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# Behavioral Responses of Commuters In Cairo Dealing With Traffic Congestion

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**Abstract**
Transportation network plays an essential role in civilization's development all over the world. It makes a critical contribution to nation's economic growth and brings considerable social benefits. In Cairo, and due to accelerated growth of population, so traffic congestion and jams problem arises as a consequence. This problem causes billions of hours of travel delay and a lot of wasted fuel besides a severe destruction of environment.
This study attempts to investigate the traffic jams in Cairo, and how commuters act daily in their typical travel. For this purpose, a mixed stated preference/revealed preference survey is created and distributed online to investigate the effect of congestion on commuters' daily life, and to trace their possible change of behavior. The collected dataset is analyzed then by means of statistical packages.

**Key Words**: Congestion; Cairo; Mitigation; Survey; behavior.

## 1 Introduction

No one could ignore the degree of importance of the traffic networks in any country. Without these networks, no civil services could be provided to citizens, no one would reach his destination and no products could be distributed. Because of all previous, decision makers in the field of traffic system management should give more attention to the aspect of making this system runs as smoothly as could be so all services in the nation would be provided correctly. On the other hand, and due to the accelerated increase in population especially in Cairo, decision makers face significant problems in running the traffic system as smoothly as well since traffic networks become more congested.
So, it is found that we should concentrate on the behavior of commuters, and how could we affect on it to integrate them on the process of congestion mitigation. By referring to previous studies and efforts in such field, it was founded that if the socioeconomic aspect of commuters affected, then their behavior will be changed, and from this point of view the vision became clearer.

## 2 Research Objectives

The main objective of this research is to study the bad aspects of traffic congestion on commuters and their behavioral responses, and how they deal with such problem in their daily commute. To achieve the main objective of this research, it could be obtained by studying the traffic flow theory and principles and to investigate causes of congestion in roads networks especially in Cairo, and exploring the previous studies, efforts and practices in reducing congestion. Also, investigating the effect of traffic congestion on the daily life of Cairo commuters, and studying their usual behavior. Finally, to help stakeholders saving resources such like time and fuel, and help saving whole environment. All previous could encourage road users to be more aware of using roads during peaks and engage them in the improvement process, directing them to use public transport, also to motivate engineers to think out of box solving such problems using alternative methods.

## 3 Review of Literature

### 3.1 Traffic Flow Theory

To have a good start, we should know that traffic flow in mathematics and civil engineering is "the study of interactions between travelers (including pedestrians, cyclists, drivers, and their vehicles) and infrastructure (including highways, signage, and traffic control devices), with the aim of understanding and developing

an optimal transport network with efficient movement of traffic and minimal traffic congestion problems" .
Traffic Flow Theory is a tool that helps transportation engineers understand and direct the properties of traffic flow. At any given time, there are millions of cars on our highways. These vehicles interact with each other and effect the overall movement of traffic, or the traffic flow. Whether the task is assessing the capacity of existing highways or designing new roadways, most transportation engineering projects begin with an assessment of the traffic flow. Therefore, the transportation engineer needs to have a stable understanding of the theories behind Traffic Flow Analysis.

### 3.2 Traffic Flow conditions and Causes of Congestion

Lieu et al. (1999) claimed that "traffic behaves in a complex and nonlinear way, depending on the interactions of a large number of vehicles. Due to the individual reactions of human drivers, vehicles do not interact simply following the laws of mechanics, but rather display cluster formation and shock wave propagation, both forward and backward, depending on vehicle density. Some mathematical models of traffic flow use a vertical queue assumption, in which the vehicles along a congested link do not spill back along the length of the link" [(1)].
Knoop & Daamen (2017) indicated that in a free-flowing network, traffic flow theory refers to the traffic stream variables of speed, flow, and concentration. These relationships are mainly concerned with uninterrupted traffic flow, primarily found on freeways or expressways. Flow conditions are considered "free" when less than 12 vehicles per mile are on a road. "Stable" is sometimes described as 12–30 vehicles per mile per lane. As the density reaches the maximum mass flow rate (or flux) and exceeds the optimum density (above 30 vehicles per mile), traffic flow becomes unstable, and even a minor incident can result in persistent stop-and-go driving conditions. A "breakdown" condition occurs when traffic becomes unstable and exceeds 67 vehicles per mile. "Jam density" refers to extreme traffic density when traffic flow stops completely, usually in the range of 185–250 vehicles per mile per lane [(2)].

