



Auto-rickshaw and its impact on the economy in Egypt (Case study: East Shubra Al-Khaimah district in Cairo)

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Abstract : The purpose of this research is to study the environmental, traffic, social, and economic impacts of the auto-rickshaw on Egyptian roadways. The case study included east of Shubra El-Khaimah in greater Cairo. The study deals with the economic effects of auto-rickshaw, including operating and maintenance costs, depreciation rates, and other costs. Data collected from the study area were including traffic volume, types of vehicles, fuel consumption rates, maintenance costs, wages, traffic map, and profit rates. Owners, drivers, and passengers were targeted in the surveys. The number of main streets in the study area containing auto-rickshaw, the impact of auto-rickshaw on travel time, accident rates, and demand rate for other modes of transportation. The analysis was done using SPSS software. we arrive at conclusions that will help to solve the problem and plan future studies. According to the study's social results, 71.17% of users are offended by auto-rickshaw traffic tariffs, 59.33% of passengers are dissatisfied with the age of auto-rickshaw drivers, 33% are afraid of traffic accidents and 72% completely reject the presence of auto-rickshaws on the roads. The proposed amendments reduce congestion rates by 66.3% compared to the current situation. The authors discovered that replacing auto-rickshaws with vehicles working with clean energy and banning tuk-tuks in the study area reduced CO₂ by 33.22%, NO_x by 40.19%, CO by 78.40%, and HC by 50.62%, and reduced travel time by 43.28%, and travel fees reduced by 90%. Standard criteria were followed for statistical work to ensure that all dimensions were dependable, with correlation coefficients of more than 0.50 for each item and its dimensions. Cronbach's alpha coefficient is greater than 60% for all study dimensions, and Cronbach's alpha coefficient for the total scale is larger than 80%.

KEYWORDS: : Auto-rickshaws, Air pollution, Tuk-tuk

Introduction

The entry of auto-rickshaws into Egypt had social, traffic, environmental and economic impacts. This leads to an increase in the number of school dropouts, pollution rates, traffic congestion, and labor wages due to the decrease in the number of craftsmen and a rise in the prices of handicrafts due to the small number of workers and their transition from basic career to auto-rickshaws driver. One of the most important economic

problems of auto-rickshaws is that the financial gains are quick, temporary, and do not require any previous experience. It also costs the government financial losses due to the failure of this category to pay taxes and government fees that owners of other types of cars do not adhere to. Auto-rickshaws are small vehicles that can accommodate two or three passengers without counting the driver and it is spread in many cities around the world. Although it is noted that most of them are in developing

countries, which have many problems with roads, transportation, traffic, and unemployment rates. Its spread is also increasing in popular and rural places, due to the lack of urban planning and the presence of narrow streets that do not allow the passage of large vehicles. Many countries do not legally recognize auto-rickshaws. You may find auto-rickshaws in some developed countries such as France, Italy, and the United Kingdom, but as a type of history or tourism, for example in America they have been used in the internal postal services[1] for 50 years or more[2], and in France,

it is used until now but in a limited number of 250 Vehicle in the whole country is used only as a kind of entertainment for tourists in the Eiffel Tower[3]. This research aimed to study the effects of the presence of auto-rickshaw in Egypt. The study area was represented in the east of Shubra El-Khaimah - Qalyubia - Egypt. The study area contains many random urban divisions, as shown in Fig.1. Data was collected through questionnaires and field surveys. To ensure sample success, surveys from different groups were taken randomly from the sample population.



Fig 1. Urban division and the most important roads in the study area

1.1 Social aspect

It is known that the transportation system is affected by the size of the population. The population of Egypt in July 2021 reached about one hundred and two million people and the population of greater Cairo alone reached about ten million people [4]. As Cairo is one of the largest capitals in the African continent and the Middle East [5]. The average population density in Egypt was 103 people per square kilometer (266 people per square mile)[6]. This has helped spread the phenomenon of tuk-tuks in Egypt, there are some names that this random car is famous for, and they differ from one country to another. In Bangladesh, it is called cars, in Nigeria, it is called Kiki Marwa, in Egypt and Cambodia, it is called tuk-tuk, in East Africa, it is called Boda-bodas and in Indonesia, it is called Bendor[7]. The spread of the rickshaw phenomenon (Tuk Tuk) has led to an increase in the crime rate and the spread of violence and rape, which has led some countries to consider granting part of the licenses to drive this vehicle to women, but one of the defects of this idea is that the crimes of rape occurred in isolated places and the victim was the driver[8]. The unemployment rate is the second reason for the spread of auto-rickshaw in Egypt.

The unemployment rate in Egypt reached 13.2% in the third quarter of 2014, which means that the government must provide about seven hundred thousand job opportunities annually to contain new entrants to the labor market, so tuk-tuk sales ranged from 60 to 65 thousand vehicles annually in 2015. The volume of users of this rickshaw in Egypt is about 30 million citizens per day with an average of 30 trips per day for one vehicle, and an average maximum speed of 40 km/h for the vehicle, the costs of obtaining a tuk-tuk license amounted to 2000 Egyptian pounds per year. Knowing the fees prescribed by the government for regular taxis, there is no detailed data on the numbers of existing vehicles and their geographical distribution, and there is no communication between government agencies and manufacturers to update the numbers of car bodies and engines. The government has decided that the legal for licensing for motorists is 21 years, bearing in mind that the legal age for private age vehicles is 18 years. There is no link between Social Security and auto-rickshaw drivers. There are many decisions taken by the Egyptian government regarding auto-rickshaws, as shown in Table 1.

Table 1. Important dates in the life of auto-rickshaws in Egypt

Year	Resolution
2005	The first appearance of the tuk-tuk in Egypt came from India through a businessperson
2008	Tuk-tuk license according to Article 7 of the Egyptian Traffic Law No. 121
February 2014	A government decision to ban the import of Tuk-Tuk for a year. Ministerial Resolution No. 417 of 2014
April 2014	Beginning of confiscations of unlicensed tuk-tuks or non-compliance with traffic plates.
2015	Tuk-tuks banned on the streets of central Cairo
2018	Reducing the issuance of licenses for the tuk-tuk in preparation for stopping the licenses.
2019	The first decision to replace the tuk-tuk with minivans appears
June 2020	The number of tuk-tuks registered with the government is 243,661 "Statistical Yearbook" (2020) (camps)
June 2021	The number of tuk-tuks registered with the government is 274,984 "Statistical Yearbook" (2021) (camps)
November 2021	The Ministry of Industry issued Resolution No. 533 of 2021 to stop importing the basic components of a three-wheeled tuk-tuk.

