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The Cost of Jaywalking on Traffic Congestion in an Intersection in Greater Cairo: A Case Study

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THE COST OF JAYWALKING ON TRAFFIC CONGESTION IN AN INTERSECTION IN GREATER CAIRO: A CASE STUDY

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A thesis submitted by Hussein Gawdat
Supervised by Dr. Khaled Abdelhalim

Abstract

There have been many studies focusing on different types of traffic delays, pedestrians' interaction at signalized intersections and economic losses as a result of these delays. However, there is a huge gap in the current literature, regionally and globally, in studying the traffic delays associated with jaywalking. In Egypt, jaywalking is considered a common phenomenon, however, population increased drastically over the past decades in Greater Cairo leading to more congested streets. This research provides a case study that investigates the economic effect of jaywalking on traffic flow in Mashaal, a sample location in Greater Cairo, due to traffic congestion. The research uses the methodology used by the World Bank to calculate the monetary value of traffic congestion due to jaywalking. There are different categories in calculating the economic impact of jaywalking as source of non-recurring delays; however, the method used will focus on calculating the direct cost due to nonrecurring travel time delays as a result of jaywalking. The empirical findings of the research are based on primary sources. In the analysis section of the research, the value of losses due to jaywalking was calculated to investigate the amount of losses as a result of the jaywalking phenomena in case study. Finally, a conclusion is drawn based on the findings; in addition some recommendations and a sample awareness campaign that could be used by policymakers in order to answer the call for further research in the field of traffic congestion and to start taking some action.

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1. CHAPTER ONE: INTRODUCTION

In Egypt, population is growing swiftly while the country's infrastructure is improving in a slower manner. Infrastructure improvements should go concurrently to close the gap between the new population and the service provided by the government. However, in developing countries improving infrastructure requires flow of investments. This gap between the service available and the demand of the new population has created a variety of obstacles that need amendments. One of these issues is traffic congestion. Traffic congestion was created due to the insufficient capacity of the road to accommodate the current demand on a certain road or area. The total numbers of cars including private, taxi, extension, commercial, customs, and diplomatic body estimated at 4.28 million car in 2015 compared to 3.24 million car in 2010 (CAPMAS).

In addition to the increasing value of cars, there are other factors controlling traffic congestion in Cairo. One of these factors is pedestrians and more specifically jaywalking. Jaywalking is the phenomena of crossing the road from an undesignated area. One of the studying area of this research is to make a survey for jaywalkers to see if they have ever had been taught to cross the road from designated areas or not. This research will be shedding lights on people behavior and reasons of random road-crossing and how to mitigate the traffic congestion evolved due to random road-crossing. With a population of 9.5 million(CAPMAS), Cairo's local officials need to reconsider investing in traffic congestion solving due to the fact that traffic congestion lead to environmental and economic complications. According to "Cairo Traffic Congestion Study" a reported developed by the World Bank which studies different

aspects of traffic congestion in Greater Cairo. There are several factors causing street congestion such as: accidents, random bus stops, vehicle breakdown, and random pedestrian crossing (jaywalking).

Moreover, there are many guidelines and regulations specified by the Ministry of Environment EEAA for vehicle checkups where a vehicle has to meet certain standards in order to be able to be functional which should decrease the number of breakdown. In addition, the Ministry of transportation has also specified bus stops where bus drivers should abide by however it is not applicable. Nevertheless, the main concern of this research is to minimize the congestion due to pedestrian crossings. Hassanien et al. (2008) adds that nearly 1,200,000 out of 2000000 cars in Cairo are classified as old cars that have lack of technology in reducing emissions.

There are scarcely number of topics dealing with the concern of crossroad and its effect on Greater Cairo streets which put the researcher into a more challenging atmosphere especially in obtaining data and in making statistics. (Ghandour,2017) published a paper under the title of "Towards More Pedestrian Friendly Streets in Cairo" of which with she handled many different concerns that shed light on some of the main important problems in Cairo's streets.. Furthermore, the World Bank report on traffic congestion in Cairo provided a great reference when going into details of data analysis. According to the Central Agency for Public Mobilization and Statistics (CAPMAS), 20% of the national mortality percentage is pedestrians; this percentage is limited to registered accidents and citizens where the ratio could be higher. With considerably a high mortality rate, there must be proper justifications for it

More than one scholar share the same perspective in two different articles of which pedestrian cross freely (jaywalk) in order to reach other mode of transportation or other facilities. (Iacono, et al., 2006; Shay et al., 2010). In addition to pedestrian safety, road congestion comes consequently where random crossing or jaywalking causes not only accidents but economic and environmental issues (World Bank). Pedestrians tend to escape means of crossing streets such as pedestrian bridges and underground passageways because they require lots of efforts. For instance, in a case study conducted near Cairo University and a metro station, most of the people who used the bridge to cross the street turned out to that they did so to have access to the metro not for safety procedures (Felix and Mohareb, 2016).

This is a six chapter research where the research seeks to investigate the value of money lost due to jaywalking. In the process, the researcher will offer some of the environmental issues and impact in the literature review in chapter 3; however, the scope of the research does not include calculating emissions or environmental imapcts.

In chapter four the researcher shares some of the answers provided by the respondents of the research. The answers are then translated from Arabic and coded under different categories. Furthermore, chapter four contains some of the footages from the video recording that will be analyzed.

In chapter five, the researcher divides the analysis into two parts. First, the calculation of the economic impact due to jaywalking, and the second is analyzing some of the quantitative data collected from video recording and the questionnaire.

Chapter six concludes the research and adds up some of the recommendations that could be used for reducing the phenomena of jaywalking. In addition it provides a suggested scope of work for further research in the same field.

1.1 Statement of purpose

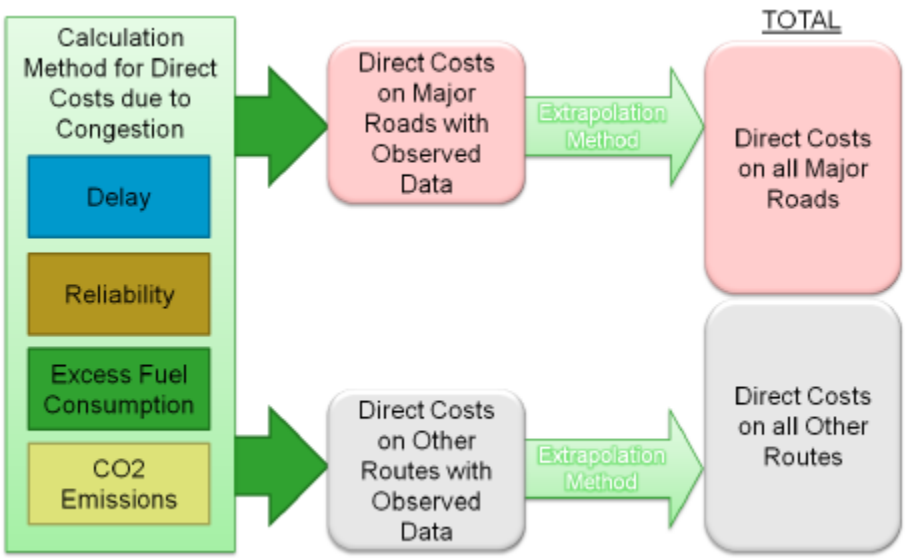
Currently, there are not enough data on pedestrians in Egypt. The researcher had to relate different literature to the Egyptian community in order to have homogeneous data. Researcher in the field of pedestrian safety, traffic congestion and public policy may find this research useful for further research.

The purpose of the research is to study the effect of jaywalking as one of the contributors to traffic congestion. In this process, the research will have to do some on site survey in order to understand the reason behind jaywalking. The research intends to help policy makers in developing a new rule for pedestrians especially in new cities to develop a better environment that encourage investment and improve the image of the country.

1.2 Scope of the research

The research aims to calculate the non-recurring delays which will be discussed in the literature, and estimate the economic impact created by jaywalking. The researcher will focus on calculating the nonrecurring travel time delay cost associated with jaywalking exclusively. The studied area will be monitored to collect primary data. These data will be the cornerstone of the study; where the analysis of this data will draw out the feasibility and the importance of eliminating jaywalking.

Equation 1: Direct Cost estimation approach



Source: Cairo Traffic Congestion study final report World Bank, May 2013.

Figure one previews different factors in calculating the direct cost dude to congestion. The scope of the research will only focus on calculating the direct cost due to delays and more exclusively nonrecurring travel time delay.

1.3 Research Question

There should be more research and investments carried out to search for reasons and better solutions for the sake of a more desirable, safe, economic environment; furthermore, in order to follow up clearly with the outcomes of this paper, The researcher generated this man question: What are the economic impact of jaywalking on traffic congestion in Greater Cairo? However this main question must be aided with other specific questions:

1. What are the main reasons behind pedestrian jaywalking?
2. How to calculate the non-recurring delays due to jaywalking?
3. How economic losses of jaywalking are measured?
4. How is pedestrians' safety related to jaywalking?

The following section will discuss a conceptual framework that explains the relationship between element of the scope of research and other factors that relates to traffic congestion. In addition, the researcher will describe the steps and methodology of collecting data and analyzing it.

2 CHAPTER TWO: Conceptual framework and Research methodology

2.1 Conceptual framework design

In this part of the research, the research puts together all part of the investigated areas shaped according to the research questions. The conceptual framework will assist the reader to have a better overview of the procedures and the topics that will be discussed in the following chapters. According to the conceptual framework produced by the researcher, there are plenty of causes that contribute to traffic flow delays in Cairo whether it is recurring delays or nonrecurring delays. For instance, there are causes such as road capacity and road design these are recurring data which can be avoided throw enhancing infrastructure to accommodate more vehicle in rush hours. Non-recurring delays caused by random car stops, road accidents and jaywalking are behind the congestion in Cairo. The conceptual framework draws a relation between jaywalking and the root cause of such act. There are several factor promoting jaywalking such as cultural, physical and socioeconomic aspects which all drains into the pedestrian perspective. Culture plays an important role in shaping the pedestrian behavior. According to Pelé et al, the chance of a pedestrian crossing against a red light differs from one country to another. Furthermore, they calculated some statistics according to their study which states “French pedestrians cross against the lights much more often (41.9%) than Japanese ones (2.1%).” (Pelé et al, 2017) this percentage can be expected to be higher in developing countries.

In addition to culture aspect, there is a socioeconomic aspect. Pedestrian is a large study group where people come in different age groups and with different capabilities.

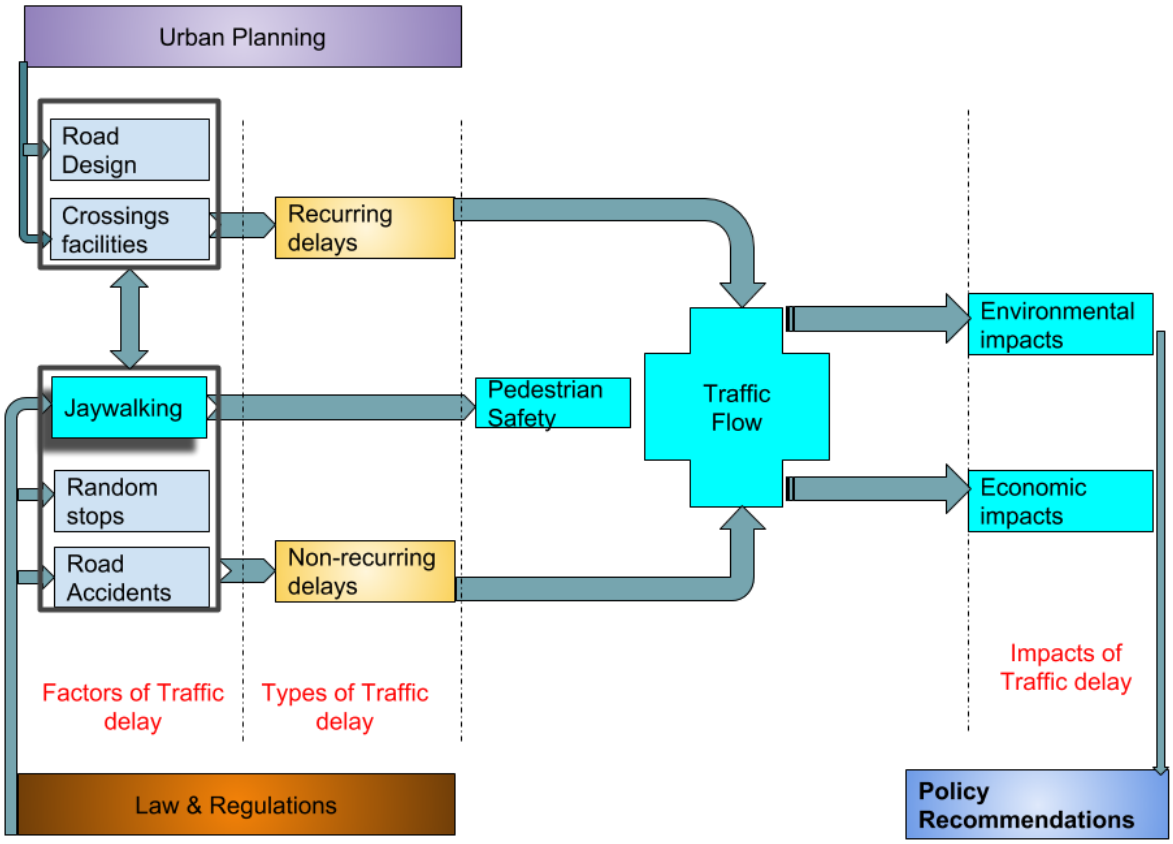


Figure 1: Conceptual Framework developed by the researcher

Source: Own study based on (Cairo Traffic Congestion study final report World Bank, May 2013)

After reading through the available literature, the researcher produced the conceptual framework shown in figure 1. The conceptual framework suggest that recurring delays can be minimized by solving issues related to road design and crossings facilities under the supervision of urban planning authority. According to the World Bank report for traffic congestion in Cairo, the more U-turns are added near an intersection the less it functions. In addition, speed bumps

reduce the traffic flow minimizing the signalized traffic function (Cairo Traffic Congestion Study, 2013). The second type of delay is associated with many sources; however, the researcher listed these three factors because they have higher contributions on traffic flow. The conceptual framework suggests that nonrecurring delays can be solved with the interference of law and order. Minimizing jaywalking is related to pedestrian safety; the researcher will shed light in further part of the research on pedestrian safety. Where there are many inputs that influence traffic flow in Greater Cairo, there must be numerous impacts; there are many impacts related to traffic flow conditions. However, in this case, the researcher decided to split the impacts into environmental and economic impacts that arise from slow traffic flow, still only economic impacts will be calculated. Finally, the outcomes of those impacts can be used to come up with alternative policy modification in different parts either related to urban design or implementation of law and order.