### 3.3 Traffic Flow Characteristics

Lieu et al. (1999) mentioned that "road traffic flows are composed of drivers associated with individual vehicles, each of them having their own characteristics". These characteristics are called microscopic when a traffic flow is considered as being composed of such a stream of vehicles. The dynamical features of these traffic flows are formed by the underlying interactions between the drivers of the vehicles. This is largely determined by the behavior of each driver, as well as the physical characteristics of the vehicles.

Because the process of contributing in a traffic flow is heavily based on the behavioral aspects associated with human drivers, it would seem significant to include these human factors into the modelling equations. However, this leads to a severe increase in complexity, which is not always a wanted thing. However, we always consider a vehicle-driver combination as a single entity, taking only into account some vehicle related traffic flow characteristics [(1)].
Traffic flow is generally constrained along a one-dimensional pathway (e.g. a travel lane). A time-space diagram (Figures 1, 2) show graphically the flow of vehicles along a road over time.

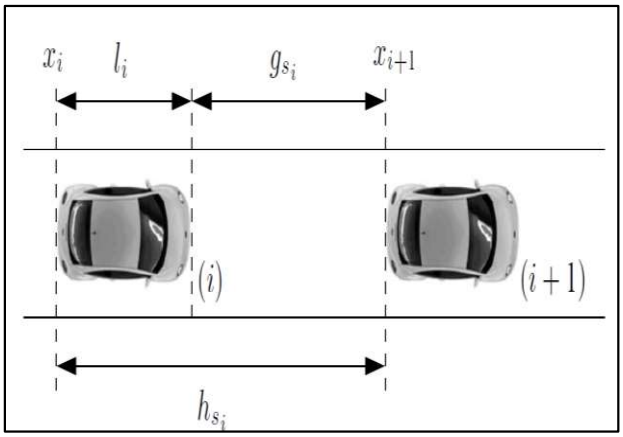



**Figure 1:** Two consecutive vehicles.

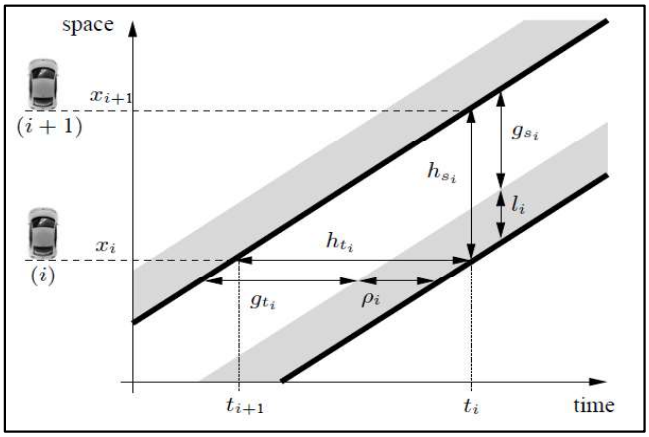



**Figure 2:** A time-space diagram showing two vehicle trajectories i and i + 1.

### 3.4 Traffic Congestion in Cairo

The world bank group, and among their 2014's report of congestion statues in Cairo presented that the Greater Cairo Metropolitan Area (GCMA), with more than 19 million inhabitants, is host to more than one-fifth of Egypt's population. The GCMA is also an important contributor to the Egyptian economy in terms of GDP and jobs. The population of the GCMA is expected to further increase to 24 million by 2027, and correspondingly its importance to the economy will also increase [(3)].

Traffic congestion is a serious problem in the GCMA with large and adverse effects on both the quality of life and the economy. In addition to the time wasted surviving in traffic, time that could be put to more productive uses, congestion results in needless fuel consumption, causes additional wear and tear on vehicles, increases harmful emissions lowering air quality, increases the costs of transport for business, and makes the GCMA an unattractive location for industry and businesses. These adverse effects have very actual and large monetary and non-monetary costs not only for the economy of the GCMA, but gave its size, for the economy of Egypt as well. Approximately 47 billion LE, are wasted every year in the GCMA due to congestion, and this is expected to increase to 105 billion LE by 2030. As the population of the GCMA continues to increase, traffic congestion is becoming worse and the need to address this congestion is becoming more urgent.

## 4 Research Methodology

### 4.1 Overview

As this study aims in general to try to solve and minimize the problem of traffic congestion in Cairo by studying the bad aspects of this problem on Cairo's commuters, a mixed stated preference/revealed preference survey was created to measure how they react with daily congestion problem within their life in order to determine if they could participate in solving congestion problem.