Source: Article in an official Egyptian newspaper on Thursday, 15 July 2021, The Official Gazette in its issue No. 252 dated November 10, 2021, No. 417 of 2014

The rationing provides a stable source of income and regulates the conditions of auto-rickshaw owners and drivers, it also provides the possibility of insurance for drivers, a database that provides knowledge of non-required professions, the driver's scientific and social background, the number of vehicles, and geographical distribution, and future studies have shown that in the event of a comprehensive and sudden ban on the tuk-tuk, it will constitute a direct threat to national security[9]. A field study conducted in September 2018 by the Institute of Environmental Studies and Research - Ain Shams University in cooperation with the Graduate School of Childhood and the Social and Field Surveys Unit at the same university. Estimated samples were taken from children in several governorates (urban and rural) and the results of the study were that the factors that pushed these children to work in the field of driving auto-rickshaws were the lack of formal education and ease of work on auto-rickshaws and a high financial return[10]. To address the safety issue, design improvements have been made to the Indian vehicles, with seat belts and pads for the interior surfaces containing metal. And the use of advanced technology, such as tracking technology, and designated lanes for vehicles - such as cyclists' paths - resulted in fluidity in traffic compared to movement before the implementation of the modifications[8]. Researcher N. Al-Yamanisaid that Egyptian auto-rickshaws participated in a program called Safe City and Safe Public Spaces. It was launched in 2011 with the support of the United Nations, with the participation of Cairo University, and in cooperation with the National Council for Women. It aims to reduce and prevent harassment

and violence against women and to provide safe areas for women's movement without harassment. The researcher gave the trainees a poster (a safe tuk-tuk), this label means to the general women that they will not experience any harassment when riding[11]. Researcher S. Kaul said that most tuk-tuk drivers consume tobacco and alcohol because they are exposed to the pressures of social life and marginalization, which puts their lives and the lives of road users at risk, study was conducted on rickshaw drivers who were randomly selected, and the results were that 76.0% of auto-rickshaw drivers smoke, and the rate of depression increased by about 90% of general drivers whose depression rate was 60%, the severity of anxiety was high in more than half of the auto-rickshaw drivers. As the rate of depression increased, so did the rates of alcohol abuse. Depression rates increased with the number of years of driving[12]. The Indian experience was to prevent and reduce the phenomenon of violence against women from harassment, kidnapping, and rape, is that India presented a pink rickshaw similar to the Iranian experiment and the experiment was a great success, as the pink rickshaw was distinguished by the use of additional systems such as GPS and other tracking systems[13]. But some things happened that shocked society, which as the exploitation of women's weaknesses and the rape of female drivers in many cases[14].

1.2 Environmental aspect

D. Botan said that the auto-rickshaw has become popular in many countries, and this vehicle carries an outdated design that is not safe for the driver or passengers and needs development

processes in the design to increase safety inside and outside the auto-rickshaws vehicle and also to protect the environment from the dangers of the current design[15]. The results showed that the average concentration of fine particles was 3.3 times higher inside the auto-rickshaw than at the surrounding level[16]. It produces very harmful combustion products to the surrounding environment, and because it is a car with always open windows. When compared three cars measured(PM_{10}) particulate matter of diameter of fewer than $10\ \mu m$ in $\mu g/m^3$ and ($PM_{2.5}$) particulate matter of diameter of fewer than $2.5\ \mu m$ in $\mu g/m^3$, in the same study area, the first with open windows, the second with closed windows, and the last with closed windows and air conditioning with air purifying filters, the studies showed the following results, the open vehicle is higher (65%) and the closed vehicle (48%) by adopting the air-conditioned car as a measuring point [5]. Most of the trips in Cairo have (PM_{10}) and ($PM_{2.5}$) up to (227) and (119) $\mu g/m^3$, and it was (AC vehicles) had the lowest average concentrations of (NO_2) and the highest levels of carbon dioxide in which nitrogen oxides and carbon dioxide increase along the crowded streets in greater Cairo, reaching (76.3 $\mu g/m^3$) and (8.23 $\mu g/m^3$), respectively. The death rate was (62/100,000) for the entirety of greater Cairo, which is greater than the rate estimated for the entire population of Egypt in the last assessment of the burden of ambient air pollution disease, which is (55/100,000)[17]. Deaths in greater Cairo are estimated at (11%) due to ($PM_{2.5}$) and (8%) due to (NO_2) for ages above 30 years[18]. The negative impact of this vehicle (automobile rickshaws) on the environment is one of the biggest negative effects, because the source of the movement of this vehicle is a two-cycle engine that produces incomplete combustion and produces very harmful combustion products to the surrounding environment, and because it is a vehicle with always open windows, opening windows in vehicles leads to exposure to higher concentrations of (PM_{10}) and ($PM_{2.5}$)[5]. A field study which is based on the use of 4 tuk-tuks that run on different types of fuel, namely natural gas, gasoline, and electricity was conducted, and the results were that the cost of clean fuel is almost equal to the cost of electricity and natural gas, and when using a mechanical engine, the cost of fuel for the same trip compared to clean fuel is three times[19].