2.2 Research methodology

2.2.1 Significance of the selected study areas

In order to choose a study area for this research, the researcher needed to assess areas where the same type of delays occurs. For instance, random bus stops should be unified in all sample areas in order to have a homogenous data collected. Otherwise the non-recurring delay due to random bus stops deviate the results. Thus the following table was generated with the area where possible data collection can be beneficial

Table 1: Selection of study area

Source: own study

	Mashaal	Areesh street	Tahrir Street	Opera square

Presence of traffic light	Yes	No	No	Yes
Presence of designated areas for crossing	Yes	No	Yes	Yes
Presence of random bus stops	Yes	Yes	Yes	No
Presence of police	Yes	No	Yes	Yes
Governorate	Giza	Giza	Cairo	Cairo

Two sample areas were selected from Giza governorate. Mashaal area is one of the samples in Giza governorate where the site has traffic light and when the traffic light is on for vehicles to pass, pedestrians keep on crossing. The other locations were nominated to be selected for case studies in two different large cities, Cairo and Giza Governorates. Still, due to safety reasons, the first area, Mashaal will be the only area for video recordings, the researcher will gather data through video recordings in this selected area; nonetheless, the questionnaires will be distributed in Mashaal and different areas in Cairo governorate such as Downtown, Dokki and Al Harm.

The reason behind selecting Mashaal to other area is that it has all the other factors that cause traffic congestion which resemble a case scenario of Greater Cairo streets. For instance, Opera Square does not have random bus stopping and cannot represent most Cairo streets since there are a lot of random stoppings; in fact, it can reduce the accuracy of the data, the procedure will be discussed in chapter 2. The replicability of the research would be valid cases that

coincide with the features of the studied intersection. In addition, the type of this research can be applied on a bigger scale.

2.2.2 Quantitative Vs Qualitative

For the sake of this research, Quantitative methodologies will be used to gather the necessary data for analysis. There are variables such as the time of delay due to pedestrian jaywalking, and the cost of time that reflects damage on the economy. In effect, a quantitative strategy will be adopted in order to have a better understanding of the relation between the variables and how close they are related. In addition, inferential statistics in quantitative strategy offer us not only the relationship between variables but the generalizability of the outcomes. This feature will be adequate for offering validity and replicability of the research in different parts of the country and not the specific targeted area.

There are many levels to work on for data gathering data and comparing it to each other. In fact, there are different attributes that can change the time of pedestrian crossings such as age, gender and health. However, pedestrian should be treated as a whole for the sake of this study; since the researcher focuses on the delay generated due to pedestrian jaywalking without differentiating between gender, age or condition. Although these categories will affect the time, the pedestrian takes to cross from point to point.

The behavior of pedestrians should be studied as well in order to see various forms of interruptions pedestrian can make in order to reach services or just pass the street to just say hello to a friend. By studying the structure of the proposed site and pedestrian behaviors, it will provide a better grasp of how far pedestrian understand their rights and duties in terms of

knowing the right place to cross from, and if they were taught to cross from designated areas or not. By distributing questionnaires to investigate the background of pedestrian who jaywalk, the researcher may generalize the findings of the research.

The researcher created a 14 question questionnaire with a mix of open ended questions to yes or no questions; the questionnaires were distributed in Down Town, Dokki and Al-Harm. The reason behind distributing the questionnaire is that it provides an overview of pedestrians' opinions for the current situation; furthermore, the yes or no kind of questions can be used as a source of collecting statistical data or can also be used for quantitative purposes as well. For instance, the researcher can collect the number of pedestrians who received guidance on road crossing. Additionally, the open ended questions can provide answers from bottom-top perspective which can be beneficial in process of customizing streets to accommodate for what pedestrians truly want.

2.2.3 Method used for calculating the economic losses due to jaywalking

First in order to be able to capture recording and use it in the research, the researcher was notified with the IRB approval after which data collection started. In order to be able to calculate the economic losses the researcher need to get some variables from the video recording. For instance, the researcher can calculate the volume of traffic flow in PCU according to the amount of vehicle counted during the peak hour recording session. Additionally, the free flow speed and congested hour speed can be approximately calculated using the length of the corridor. For example the free flow speed can be calculated at 6 am in the morning using the corridor length and the time taken by a randomly selected sample of vehicles to drive the length of the selected area, the corridor length, however it was assumed to be 20 km/hr

To analyze the data collected, the researcher needs to count the number of vehicles and different transportation mod either using software such as Camlytics, Smart Traffic analyzer (STA), etc. which will count the number of vehicles and classify them by mod. Still, Camlytics didn't read the video rendered from the camera very well which resulted in miss counting or errors in the counting process. Thus, the researcher had to use manual counting in order to get accurate and classified results. Furthermore, the researcher will calculate the travel time delay cost using the same method stated in the World Bank report. From the video captured by the researcher, the average peak hour speed and volume of vehicles will be estimated. The researcher will use the following formula to calculate the travel time delay for non-recurring delays:

Equation 2: Nonrecurring travel time delay

$$\textbf{Nonrecurring Travel Time Delay}_{(\$)} = \sum_{\textbf{for all vehicular modes}} \textbf{Incident Delay Ratio} \times \textbf{Vehicle Occupancy}_{\left(\frac{\textbf{passenger}}{\textbf{vehicle}}\right)} \times \textbf{Value of Time}_{\left(\frac{\$}{\textbf{hour/ton}}\right)} \times \textbf{250 Working Days} \times \textbf{Length of Corridor}_{(km)} \times \textbf{Volume of Vehicles at Congested Period}_{(pcu)} \times \left(\frac{1}{\textbf{Average Congested Hour Speed}_{\left(\frac{km}{hr}\right)}} - \frac{1}{\textbf{Free Flow Speed}_{\left(\frac{km}{hr}\right)}}\right)$$

Source: Cairo Traffic Congestion study final report World Bank, May 2013.

The equation divides each vehicular mode and after calculating each, they will be summed up to get the total. Listed below is a quick description of main inputs to the equation.

Incident delay ratio: the ratio between jaywalking incident and total traffic volume as the weight factor to multiply. The ratio will be multiplied by the recurring travel time delay cost in order to get the non-recurring travel time delay as a result of jaywalking.

Vehicle occupancy rate: It is a constant value measured and used from the strategic Development Master Plan Study conducted by the Ministry of planning as cited in World Bank report. This value is multiplied by the number of cars, microbuses, minibuses and buses. Taxis

and pickups were assumed to be passenger cars. No motorcycles were counted in the study. However, for trucks counted there is another factor called Payload factor, refer back to chapter 2, which is multiplied by the number of trucks

Since the study area was a signalized intersection, the length of the corridor was assumed to be 1 km since the length of the studied intersection is very small.

Furthermore, the volume of vehicles at congested period is the sum of the numbers of each mode as counted by the researcher. However, according to the equation the value must be in passenger car unit (PCU), thus the number of any mode other than passenger vehicle should be converted by the values in table 15.

Equation 3: Recurring travel time delay:

$$\textbf{Recurring Travel Time Delay}_{(\$)} = \sum_{\text{for all vehicular modes}} \frac{\textbf{Vehicle Occupancy}_{\left(\frac{\text{passenger}}{\text{vehicle}}\right)}}{} \times \textbf{Value of Time}_{\left(\frac{\$}{\frac{\text{hour}}{\text{ton}}}\right)} \times 250\ \textbf{Working Days} \times \textbf{Length of Corridor}_{(\text{km})} \times \textbf{Volume of Vehicles at Congested Period}_{(\text{pcu})} \times \left(\frac{1}{\textbf{Average Congested Hour Speed}_{\left(\frac{\text{km}}{\text{hr}}\right)}} - \frac{1}{\textbf{Free Flow Speed}_{\left(\frac{\text{km}}{\text{hr}}\right)}}\right)$$

Source: Cairo Traffic Congestion study final report World Bank, May 2013.

Equation 2 will be used in the calculation process to reduce the complexity of calculation. The total cost of recurring travel time delay will be calculated, and then it will be multiplied by the incident factor of jaywalking. The reason of doing this step to ensure that, jaywalking is the only targeted kind of nonrecurring delay. In effect, random bus stopping, and other non-recurring factors will be eliminated.

The researcher will use the same value of vehicle occupancy, calculated by the strategic Development Master Plan Study for Sustainable Development of the Greater Cairo region in the

Arab Republic of Egypt, as cited in the report. There are different values for vehicle occupancy according to the vehicle mode. The table below shows the values for each mode:

Table 2: Vehicle occupancy factors (passenger/ vehicle)

Passenger Car	Microbus	Minibus	Bus
1.5	13	21	49

Source: Cairo Traffic Congestion study final report World Bank, May 2013.

Table 3: Payload Factors (Tons/vehicle)

Light Truck	Medium Truck	Large Truck
5	9	15

Source: Cairo Traffic Congestion study final report World Bank, May 2013.

The number of trucks shown in chapter 4 is a mix of light and medium weight trucks; therefore, the value of payload used in truck mode will be the average value of light and medium weigh truck. The researcher will use a payload of 7 tons/ vehicle. The following table will show the number of passengers in buses and microbuses

Table 4: Bus capacities (developed by the researcher)

Mode	Full Capacity
Microbus	10
Minibus	30
Bus	60

Source: own study

The full capacity value used for microbuses is an average of three types of microbuses sharing Cairo traffic which are Suzuki type (7 seats), Volkswagen type (10 seats) and Toyota type (15 seats). The bus capacity will be used to estimate the value of time for transit riders (Cairo Traffic Congestion study final report World Bank, May 2013). Due to lack of data for

time for transport users, the researcher will use the following data shown in figure 4 as cited in Cairo Traffic Congestion study final report World Bank.

Table 5: Value of Time for Transport Users Categories

Passenger Car Users (LE/Hour)	Transit Riders (LE/Hour)	Freight Transporters (LE/Ton)
13.8	3.5	4.2

Source: Cairo Traffic Congestion study final report World Bank, May 2013.

These values are greatly underestimated since Egyptian pound has varied drastically since it's floating in 2016-2017 period. In order to account for inflation taking year 2002 as a base year for estimation to year 2018 as the current year, the following method was suggested by Dr.Ahmed Mousa[1], an expert in the field, to account for inflation. The value of time of passenger car users will increase by 35% where the other value of time will only increase by 20%. The following table shows the new data available for Value of Time for Transport users.

Table 6: 2018 Value of Time for Transport Users Categories

Passenger Car Users (LE/Hour)	Transit Riders (LE/Hour)	Freight Transporters (LE/Ton)
18.6	4.2	5.04

Source: Dr.ahmed Mousa

[1] "He was responsible for reviewing and updating the existing transportation models for Cairo (CREATS Transport model) and Egypt (MINITS) and developing transportation plans on the national, regional, international and cross-borders level including work on Egypt's Bus Rapid Transit (BRT) systems and the master plans for Greater Cairo Region, national freeways road network and logistic centers." www.linkedin.com/in/ahmed-mosa-b35a1b28/

"Dr. Mousa has over 15 years of experience that combine research/academic knowledge and practical experience. He won several awards, as well as authored and co- authored more than 60 papers in leading journals, conferences/workshops presentations and technical reports. "www.linkedin.com/in/ahmed-mosa-b35a1b28/

2.3 Data collection method

Due to the nature of the research, most of the data gathered is primary data collected from the selected areas of study. The data collection part will be divided into two parts. The first part is concerned with recording live footages from the selected locations. A camera will be attached on top of a building in the studied area to monitor each jaywalking interruption occurs, in addition the video tool will be useful when calculating the free flow speed of the vehicles and the speed due to the jaywalking interruption. Video recording is considered one of the most powerful tools for maintain accuracy and minimizing human error; for instance, it eliminates human error associated with counting the number of jaywalking incidents to give more accuracy in the analysis process. In order to measure the critical effect of jaywalking, each of the proposed study area will be monitored for two periods daily for two days. The first period is from 7 am to 10 am which is the morning peak hour. The second period starts from 3 pm to 7 pm where the period witnesses very congestion streets in different parts of the city. The recording session will be conducted in the month of March where it is school season which gives the study the advantage of studying the situation in the most critical case. These recordings will be focusing on the traffic flow due to the incident or in this case jaywalking. Measuring the traffic flow in the presence of jaywalking is not enough. Additionally, the researcher needs to measure the free flow of vehicles without interfering of jaywalking. Free flow will be recoded for an hour from 6 am to 7 am in order to estimate the speed of vehicles without the presence of any interruptions.

