodological for residential areas including mixed use (commercial and residential) need coordination between commercial traffic demands and other of residential. The main traffic demand in residential area is easy arriving to local street that mean two-way streets are suitable. But in this study, there are three limits:

- The study shows the existing areas not the new, which requires dealing with the current situation with coordination between the traffic demands of existing uses.
- The urban pattern is linear and organic network street, which increase traffic and encourage cars' speed.
- The mixed use -residential and commercial- in local streets, which increase crowding and noise levels.

Accordingly, the traffic methodological requires:

- Determination most crowded streets and their characteristics.
- Designing models for traffic.
- Comparison between designed model and current state of case study.

The research methodology takes four steps: (Figure 1)

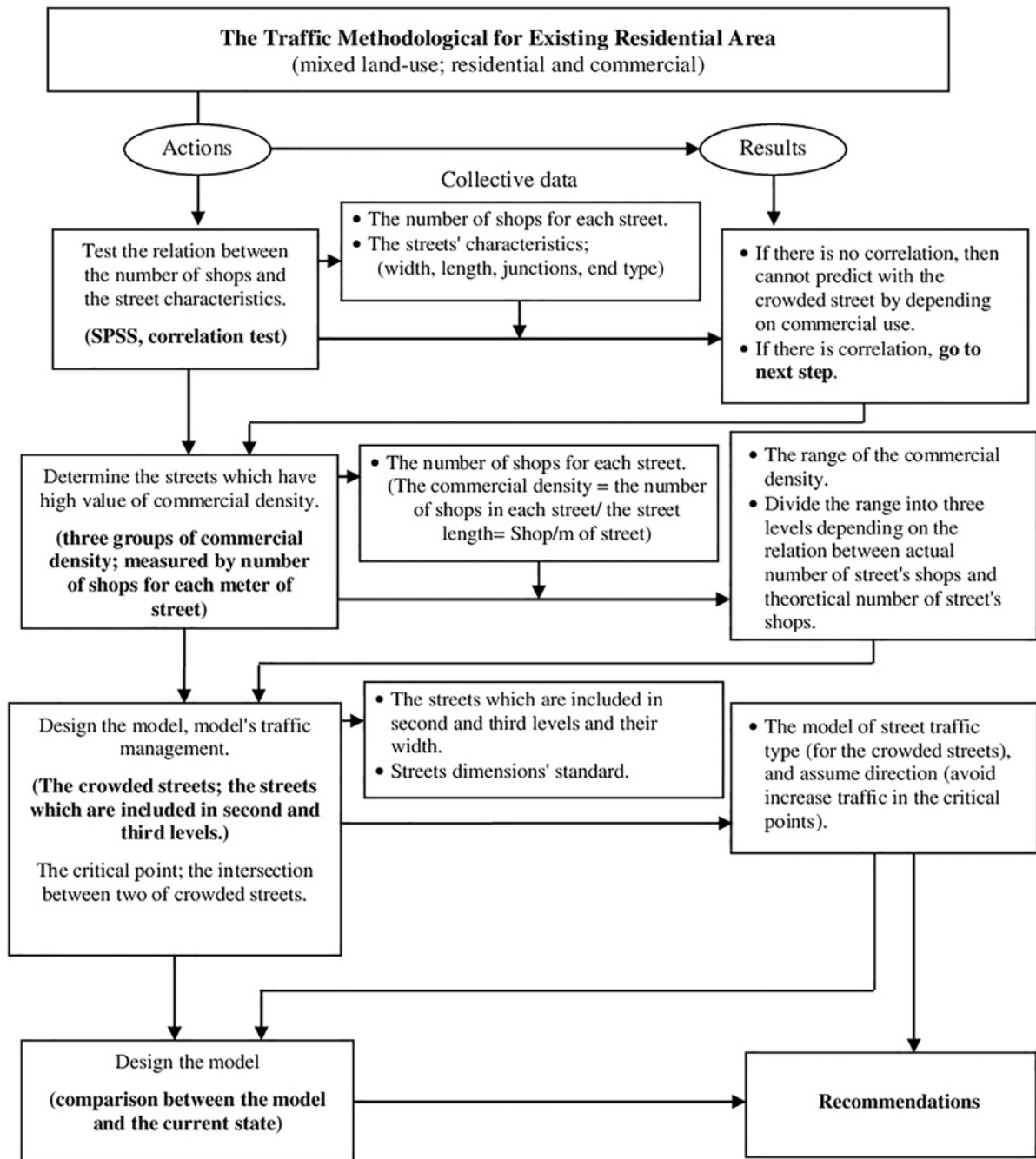


Figure 1. The research methodology

**First step: Determine the streets' characteristics and relation with the number of shops:**

Test the relation between the number of shops and the street's characteristics, where the shops increase traffic volume because there are cargoes' and shoppers' movement. The data are analyzed by using the statistical package for social sciences (SPSS). The correlation between number of shops and street's characteristics (width, length, number of junctions, and end type -closed or opened-), which was tested by Parson correlation coefficients for all characteristics except end type which was tested by Spearman correlation coefficients.