1.3 Economic aspect

T. R. Bagul said that excessive deceleration, braking, and repetitive acceleration increase the rates of greenhouse gas emissions notably, there has been a significant increase in auto-rickshaws all over the world during the past two decades, especially in developing countries. Auto-rickshaws are a responsive system, also called Intermediate Public Transport (IPT) due to the nature of their operation, the number of auto-rickshaws in India in 2016 amounted to (7,475,147) off-road vehicles, which is equivalent to the number of vehicles in the Netherlands. The annual sales volume reached (800,000) vehicles. The average trolley trip in Indian cities is about (100 km/day) with an average of (45) passengers per day, with an average speed of about (5.5) km/day. However, auto-rickshaws are the solution available to bridge the gap between transportation and personal vehicles. Especially in cities with low income and high population density, the study notes that when switching to (electric) rickshaws at 5%, will bend the ecosystem and prevent disastrous consequences from continuing the current situation[20]. By 2030, emissions will be reduced by 6.30% compared to the base scenario if a switch is made to electric vehicles. The study shows that the expected amount of carbon dioxide emissions will be (1,696,670) tons/year, and (HC) and (NO_X) emissions will be (2,067,371) tons/year[20]. Egypt is characterized by the multiplicity and diversity of its means of transportation, especially in the capital, Cairo. Where most of the city's population depends on public transportation, and public transportation in Egypt can be divided into two types (formal and informal). The informal transport sector is on the rise due to the lack of formal means of transport in some areas. The most informal of these is the tuk-tuk, which is widely available in poor neighborhoods and low-income areas[21]. A field study conducted in 2015 said that (30) million citizens depend on tuk-tuks daily, and (3) million job opportunities are provided by tuk-tuks in Egypt, and (6) million citizens consider tuk-tuks as a main source of income. Whether it is a driver, owner, technician, or spare parts dealer, the average per capita income from a tuk-tuk is (100) Egyptian pounds per day, and the income of tuk-tuk owners is (9) billion pounds, and there are (15) factories that are feeding industries, and there three companies owning the import and assembly of tuk-tuks, and the annual revenue from customs and taxes on tuk-tuks amounted to (500) million pounds annually[9]. Rickshaw continues to spread rapidly

in India, due to their small size, ease of control, uncomplicated design, and ease of maintenance and repair, which leads to increased air pollution. But auto-rickshaws have a bad reputation as an example (individual greed) due to the increase in passenger freight and traffic tariffs, with much controversy emerging about the ban within Indian society, where the presence of this rickshaw in the community plays an active role in urban areas, and it is also a source of income for a large segment from the community [14]. A study on determining and evaluating the level of service on the road by researchers "Dipa Sharma" and "Depapratim Pandit", the study showed that there are gaps in public transportation systems in developing countries, resulting in intermediate transportation to fill these gaps, including the auto-rickshaw, And that these gaps are the main reason for the emergence of informal transport vehicles and illegal employment [22]. The Egyptian Center for Economic Studies estimates the size of the informal economy at about 40% of the Egyptian national product, and that the informal economy employs about 40% of nonagricultural workers, according to World Bank statistics. The economist Hernando de Soto believes that legalizing 5% of the informal sector could double the size of the Egyptian economy within years, if half of the fees prescribed by the government for licensing Currently are imposed, the increase in the Government treasury will increase by about (500) million pounds annually, in addition to income taxes on rickshaw drivers and customs duties on importers [9]. "Santiago Roca" and "Luis Chimabuco" pointed out in a paper published in Transport Policy on Transport Economics, that workers can be divided into illegal workers, regular workers, and informal workers, and that competition within the transport market is unfair in the presence of this tripartite division because there is one category that bears government fees, development and modernization and the other two cases are the beneficiaries of the full profit because their joint policy is to reduce the cost and obtain the largest profit from the market without paying the Government's rights, it is also gaining popularity in the weak transportation field by offering lower comfort and higher speeds [23]. Mileage within Indian cities by auto-rickshaws 18 to 20 km/liter (45 mpg) Mileage on the highway 25 km/liter (60 mpg) Average traveled distance 40 to 60 km/day Maximum speed 56–80 km/h (35–50 mph) Fuel Tank capacity 8 liters (including 1.4 liters reserve) Gas tank capacity 145 km to 190 km (90 miles to 120 miles) [24].

1.4 Traffic aspect

Simon Harding said that Auto-rickshaws do not have fixed routes, and they prefer winding, hardroads, it acts as a service intermediary between modes of transportation, especially railways. Because use the causes of congestion in cities and urban areas are the presence of pedestrians and intersections, poor planning of traffic lights, irregular bus stops, and unauthorized parking on the side of the road, especially during peak hours [25]

1.5 Research methodology

The research is summarized in four aspects (social - environmental - economic - traffic). By conducting surveys, questionnaires, field visits, as well as roadside interviews, using generally accepted statistical methods such as manual counting and comparisons. And reviewing research and theses related to the four academic aspects in the study area or areas that are similar in societal characteristics and share the rickshaw as an essential element. A study of the current situation (with the auto-rickshaw) and a proposal to solve the current problem by preventing and replacing motorized vehicles (without). (A case study with and without). And then compare the collected data with the available government data. The research team developed the null hypotheses through which the type of questions was determined within each of the four sub-districts. The size of the community sample (the survey list method) and the methods of taking the community segments was determined. We can summarize the research methodology through statistical work with the following items:

- Research variables and study hypotheses.
- Statistical methods of analysis.
- Study Population and Determining the Sample Size
- Frequency and relative tables.
- Test the validity and reliability of the survey dimensions
- Research hypothesis results.
- Research variables and study hypotheses:
 - Auto rickshaw effect on social life and its basic dimensions (drop out of school, increasing crime rates, the spread of addiction, reducing the unemployment rate, increasing child labor).
 - Auto rickshaw effect on increased pollution rates and its basic dimensions (Increasing air pollution

rates, increasing visual and audio pollution rates, Increasing pollution inside the vehicle).

- Auto rickshaw effect on the economic conditions and its basic dimensions (increasing labor wages, Reducing the number of workers and technicians, Extinction of some crafts and handicrafts, Reducing the other transportations demand, the spread of the informal economy, Losing of Egyptian legal fees, Increasing oils and fuels consumption).

- Auto rickshaw effect on the traffic side and its basic dimensions (Increasing accident rates, increasing traffic congestion, increasing Traffic tariff, reducing trip time, increasing depreciation of roads, Increasing numbers of trips).

The summary of the questionnaires and surveys was as follows

- To study the social effects, special questionnaires were made (dropping out of education for children working on the tuk-tuk - crime rates in tuk-tuk and addiction - the size of unemployment - a questionnaire about the public's opinions of problems related to the tuk-tuk, such as the age of the driver and the sense of safety inside the rickshaw).