The next part of collecting data is of a qualitative approach where the researcher will distribute questionnaire in Mashaal in which the recording took place, in addition to Down Town, Dokki and Al-Harm. The reason behind jaywalking is to identify reasons behind jaywalking. The results that will be collect will significantly be useful for the purpose of the

research and for further studies in that field since the data available for this kind of research is limited. This part of data collection has a crucial aspect where a different part of the jaywalkers' mentality is revealed. This could be a starting point to understand the reason behind the phenomena. Answers of the questionnaires will provide some evidence that could be used in ensure some unjustified facts and to aid further researchers. A copy of the questionnaire will be attached in the appendix for further data about what was the kind of questions being asked.

2.4 Sampling

This kind of topics does not have much information that requires many experimental work and field data gathering in order to ensure reliability. This bring the sampling part where it will be taken randomly with large number to ensure the same inputs and outputs would be applicable to as many scenarios as possible to have a better model that can be used for further purposes. Random selection will provide a wider range of answers and represents the Egyptian street with its variability.

For the questionnaire a number of 50 copies were distributed on jaywalking cases only in order to collect reliable data. 20 copies of the total count was distributed in Mashaal in order to make the data coherent. Since the video shows jaywalking actions, however, these actions should be justified by random jaywalkers to have an overview of how they perceive crossing the street, their safety and issues related to congestions.

2.5 Study limitations

This research deals with new scope which is the effect of pedestrian behavior in jaywalking on the economic status of Egypt. Pedestrian behavior cannot be easily comprehended

because it's hard to give clue to each action a pedestrian have or each reason s(he) have in mind before crossing the road. In addition, there are security reasons that prevent the researcher for recording and taking some footage in some crucial places that would have contributed to the research positively. There are current budget required by the researcher in order for the researcher to gather all the required data hence the researcher had to pay some money for accommodation.

Furthermore, the camera used for recording the videos had low light sensitivity and had bad vision at night. Most of the recordings after 6 have low quality or unclear. In order to fix this issue the footage was modified using VLC to adjust the quality of the video to be able to annually count vehicles and pedestrians, which had a good effect in early low light condition however it didn't help in counting at late low light condition. In addition, there are budget restrictions where there are available programs that could be used for automatic counting and making simulation for pedestrians and vehicle, however it need to be bought to unlock its full function.

There are several factors other than jaywalking affecting jaywalking in the studied intersection at Mashaal such as random bus stops, presence of some worn pavement at the intersection. However, due to safety concerns the studied intersection is the most appealing. Additionally, adding different factors affecting traffic congestion may influence the results, still there are many ways to adjust the findings to suit the targeted effect due to jaywalking.

Another key limitation for the study was that Mashaal intersection was not a standardized intersection, it doesn't represent all intersections in Greater Cairo, and still it provides a descent case study with different conditions that still hinders traffic movements in similar areas.

Figure 2: Mashaal intersection

Source: (Source Google maps @ 29°59'12.6"N 31°08'29.1"E)

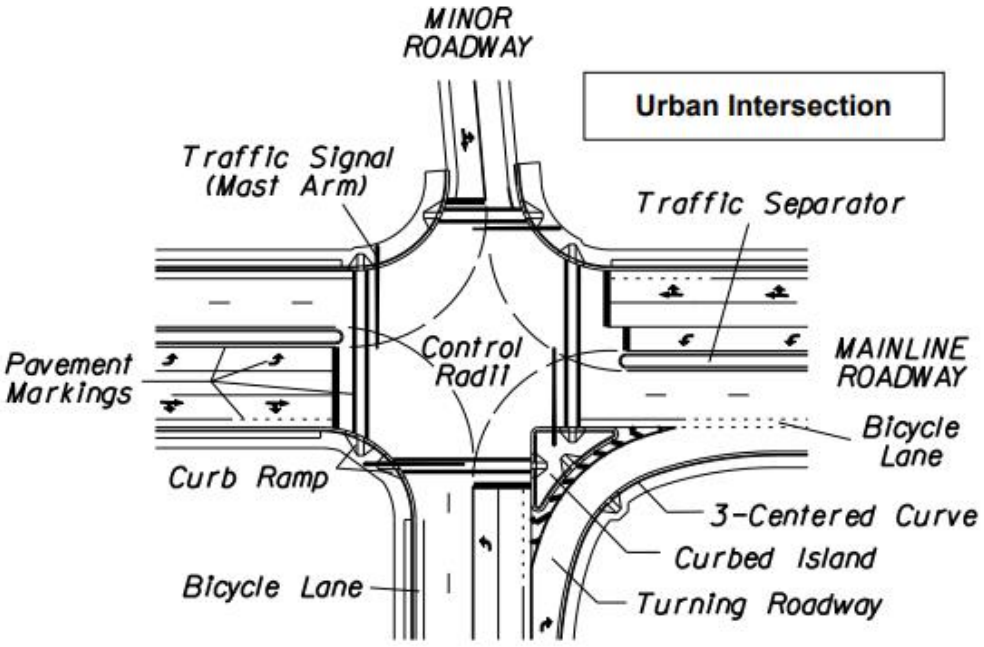


Figure 3: Standard intersection

Source: Florida Intersection Design Guide, 2015

Figure 3 illustrates the criteria and standard design of intersections. This design was adopted from the Florida Intersection Design Guide where there are different factors and elements missing from the intersection in Mashaal. For instance, the directions of flow are different where Mashaal intersection have the four coming lanes in one direction and exiting towards a two lane to the right, additionally, the direction is in one way for vehicles moving towards forward direction. Mashaal has no island between the two roadways however it has a traffic separator as the one in figure 3. Still, pedestrians use it as an island for crossing the road. In addition, Mashaal has a traffic policemen post designated for police units or traffic patrols in front of the curb ramp. Finally, there is poor condition of pavement in the zebra lines zone which forces the approaching vehicles to slow down in order reduce impacts on vehicles.

2.6 Ethical consideration

There are many ethical issues regarding the confidentiality of interview or questionnaire takers. However, this kind of research doesn't require job position, name or title. It deals with the respondents anonymously which shall ensure the confidentiality of those taking the questionnaires. Regarding the video recording it would recognize faces because it will be adjusted in a top view monitoring only movements and faces.

3 CHAPTER THREE: Literature review

3.1 Traffic congestion

There are abundant literatures investigating traffic congestion and traffic flow for different cities all over the world. The world is moving towards more sustainable approaches in every corner of our lives. Traffic congestion has been growing till it became a problem that need to be tackled. According to the World Bank Cairo traffic congestion report, congestion can be defined as follows "congestion comprises motionless or slowly moving lines of vehicles on a freeway or urban street, a lane closure because of road construction or an accident, or some sort of traffic backup."(World Bank, 2013). Furthermore, we can define traffic congestion "as a condition of traffic delay (when the flow of traffic is slowed below reasonable speeds) because the number of vehicles trying to use the road exceeds the traffic network capacity to handle them" (UNHCR Report 463,2010). "Traffic congestion can be considered as a supply management problem. The transportation infrastructure (i.e., roadways) can be considered as supply for use by drivers (demand). If these supplies are limited in terms of capacity and demand is high, congestion is likely to occur."(Brath, 2008). The UNHCR report implies that congestion is one of the main reasons behind excess time and money costs to business and households (UNHCR Report 463).

According to the World Bank report, there are two forms of congestions. The first form is recurring congestion which occurs due to expected acts or higher demand on a road which has been designed according to a certain value; this can be best described as rush hours where there

is no problem exists in the road however the capacity couldn't handle large number of vehicles thus congestion appears. There are different sources that suggest modifying the design or add other routes in order to solve this kind of congestion. The second form of congestion called nonrecurring congestion which is caused as a result of unpredictable and in most cases random acts. These random acts can be accidents, random bus/micro buses stops, slowing down due to bad road quality, vehicle breakdown and pedestrians' jaywalking. According to "Cairo Traffic Congestion Study, 2013" while the number of pedestrians keeps increasing throughout the day, they interfere with traffic flow leading to low average speeds regardless the low traffic volume. In this paper, the researcher will focus on nonrecurring congestion occurs as a result of jaywalking.

3.2 Jaywalking

In order to understand the effect of jaywalking on traffic congestion, first we need to define it. Jaywalking is to cross the road illegally or from a point that was not specified for crossing. For pedestrians, crossing from one point to another is the main common ground. Nevertheless, some may risk their lives just to cross the other side. In Egypt, there is no specific rule for crossing the road; hence people developed their own way to cross. Most pedestrian here in Cairo, just look to see if the there are no vehicles in order to cross or not; even if there are vehicles pedestrian sometimes yield for a vehicle or two before crossing. In some cases, pedestrian can be stuck in the middle of the road waiting for a vehicle to yield so crossing can be possible. In order to ensure pedestrian safety and avoid crashes, some countries imposed a fee for pedestrian who jaywalk or cross illegally. For instance, according to UAE government, the government issued a ministerial Resolution number 178 for the year 2017 which charge a fee of 400 AED for jaywalking which is equivalent to nearly 2000 EGP (UAE government).

Zheng et al. (2015) developed a model that shows the steps of each drivers and pedestrians in taking actions. Figure 1 shows the framework created by Zheng et al.

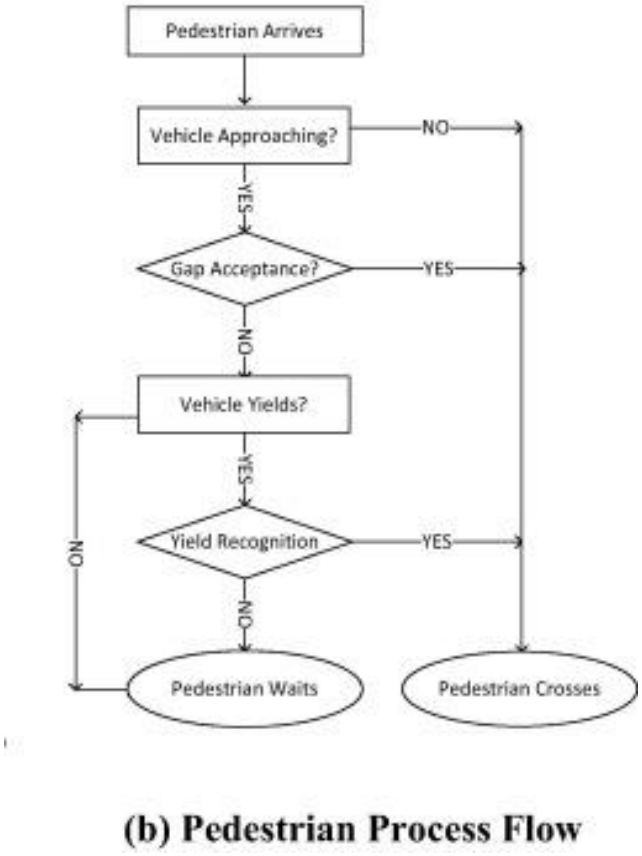


Figure 4: Zheng et al. Framework,2015, p.93

The framework shows how pedestrians will act from arrival to the specified place for crossing to yielding of vehicles. However, in countries with large populations, it is not always that trivial. For instance, in Cairo, there are large numbers of sudden stops by buses and microbuses or even taxis stopping to get customers. In addition to these stops, there is large population per square meter which could paralyze the traffic flow if vehicles decide to yield every time jaywalkers are observed. Sometimes the driver doesn't have the option to resume

driving since there are a lot of people jaywalking at the same time. Furthermore, the time taken differs according to age of pedestrian.

3.3 Pedestrian safety

Pedestrian safety comes conjugate to jaywalking. Lipovac et al, states that jaywalking or illegal road crossing is the main reasons of pedestrian accidents and it causes severe injuries globally as cited in Pelé et al. (2017).There are global measures, codes and indicators for countries all over the world that shows and compares different countries to each other according to mortality rate of different type of road users. Tracing back the percentage of mortality of each road user, governments can analysis data and amend policy related to this issue. For instance, if the mortality rate of 4 wheel vehicle is high, the government should immediately take action into adjusting driving law through limiting driving speed, improving road quality and hence safety. According to the World Health Organization, the estimated number of road traffic death in 2013 recorded 10466 with a death rate of 12.8 per 100,000 of population. The value is divided into different road users where 4 wheel vehicles comes in 1st place of a percentage of 48.6 followed by pedestrian calculated at 29.2% (WHO). This value is considered problematic when compared to most of European countries registered to 3.7 in Spain and 5.1 in France for instance, however, the rate is lower than most of African countries however one of the highest due to the big population of Egypt(WHO).

In order to understand the reason of death, there should be a study on why the pedestrian had to cross in an unsafe manner. Pedestrians can cross in a rush if there is a personal urge such as being late for an appointment or for work, or for instance there is harsh weather condition that put him/her in need to cross immediately without waiting advancing vehicles (Koh, et al, 2014).