It is worth to mention that three main questions are asked as a guideline for research objectives and as indicators for creating the survey. These questions are:

1. What are the common demographic circumstances of respondents who deal with congestion problem?
2. How congestion problem affects the daily life of respondents, and how they deal and act with it?

### 4.2 Survey design and deployment

After completing creation of survey statements, it was presented to specialists for arbitration, and necessary modifications were performed. On the next step, an online copy of survey is designed in both Arabic and English languages, including introductory movies to congestion pricing and peak-avoidance rewards, besides presenting scenario by means of graphs, and then it was sent for 10 respondents for the purpose of piloting, and a second round of modification performed. When it is assured that everything is ok, the survey was deployed within several channels in Cairo, and data collected after about three months of deploying, the analyzed.

## 5 Data Analysis and Results

After survey close time, about 885 responses were collected in both Arabic (701) and English (184) versions. All responses were collected completely with no missing answered statements.

### 5.1 Demographic Characteristics of respondents:

The study's sample size was observed to contain 59.4% of them as males and the rest 40.6% as females Figure (5). Most of participants ages are located within a category between 25 and 34 years (about 36%), while 29.2% of them are on ages between 18 and 24 years, and 27.8% of them are located on the age interval between 35 and 44 years old. The rest few respondents of this study are older than 45 years old while only just 1.7% prefer not to mention their ages (Figures 3, 4).

Most of participants are working full time (about 59.5%) and 22.8% of them are students. Also, about 8% of respondents are working part time, while 2.7% of them are working from home. However, about 7% of participants are un-employed (Figure, 5)

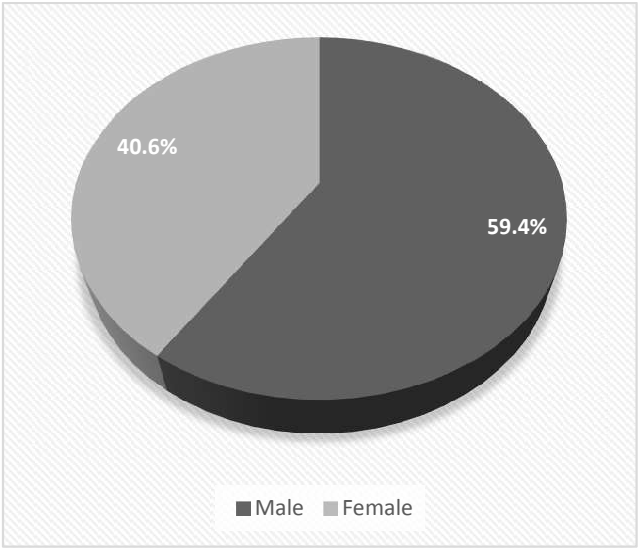



**Figure (3):** Gender Distribution.

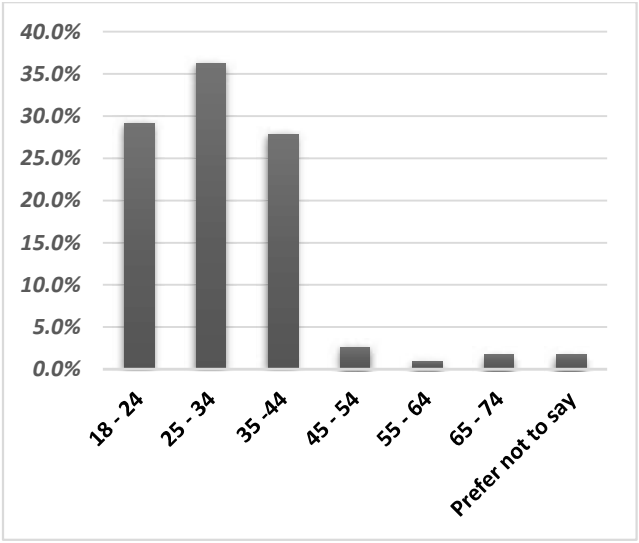



**Figure (4):** Age Distribution.

The household distribution of study's sample size is observed to contain 4 persons per family on the majority

with percentages of about 34%, and about 29.3% of families contain 5 persons, while 18% of these families contain 3 persons. A few families for respondents contain 1, 2, 6 or more than 6 persons per each family (Figure, 6). Most of respondents have a driving license (70% of them), while the rest have not. Furthermore, and regarding car ownership, the majority of participants (about 53.4%) have one car, while about 19% have two or more cars. However, a percentage of 27.5% of respondents have no cars. These results are presented on Figures (7, 8) respectively. The monthly income distribution for study sample size is located almost equally within different low and moderate income levels, since about 29%, 26% and 23% of people are assigned to have income levels of LE2,000-LE 5,000, less than LE2,000 and LE5,001-LE10,000 respectively. The rest 21% of respondents have an average monthly income more than LE10,000 (Figure 9).