Correlation analysis is used to describe the strength and direction of the linear relationship between two variables. Parson's Rank Order Correlation ( $\rho$ ) is used to calculate the strength of the relationship between two variables of parametric type, while Spearman's Rank Order Correlation ( $\rho$ ) is used to calculate the strength of the relationship between two variables, one parametric and the other non-parametric type (Julie, 2005).

This test deduces the Correlation Coefficient and the significance level, which is referred to as Sig. (1-tailed). If this significance level has a value less than 0.05 then this proves the existence of correlation between the tested variables, while the negative sign in front of the (Correlation Coefficient)  $r$  means there is a negative correlation between the two variables. The value of correlation ( $r$ ) ranges from  $-1.00$  to  $1.00$ . This value will indicate the strength of the relationship between variables. A correlation of  $0$  indicates no relationship at all, a correlation of  $1.0$  indicates a perfect positive correlation, and a value of  $-1.0$  indicates a perfect negative correlation (Julie, 2005). Jacob Cohen (1988) suggests the following guidelines (Jacob, 1988):

$r = .10$  to  $.29$  (or)  $r = -.10$  to  $-.29$  small;

$r = .30$  to  $.49$  (or)  $r = -.30$  to  $-.49$  medium;

$r = .50$  to  $1.0$  (or)  $r = -.50$  to  $-1.0$  large.

### **Second step: Determine the streets which have high values of commercial density:**

The commercial density can be measured by number of shops for each meter of street. It was calculated by using this equation:

$$\text{The commercial density} = \frac{\text{the number of shops in each street}}{\text{the street length}} = \text{Shop/m of street} \quad (1)$$

The range of the commercial density's results were divided into three groups by depending on the maximum theoretical number of street's shops.

The commercial service standard of Egypt shows that the shop area is between  $30$  to  $60\text{m}^2$  with minimum façade's length  $3\text{m}$ , then the maximum theoretical number of street's shops (if the shops at ground floor only) is calculated by using this equation;

$$\text{The maximum theoretical number of street's shops} = (\text{Street length} * 2) / 3 = \text{shops} \quad (2)$$

Accordingly, the commercial density can be divided into three groups as following:

- The actual number of street's shops  $\leq 15\%$  of the maximum theoretical number of street's shops.

Then the commercial density is low. (First level)

- The actual number of street's shops =  $15.1\%$  to  $30\%$  of the maximum theoretical number of street's shops.

Then the commercial density is moderate. (Second level)

- The actual number of street's shops  $> 30\%$  of the maximum theoretical number of street's shops.

Then the commercial density is high. (Third level)

Determine the crowded streets: The streets which record moderate and high values of the commercial density cause different levels of problems for their residents and need to manage the traffic.

### **Third step: Design the model, model's traffic management:**

The traffic management model concentrates on;

- The type of traffic at crowded streets, which streets will be one-way and two-way by depending on street width.
- The direction of traffic at one-way streets, that will be designed with respect and avoid the intersection between two of crowded streets (the critical point).

### **Fourth step: Design the model, comparison between designed model and traffic current state:**

This comparison leads to the recommendations for traffic management in existing residential area.

#### 4. Case study

Luxor city is one of the most tourism cities in Egypt. It has mixed land-use over all city areas; archeological, tourism, commercial, residential and administrative uses. The combination among these uses and the city's role as a residential city require specific study for managing traffic.

The area of case study is the south district in Luxor city, where there are two main mixed uses; residential and commercial, its area about 289.522 hectare including 47.58 hectare under construction (for Urban Planning (GAUP), 2015)(Figure 2)