There are different violating conditions where pedestrian tend to follow their own instinct. Daff and Cramphorn argue that pedestrian will cross if possible so that delay time is minimized as much as possible, furthermore, Xu et al added that the quality of infrastructure system(ie, the quality of design of road, collection areas and intersections, etc..) affect the pedestrian violating behavior. Moreover, Evans and Norman states that the theory of planned behavior which states that whenever an act is easy to perform, the pedestrian will not hesitate to take action(as cited in Koh, et al, 2014). According to Tarawneh, 2001 cited in Chandra et al, 2013; Montufar et al., 2007 the average crossing speed of pedestrian tend to be lower when the speed limit is low; for instance, when the speed limit was 70 km/h the pedestrians' crossing speed was faster than when recorded in different area with speed limit of 50 km/h(Demiroz,2015). The lower the speed limit or the slower the approaching vehicle, the safer the pedestrian feels when crossing the road (Demiroz, 2015). According to the guidelines for pedestrians' facilities generated by the Indian road congress, pedestrians should feel safe and secure day and night. In addition, it is recommended to add pedestrian footpath in all new and old roads.

3.4 Economic impact

This part of the literature is a cornerstone for the reader in order to keep up with the findings of the research. According to many literature reviews, traffic congestion causes different impacts mainly economic and environmental. Schrank et al states that according to the Texas Transportation Institute, traffic congestion account for $ 120 billion yearly as cited by Beaudoin et al. In addition, the expected cost of congestion in 2030 is expected to be 50 %.(Beaudoin). According to the World Bank executive note on traffic congestion in Cairo the cost of congestion in Greater Cairo is estimated to 47 billion LE which is equivalent to 8 billion USD; the value is forecasted to increase to 105 billion LE by 2030.

Sweet (2011) classifies impact of congestion into two main impacts where he classifies them as follow. The first order impact is related to travel delays and the reliability of travel time. In addition, the impact deal with how valuable the time delayed to individuals and how the individuals adopt to it. The second impact deals with changing intra-metropolitan households and business reallocation, more briefly the second impact redistributes economic activity in a certain area. Furthermore, Sweet adds that in order to calculate the value of delays, some literature compare actual to target speeds using average hourly values. He states that the intensity of delays and the value of time are subjective that they depend on standards used to differentiate between congested and uncongested conditions and the value of the activity the individual would have accomplished if the traffic was uncongested. There are different factors of course to these mentioned by sweet. For instance, Texas Transportation Institute assigns hourly values for travel delays for each type of travelling unit where a private vehicle has a value of nearly $106 as stated by Chui et al and cited by Sweet. In addition to travel delays, unreliable travel times, a key component developed by nonrecurring delays. Most of the researchers use the ratio between recurring to non-recurring delays to have a good estimate to travel time reliability. Besides the travel time delay, Travel time reliability incurs Scheduling delay which is defined as "the additional time that drivers allocate to a trip in order to arrive at the desired time despite the possibility of congestion delay" (Sweet, 2011). Not all scholars agree on comparing free flow speeds to travel delay speeds because it underestimates the adaptations an individual can take in order to overcome congestion. For instance, some might change their route every morning in order to overcome daily congestion, or they can change their departure time to drive in less congested conditions (Sweet, 2011). In this study the comparison of free flow speed compared to travel delay speed aims to put some pedestrian rules in order to reduce the congestion in most

cities due to pedestrian, additionally and more importantly, to promote pedestrian safety in Egypt.

According to Boarnet, reducing congestion is directly proportional with increasing economic capacities as cited by Sweet, 2011. There have been various studies on the effect of infrastructure investments and long term business outputs and productivity which was pioneered by key authors in the field as Nadiri(1996) and Aschauer (1989). However, there is another approach that focuses on the effect of travel time, traffic capacity on production costs (NCHRP). According to Sweet, there are different scholars who study the effect of congestion on productivity however there are different scope for each. For instance, there was a study focusing on productivity through firm level; another one sought productivity on the country level and other studying it in terms of national productivity (Sweet, 2011).

3.4.1 Different Categories of congestion costs

(Weisbrod et al, 2003) divided congestion costs into 3 types. The first is **Travel cost** where simply, as a result of congestion in a certain set of routes or a certain traffic system, vehicles and other modes require longer travel time and additional operating cost for drivers. They added "The added time and expense for drivers and passengers are the key components of travel system efficiency measures covered in traditional engineering-based benefit-cost studies." The second type is the **Additional Business Operating cost** where service delivery and freight businesses can be affected by traffic congestion; for example, in time sensitive freight or shipments that are required to be delivered in a specific time can be delayed causing extra additional costs such as reliability costs and logistics costs. The last type of congestion cost is Productivity. "Generally, congestion can reduce the size of business labor market areas,

customer delivery market areas and/or shopper market areas that can be served or accessed within a limited window of reasonable travel time."

Furthermore, the World Bank classifies direct cost due to congestion as follows:

- Travel time delay
- Reliability
- Excess fuel consumption
- CO2 emissions

(Cairo Traffic Congestion Study, 2013) indicates that the amount of total direct cost due to congestion in year 2010 30.75 billion LE where 14.66 where generated from just delays (Recurring and nonrecurring), 9.15 billion LE from reliability and 6.56 billion LE from Excess fuel consumption. Furthermore, the forecasted cost of congestion in GRMA was estimated at 68.40 billion LE where the value of delays had a value of 32.61 with the same ratio and distribution as in 2010 47% of the total direct cost.

In addition there are indirect costs arising from:

- Road safety;
- Vehicle operating costs;
- Health and environmental impacts from poor air quality;
- Labor productivity, business operations, and agglomeration effects;
- Housing; and
- Suppressed demand.

3.5 Environmental impact

Traffic congestion is a main contributor to CO2 emissions into the atmosphere. With a call for green environment, governments are obliged to and abide by SDGs. Policymakers targeted emissions produced from Transportation through improving vehicles and making them more environment friendly. For instance, there are some initiatives such as reducing the power required by the vehicle, reducing the weight of the vehicle using other lighter material and using hybrid and fuel-cell vehicles (Barth, 2008). However, these kinds of improvement take some time in order to adopt such technology. Additionally, developing countries import this kind of new technology which is not feasible for large populations. The issue with traffic congestion is that vehicles move at very low speed and according to many studies this kind of pause and resume incur more emission compared to green driving or steady driving (Barth, 2008). In this act, Vehicles produce emissions of Carbon monoxide, Carbon dioxide, nitrogen oxides and other factors such as particulate matter; the more time spend by vehicles in traffic, the more emissions produced (Zhang, 2011). Furthermore, Frey et al added in their report, which was about reducing emissions by enhanced traffic management system, that when vehicles accelerate they produce more emissions (Frey et al. 2001). They also calculated on-road data measurements, which is preferred in quantitative data collection because it is based on real life scenarios, of emissions such as Carbon monoxide, Nitrogen oxides and other elements increased by 50% during congestion compared to free flow (Frey et al, 2001). Locally, the Egyptian Environmental Affair Agency (EEAA) has put some effort in improving the ambient air quality in Greater Cairo and some other governorate. One of the campaign initiated was to make car checkups in order to make that the emission produced by the vehicles is acceptable otherwise the driver will be given a period of one month to fix the engine. The budget for importing the gadget used was 15 million

Egyptian pounds (EEAA accomplishments report for year 2013). According to "Air pollution in Greater Cairo" a report generate by the World Bank, Transportation weights most of the production of NOx gases with a value of approximately 79% mostly comes from heavy duty trucks (Air pollution in Greater Cairo the World Bank report, 2013). When traffic congestion force vehicle to drive in a speed under 45 mile/hr, generally produce more emissions due to the fact that at low speed, vehicles go through a cycle of acceleration and deceleration. Consequently more grams per mile are generated since vehicles don't travel long distance in congested parts.(Barth, 2008).

According to "Sustainable Development Strategy: Egypt's Vision 2030" report issued by Ministry of Planning, Monitoring and Administrative Reform Cairo, Egypt, the environmental degeneration generating from air pollution costs Egypt a monetary value of 2.42 billion L.E/annually(Sustainable Development Strategy: Egypt's Vision 2030, 2016). Although the report pointed out some of economic loses associate by Environmental impacts, the report didn't show any improvement in the indicators regarding greenhouse gases. They target only emission produced from ozone depleting gases. Furthermore, there are financial issues stated as follows "lack of funding for the implementation of the plans to reduce the rates of air pollution has led to the increase of their financial burden on the State, threatening their sustainability and resulting in a decline of the progress of these programs and an increase in air pollutants along with the negative impacts on the environment and public health" (Sustainable Development Strategy: Egypt's Vision 2030, 2016).

4 CHAPTER FOUR: Field investigation results

In this part of the study, the collected data will be spread out and be prepared in order to be analyzed in the next chapter. In order to collect the required data such as the traffic flow, the researcher had to study the area carefully. The researcher had to stay in a place facing the intersection in order to capture videos; the videos will help in increasing the accuracy of the data collected and it can be considered as a reliable source for counting traffic flow. This method guarantees good estimates and minimizes human error. In contrast with being with the same level of the vehicles where some vehicles can be missed in the counting due to restricted vision, furthermore, the videos can be played if there are some miscounting by the researcher; this feature can reduce human error in counting the traffic flow and number of pedestrians. However the top view eliminates these kinds of restrictions.

Figure 6 shows an image captured from google earth of al Mansoryia intersection. Vehicles are coming from Al remaya square into the beginning al Ahram Street near the Pyramids area reaching this intersection. The researcher developed a color coding system for the purpose of the research to evaluate the crossings areas as follows:

Table 7: color coding

Color	attribute
Yellow	Signalized traffic
Blue	Designated crossing area
Red	Direction of flow used for calculation
Orange	Pedestrian curbs

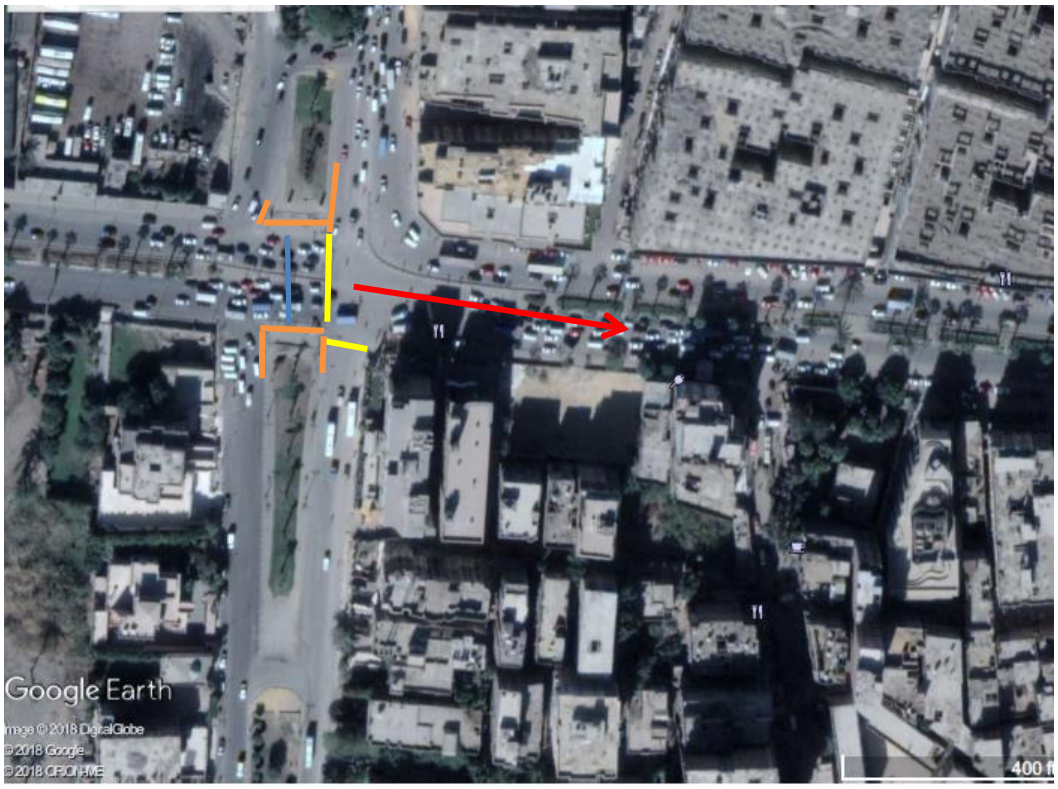


Figure 5: Mansoryia intersection

(Source: Google Earth @ 29°59'12.6"N 31°08'29.1"E)

The researcher recorded the area shown in figure 6 for two days to collect two peaks flows in two mid-week days; starting Monday afternoon and ending Wednesday morning. The data collected was recorded in the month of March where there were presidency campaigns and school period which gives the collected data an edge since it was recorded in a more populated scenario. However, any weather condition is not taken into consideration since under different traffic conditions the values will increase accordingly. For instance, humidity and high temperature can affect the emissions produced from vehicles. For the purpose of the research, only one direction was taken into consideration. The flow will be calculated from left to right excluding the flow going north as indicated by the red arrow in figure 6 (i.e. direction to the east) ; in addition, jaywalking incidents interfering with the flow to the north are not counted. Figure 6

shows different element in the intersection, for instance, there are erased zebra lines area, represented as blue lines in figure 6, the area is supposed to be the designated area for pedestrians to cross safely; still there are no traffic lights for the pedestrians to cross in a timely manner. In addition there is a narrow island between the two roads which is inadequate to be used as a crossing island between the two roads. This part witnesses many pedestrians, yet it can not withstand many pedestrians since the design is neither not meant for crossing nor designed according to the standards. Aside from pedestrians' behaviors, drivers tend to go all the way to block the way for pedestrian in their designated area for crossing. (Shown in figure 6 as a blue line). These zebra lines, assuming that they still in good shape to be seen by pedestrians, should be used as a guidance for both pedestrians and drivers; the first should use it to cross safely and the later should abide by it in order to leave room for pedestrians to cross from designated areas safely.