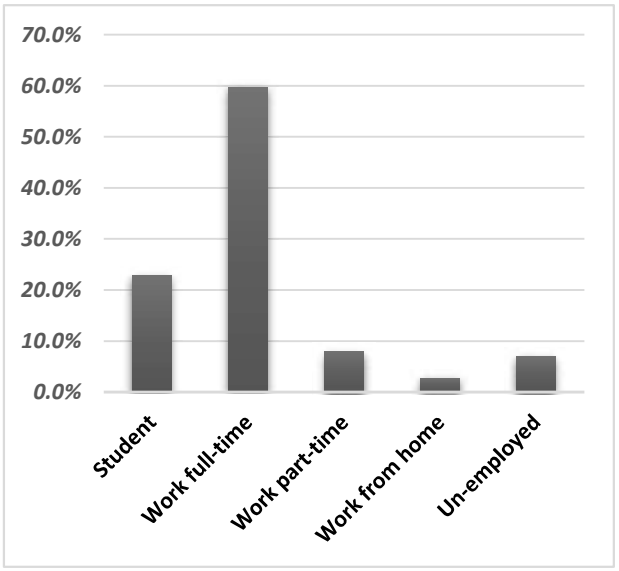



**Figure (5):** Employment Statue.

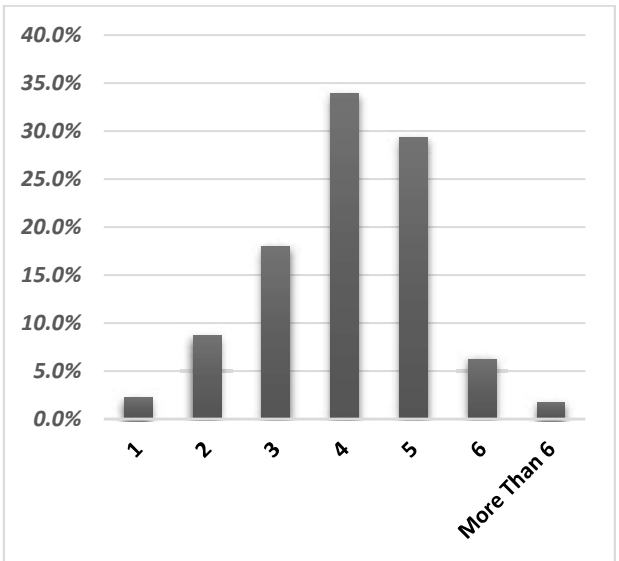



**Figure (6):** Household Size.

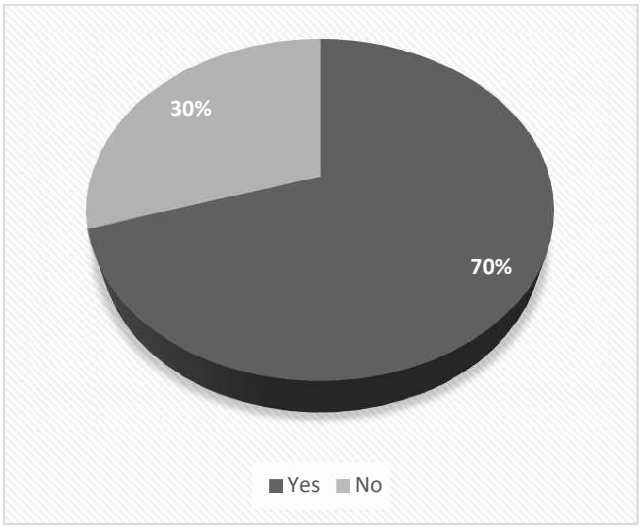



**Figure (7):** Driving License Ownership.

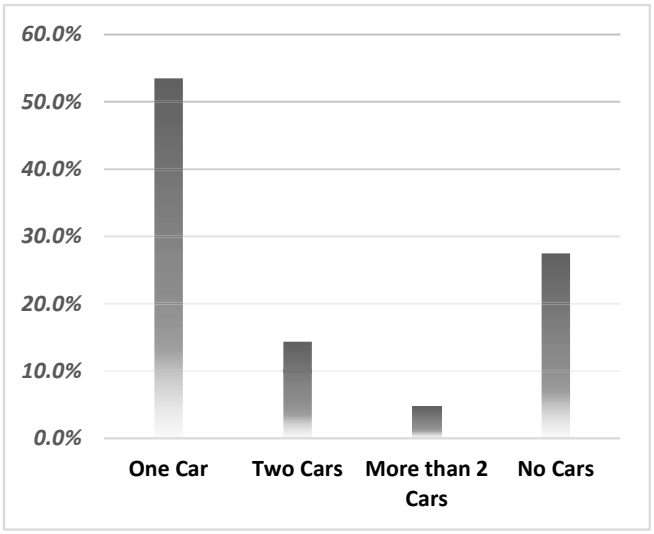



**Figure (8):** Car Ownership.

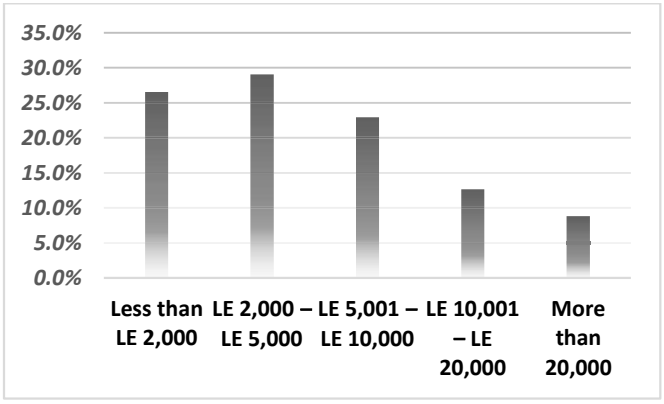



**Figure (9):** Monthly Income.

### 5.2 Interaction with Congestion in Cairo

Results obtained clarified that there is a massive congestion problem in Cairo where people really suffer from, and this problem plays an essential role in choosing