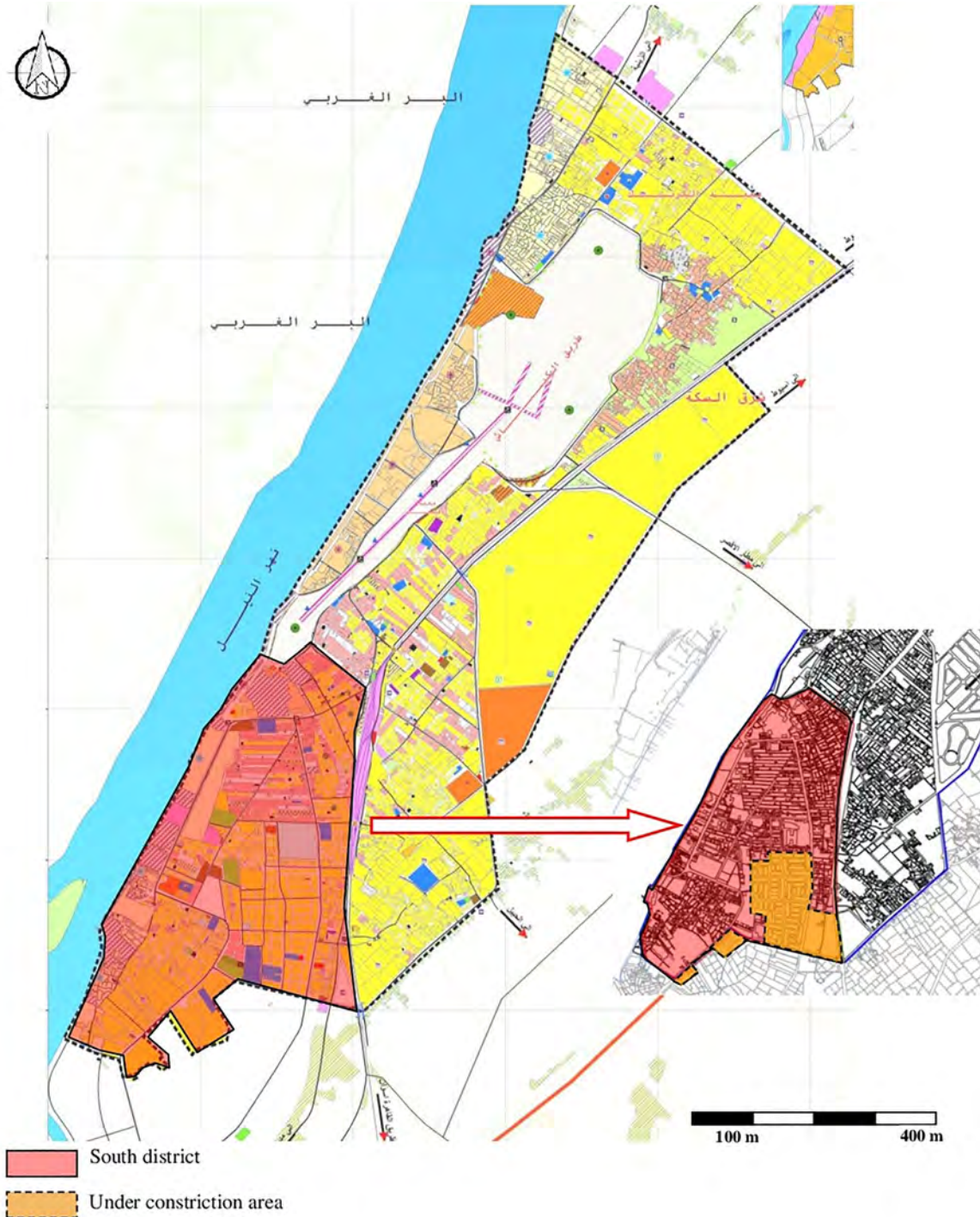


Figure 2. Luxor city map (for Urban Planning (GAUP), 2015)

#### 4.1. Luxor's south district description

The urban pattern appears into two types; linear and organic. Linear type appears in an area which was planned and built as a residential area since 1970 in western area, while the organic type was earlier than linear and appears in eastern and western southern area. This district was designed as a residential area but now it has mixed use: residential and commercial use.

Through this study, the district is divided into three parts between four vertical main streets (streets extend from north to south).

All streets have numbers for easy dealing with thought applied study. The four main streets are A, B, C, D and some of the main streets were divided into parts if the street has different characteristics along its length. The horizontal streets, which linked two main streets, take a number beside two letters (the letters of two linked streets) such as 1AB, 2AB, . . . , and so on, while the vertical streets in each part take also a number beside the two letters but invert letters such as 1BA, 2BA, . . . , and so on. (Figure 3)