4.1 Video Data

After recording the video and processing the data, the researcher generated the following tables which shows the number of vehicles, microbuses, minibuses and buses each 15 min in every peak hour period. Separating different modes of vehicles is crucial in the process of calculating the economic impact of jaywalking since each mod has different inputs and variables. Nevertheless, jaywalkers who interfere with the direction of traffic flow were counted, others crossing and interfering with the other direction, going north to the figure 6, were not counted. For instance, pedestrians crossing at signalized traffic lights were not counted. Additionally, the researcher separated gender in counting jaywalker to make a comparison between gender in terms of which gender tend to jaywalk more. Pedestrians were not counted in some specific times due to limitation of the camera's vision at night as shown in the following tables.

Table 8: Monday afternoon Traffic flow

Source: primary source

Afternoon peak	Vehicles	Microbus	Minibus	Bus	Truck	Jaywalking incident (male)	Jaywalking incident (female)
Monday (3-3:15)	305	105	25	3	16	130	67
Monday (3:15-3:30)	314	73	37	3	28	90	69
Monday (3:30- 3:45)	377	87	39	7	30	120	72
Total (45 min)	996	265	101	13	74	340	208
Monday (3:45- 4:05)	541	112	75	9	32	170	87
Monday (4:05- 4:20)	290	80	32	7	13	55	26
Monday (4:20- 4:30)	360	140	50	11	28	32	14
Total (45 min)	1191	332	157	27	73	257	127
Monday (4:30-4:45)	432	118	63	8	13	55	25
Monday(4:45-5:00)	430	142	69	14	40	46	22
Monday (5:00- 5:15)	375	80	68	12	35	54	27
Total (45 min)	1237	340	200	34	88	155	74
Monday(5:15- 5:30)	430	104	70	12	29		
Monday(5:30- 5:45)	410	110	51	14	32		
Monday(5:45- 6:00)	394	91	47	10	27		
Total (45 min)	1234	305	168	36	88		
Monday (6:00- 6:15)	421	76	32	14	22		
Monday(6:15- 6:30)	409	68	27	4	18		
Monday (6:30-6:45)	352	80	23	6	21		
Total (45 min)	1182	224	82	24	61		

Table 9: Tuesday Morning traffic flow

Source: primary source

Morning peak	Vehicles	Microbus	Minibus	Bus	Truck	Jaywalking incident (male)	Jaywalking incident (female)
6:00- 6:15	120	82	26	6	18	31	3
6:15- 6:30	182	126	36	6	23	55	13
6:30- 6:45	210	150	35	11	16	77	28
Total (45 min)	512	358	97	23	57	163	44
6:45- 7:00	310	117	55	10	11	74	42
7:00-7:15	275	104	40	12	18	101	50
7:15- 7:30	290	120	46	11	11	90	47
Total (45 min)	875	341	141	33	40	265	139
7:30- 7:45	310	109	48	5	11	65	35
7:45- 8:00	330	115	40	8	15	110	57
8:00- 8:15	479	120	42	4	16	90	60
Total (45 min)	1119	344	130	17	42	265	152
8:15- 8:30	430	109	37	7	17	85	70
8:30- 8:45	386	110	29	9	20	91	60
8:45- 9:00	340	105	35	6	18	109	35
Total (45 min)	1156	324	101	22	55	285	165
9:00- 9:15	355	118	40	8	22	107	28
9:15- 9:30	370	109	42	5	24	70	26
9:30- 9:45	415	101	37	4	21	86	41
Total (45 min)	1140	328	119	17	67	263	95

Table 10: Tuesday afternoon traffic flow

Source: primary source

Afternoon peak	Vehicles	Microbus	Minibus	Bus	Truck	Jaywalking incident (male)	Jaywalking incident (female)
3:00-3:15	325	137	25	1	29	95	34
3:15-3:30	335	95	35	7	27	90	45
3:30- 3:45	333	102	38	10	31	125	54
Total (45 min)	993	334	98	18	87	310	133
3:45- 4:00	310	80	48	7	33		
4:00- 4:15	328	72	65	5	28	60	34
4:15- 4:30	290	100	50	6	30		
Total (45 min)	928	252	163	18	91	60	34
4:30-4:45	310	95	65	5	32	85	26
4:45-5:00	325	110	67	12	30		
5:00- 5:15	318	119	65	11	18	45	13
Total (45 min)	953	324	197	28	80	130	39
5:15- 5:30	340	120	70	11	16		
5:30- 5:45	303	115	75	13	13		
5:45- 6:00	290	72	59	10	17		
Total (45 min)	933	307	204	34	46		
6:00- 6:15	310	95	64	12	14		
6:15- 6:30	280	81	56	13	12		
6:30-6:45	287	80	29	7	19		
Total (45 min)	877	256	149	32	45		

Table 11: Wednesday morning traffic flow

Source: primary source

Morning peak	Vehicles	Microbus	Minibus	Bus	Truck	Jaywalking incident (male)	Jaywalking incident (female)
6:00- 6:15	135	75	24	7	16	72	12
6:15- 6:30	170	115	33	9	21	92	25
6:30- 6:45	225	135	35	7	25	106	57
Total (45 min)	530	325	92	23	62	270	94
6:45- 7:00	220	110	28	10	22	85	37
7:00-7:15	257	130	30	5	19	105	61
7:15- 7:30	310	115	37	4	15	73	25
Total (45 min)	787	355	95	19	56	263	123
7:30- 7:45	300	112	40	7	13	94	47
7:45- 8:00	323	126	38	5	17	130	71
8:00- 8:15	319	122	35	5	22	105	65
Total (45 min)	942	360	113	17	52	329	183
8:15- 8:30	307	137	34	4	21	95	49
8:30- 8:45	338	152	38	6	20	132	80
8:45- 9:00	357	125	37	7	18	87	43
Total (45 min)	1002	414	109	17	59	314	172
9:00- 9:15	282	116	33	7	20	97	39
9:15- 9:30	346	116	30	5	17	97	55
9:30- 9:45	379	114	32	6	23	117	63
Total (45 min)	1007	346	95	18	60	311	157

- Some of the afternoon data doesn't have pedestrian counting due to the sensitivity of the camera used to record the traffic movement.

Table 3 show the traffic flow heading Giza direction for Tuesday afternoon peak period where exclusively, there was presidential campaigns around the studied location. Starting from 4:30 pm the flow starts to increase due to rush hour making the street in high congestion condition. In case of high congestion, the researcher didn't count jaywalking scenarios since the street was already congested due to different factors such as road capacity, U-turn, and random stops near Zaghlol Street for dropping and pick up passengers.

Figure 6: Afternoon traffic flow

(Captured by the researcher)

Figure 4 shows a scenario where the flow reaches a high congestion status. When the signal turns red, there will be some vehicles stuck in the middle of the intersection blocking the way to the direction other direction. For cases similar to the one shown in figure 4, the researcher didn't count the number of pedestrian; where jaywalking in this case is not the main contributor to slowing down the traffic as much as the design capacity of the street. Jaywalking in this case cannot be hazardous in this scenario, since most vehicles are driving at a very low speed.

Furthermore, The researcher observed the nearby and added some illustrations on figure 5 where Zaghlol street could be considered as an attraction for traffic congestion where some pedestrian cross the street from the other side to reach Zaghlol street or to reach transportation indicated by the red arrow. Figure 5 shows the wider look, captured form google maps, for the studied area where there are different factor that could contribute to even more jam. For instance, the blue circle identifies the area where most public transportation whether microbuses, minibuses or buses. Each mode of these stops at this spot to drop off or carry on passengers. By stopping in this area where vehicles just started accelerating from the signalized intersection, the three lanes street shapes a bottle neck where only a single lane is working and the other two are used as bus stops for picking up passengers.

Figure 7: Other factors contributing to more jam

(Source Google maps @ 29°59'12.6"N 31°08'29.1"E)

4.2 Video Interpretation

Figure 8: Typical morning condition

Source (Captured by the researcher)

The circled part is where most of random stopping occurs. During observation of the area, it was obvious that pedestrians tend to take the red color pathway to reach the blue circle area where they can reach to their daily transport. There are some cases where a minibus arrives empty and waits while a guy keeps calling for passengers to make it full to go. The time taken to fill the minibus varies depending on many factors such as the presence of policemen.

According to figure 6, there are different factors that are crucial in any intersection which are not spotted in the studied area. The following factors had no presence in the studied area:

- No zebra lines to indicate places where pedestrian should cross.
- No signalized traffic for pedestrians
- Insufficient space either in curbs(where pedestrian wait for their turn to cross) or in islands that splits road into two way to accommodate for large number of pedestrians

Figure 9: Mass Jaywalking

(Captured by the researcher)

There are factor related to pedestrians' crossings however, there were some additional factors in the area such as bad pavement in some segments of the street where vehicles tend to slow down or maneuver the broken areas. Yet there are other factors, for instance, the following pictures shows sample of pedestrians waving to bus to stop even though this is not a designated place for a bus stop, however the bus driver slows down in the middle of the street to let the passengers in.

Figure 10: Bus slows down for passengers

Source: (Captured by the researcher)

Figure 11: Bus stopping

Source: (Captured by the researcher)

Sometimes there are two or more buses that slow down or park near each other blocking two or more lanes to drop or pick up passengers. Accordingly, pedestrians find this curb n attractive place to arrive at to catch guaranteed transportation.

While observing the area, the researcher noticed some factors that contribute to traffic congestion. There are three aspects that need to be considered:

- Safety
- Signal timing
- Police interference
- Bus stopping

4.2.1 Safety

Figure 12: Pedestrian runs after public transportation

Source: (Captured by the researcher)

The pictures above show some unsafe conditions for pedestrian. The first picture shows two men running to enter the bus while it is moving and a woman is running to catch the bus while the traffic signal is green for vehicles to pass freely. Having frequent and designated places for public transportation could prevent these kinds of unsafe behavior of pedestrians; also, having a regulatory body for pedestrians to act wisely and cross safely.

Figure 13: Pedestrian runs after public transportation 2

Source: (Captured by the researcher)

The second image shows the same woman still running after the bus keeping no attention for her safety. Another point regarding safety of pedestrian or transit riders, they shift from passengers to pedestrians in the middle of the street making them more vulnerable to the approaching vehicles in an unsafe manner that could put their lives in risk.

The following screen shots are captured by the researcher from the video showing pedestrian waving to the bus to stop in order to catch it. Some of these pedestrians are old or doesn't have good physical with low crossing speed. Bus drivers tend to take right in a wide radius in order to avoid parking microbuses and minibuses. In this act of taking a wider radius, the bus driver notice pedestrians waving at him thus he stops or slows down immediately without any chance of getting closer to the curb.

Figure 14: Pedestrians while catching public transportation 1

Source: (Captured by the researcher)

Figure 15: Pedestrians while catching public transportation 2

Source: (Captured by the researcher)

Although running after the bus is not considered crossing the street, however, it is unsafe for pedestrian and for other road users since the first can cause an accident putting both road users in danger. In effect, put more effort in improving infrastructure for the use of pedestrians will have positive impacts on enhancing a better life for Greater Cairo's pedestrians and improving efficiency of road capacity in rush hours.

4.2.2 Signal timing

Concerning this part, there are many topics discussing how to effectively manage signal timing to reduce traffic jam. The researcher found by observation that drivers tend to rush in the 3 second yellow timer in order not wait for the red light. In this process the drivers are stuck in the middle of the road blocking the way for the other direction.

Figure 16: Signal timing 1

Source: (Captured by the researcher)

Sometimes this phenomenon can cause street blockage as shown in Figure 15. Even if the blockage can be for some seconds, the signalized traffic is counting down while no vehicles are moving which causes more delays and unreliability. Nevertheless, in the early period between 6-7 am there are some drivers that violate the traffic signal where sometimes there were drivers coming in the intersecting direction. These kinds of actions can put the lives of drivers and anyone near them in danger.

Figure 17: Signal timing 2

Source: (Captured by the researcher)

Figure 15 shows a screen shot that was recorded in the afternoon peak period. However, road blockage such as the one shown if figure 15 starts forming from 4:30 pm and continues to happen till 7 pm with less frequency. Further studies need to tackle the 3 seconds phenomenon. In addition, if cameras are working, they still do not count vehicles' drivers and do not issue any fines since it is not illegal. In effect, drivers ten to rush to cross before the 3 seconds are out; in this process, it is considered as a high risk on pedestrians or even vehicles that could be coming from the intersecting side.

4.2.3 Police presence

One critical issue is the police or traffic men authority in streets. The following pictures were taken by the researcher to indicate the effect of the presence of policemen to regulate the stopping of public transits. There are policemen who were wearing black in the pictures, however, they don't stay in their location, they keep checking and interfere when sever congestion takes place. The other type is the traffic patrol or traffic solider, literally translated, as shown in the picture wearing the yellow reflective outfit that stays there most of the time. However, due to observation, drivers don't put into their consideration the presence of these soldiers. According to the recording, some drivers even break the traffic light disregarding the presence of the traffic soldiers or when the policemen with the notebook aren't there putting both other drivers and pedestrians in danger.