- The pollution rates resulting from the tuk-tuk studied using the rates already measured in Egypt. (Ph.D. thesis from Benha University). With data collection on visual and audio pollution through three questionnaires of different seasons and distribution to ensure the quality of the results.

-To study the traffic impact of tuk-tuks on the roads under study, including accident rates and congestion. The work team executed field studies (studying the relationship of congestion with time - studying the occupancy rate of the tuk-tuk by roads - studying the traffic tariffs for different means)

-To study the economic impact of the tuk-tuk in Egypt. The research team executed(a field survey for the preparation of workers, technicians, and boys before and after the appearance of the tuk-tuk - a field study for a project with the same capital - a study of the consumption value of fuel and oils for the tuk-tuk).

- Make many actual comparisons to compare with other means of transportation to choose the alternative.

2. Data collection

Data collected within the study area between May 2019 to January 2022 by field surveys. The data can divide into:

2.1 Social Data

The research team found through field surveys in the study area that the area is first-class industrial. It has only a small agricultural part, but it is owned by the government and used in agricultural research operations ⁽¹⁾. Most of its residents are low-income, according to government estimates, and a small part of them are from the middle class ⁽²⁾. There is no urban planning, so randomness or non-engineering planning controls the urban divisions in it ⁽³⁾. Table 2 identifies most of the general data required in the research for the study area.

(1) Presidential Decree No. 1445 of 1967

(2) A questionnaire executed by the research team and data review with the employees of the technology center of the district.

(3) Field surveys executed by the research team using the ground and urban maps of the study area.

Table 2. General data for the study area

Area name ^(a)	Shubra El-Khaimah, the second district
The area of the study area ^(a)	16.5km ²
Traffic division of the study area ^(a)	Five zones
Number of populations in the study area ^(b)	694,922
number of males ^(b)	362,898
Ages between 15-44 ^(b)	168,748 people
Number of families ^(c)	120,149
The average number of the vehicles under study in the study area ^(c)	15,000 tuk-tuk
The average number of workers driving a tuk-tuk ^(c)	60,000
The average number of beneficiaries of a tuk-tuk ^(c)	180,000

- (a) East Shubra El-Khaimah employees
- (b) The Central Agency for Public Mobilization and Statistics (CAPMAS) with an update from the files of the Technological Center in East Shubra El-Kheima
- (c) Prepared by the research team through field surveys within the study area. The surveying included garages, parking lots, road interviews, and output compared by the neighborhood.

2.2 Environmental Data

The research team indicated that the types of vehicles used within the study area do not follow international standards (there are many mass transit vehicles in the study area that are dilapidated and very old). Most of the available vehicles run on petrol and diesel only, natural gas is extraordinarily little. Electric cars do not exist. Table 3 shows the types of fuels used within the study area.

Table3. Types of vehicles and fuel used to work them

Vehicle name	Auto-rickshaw	Bus	Tractor-trailer	Truck	Van	Car	Three-wheeler	Two-wheeler	Minibus	Microbus
Fuel type	Gasoline	Diesel	Diesel	Diesel	Gasoline	Gasoline-diesel-natural gas	Gasoline	Gasoline	Diesel	Gasoline Diesel

Prepared by the research team through field surveys

2.3 Economic Data

The data on the economic aspect was collected by the research team and were determined in terms of (auto-rickshaw price, fuel and oil consumption, average depreciation, and maintenance).

2.3.1 The prices of auto-rickshaws in Egypt

The data collected showed that there are many ways to buy the auto-rickshaws, such as cash

purchase, installment, and other systems located within the study area, and clarifying the discrepancy in prices between dealers and distributors. Average prices were taken based on the same study area by asking direct sales centers, it is noted that the percentage of purchases in installments exceeds 50% within the study area, as shown in Fig. 2.

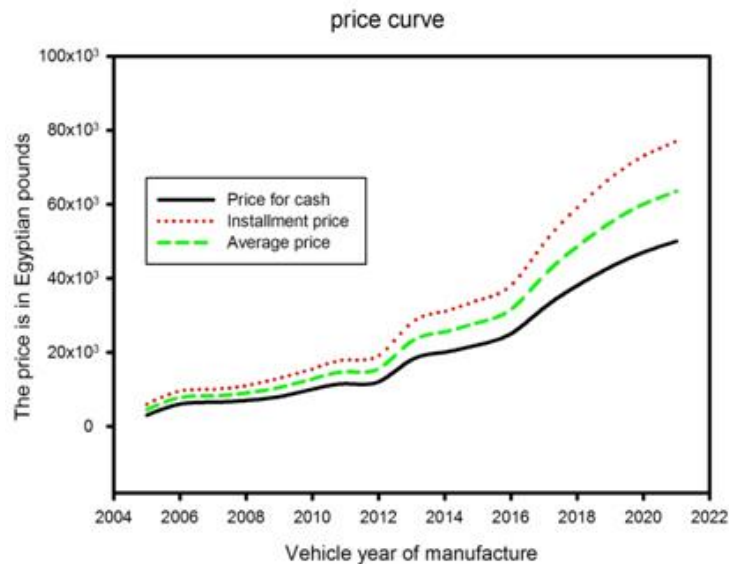


Fig 2. Price curve with a year of production Prepared by the research team through a field survey

2.3.2 Auto-rickshaws and depreciation

Surveys within the study area by the research team (from the survey of owners of these models and distributors of spare parts) showed that the rate of operation of machines depends on their efficiency. So that the efficiency of the auto-rickshaw above 80% works an average of 25 days per month, and its efficiency is less than 80% and more than 50%

works for 22 days per month, and the vehicles with an efficiency of less than 50% work for 18 days per month. The most important reasons for reducing working days are (obsolescence, multiple maintenances, manufacturing problems, and spare parts not approved in the local market, as shown in Fig.3