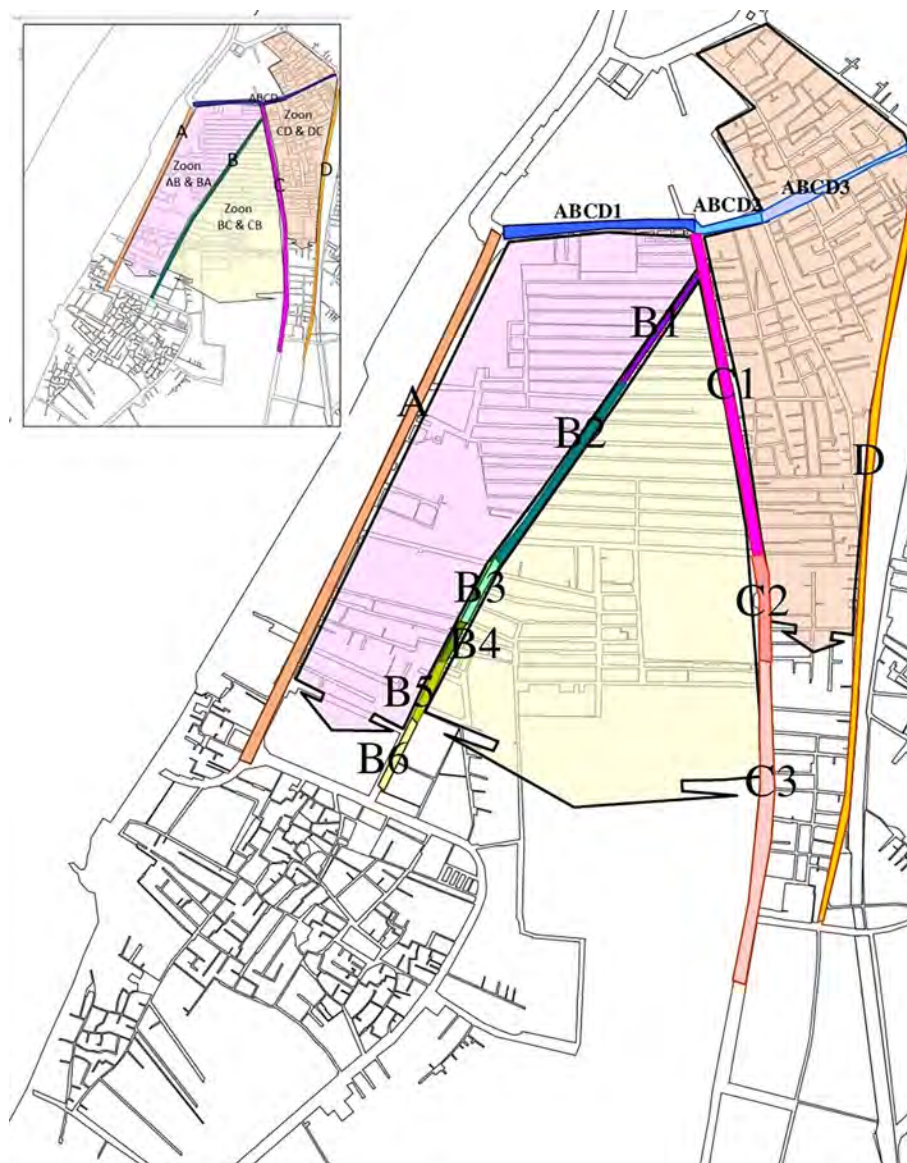


Figure 3. Luxor's south district and its parts

#### 4.2. Data collection and study variables

The author counted the number of shops for each street through field visits, and measured the streets' characteristics (width, length, junctions, and end type -closed or opened-) from digital AutoCAD map. All of the data was recorded in SPSS file and excel file to test correlation between variables and calculate the commercial density, the maximum theoretical number of street's shops, and the crowded streets. Table 1 shows case study data.

Table 1. Overview of the case study data.

| The Area     |       | Number of streets | The range of junctions' number (for each street) | Number of closed streets | Total number of shops | The range of area's shops no. (measured for each street) | The range of commercial density (shop/m of street) |
|--------------|-------|-------------------|--|--------------------------|-----------------------|--|--|
| Zone         | AB    | 32                | 0: 3   | 13                       | 342                   | 0: 58  | 0: 0.15  |
|              | BA    | 6                 | 0: 9   | 3                        | 31                    | 0: 14  | 0: 0.073   |
| Zone         | BC    | 23                | 0: 5   | 1                        | 708                   | 0: 114   | 0: 0.311   |
|              | CB    | 5                 | 0: 14  | 1                        | 78                    | 3: 56  | 0.015: 0.146                                       |
| Zone         | CD    | 123               | 0: 7   | 55                       | 198                   | 0: 21  | 0: 0.129   |
|              | DC    | 50                | 0: 38  | 16                       | 213                   | 0: 60  | 0: 0.245   |
| Main streets | A     | -                 | 10   | -                        | 26                    | -  | 0.0215   |
|              | B(B1) | -                 | 14   | -                        | 85                    | -  | 0.273  |
|              | B(B2) | -                 | 20   | -                        | 75                    | -  | 0.166  |
|              | B(B3) | -                 | 5  | -                        | 7                     | -  | 0.0434   |
|              | B(B4) | -                 | 4  | -                        | 5                     | -  | 0.0499   |
|              | B(B5) | -                 | 1  | -                        | 0                     | -  | 0  |
|              | B(B6) | -                 | 3  | -                        | 0                     | -  | 0  |
|              | C(C1) | -                 | 34   | -                        | 142                   | -  | 0.202  |
|              | C(C2) | -                 | 4  | -                        | 12                    | -  | 0.0517   |
|              | C(C3) | -                 | 9  | -                        | 17                    | -  | 0.0317   |
|              | D     | -                 | 4  | -                        | 0                     | -  | 0  |

#### 5. Results and discussion of findings

The results include four stages according to the steps of research methodology, they are:

1. The correlation test was conducted between the number of shops and streets' characteristics (width, length, number of junctions, and end type -closed or opened-):

- The test of correlation between the number of shops and streets' characteristics (width, length, number of junctions) show that there is not correlation between number of shops and street width. And there is a positive correlation between number of shops and both of street length, number of junctions equals to 0.483 and 0.423 respectively with significance at the 0.01 level.
- The test of correlation between the number of shops and the street end type (closed or opened) show that there is a positive correlation equals to 0.33 with significance at the 0.01 level:

2. Determine the crowded streets -have high values of commercial density-:

- The maximum theoretical number of street's shops was calculated and then the commercial density levels are determined. Accordingly, the crowded streets will be known. Table 2 shows the crowded streets' results.