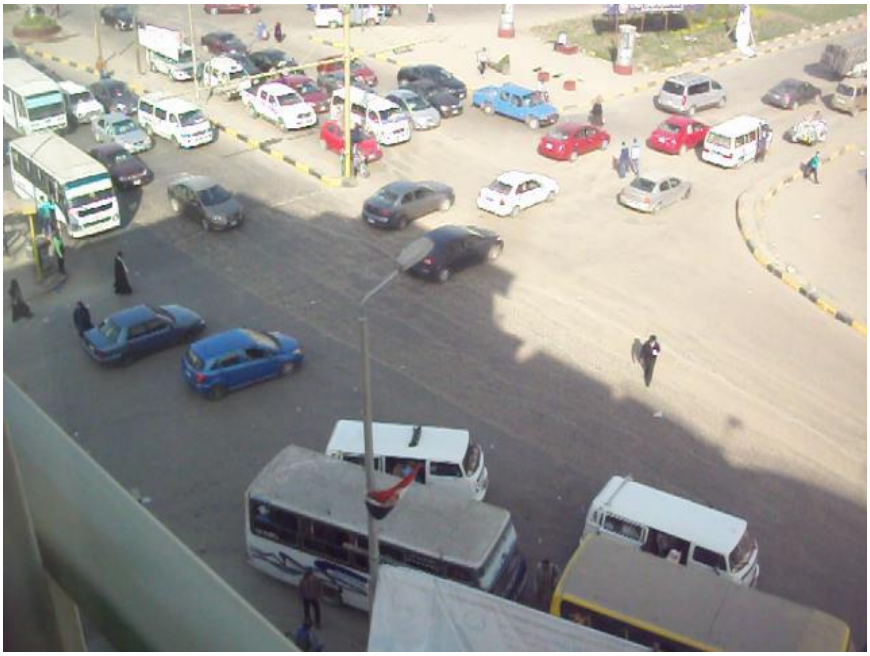


Figure 18: Police presence

Source (Captured by the researcher)

First the microbuses stopped to drop off or pick up passengers in an undesignated area

The policeman notices the violation and approaches the microbuses to give them a warning

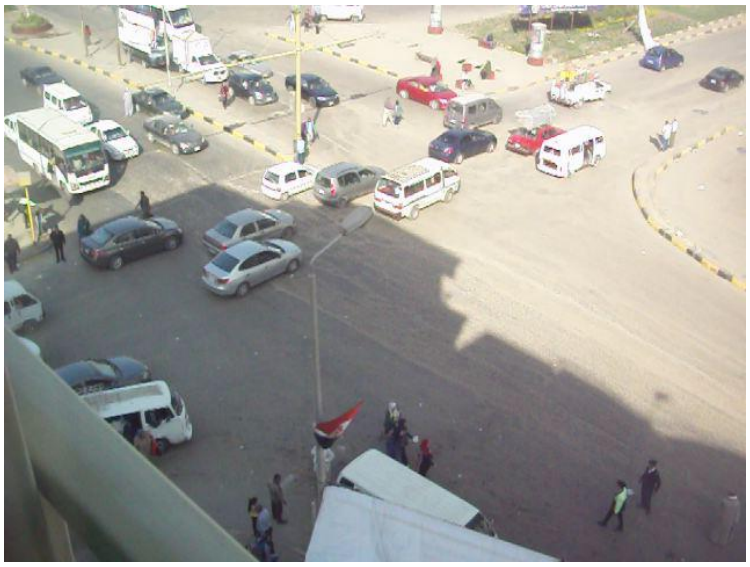


Figure 19: Police presence 2

Source: Captured by the researcher

When the policeman arrived, they started moving

Figure 20: Presence of a police officer and traffic patrol

Source: Captured by the researcher

Figure 21: Bus driver dropping off passengers

(Captured by the researcher)

Figure 19 shows public bus dropping off passengers in front of traffic patrol in an undesignated stopping area.

Figure 22: Policeman in the middle of a moving traffic

Source: (Captured by the researcher)

4.2.4 Bus stopping

Figure 23: Microbuses and minibuses stopping in undesignated areas

Source: Captured by the researcher

Bus stopping is one of the major issues in thi

The following part of the research discusses some of the answers provided by pedestrians who were involved in answering a survey. The questionnaire was developed by the researcher focusing on the pedestrian point of view. The following table shows different categories as classified by the researcher in order to code the answers. In addition, each pedestrian answered the questionnaire personally without interference; the researcher then put what each one has said in a quote and classified what they said accordingly. The researcher classified the answers into 5 main categories where the questions for these answers were to shed light on dissatisfaction, lack of service and personal point of view.

4.3 Questionnaire analysis

After collecting the data from the respondents, the researcher categorized the answers into five categories in order to directly tackle key issues according to the gathered data. Additionally, the researcher translated some of the responds from Arabic into English in order to have a better vision of what pedestrians think. Table 7 shows some of the answers to different parts of the questionnaire.

Table 12: pedestrians' answers for questionnaire (Categorized)

Source: own study

Category	Specific	Citation translated by the researcher into English from the survey
Law	Traffic law Absence of surveillance Implementation of law Street patrols Traffic Signs	"Cars are not respecting the traffic signal" - "Traffic patrol absence to remove violators"- "drivers don't give attention to traffic signs" " I feel like policemen don't care if I crossed while the pedestrian light is red, so I cross anyway"
Safety		" Rush of pedestrian"
Infrastructure	Traffic lights Pedestrian bridges and tunnels Congestion	"Absence of signalized traffic for both vehicles and pedestrians, and putting a fine for violators" – "there are not enough traffic lights" "If there is a traffic light, I wait, however, there are a lot of streets where there are no traffic lights"

		"Because it is always congested"
Culture	Group activity Instructions No lessons	"People don't wait when the light is green for cars" "the reason I don't wait for signalized traffic is that I haven't learned to wait for the traffic light, in addition it is a group behavior, everyone around you doesn't wait" " I was accustomed to it"
Personal	Lateness Lack of attention	"The reason I didn't wait for the signalized traffic is that I was late for my work" "Shortage of time" "Because I am always late" "I am not taking it seriously "

According to the answers collected, infrastructure was on top of the concern list of respondents. The location of the respondent is not directly related to the answers provided, since a lot of signalized traffics are either not in place or broken. Some of the respondents' answers were that "I cannot find any traffic light to follow, if there are I immediately cross form the traffic light"

4.3.1 Respondents' Recommendations for safe environment for pedestrian crossing

The following recommendations show some of the proposed solutions created by the respondents with no interfering from the researcher. However, the researcher put each categorized these recommendations under promoting safe pedestrian crossings. The respondents answered an open ended question on how to ensure safe crossings for pedestrians.

Table 13: Sample respondents' safe crossing recommendation 1

Source: own study

Recommendations	Category
" Existence of more pedestrians tunnels and bridges"	Infrastructure
"The presence of tunnel with electric stairs for elders and disabled members"	Infrastructure
"Teaching children the importance of the right way to cross the road"	Education
" Remove most of U-turns from roads"	Infrastructure
" Putting harsh fine on violators"	Law
"the existence of pedestrian traffic police"	Law
"Fines and awareness. Sometimes, although there are signs on the road, people just jaywalk and policemen don't care"	Law, Education.
"Drawing of guidance path for pedestrian and splitting it into directions"	Infrastructure
"Awareness"	Education

Most of the answers collected showed that infrastructure and law plays a crucial role in achieving safer environment for pedestrians. There were considerable amount of response that mentioned bridges and tunnels as one of the elements for achieving safe crossings. However, focusing on infrastructure can be challenging and not feasible for developing countries. There are priorities in taking actions for improving infrastructure and these actions need to be customized

to suit the current and future projects. In contrast to unfeasible projects for improving infrastructure, education offers a good alternative to increase and promote safe pedestrians' crossings through awareness campaigns and teaching children at early stages the basics of legal crossings without having to jaywalk or get in a road accident. Also pedestrian at older stages in their lives can change their jaywalking routine and adopt new safer crossing habits. Also, improving the law so that it can get to violators instantly will reduce the number of violators, thus decrease the risk associated with these violators and put pressure on others to follow safe driving rules.

4.3.2 Respondents' recommendations for reducing traffic congestion

The following recommendations were extracted from the surveys where the respondents were asked to answer the following open ended question "how can traffic congestion be reduced?"

The answers provided in Table 13 gives a qualitative results that could be used in bottom-up decision making or future studies for improving different aspects related to traffic congestions such as Issuance of driving license is technically unchallenging. For instances some of the respondents solutions was to reduce the wasta factor in obtaining the driving license could reduce the amount of drivers with low driving skills and drivers with violating attitude. Furthermore, fixing traffic light was not the only issue for rehabilitating, and pedestrian crossing areas, such as curbside and sidewalks, are on the waiting list of improvements to accommodate the number of pedestrians.

Table 14: Sample respondents' reducing traffic congestion recommendations

Source: own study

Recommendations	Category

“Reducing the price of lands in places outside crowded cities to reduce population concentration”	Legislation, Urban planning
“ Considering places for pedestrian crossings”	Infrastructure
“ The presence of more policemen”	Law
“Increase the quality of service in public transportation”	Infrastructure
“Implementation of rules”	law
“Remove wasta in the process of license registration. Increasing parking plots”	Law and infrastructure
“Fixing traffic lights”	Infrastructure
“Increase the awareness of people to ride more bikes”	Education and Infrastructure
“Widening the road – increasing the awareness of people”	Education – Infrastructure
“ Each type of vehicle has different lane”	Infrastructure
“Paving of roads”	Infrastructure
Removing parked car from the sides of the road”	Law and infrastructure

- A copy of the survey is attached in the appendix for further investigation about the type of questions being asked.

5 CHAPTER FIVE: Data analysis and discussion

5.1 Calculation of non-recurring delay

In order to calculate the travel time delay due to nonrecurring delay, the following values were used:

Free flow speed = 20 km/hr

Congested hour speed= 9.5 km/h

Incident Delay ratio was calculate as the number of jaywalking count divide by the total traffic flow in PCU

Incident delay ratio = 2216/6955 = 0.32 (based on the video recording) where 2216 is the number of jaywalking incidents and 6955 is the total number of traffic flow.

In order to convert the number of microbuses, buses and trucks into passenger car unit (PCU), the number of each is multiplied by a factor from table 15

Table 15: PCU values

Source: JICA report Cairo regional area transport study

Type	PCU factors
truck	2.5
bus	3
minibus	2
microbus	1.5

These factors are based on JICA report Cairo regional area transport study as cited by Abd-Elaziz et al, 2017.

As mentioned in chapter 2, the following formula will be used to calculate the nonrecurring

delay due to jaywalking.

$$Recurring\ Travel\ Time\ Delay_{(\$)} = \sum_{for\ all\ vehicular\ modes} Vehicle\ Occupancy_{\left(\frac{passenger}{vehicle}\right)} \times Value\ of\ Time_{\left(\frac{\$}{hour\ ton}\right)} \times 250\ Working Days \times Length\ of\ Corridor_{(km)} \times Volume\ of\ Vehicles\ at\ Congested\ Period_{(pcu)} \times \left(\frac{1}{Average\ Congested\ Hour\ Speed_{\left(\frac{km}{hr}\right)}} - \frac{1}{Free\ Flow\ Speed_{\left(\frac{km}{hr}\right)}}\right)$$

Source: Cairo Traffic Congestion study final report World Bank, May 2013.

Nonrecurring Travel Time Delay= Incident delay ratio x Recurring Travel Time Delay

Recurring Travel Time Delay =∑all modes Vehicle occupancy × Value of time × 331 working days × Length of corridor × Volume of vehicles at congested period (pcu) × $(\frac{1}{average\ congested\ hour\ speed} - \frac{1}{free\ flow\ speed})$

- Vehicles =1.5*18.6*1*4268*$(\frac{1}{9.5} - \frac{1}{20})$*331 = 717.024*0.0703*250

  = 2,213,304.5 L.E

- Micro buses converted to pcu = 13 × 4.2 × 1 ×2700× $(\frac{1}{9.5} - \frac{1}{20})$*331 = 2,696,622.2 L.E

- Minibuses converted to pcu = 30 × 4.2 ×1 × 1008× $(\frac{1}{9.5} - \frac{1}{20})$*331

  = 2,323,243.7 L.E

- Bus converted to Pcu = 60× 4.2×1× 282 × $(\frac{1}{9.5} - \frac{1}{20})$*331

  = 1,299,910 L.E

- Trucks converted to pcu = 7 × 5.04× 1× 723 × $(\frac{1}{9.5} - \frac{1}{20})$*331

  = 466,584.8 L.E

Recurring Travel Time Delay =

2,213,304.5 +2,696,622.2 +2,323,243.7 +1,299,910 +466,584.8 = 8,999,665.2 LE

In order to get the value of nonrecurring travel time delay, the total cost of recurring travel time delay will be multiplied by the factor of incidence ratio of jaywalking.

Nonrecurring Travel Time Delay= 0.32 x 8,999,665.2 = 2,879,892.9 L.E

This value is exclusive for the studied area, in order to extrapolate the value to count for nonrecurring delays across Greater Cairo; the result should be multiplied by the number of signalized intersection having similar features to the one involved in the study.