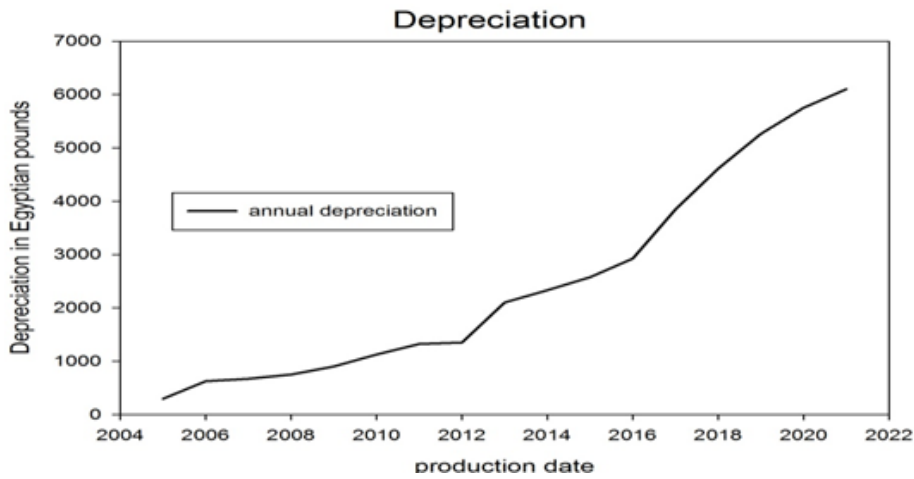


Fig3. The relationship between annual consumption and production date
 Prepared by the research team through field surveys of owners, spare parts stores, and sales centers

2.3.3 Fuel and oil usage data

Surveys within the study area for drivers and owners of a tuk-tuk found that the rate of consumption of fuel and oil affect by the age and condition of the vehicle, as shown in Table 4. The older the vehicle, the higher the fuel and oil consumption and the shorter the operating period. It turns out that most of the vehicles use gasoline(80). There are no natural gas or electric vehicles within the study area. Most auto-rickshaw owners cannot maintain the vehicle to save cost. Some of them use

oils several times, which ends the life of the engine and increases the rates of emissions and environmental pollutants. And it turned out that the rate of an oil change for vehicles that operate two shifts every 4 days an average of seven times a month, while for vehicles that operate once every week an average of 4 to 5 times a month.(Noting that the rates taken from the study area correspond to the rates in the report issued by the Central Agency for Mobilization and Statistics entitled Fuel Consumption for the year 2014)

Table4. Monthly consumption of fuel and oil according to the condition of auto-rickshaw

The condition of the vehicle	New (100-80) %	Used (80-50) %	Worn out <50%
Gasoline in liters	225	264	288
Oil per kilometer	10.5	9.6	11.5

Prepared by the research team through a field survey

2.4 Traffic Data

The purpose of studying the impact of this vehicle on traffic is to determine the difference resulting from the proposal to replace these vehicles with another type. So, data collected on: (traffic density, trip time, ticket price, and traffic map). The research team relied on the field study and manual

counting supported by cameras, mathematical equations, experiments, research, and studies discussing the same topics and approaching the same conditions in the study area. The main paths in the study area identified in Fig. 4, then three main paths were identified as a study sample, as in Fig. 5.

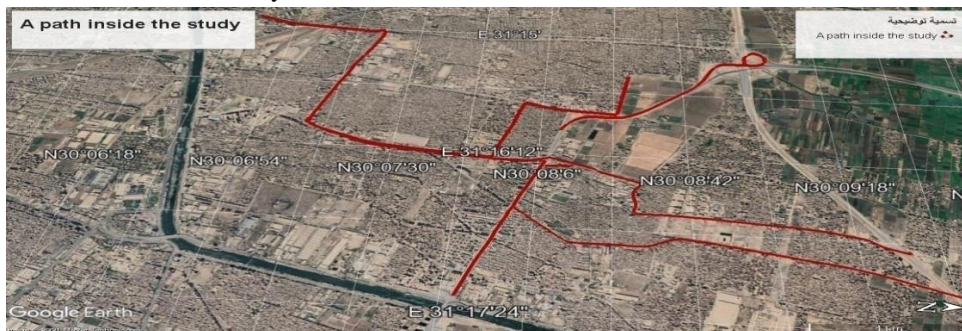


Fig 4. The most frequently used paths within the study area



Fig 5. The three tracks under study

a) Network characteristics

The data of routes and most of the usual trips within the study area were collected by the research team for the external and internal routes through the files of the study area from the Qalyubia governorate

building, and the focus was on the three roads under study and their data as shown in Table 5. The volume of traffic on the focus routes, as shown in Table 6.

Table 5. Data for routes under study

Route name	El Shaarawy Ring Road	Bahteem Ring Road	EL Sharie- EL gdid
Route code	1	2	3
Route length	3.21 km	3.13 km	5.85 km
Route width	14m	21m	40m
Route type	Multi-Lane (4)	Multi-Lane (6)	Multi-Lane (10)
Classification of the route	urban road	urban road	urban road

Table 6. Traffic volume for the study area

Route code	Bus	Tractor-trailer	Truck	Vans	Car	Three-wheeler	Auto-rickshaw	Two-wheeler	Cycle	Microbus	Minibus
1	4	1	26	8	325	36	1986	65	12	7	5
2	54	12	56	12	751	122	910	125	35	25	85
3	180	25	113	50	3215	362	3268	429	125	20	90

b) Study alternatives

The available alternatives studied included replacing the auto-rickshaw with four alternative

vehicles: 1- Bus, 2- Minibus, 3- Microbus, 4- Van. The number of passengers imposed in the study, as shown in Table 7.

Table 7. Assuming the passenger volume for each vehicle used within the study

Suggested alternative	Bus	Minibus	Microbus	Van	Auto-rickshaw
Number of passengers	80	38	14	7	3

c) Travel time

A field monitoring executed using statistical and traffic methods to record the traffic volume and trip time at that volume, resulting in the following equation, as shown in Fig. 6.

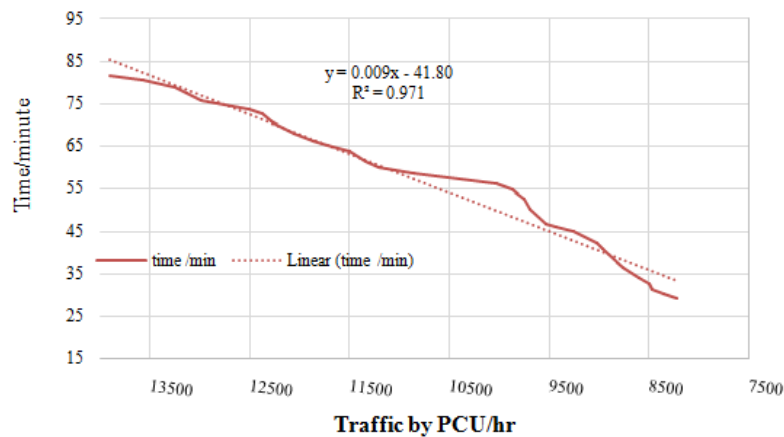


Fig 6. Time curve with traffic density

d) Trip cost in the study area

The prices for trips collected by the research team using different routes and different modes of

transportation within the study area, as shown in Table 8.