Table 2. The crowded streets' characteristics and results

| The area     | Street number | Street length (m) | Street width (m) | The commercial density level | The commercial density (shop/m of street) |
|--------------|---------------|-------------------|------------------|------------------------------|---|
| Zone AB & BA | 11AB          | 256.69            | 5.58881          | Moderate                     | 0.1013                                    |
|              | 13AB          | 375.0466          | 10.77988         | Moderate                     | 0.1546                                    |
|              | 15AB          | 251.3456          | 9.404762         | Moderate                     | 0.1154                                    |
|              | 26AB          | 259.9234          | 7.645833         | Moderate                     | 0.127                                     |
| Zone BC & CB | 3BC           | 118.603           | 7.200714         | Moderate                     | 0.118                                     |
|              | 4BC           | 144.7649          | 10.79738         | High                         | 0.3108                                    |
|              | 5BC           | 171.7848          | 5.85869          | Moderate                     | 0.1106                                    |
|              | 6BC           | 195.4872          | 4.860833         | Moderate                     | 0.1381                                    |
|              | 7BC           | 226.0161          | 12.0544          | High                         | 0.2478                                    |
|              | 10BC          | 315.1009          | 10.95464         | Moderate                     | 0.1142                                    |
|              | 12BC          | 376.3282          | 9.80131          | High                         | 0.2152                                    |
|              | 13BC          | 404.6608          | 6.125119         | Moderate                     | 0.1532                                    |
|              | 14BC          | 431.108           | 9.51369          | High                         | 0.2644                                    |
|              | 15BC          | 462.9964          | 9.066429         | High                         | 0.203                                     |
|              | 16BC          | 495.4218          | 16.84524         | Moderate                     | 0.1171                                    |
| 1CB          | 383.582       | 9.020119          | Moderate         | 0.146                        |   |
| Zone CD & DC | 2CD           | 54.4158           | 3.866667         | Moderate                     | 0.1286                                    |
|              | 4CD           | 70.3721           | 6.38             | Moderate                     | 0.1279                                    |
|              | 6CD           | 77.3529           | 6.60369          | Moderate                     | 0.1293                                    |
|              | 26CD          | 164.8             | 7.286905         | Moderate                     | 0.1274                                    |
|              | 116CD         | 78.1107           | 4.57131          | Moderate                     | 0.1024                                    |
|              | 117CD         | 72.0134           | 4.235952         | Moderate                     | 0.1111                                    |
|              | 12DC          | 175.7927          | 13.78643         | High                         | 0.2446                                    |
|              | 19DC          | 386.9104          | 6.714286         | Moderate                     | 0.1551                                    |
| Main streets | ABCD2         | 140.3365          | 26.69262         | Moderate                     | 0.1781                                    |
|              | ABCD3         | 335.0962          | 10.43595         | High                         | 0.2745                                    |
|              | B1            | 311.0156          | 11.27107         | High                         | 0.2733                                    |
|              | B2            | 451.4486          | 20.69179         | Moderate                     | 0.1661                                    |
|              | C1            | 702.4718          | 27.59405         | Moderate                     | 0.2021                                    |

- The results which were recorded at table 2 was shown on case study map in Figure 4, where the crowded streets and critical points were determined. From this figure some facts can be concluded, they are:

A- The zone BC & CB area has the most crowded streets and critical points by comparison with the other zones of case study.

B- The crowded main streets are B1, B2, C1, ABCD2, ABCD3.

That means the higher commercial density for main streets records the higher commercial density of the local streets linking them.



Figure 4. The crowded streets and critical points

3- Design model’s traffic management:

- Determine the type of traffic at crowded streets -road direction; one-way or two-way:

The type of street’s traffic -one-way or two-way- concerns its width and the standard of street dimensions. The ideal design for main street width contains three main parts: sidewalk, roadbed, and center median. (Figure 5)

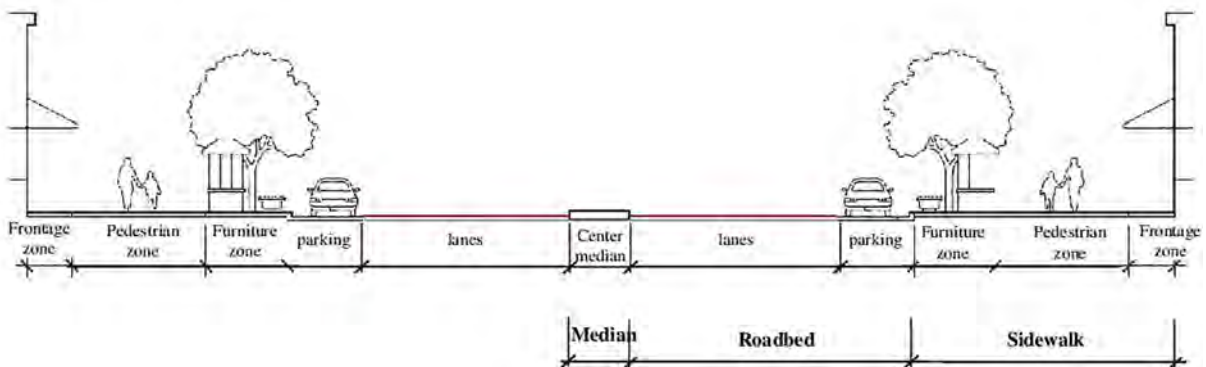


Figure 5. The street’s parts -road section-

— Sidewalk standards should accommodate higher anticipated pedestrian volumes and provide ample space for an expanded frontage zone and furniture. Design guidelines recommend a minimum sidewalk cross-section of 1.5 m, this width enough for two people walking side by side. The ideal width for pedestrian zone should be 1.5 – 2.1m

in residential areas and 2.4 – 3.6m in commercial areas (Joseph & E.K, 1984). According to study area -mixed use; residential and commercial- and it really exists, so the sidewalk will be 2.4 m at least.