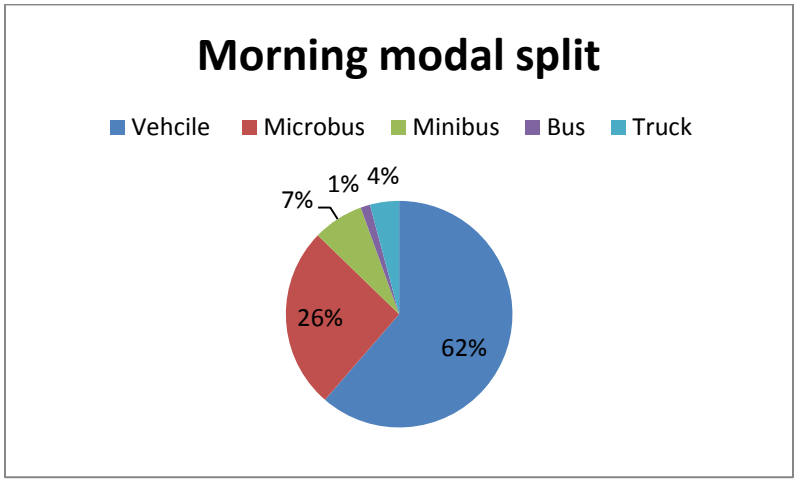


Figure 24: Modal split traffic morning (Developed by the researcher)

Source: own study

Figure 9 shows the modal split of the studied traffic flow. This diagram represents the percentage of street users according to the mode they are taking. For instance people using private cars and taxis represents 62% of the total traffic flow in the studied area. This kind of data can be used in designing new streets or in improving the transportation infrastructure. For instance, the government might increase the number of official public transports and reduce the number of microbuses and minibuses to reduce the number of random bus stops. Still, most of the Public buses stop in undesignated area for stopping or randomly too, however Public buses run by the government can be easily administrated. Nevertheless, microbuses contribute to 26% of the total traffic flow, with this value a lot of random stops will occur. Only 1% of the traffic flow is buses, yet not all the buses counted are government-bound, there are a lot of private busses used to transport workers and employees of different entities. Thus this value does not

really represent the percentage of public buses. In effect, the number of public buses is very small in a period of 4 hour study. There were no drastic changes in the modal split of the morning peak and the afternoon peak. Although the change is quite small, the afternoon peak seems to be more congested than the morning peak.

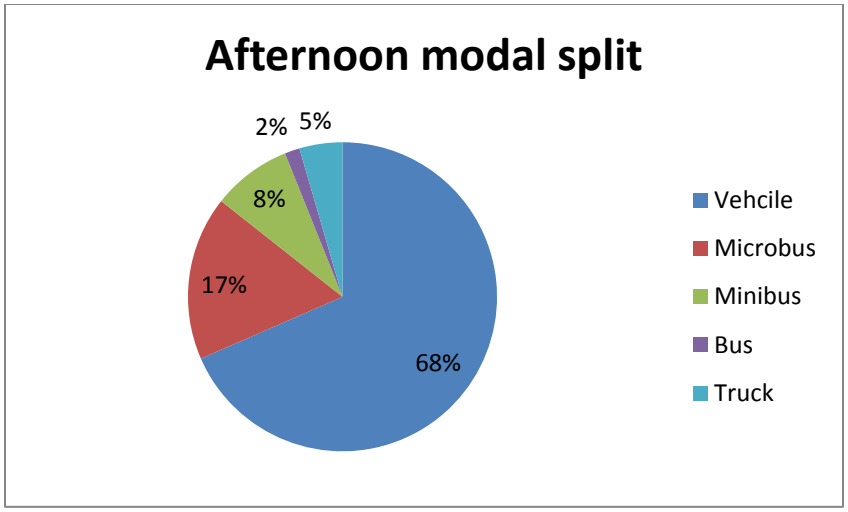


Figure 25: Afternoon Modal split (Developed by the researcher)

Source: own study

Improving the transportation infrastructure will result in reducing the number of trips made by passenger-vehicles and will increase the number of trips taken by public transportation; this will spread the use of public transportation which may be useful since ministries could allocate more resources to improve the public transportation services. By increasing the availability of public transportation in a designated bus stop, pedestrians will not jaywalk quickly in order to catch the bus. However, pedestrian can wait in a designated bus stop with a screen showing the time of arrival of buses and different routes.

5.2 Pedestrian Safety

Figure 26: Microbus-pedestrians interaction 1

Source: Captured by the researcher

Figure 27: Microbus-pedestrians interaction 2

Source: Captured by the researcher

As per the picture, the microbus, the motorcycle and the bus had to slow down and yield to the crossing team. Still the drivers tend to slow down till they are very close to the pedestrians as seen in the pictures above. The speed of crossing varies according to different factors; one of these factors is the age. Age is a crucial factor in the crossing speed of jaywalkers (Demiroz et al,

2015). However, older people should put longer safety margin for crossing illegally which was not the case in the picture. Even if the crossing pedestrian is old, the drivers will not leave a fair distance, however, they will get as close as possible to ensure that they are not stopped or stuck.

5.3 Questionnaire analysis

According to the questionnaire, most of people who took the questionnaire did not get any instruction or education on how to cross the street legally or without causing any interruptions. One of the answers of people who believe that they were taught to cross the street were “My father told me to look left and right before crossing” this way could possibly ensure safety, however it doesn’t put any consideration of other factors affected due to jaywalking. Additionally, all the answers indicate that people believe that there are positive values of crossing streets from signalized traffic locations. Furthermore, most of the people agree on there are not enough signalized traffic lights for them to pass in a right manner.

According to a study conducted in Izmir, Turkey, most of the people who crossed illegally, jaywalkers, claimed that they jaywalk to save time with almost a ratio of 71% while 15% said it was hard for them to climb the stairs of the overpass, bridge. A small percentage of 10% said that they jaywalk when the streets are empty (Demiroz et al, 2015). Comparing these results to the one generated from the collected questionnaires, almost all of the answers can be divided into two answers; the first was that there are no or not enough signalized traffic lights for them to pass accordingly. The second answer was “Rush” where most of people don’t like waiting for a long time in order to cross. In the same previous study, Demiroz et al study the relation between the position of the approaching vehicle and the number of attempts the pedestrian try to cross the road. The study showed that as the distance increases the number of

attempts increases as both the jaywalker and the driver try to make eye contact to see who will yield; if the jaywalker see a green light in the driver's eye, he will pass (Demiroz et al, 2015). However, the distance of observation in this research was almost 50 m or less since jaywalkers in the studied area cross from many points. The following pictures shows a sequence where three women and 3 men are trying to cross to the other side while a microbus is approaching from nearby and a bus is approaching from a distance.

From the data collected, it was the ratio of female and male jaywalkers is shown in Figure 11. The ratio was calculated based on morning peak hours since afternoon peak hours witness mostly recurring delays especially from 5-7 pm. Although the difference in the ratio is an issue, however this drastic difference in the ratio does not necessarily mean that females tend to take safer course of action while crossing the road, but rather it could be an uneven topography of the studied area where the number of males may be higher than of females.

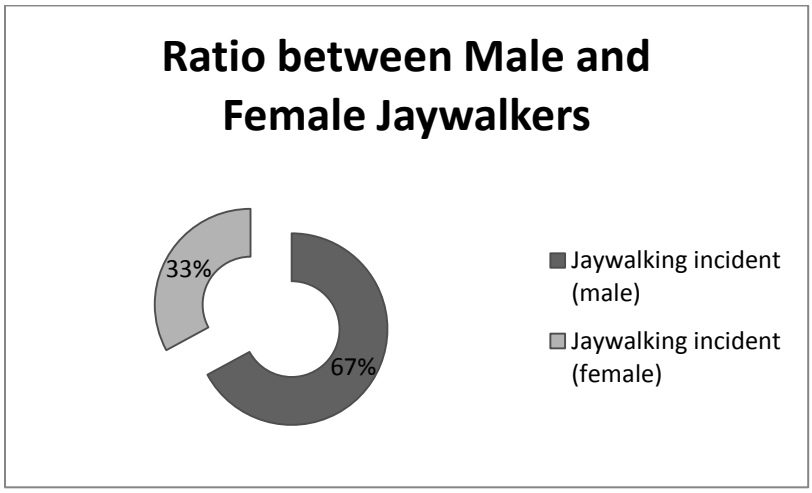


Figure 28: Ratio between male and female jaywalkers

Source: own study

The answers collected from questionnaire revealed some of cultural aspects behind Jaywalking. Pedestrians who participated in the survey were asked to answer a yes or no

question among other question in the survey which stated “Have you ever had training or guidance for crossing the street?” following up with this question, there was another one which gives space to responders to elaborate more on their yes answer only. Figure 12 shows the ratio between pedestrians who took guidance in their earlier stages of their lives. Although 38% of the surveyed pedestrians claimed that they had some guidance, there were some fallacies in their answers. For instance, some of the respondents’ answers were “my father” or that I’ve been taught to look left and right. One of the answers was from a man aged between 46-60 years old; he said that he has been taught from school books how to cross the street.

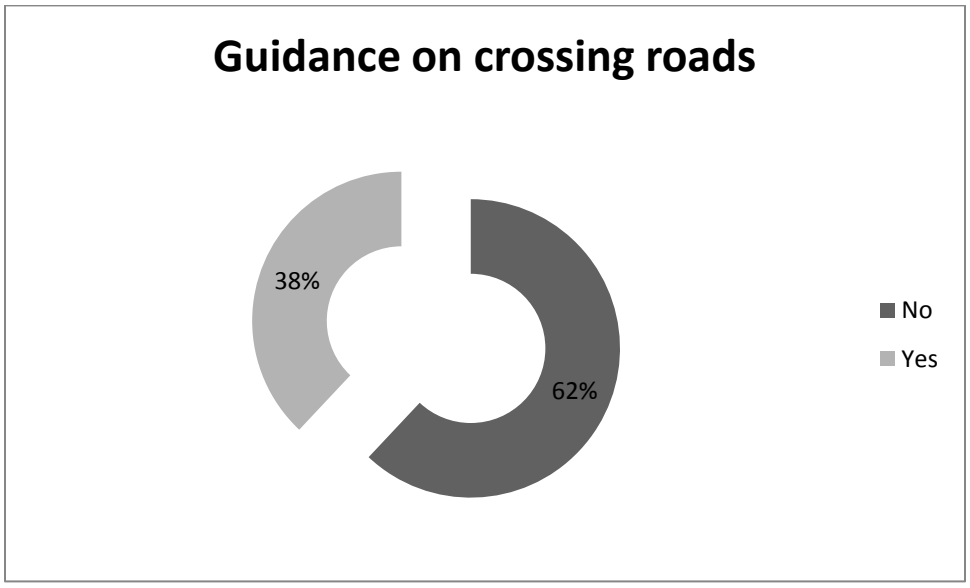


Figure 29: Guidance on crossing street

Source: own study

Considering the last question in the survey, nearly most of the respondents agreed on adopting new law for pedestrians. The last question was a yes or no question as well where only 10% disagreed on accepting a new law for pedestrians, while the majority agreeing with a new law for pedestrians. There were no details about the proposed new law, however high percentage agreed on the new law without real evaluation. In effect, pedestrian wants to be guided by a

certain law, since jaywalking is unsafe and uneconomic for them and for other road users. A new law can ensure that they have rights and other duties towards other road users and towards their lives.

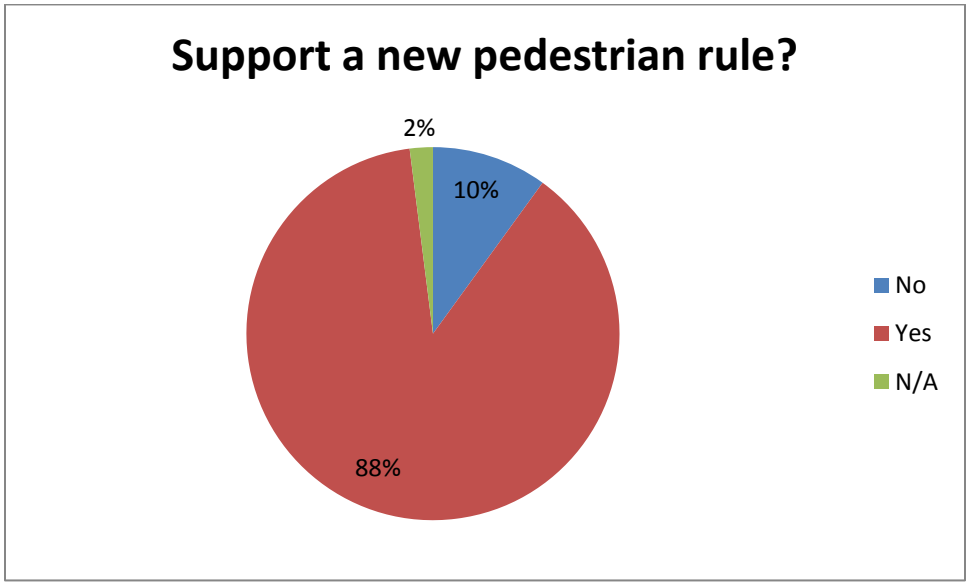


Figure 30: Percentage of yes/no for a new law for pedestrians

Source: own study

i.e. N/A answer showed that the respondent skipped the question.

Some of the respondent preferred not to answer the question, others answered no with a percentage of 10%. In addition, according to one of the respondents, he answered the question no as mean of saying the people have had enough. Although 88% represents high acceptance rate of issuing of a new law, however, these percentage can easily change their minds if the new law did not sync with their ideology of crossing the road.

6 CHAPTER SIX: Conclusion and Recommendations

The research helped in investigating the current conditions of pedestrians in Greater Cairo and studied the effect of jaywalking on the traffic flow and showed the economic impact of jaywalking in a chosen sample of Greater Cairo. The main reason behind this study was to notify policymakers that jaywalking not only causes accidents and losses in areas with high speed but also causes economic losses in areas with average to low speed. The research findings were based on the procedure and methodology previously used by the World Bank in "Cairo Traffic Congestion Study Final Report". The non-recurring travel time delay cost calculated is part of the direct cost associated with traffic delays. The economic value produced from the data entered represents the economic loses in the selected study area only throughout duration of one year. Consequently, if extrapolation is applied, where intersection having the same characteristics and traffic flow, the total amount of economic loses throughout Greater Cairo will be the result, which is not the case in this study. In addition to these empirical data, the researcher collected data from distributed questionnaires in order to ensure the reasons and causes behind jaywalking from the jaywalkers' point of view.