Table 8. Change in the ticket price for the trip before and after the proposed

Vehicle used	Auto-rickshaw ^(a)	Bus	Minibus	Microbus	Van
Price per trip (LE)	20	5	2	3.5	3

(a) Through field surveys in the study area conducted by the research team, it found that the highest percentage of the number of passengers during the trip on the auto-rickshaw is one person and the tariff of average trip distance exceeds (2.5) kilometers is (20). Egyptian Pound.

analyze the responses to achieve the objectives of the study and test its hypotheses.

3. Data analysis

The research variables include the auto-rickshaw effect on social life, increase pollution rate, economic conditions, and traffic study.

2.5 Roadside Interview Data

A sample of (210 questionnaires) by randomly selected and distributed over the study area as a representative sample. In obtaining data, the research team relied mainly on the survey method, and they prepared the survey in the form of phrases and inquiries, which it was possible to study and

3.1 Reliability and validity analysis

a) The internal validity of the study dimensions

To measure the internal consistency, the researcher used Spearman's ranks correlation between each item and the total variable as shown in Table 9.

Table 9. Correlation coefficients for the study's dimensions

Study's dimensions	Correlation coefficient		Validity
	Minimum	Maximum	
Auto-rickshaw effect on social life	0.481	0.645	Valid
Auto-rickshaw effect on a traffic study	0.599	0.792	Valid
Auto-rickshaw effect on economic conditions	0.546	0.669	Valid
Auto-rickshaw effect on increased pollution rates	0.642	0.775	Valid

Source: Prepared by the researcher based on the results of statistical analysis SPSS.

The results of the above table confirmed that: The validity of all items in all dimensions of the study was confirmed by the values of the correlation coefficients, which range between (0.481 to 0.792). All of them were significant at the 0.01 level and were used in our analysis.

b) Cronbach's alpha to measure the reliability of the study's dimensions

The researcher measured the reliability of the study variables and dimensions through Cronbach's alpha coefficient (α), as shown in Table 10.

Table 10. Cronbach's alpha coefficients for study variables and dimensions

Dimensions		Number of items	Cronbach's alpha
First dimension	Auto-rickshaw effect on social life	5	0.685
Second dimension	Auto-rickshaw effect on a traffic study	6	0.755
Third dimension	Auto-rickshaw effect on Economic conditions	7	0.688
Fourth dimension	Auto-rickshaw effect on increased pollution rates	3	0.753
Total		21	0.865

Source: Prepared by the researcher based on the results of statistical analysis SPSS.

From the above table, it can be noted that Cronbach's alpha coefficient is greater than 60% for all dimensions of the study, also Cronbach's alpha coefficient for the total scale is greater than 80%. Therefore, the authors believe that a questionnaire is a reliable tool for the research, and the researcher will continue with the analysis.

3.2 Social consequences

Hereafter, the social consequences of entering auto-rickshaw on Egyptian roads. Represented in the study area as a community sample.

3.2.1 Descriptive statistics T-test

The results of the descriptive statistics test are shown in Table 11.

Table 11. Descriptive statistics T-test results

No.	Dimensions	Mean	Standard deviation	Coefficient of variation	T-Test	Sig
1	To what extent do you agree or disagree with the effect of auto-rickshaw dropping out of school.	3.83	0.98	0.26	11.94	0.00
2	To what extent do you agree or disagree with the effect of auto-rickshaw on increasing crime rates.	4.42	0.57	0.13	35.21	0.00
3	To what extent do you agree or disagree with the effect of auto-rickshaw the on spread of addiction.	4.59	0.62	0.13	36.30	0.00
4	To what extent do you agree or disagree with the effect of the auto-rickshaw unemployment rate.	4.63	0.88	0.19	26.15	0.00
5	To what extent do you agree or disagree with the effect of Auto-rickshaw on increasing child labor	3.65	0.87	0.24	10.44	0.00

Source: Prepared by the researcher based on the results of statistical analysis SPSS.

From the above table, it can be concluded that the average for all dimensions of social life: (dropping out of school, increasing crime rates, spreading addiction, reducing the unemployment rate, and increasing child labor) is higher than (3), which confirms the respondents' agreement on these dimensions. Also, it can be noted that the low value of the standard deviation and coefficient of variation (<30%) means that there is a concentration in the answers and the dispersion is small. From a single T-test model, it can see that the moral level is 0.0 which is less than 0.01 for all dimensions of social life, so the authors reject the

null hypothesis, which means that there is a statistically significant effect of the motorized cart on the community through these dimensions (school dropout, increased Crime rates, addiction prevalence, reducing the unemployment rate, and increasing child labor) from the respondents' point of view.

3.2.2 Paired sample T-test

The results of the Paired sample T-test as shown in Table 12

Table 12. "Paired sample T-test" results

Dimension	Vehicle	Mean	T-Test	Sig
Drop out of school	Public transport	2.69	-13.04	0.000
	Auto-rickshaw	3.83		
Increasing crime rates	Public transport	2.38	-25.45	0.000
	Auto-rickshaw	4.42		
Spread of addiction	Public transport	2.71	-18.28	0.000
	Auto-rickshaw	4.59		
Reducing unemployment rate	Public transport	2.96	-18.28	0.000
	Auto-rickshaw	4.63		
Increasing child labor	Public transport	2.44	-13.38	0.000
	Auto-rickshaw	3.65		

Source: Prepared by the researcher based on the results of statistical analysis SPSS.