— Roadbed; the width of lane is 3m which provides adequate safety in urban settings while discouraging speeding. Parking lane width of 2.1 – 2.7m is generally recommended (W. Donald, Alan, & Robert, 2003). Then the roadbed for main street in the study area will be;

3 – 6m if it has not parking (one lane and two lanes respectively)

5.1 – 11.7m if it has parking (one lane and two lanes respectively)

— Center median is usually included in main street. This part divides street into two directions and its width depends on the available street width. In case study it will be 0.5m (as it actually was designed in area).

Table 3. Shows the designed dimension of case study's streets

| Street type  | Total street width (m) minimum | Total street width (m) maximum | Sidewalk (m) Min. | Sidewalk (m) Max | Roadbed (m) Min for one lane | Roadbed (m) Max. for one lane & parking | Center median (m) Min. | Center median (m) Max. |
|--------------|--------------------------------|--------------------------------|-------------------|------------------|------------------------------|---|------------------------|------------------------|
| Main street  | 17.3                           | 26.1                           | 2.4               | 3.6              | 3                            | 5.7                                     | 0.5                    | 1.5                    |
| Local street | 7: 7.5                         | 13.7                           | 0.5               | 1.5              | 3                            | 5.1                                     | 0                      | 0.5                    |

Note:

- Two lanes for each direction is assumed in calculation total street width for main street.
- One lane for each direction is assumed in calculation total street width for local street.
- The closed end street which is its total width less than the minimum value will be pedestrian's street.

According to table 3. If the actual street width is equal or less than the minimum calculated width then the street will be one-way. And if it is more than the minimum calculated width then the street will be two-way.

Table 4 shows the type of case study's crowded streets, and their commercial density level, and Figure 6 translates the table's data on case study's map by showing the location of the type of crowded streets.

Table 4. The type of crowded streets (one-way or two-way)

| The area     | Street number | Street width (m) | The type of street (one-way or two-way) | The commercial density level |
|--------------|---------------|------------------|---|------------------------------|
| Zone AB & BA | 11AB          | 5.58881          | One-way                                 | Moderate                     |
|              | 13AB          | 10.77988         | Two-way                                 | Moderate                     |
|              | 15AB          | 9.404762         | Two-way                                 | Moderate                     |
|              | 26AB          | 7.645833         | One-way                                 | Moderate                     |
| Zone BC & CB | 3BC           | 7.200714         | One-way                                 | Moderate                     |
|              | 4BC           | 10.79738         | Two-way                                 | High                         |
|              | 5BC           | 5.85869          | One-way                                 | Moderate                     |
|              | 6BC           | 4.860833         | One-way                                 | Moderate                     |

*Continued on next page*

Table 4 continued

|              |       |          |                     |          |
|--------------|-------|----------|---------------------|----------|
|              | 7BC   | 12.0544  | Two-way             | High     |
|              | 10BC  | 10.95464 | Two-way             | Moderate |
|              | 12BC  | 9.80131  | Two-way             | High     |
|              | 13BC  | 6.125119 | One-way             | Moderate |
|              | 14BC  | 9.51369  | Two-way             | High     |
|              | 15BC  | 9.066429 | Two-way             | High     |
|              | 16BC  | 16.84524 | Two-way             | Moderate |
|              | 1CB   | 9.020119 | Two-way             | Moderate |
| Zone CD & DC | 2CD   | 3.866667 | Pedestrian's street | Moderate |
|              | 4CD   | 6.38     | One-way             | Moderate |
|              | 6CD   | 6.60369  | One-way             | Moderate |
|              | 26CD  | 7.286905 | One-way             | Moderate |
|              | 116CD | 4.57131  | One-way             | Moderate |
|              | 117CD | 4.235952 | One-way             | Moderate |
|              | 12DC  | 13.78643 | Two-way             | High     |
|              | 19DC  | 6.714286 | One-way             | Moderate |
| Main street  | ABCD2 | 26.69262 | Two-way             | Moderate |
|              | ABCD3 | 10.43595 | Two-way             | High     |
|              | B1    | 11.27107 | One-way             | High     |
|              | B2    | 20.69179 | Two-way             | Moderate |
|              | C1    | 27.59405 | Two-way             | Moderate |



Figure 6. The type of crowded streets

- The direction of traffic at one-way crowded streets

The guidelines for determining the direction of one-way streets are:

A- Depending on the commercial density values and levels: the direction of traffic tends to steer from the higher commercial density street towards the lesser one.

B- Depending on the street width; the direction of traffic tends to steer from the narrower street to the wider one.

C- Depending on critical points; avoid increasing traffic at them.

Accordingly, the streets directions in case study are described as following.