their work or living places. Congestion also makes people of city to somehow to leave it to a quite/small city.

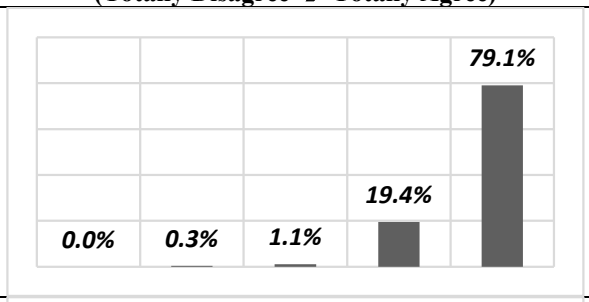
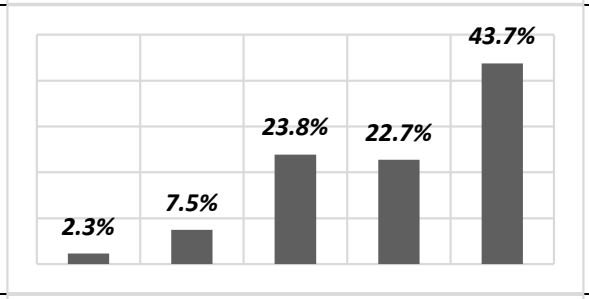
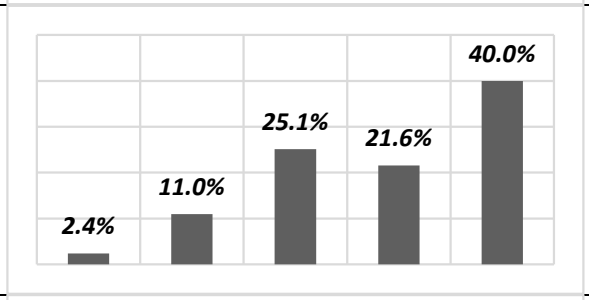
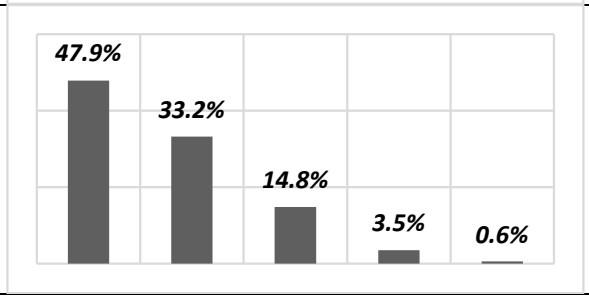
On the other hand, no one can deny how bad public transportation network is, and this was observed from responses degree of satisfaction on this issue. Furthermore, people believe that lack of enforcement, reckless driving behavior and heavy trucks are major contributing factors to congestion problem.