It is clear from Table 12 that, the Sig level for all dimensions of social life (drop out of education – Crime rate increase – addiction spread – Reducing unemployment – child labor increases) is less than 1%. Hence, the authors reject the null hypothesis, which means there is a significant difference between the effect of public transport and auto-rickshaw on the dimensions of social life from the respondent's point of view. mean effect of public transportation for all dimensions of social life are higher than three, which confirms that passengers tend to disagree on the effect of public transportation on these dimensions, in contrast to the effect of the auto-rickshaw.

3.3 Environmental consequences

They represent the environmental consequences of entering the auto-rickshaw on the Egyptian roads. in the study area as a community sample.

3.3.1 Amount of change in the outputs of exhaust gases before and after the proposed amendments

As shown in Table 13.

Table 13. Exhaust products as a ratio to illustrate the situation before and after the proposed amendments

Gases (kg/hr.)	CO ₂		HC	
	Total	%	Total	%
Current situation	67.29	100.00	283.06	100.00
Changing by bus	44.93	66.78	158.03	55.83
Changing by minibus	51.07	75.90	195.51	69.07
Changing by microbus	59.57	88.52	139.76	49.38
Changing by van	57.31	85.16	216.20	76.38

Gases (kg/hr.)	NO _x		CO	
	Total	%	Total	%
Current situation	343.19	100.00	3114.55	100.00
Changing by bus	234.88	68.44	672.70	21.60
Changing by minibus	281.00	81.88	744.55	23.91
Changing by microbus	207.54	60.47	843.92	27.10
Changing by van	205.28	59.81	2244.18	72.05

Note: Exhaust gases ratios were taken from a similar study; with the use of hypotheses based on scientific grounds in the case of vehicles not available in the study. Source [26]

3.3.2 Descriptive statistics

The following results as shown in Table 14 refer to the descriptive statistics of environmental consequences.

Table 14. Descriptive statistics

No.	Dimensions	Mean	Standard deviation	Coefficient of variation	T-Test	Sig
1	To what extent do you agree or disagree with the effect of auto-rickshaw on increasing air pollution rates	4.10	0.92	0.23	16.83	0.00
2	To what extent do you agree or disagree with the effect of auto-rickshaw on increasing visual and audio pollution rates	4.41	0.60	0.14	33.06	0.00
3	To what extent do you agree or disagree with the effect of auto-rickshaw on increasing pollution inside the vehicle	4.56	0.61	0.13	36.36	0.00

Source: Prepared by the researcher based on the results of statistical analysis SPSS.

From the above table, it can be concluded that: Mean for all dimensions increase pollution rates (increasing air pollution rates, increasing visual and audio pollution rates, increasing pollution inside the vehicle) are higher than (3), which confirms the agreement of respondents on these dimensions. The authors also observe the low value of the standard deviation and the coefficient of variation (less than 30%), which means there is a concentration in the answers and the dispersion was small. From the one-sample T-test, it can see that the significant level is 0.0 which is less than 0.01 for all dimensions of increased pollution rates, so the authors reject the null hypothesis, which means there is a statistically significant effect of auto-rickshaw on increased pollution rates through

dimensions (increasing air pollution rates, increasing visual and audio pollution rates, increasing pollution inside the vehicle) from the respondents' point of view.

3.4 Economic results

The economic results of entering the auto-rickshaw on the Egyptian roads are represented in the study area as a community sample.

3.4.1 Paired sample T-test

The results of the Paired sample T-test as shown in Table 15.

Table 15. "Paired sample T-test" results

Dimension	Vehicle	Mean	T-Test	Sig
Increasing labor wages	Public transport	2.25	-17.15	0.000
	Auto-rickshaw	3.87		
Reducing the number of workers and technicians	Public transport	2.20	-33.55	0.000
	Auto-rickshaw	4.57		
Extinction of some crafts and handicrafts	Public transport	2.30	-42.99	0.000
	Auto-rickshaw	4.83		
Reducing the other transportations demand	Public transport	2.53	-12.76	0.000
	Auto-rickshaw	4.18		
Spread of the informal economy	Public transport	2.51	-23.95	0.000
	Auto-rickshaw	4.38		

Losing Egyptian legal fees	Public transport	1.73	-22.74	0.000
	Auto-rickshaw	3.38		
Increasing oils and fuels consumption	Public transport	3.19	-7.46	0.000
	Auto-rickshaw	4.02		

Source: Prepared by the researcher based on the results of statistical analysis SPSS.

It is clear from the previous table that, the Sig level for all dimensions of the economic conditions (increasing labor wages, reducing the number of workers and technicians, extinction of some crafts and handicrafts, reducing the other transportations demand, the spread of the informal economy, losing of Egyptian legal fees, increasing oils and fuels consumption) are less than 1%. Hence, the authors reject the null hypothesis, which means there is a significant difference between the effect of public transport and auto-rickshaw on the dimensions of the economic conditions from the respondent's

point of view. mean effect of public transportation for all dimensions of the economic conditions are higher than three, which confirms that passengers tend to disagree on the effect of public transportation on these dimensions, in contrast to the effect of the auto-rickshaw.

3.4.2 Paired sample T-test

The results of the Paired sample T-test as shown in Table 16.

Table 16: "Paired sample T-test" results

Dimension	Vehicle	Mean	T-Test	Sig
Increasing accident rates	Public transport	2.24	-	0.000
	Auto-rickshaw	4.20	21.34	
Increasing traffic congestion	Public transport	2.91	-	0.000
	Auto-rickshaw	4.78	23.10	
Increasing Traffic tariff	Public transport	2.90	-	0.000
	Auto-rickshaw	4.66	26.58	
Reducing trip time	Public transport	2.38	-16.78	0.000
	Auto-rickshaw	3.96		
Increasing depreciation of roads	Public transport	3.01	-10.58	0.000
	Auto-rickshaw	3.92		
Increasing numbers of trips	Public transport	2.74	-15.39	0.000
	Auto-rickshaw	4.16		

Source: Prepared by the researcher based on the results of statistical analysis SPSS.

It is clear from the previous table that, the Sig level for all dimensions of the traffic study (increasing accident rates, increasing traffic congestion, increasing traffic tariff, reducing trip time, increasing depreciation of roads, increasing numbers of trips) are less than 1%. Hence, the authors reject the null hypothesis, which means there is a significant difference between the effect of public transport auto-rickshaws on the dimensions of the traffic study from the respondent's point of view. The mean effect of public transportation for all dimensions of the

traffic study is higher than three, which confirms that passengers tend to disagree on the effect of public transportation on these dimensions, in contrast to the effect of the auto-rickshaw.