***The direction of one-way street:***

- Streets 3BC, 5BC, and 6BC their directions will be from B1 to C1 because street B1 is higher commercial density than C1.
- Street 13BC its direction will be from B1 to A (5BA), because street B1 is higher commercial density than A.
- Street 2CD will transfer to Pedestrian's street because it has closed end and narrow width.
- Streets 4CD and 6CD their directions will be from C1 to D because street C1 is higher commercial density than D.
- Street 19DC its direction will be from ABCD2 to into street because zone DC & CD has organic tissue so who takes this direction only needs to arrive somewhere in this zone.
- Street 26AB its direction will be from A to C because the two parts of street B -B3 and B5- were closed for security procedures.
- Street 26CD has not been determined as yet, because the abutting area is under construction.
- Streets 117CD and 116CD their directions will be from D to C because they begin from main street which separates two districts.
- Main street B1 is narrow and has high commercial density, so it will be one-way street its direction from C1 to B2

***The respect of critical points, direction modification for some two-way streets:***

- 13AB will be divided into two parts, first part starts from B2 street to intersection with 6BA street its direction will be from B2 to 6BA, and second part starts from 6BA, this part will be two-way. That is because the first part of street B2 is higher commercial density than 6BA and the start point of street from B2 is crowded by critical points, while the second part is wider than the first where its width is 13.3m and length 90.5 and has low number of shops, only four shops.
- Street 7BC its direction will be from B2 to C1, where there is two attached critical points at street B2 and needs to reduce its crowding so the direction will be out of street not into it.
- Street 15AB its direction will be from B2 to A, because street B2 is higher commercial density than A.
- Street 10BC its direction will be from C1 to B2 because street C1 is higher commercial density than B2.
- Street 12DC its direction will be from D to C because the street does not run in a straight line; it has difficult curve which causes unclear vision for the driver, and to supply the south district with traffic go into it beside main streets.

- Street 1CB its direction will be from 16BC to 12BC because this street has five junctions, four of them cross section intersections and all them act as critical points.
- Streets 12BC, 14Bc, and 15BC Their directions will be from C1 to B2 because they have high commercial density.

4. Design the model, comparison between designed model and traffic's current state:

Two traffic management maps of case study were prepared, the first shows the designed model (Figure 7) and the second shows the current state (Figure 8). Then the comparison between them was recorded in table 5.



Figure 7. The designed model



Table 5. The comparison between traffic in current state and designed model

| Street number | Traffic in current state | Traffic in designed model        | The comment   |
|---------------|--------------------------|----------------------------------|---|
| 11AB          | Undefined                | From B1 to A                     | Moderate commercial density, and B1 higher density than A.  |
| 13AB          | From A to B2             | From B2 to A                     | Street can be two-way but there is crowded critical points at its beginning from B2, so the street is divided into two parts; one-way from B2 to 6BA and two-way from 6BA to A. |
| 14AB          | From B2 to A             | Undefined (two-way, recommended) | Low commercial density, its width suitable for being two-way.   |
| 15AB          | From A to B2             | From B2 to A                     | Street can be two-way but it has high commercial density, so the street recommends to be one-way.   |
| 16AB          | From B2 to A             | Undefined (two-way, recommended) | Low commercial density, its width suitable for being two-way.   |
| 26AB          | From B4 to A             | From A to C1                     | Two parts of street B; B3 and B5, were closed for security procedures.  |
| 3BC           | Undefined                | From B1 to C1                    | Moderate commercial density, and B1 higher density than C1.   |
| 4BC           | Undefined                | Two-way                          | Moderate commercial density, and its width suitable to be two-way.  |
| 5BC           | Undefined                | From B1 to C1                    | Moderate commercial density, and B1 higher density than C1.   |
| 6BC           | Undefined                | From B1 to C1                    | Moderate commercial density, and B1 higher density than C1.   |
| 7BC           | From B2 to C1            | From B2 to C1                    | Street can be two-way but there is crowded critical points at its beginning from B2, so the street recommends to be one-way.  |
| 9BC           | From B2 to C1            | Undefined (two-way, recommended) | Low commercial density.   |
| 10BC          | Undefined                | From C1 to B2                    | Moderate commercial density, and C1 higher density than B2.   |
| 11BC          | Undefined                | Undefined (two-way, recommended) | Low commercial density.   |
| 12BC          | From B2 to C1            | From C1 to B2                    | Street can be two-way but it has high commercial density, so the street recommends to be one-way.   |
| 13BC          | From C1 to B2            | From C1 to B2                    | Moderate commercial density, and C1 higher density than B2.   |
| 14BC          | From B2 to C1            | From C1 to B2                    | Street can be two-way but it has high commercial density, so the street recommends to be one-way.   |