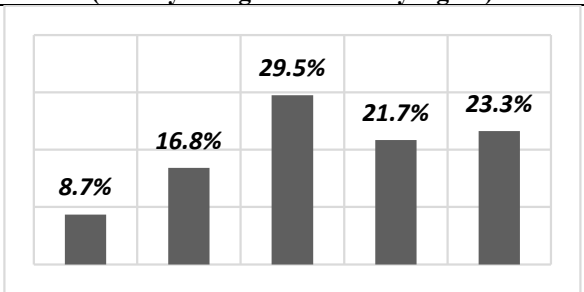
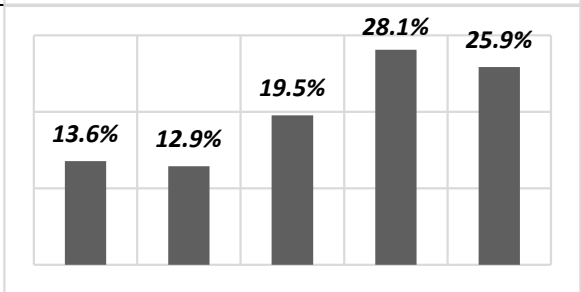
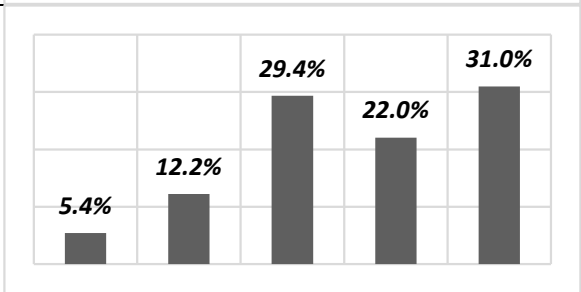
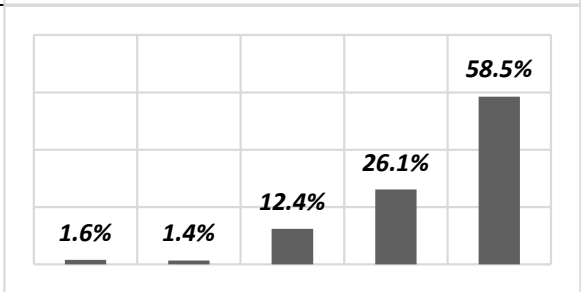
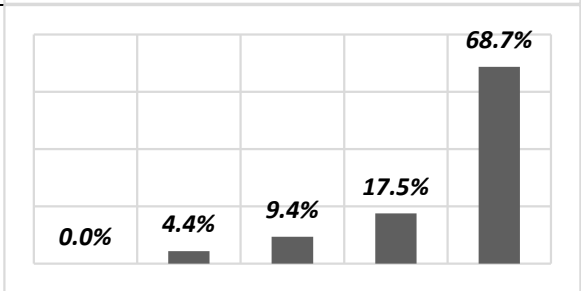
Opinions of respondents of how they react with daily congestion in Cairo differ from one to another, some of them have the ability to adjust their departure and arrival times, others could make a productive use of time in congestion, and some use technology or their own knowledge to determine routes within their trips, however, others could not.