The data collected were from population where the video was taken to ensure that make the data more coherent and credible. The findings of the questionnaire were crucial, since most of the answers indicated that most of the pedestrians didn't receive any instructions or education on the right places to cross the streets and those who did get any instructions still didn't get to know pedestrian rights or the locations to cross safely without causing any interruptions or delays to other road users. Nearly the entire respondents of the questionnaire indicated that they

are aware that traffic congestion causes economic and environmental impacts and more than 85% of the surveys showed that people are supporting the issuing of a new law for pedestrians. The following section will be discussing some of the recommendations assuming that authorities have the will for changing the current situation. The research offers updated Value of Time which increased the accuracy of the findings, in addition it can be used for further research.

6.1 Recommendations

This part of the research is intended to help policy makers and other authorities in adopting some changes or techniques in order to eliminate jaywalking phenomena in Greater Cairo streets. Recommendations in this research rest on the following pillars:

- Policy makers and planning processes
- Rehabilitating Infrastructure
- Education and awareness campaigns
- Enforcement of law.

6.1.1 Policy makers and planning processes

The first pillar is a set of recommendations tackling the root causes from the beginning in order to prevent future complications. Policy makers can make use of some of the free research conducted by students as long as it is valid and credible to further investigate a certain issue. For instance, this research can effectively help policy makers in adopting new rules and guidelines for pedestrians in order to save lives and money. The research shows evidence that jaywalking costs the country. In addition, it suggests a safer environment for pedestrians. The proposed solutions or recommendations may be challenging, however, is much feasible and more economic. The impact of this research in real life is totally in the hands of policy makers. In

order to achieve safer and more economic environment, policy makers enhance the planning processes to accommodate for global standards especially in new cities. The planning process is a crucial process; for example, when designing a newer city such as the new capital in Egypt where they focused on providing full transportation network for the sake of more pedestrian friendly atmosphere.

6.1.2 Rehabilitating Infrastructure

The recommendations in the first pillar mainly addressed newer cities where the recommendations target the planning process. In the second pillar, the recommendations are focusing the improvement of the current condition. In order to try to introduce new law or call for any change, the infrastructure of Greater Cairo's streets needs rehabilitation in order to accommodate for the increase in the population and for a better pedestrian friendly streets. According to the survey collected, people's answer circulated around the idea that there was no traffic light for them to wait for their turn to wait. Sometimes, there was pedestrian traffic light, however it is not working. Furthermore, in the studied area there was no suitable curbside for pedestrian to wait for their turn to cross. In addition, the presence of zebra lines in limited to some places and is not widespread across Greater Cairo's streets. The researcher listed the following rehabilitation to be one of the most crucial in decreasing jaywalking:

- Rehabilitate the curbside and sidewalks in order to accommodate more pedestrians and reduce the number of pedestrians walking in the street and not in the sidewalks
- Fix the current signalize traffic lights in most of atrial streets and intersections if crossing will be from above the ground

- Place rails in the edge of the side walk with only openings at the designated areas for crossing
- To prevent the cutting of the metal rails by unknown, place some camera surveillance to detect the doers and put them in harsh punishment
- Repaint zebra lines in order to be seen by both rivers and pedestrians
- Add pedestrian crossing signs at the designated areas for pedestrian guidance
- Inspection of tunnels and bridges and assessment of the cost of improving them ,since there are tunnels that are not in use due to safety, hygiene and effort issues. For instance, authorities can add areas of activities near tunnels and bridges so that pedestrian are attracted to the designated crossing areas.

Some of the given recommendations were based on people who did the survey which involves citizens in the process of decision making. Moving from top down decision to bottom down decision could help in these cases, since the purpose of these rule or rehabilitations were to improve the quality of life for citizens and ensure their safety. One good study of bridges is the one near Cairo University where rails are installed in the island between the two streets two prevent pedestrian from crossing illegally and to encourage them to use the bridge. There were elevators and electric stairs to facilitate climbing the stairs for elders and for those with disabilities. However, the electric stairs and elevators were broken down making it challenging for all pedestrians groups to use the bridge.

This process of rehabilitation is a crucial step in order to go to the next pillar that handles education of citizens and introducing new awareness campaigns for old and new generations.

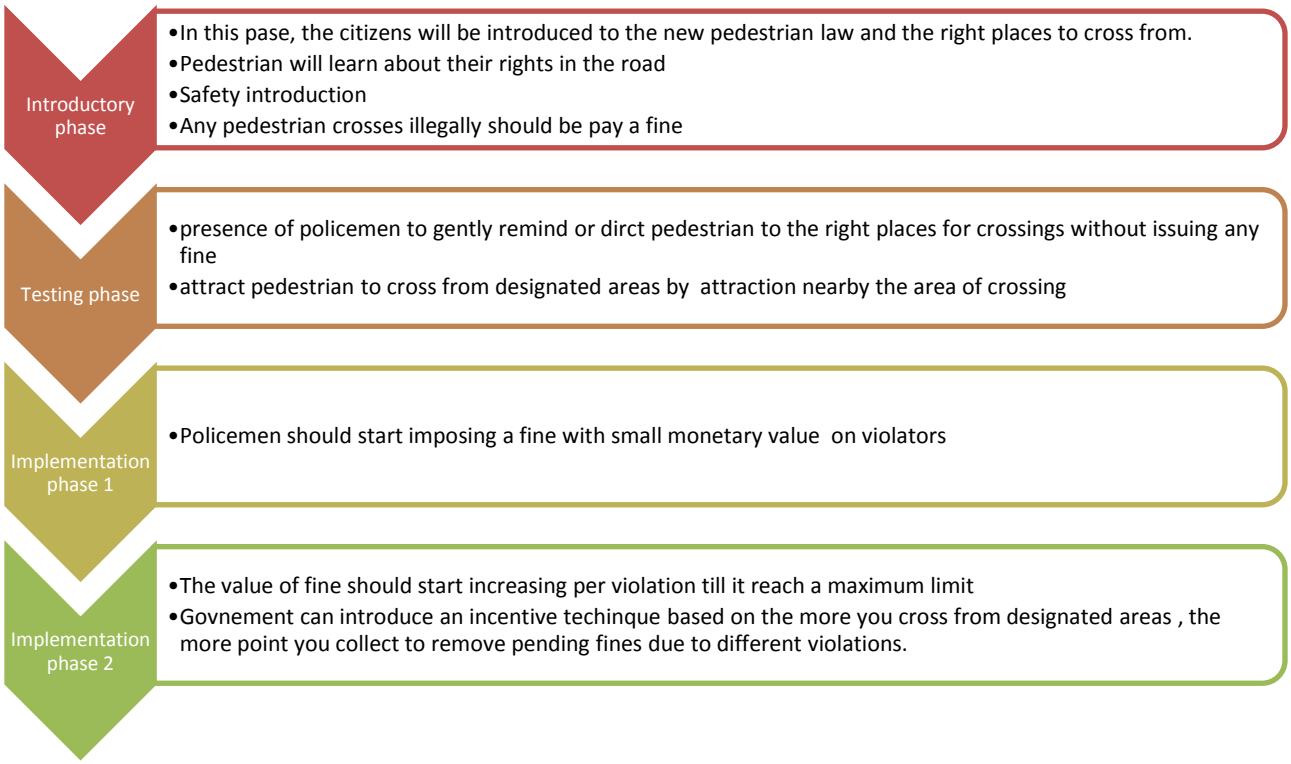
6.1.3 Education and awareness campaigns

After rehabilitating streets and improving of the signalized traffic system to account for pedestrian movement, the pedestrians should now be accountable for illegal crossings since most designated part for crossings should be in good condition as mentioned in pillar two. It is hard to change a cultural behavior that has been active for long time. However this pillar introduce new educational campaigns to teach citizens from early stages in their lives to cross the street responsibly without causing any harm to other citizens categories and without any harm to the country. Since most of the answers was that "I haven't received any instructions for crossing the road" where the answers came from various age groups, the government should invest in addressing this issue. This part of recommendations should be addressed to the ministry of education and ministry of interior where the first will teach children in their early childhood to cross the street from the designated areas; starting from early childhood creates a new culture for crossing the road which will eliminate jaywalking for future generations. The later should introduce new test for drivers in order to respect pedestrian crossing signs in the street and to abide by them. For instance the Ministry of interior in the United Arab of Emirates issued Ministerial Resolution No. (178) for the year 2017 on Rules and Procedures of Traffic Control which indicates the type of violation and the amount of black points per violation and the amount of payable fine. There is a section related to pedestrians and their priorities; for instance, any pedestrian who jaywalks will be issued a fine of 400 AED. Furthermore, it imposes a fine towards drivers who don't yield to pedestrian in designated crossings areas of 500 AED. This kind of fines is presumably difficult for the Egyptian government to apply due to economic conditions of the country and the average lower income. In effect, there should be alternatives such as awareness campaigns for adults or different road users. These campaigns could be

divided into phases to assess the effectiveness of each phase and decide to continue or not. The cost of campaigns will be significantly lower than any improvement or complicated update in the infrastructure. The researcher developed a schematic diagram in order to show a suggestion of the process of campaigning. It involves 4 phases that starts with an introductory phase in which the government introduce citizens to the new upcoming change that they are about to experience. The second phase is guiding phase where pedestrians are guided to the designated crossing areas without paying any fine. The implementation phase is divided into two phases in order to measure the refusal rate of pedestrian by collecting a small fine from violators which will increase incrementally based on the violator record.

Table 16: Sample awareness campaign

Source: own study



6.1.4 Enforcement of law

Issuing policies is not the hardest part, however implanting them and making sure they are being applied is more crucial. The issue of jaywalking could affect many aspects of the country; many policies could be issued regarding jaywalking or pedestrians in general. For instance, a better more pedestrian friendly street policy could be adopted by urban authorities; furthermore, reducing the number of vehicles and integrating public transportation and providing a smarter system for citizen could reduce the number of private car drivers. In effect, the amount of emission could be reduced if the environmental and traffic authorities engage in addressing sustainable policy framework. These policies, however, cannot be considered sustainable, if it is not being practiced or not being applied in real life. There are many policies addressing crucial issues, however, if it is not being activated, then it is not effective. The recordings showed that minor groups from traffic police such as traffic patrols don't have authority or absolute power over vehicles drivers or road users. The following recommendation was based on situation observed from the video recording of the sample location, in addition to collected surveys.

In order to fully utilize their potential in reducing traffic congestion, capacity building is key point here for traffic patrols to be more effective and more efficient in handling delay related issues for example improving communication skills with pedestrians and drivers, empower traffic patrol to help policemen to assign fines to violators, give them notes to take fines so when microbuses stops or other random stopping occurs, for instance, the violator will most probably move before the traffic patrol approach him/her as they will move when they detect policeman coming with note to record a fine.

6.2 Future research

After completing this study, it is assumed that more research should include more sample locations in areas with different street categories as the data was collected from an intersection. In addition, time is crucial in likewise studies where weather, days of the week, months of the years can make a difference. For instance, if the life span of the study can be extended for a period of 6 month or a year to see the full image since there are months that witness lower congestion than normal situations such as morning and before iftar in Ramdan may vary from morning and afternoon of a normal day in February or summer vacation where most people escape Cairo and Giza that streets become less crowded. These kinds of variations can affect the findings of the study. There are many different aspects that can be studied each in a research, however, there are different trends in research that could make contribution such as traffic congestion pricing where the government puts a toll on vehicles entering very congested areas to make for the congestion price that will be generated as a result of congestion. In effect, vehicles users will try finding alternative ways to avoid areas where congestion exists. This topic is recommended for future research where it has many different unchecked parts in literature especially in the Middle East region since it exists in developed countries exclusively. Finally, comparing the outcome of this research with cost of rehabilitating intersection could provide policy makers with even more tailored and more feasible alternatives.

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Appendix A

Sample Questionnaire in Arabic

١- النوع

١. ذكر
٢. انثي
٣. غير ذلك

٢- السن

١. ١٨-٢٤
٢. ٢٥-٣٤
٣. ٣٥-٤٥
٤. ٤٦-٦٠
٥. ٦٠<

٣- من اين تعبر الشارع؟

١. عند الاشارة
٢. عبرنفق المشاه / عبر كوبري المشاه
٣. من اي حتة

٤- هل تلقيت أي إرشادات على كيفية عبور الشارع؟

١. نعم
٢. لا

٥- اذا كانت الاجابة نعم، اشرح موجزا ماذا تعلمت و من أي جهة أو شخص؟

٦- هل تنتظر الاشارة الخضراء لتعبر الشارع؟

١. نعم
٢. لا

٧- ما السبب خلف عدم انتظارك للاشارة الخضراء؟

٨- من وجهة نظرك، هل هناك فائدة للمشاة أو عابري الطريق من الإشارات الضوئية؟

نعم

لا

٩- ما هي الآثار، من وجهة نظرك، لزحمة المرور؟

١٠- هل تعتقد ان زحمة المرور تتسبب في خسائر مالية و بيئية؟

نعم

لا

١١- ما الذي يزعجك عند عبور المرور؟

١٢- ما هي مقترحاتك لتحقيق العبور الآمن للمشاة؟

١٣- ما هي مقترحاتك لتخفيف زحمة المرور؟

١. نعم

٢. لا