Continued on next page

Table 5 continued

| Street number | Traffic in current state | Traffic in designed model | The comment   |
|---------------|--------------------------|---------------------------|---|
| 15BC          | From C1 to B2            | From C1 to B2             | Street can be two-way but it has high commercial density, so the street recommends to be one-way.                     |
| 16BC          | Two-way                  | Two-way                   | Moderate commercial density.  |
| 1CB           | Two-way                  | From 16BC to 12BC         | The street has five junctions four of them cross section intersection.  |
| 2CD           | Undefined                | Pedestrian's street       | Closed end street and narrow width.   |
| 4CD           | Undefined                | From C1 to D              | Moderate commercial density, and C1 higher density than D.  |
| 6CD           | Undefined                | From C1 to D              | Moderate commercial density, and C1 higher density than D.  |
| 26CD          | Undefined                | One-way (undefined now)   | Moderate commercial density, and the attached area still under construction.  |
| 116CD         | Undefined                | From D to C               | Moderate commercial density, link between street which separate to district.  |
| 117CD         | Undefined                | From D to C               | Moderate commercial density, link between street which separates to district.   |
| 12DC          | From D to C (ABCD2)      | From D to C (ABCD2)       | Street can be two-way but it has high commercial density and difficult curve, so the street recommends to be one-way. |
| 19DC          | Undefined                | From ABCD2                | Street has moderate commercial density, and it acts a local street at organic tissue urban pattern.                   |
| ABCD2         | Two-way                  | Two-way                   | Main street.  |
| ABCD3         | Two-way                  | Two-way                   | Main street.  |
| B1            | From C1 to B2            | From C1 to B2             | Street has high commercial density.   |
| B2            | Two-way                  | Two-way                   | Main street   |
| C1            | Two-way                  | Two-way                   | Main street   |

The comparison between traffic in current state and designed model concluded that:

- The current state ignored some of the streets which have moderate or high commercial density, such as; 3BC, 5BC, 6BC, 10BC, and 11AB, on the other hand, determined some streets' traffic type as one-way although they have no problem in traffic or commercial density and do not need to fix direction, such as; 14AB, 16AB, and 9BC.
- The current state ignored discharging traffic from crowded street to the other's less density, such as; 15AB, 7BC, 13BC, and 14BC.
- The current state did not treat critical points, such as: the intersection points between streets 13AB and B2 and between 7BC and B2 where the traffic of street B1 and 13AB pours into these points, so these points need to reduce traffic.

## 6. Recommendations

1. The traffic in residential areas can be managed by depending on the commercial use volume in each street. Where there is a relation between the number of shops and the streets' characteristics; length, junctions, end type.
2. The main streets in residential area have a high record of commercial density, so they should be of good design and good procedures for managing traffic.
3. The number of shops in the existing residential areas should be limited, where the increasing of shops' numbers causes crowded traffic.
4. The current design of the residential's streets should be revised before creating more commercial services.
5. Distinguishing the designed model from the current state in managing traffic would seem to suggest that the designed model should be applied.
6. The framework of traffic methodological for existing residential area, which was presented in this paper, can be used and applied at different areas.

## 7. Conclusion

Traffic management is one of most important urban and planning studies, it has many fields related such as; traffic engineering, social-culture, environment, economic, . . . . and so on. Most of the traffic management studies focused on using tools and procedures to control speed and congestion such as; physical elements -video camera, variable message signs, traffic signals, speed calming-, communication equipment, software and operators, . . . . etc. These tools and procedures are used at the both new areas and existing areas.

The traffic management for existing area added other procedures to control and reduce the current problems in them, such as: close some streets and convert them for pedestrian's street, determine the street type (one-way or two-way), and determine the direction of the one-way street. That, what the local authorities depended on in Egypt's cities as shown in research case study; South District of Luxor City.

The traffic management procedures of Luxor city's authorities are not the ideal solution, some streets became more crowded and the traffic path to residential buildings became longer with many difficult intersections. Therefore, this paper designed the traffic methodological for existing residential area. The methodological focused on determining the streets type (one-way or two-way) and the direction of one-way. It is based on the number of shops at each street and streets' characteristics; width, length, junctions, end type. The methodological was tested by designing a model for traffic, which showed the streets type (one-way or two-way) and the direction of one-way, then the

designed model was compared with the current state of the case study. The traffic methodological consists of four steps:

- Determine the streets' characteristics and relation with the number of shops.
- Determine The streets which have the high values of commercial density -the crowded street-.
- Design the model, model's traffic management.
- Design the model, comparison between designed model and current state traffic.

The results showed;

- The correlation between the number of shops and streets' characteristics (length, number of junctions, end type -closed or opened-) show positive correlations with street length, number of junctions equals, and end type equal to 0.483 & 0.423 & 0.33 respectively.
- Determination the crowded streets are based on:

A-The maximum theoretical number of street's shops.

B- The actual number of street's shops.

C- The street's commercial density.

- Determination the streets type (one-way or two-way) is based on:

A- Actual street width.

B- Streets dimensions standard.

- Determination the one-way streets' direction is based on:

A- The direction of traffic tends to steer from the higher commercial density street towards the lesser one.

B- The direction of traffic tends to steer from the narrower street to the wider one.

C- Avoid increasing traffic at critical points.

In the case of the street width suitable for two-way and the street has high value of commercial density or has critical points, then the recommendation will be; convert street to one-way.

The comparison between designed model and current state showed there are some ignored points in the current state. So, the research recommends applying the designed model at south district of Luxor city, and use the traffic methodological for existing residential areas in other cases.

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