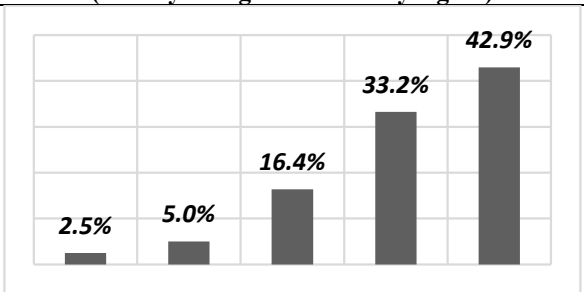
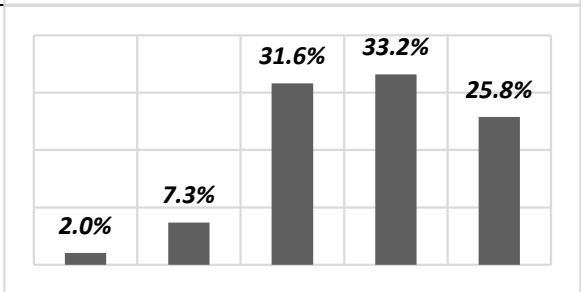
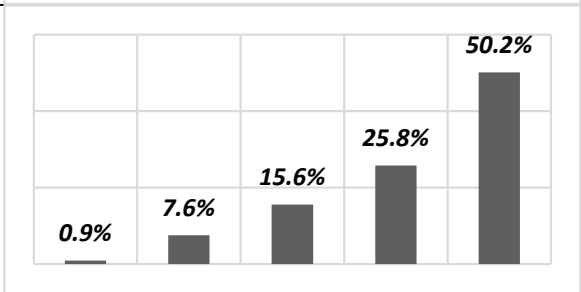
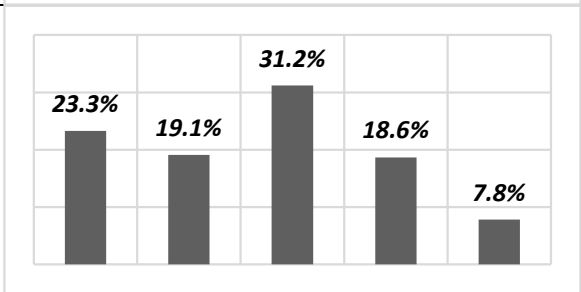
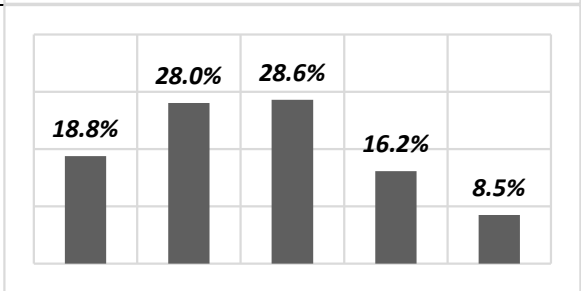
The good news that almost all people in Cairo have serious endeavors to participate on the congestion mitigation process if logical solutions introduced, even if few others have not.

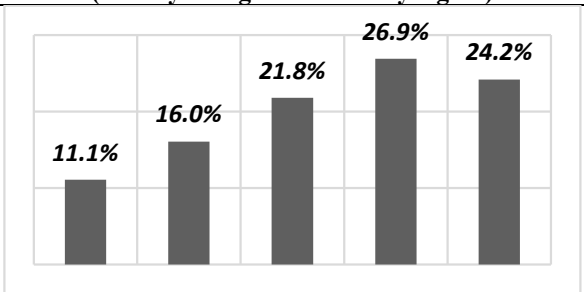
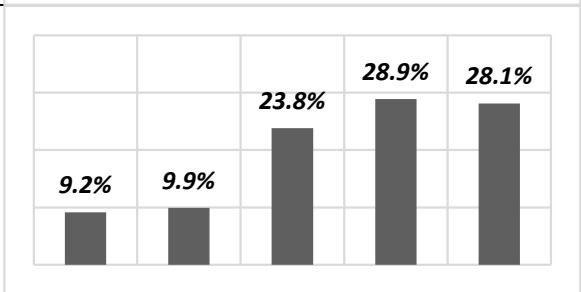
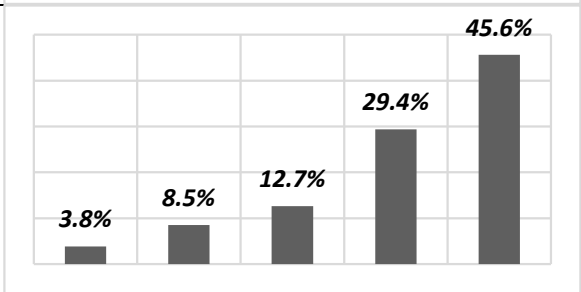
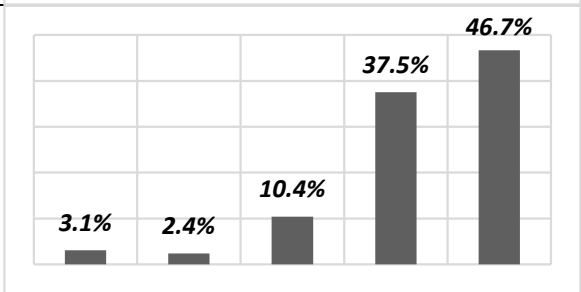
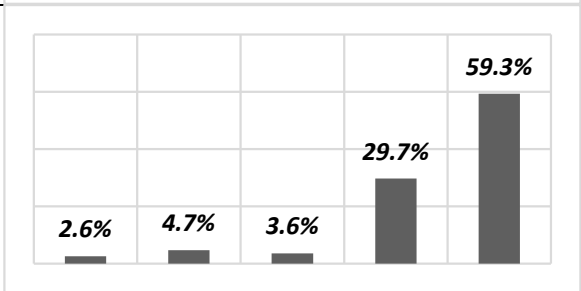
All previous statements and respondent's behavior dealing with congestion are summarized on Table (1).

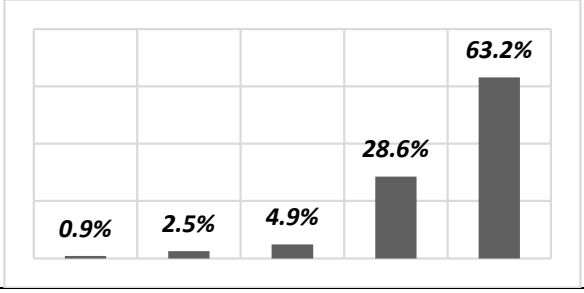
**Table 1:** Distribution of respondents' reaction with traffic congestion.

| Q. | Statement | Mean Score | Distribution of Responses (Totally Disagree ➔ Totally Agree) |
|---|---|---|---|
| **1** | Traffic congestion in my city is a big problem | 4.77 |   |
| **2** | Traffic is a major factor in choosing where to live | 3.98 |   |
| **3** | I like living in a small and quiet city instead of a bustling/noisy city | 3.86 |   |
| **4** | *Continued* Public transportation in Cairo is viable/convenient | 1.76 |   |

| Q. | Statement | Mean Score | Distribution of Responses (Totally Disagree ➔ Totally Agree) |
|---|---|---|---|
| **5** | I prefer to drive my own car rather than travelling by any other means | 3.34 |   |
| **6** | I may consider biking/walking as means of transportation | 3.4 |   |
| **7** | Traffic is a major factor in choosing where to work | 3.61 |   |
| **8** | I believe that lack of traffic enforcement is a major contributing factor to traffic congestion | 4.39 |   |
| **9** | I believe that reckless driving behavior is a major contributing factor to traffic congestion *Continued* | 4.51 |   |

| Q. | Statement | Mean Score | Distribution of Responses (Totally Disagree ➔ Totally Agree) |
|---|---|---|---|
| **10** | I believe that heavy vehicles are a major contributing factor to traffic congestion | 4.09 |   |
| **11** | It is difficult to estimate how long it takes to reach my destination | 3.73 |   |
| **12** | In my typical day, too much time is wasted in congestion | 4.17 |   |
| **13** | I make productive use of the time I spend on my daily commute | 2.69 |   |
| **14** | I have the ability to adjust my departure and arrival times | 2.68 |   |

| Q. | Statement | Mean Score | Distribution of Responses (Totally Disagree ➔ Totally Agree) |
|---|---|---|---|
| **15** | I base my trip routing based on accessing trip condition's data | 3.37 |   |
| **16** | I plan my travel choices based on my knowledge of congestion in Cairo | 3.57 |   |
| **17** | Sometimes I think twice before making a shopping trip because of congestion | 4.05 |   |
| **18** | I am willing to contribute to reducing traffic congestion; even if others are not | 4.22 |   |
| **19** | I can dispense my car when there are viable/convenient alternatives | 4.38 |   |

| Q. | Statement | Mean Score | Distribution of Responses (Totally Disagree ➔ Totally Agree) |
|---|---|---|---|
| **20** | I am willing to contribute to solving congestion when logical/serious solutions are presented | 4.51 |  |



Furthermore, respondents' opinions regarding usual departure times, delays, peak times and others varied from one to another assuring that majority think Thursday is the most congested day of week, and 4:00-6:00pm is the common peak time faced during the day.

**Conclusions**

Results clarified that there is a massive congestion problem in Cairo, where people really suffer from, and this problem plays an essential role in their daily decisions. Also, it was observed that people were not satisfied with the public transportation network in Cairo. Moreover, it was found that most of them were not satisfied also with the enforcements laws in the city, and they refused the reckless driving behavior. Almost all people in Cairo have serious endeavors to participate on the congestion mitigation process if logical solutions introduced, even if few others have not.

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