3.5 Traffic results

The auto rickshaw entering the Egyptian roads represented in the study area as a community sample. The purpose of the traffic study is to determine the difference between four variables for trips within the study area, to determine the extent of the effects resulting from the presence of auto-

rickshaw on the road, and the variables are outlined in the following subsections.

3.5.1 The amount of change in traffic density on a segment of the study area before and after the proposed.

Due to the multiplicity of types of transportation within the study area, or more precisely, the three urban roads on which the study was established, it was reported to convert the inventory operations to the passenger car unit (PCU) to facilitate dealing with traffic equations, as shown in Equation 1 and programs for **Table 17**. PCU factors used in traffic studies

transportation and traffic operations. The multiple linear regression method was used. Since it is compatible with highly heterogeneous traffic like the case study [27], as shown in Table 17.

Equation (1) PCU by peed-based method

$$PCU_i = \frac{V_c/V_i}{A_c/A_i} \quad (1)$$

V_i and V_c = mean speeds of vehicle type 'I' and car respectively.

A_i and A_c = respective projected rectangular areas of vehicle type 'I' and car; on the road.

Road code	Bus	Tractor-trailer	Truck	Vans	Car	Three-wheeler	auto-rickshaw	two-wheeler	Cycle	Microbus	Minibus	
1	4	1	26	8	325	36	1986	65	12	7	5	
2	54	12	56	12	751	122	910	125	35	25	85	
3	180	25	113	50	3215	362	3268	429	125	20	90	
PCU factor	5.03	6.5	3.52	1.7	1	1.3	0.96	0.23	0.45	2.5	3.5	Total PCU
Current situation	1197	247	686	119	4291	676	5917	142	77	130	630	14114
Changing by bus	2360	247	686	119	4291	676	0	142	77	130	630	9358
Changing by minibus	1197	247	686	119	4291	676	0	142	77	130	2333	9898
Changing by Microbus	1197	247	686	119	4291	676	0	142	77	3432	630	11497
Changing by van	1197	247	686	4610	4291	676	0	142	77	130	119	12175

3.5.2 The amount of change in travel time before and after the proposed

The amount of change in travel time before and after the proposed amendments as shown in Table 18.

Table 18. Amount of reduction in travel time

State	Vehicle/hr.	time/min.	Amount of reduction in travel time	
Current situation	14114	86.63	current situation	%
Changing by bus	9358	43.35	Changing by bus	50.0
Changing by minibus	9898	48.27	Changing by minibus	44.3
Changing by microbus	11497	62.82	Changing by Microbus	27.5
Changing by van	12175	68.99	Changing by van	20.4

3.5.3 The amount of change in the ticket price for the trip before and after the proposed.

The amount of change in the ticket price for the trip before and after the proposed amendments, as shown in Table 19.

Table 19. Amount of change in the ticket price for the trip before and after the proposed

Vehicle used	Auto-rickshaw	Bus	Minibus	Microbus	Van
Price per trip (LE)	10	5	2	3.5	3
Reduction ratio %	0	-75	-90	-82.5	-85

3.5.4 Descriptive statistics test

Descriptive statistics test results as shown in Table 20.

TABLE 20. Descriptive statistics test results

No.	Dimensions	Mean	standard deviation	coefficient of variation	T-Test	Sig
1	To what extent do you agree or disagree with the effect of auto-rickshaw on increasing accident rates	4.20	0.87	0.21	19.42	0.00
2	To what extent do you agree or disagree with the effect of auto-rickshaw on Increasing traffic congestion	4.78	0.53	0.11	46.95	0.00
3	To what extent do you agree or disagree with the effect of Auto-rickshaw on increasing traffic tariff	4.66	0.73	0.16	32.03	0.00
4	To what extent do you agree or disagree with the effect of Auto-rickshaw on reducing trip time	3.96	0.95	0.24	14.29	0.00
5	To what extent do you agree or disagree with the effect of auto-rickshaw the on Increasing depreciation of roads	3.92	0.99	0.25	13.15	0.00
6	To what extent do you agree or disagree with the effect of auto-rickshaw on increasing numbers of trips	4.16	0.82	0.20	20.08	0.00

Source: Prepared by the researcher based on the results of statistical analysis SPSS.

From the tables 20, it can conclude that: Mean for all dimensions of the traffic study (increasing accident rates, increasing traffic congestion, increasing traffic tariff, reducing trip time, increasing depreciation of roads, and increasing numbers of trips) are higher than (3), which confirms the agreement of respondents on these dimensions. Also, it can see the low value of the standard deviation and the coefficient of variation (less than 30%), which means there is a concentration in the answers and the dispersion was small. From the one-sample T-test, it can see that the significant level is 0.0 which is less than 0.01

for all dimensions of a traffic study, so the authors reject the null hypothesis, which means there is a statistically significant effect of auto-rickshaw on the traffic study through dimensions (increasing accident rates, increasing traffic congestion, increasing Traffic Tarif, reducing trip time, increasing depreciation of roads, and increasing numbers of trips) from the respondents' point of view.

3.5.5 Paired sample T-test

Paired sample T-test result, as shown in Table 21.

Table 21. "Paired sample T-test" results

Dimension	Vehicle	Mean	T-Test	Sig
Increasing accident rates	Public transport	2.24	-21.34	0.000
	Auto-rickshaw	4.20		
Increasing traffic congestion	Public transport	2.91	-23.10	0.000
	Auto-rickshaw	4.78		
increasing Traffic tariff	Public transport	2.90	-26.58-	0.000
	Auto-rickshaw	4.66		
Reducing trip time	Public transport	2.38	-16.78	0.000
	Auto-rickshaw	3.96		
Increasing depreciation of roads	Public transport	3.01	-10.58	0.000
	Auto-rickshaw	3.92		
Increasing numbers of trips	Public transport	2.74	-15.39	0.000
	Auto-rickshaw	4.16		

Source: Prepared by the researcher based on the results of statistical analysis SPSS.

It is clear from table 21 that, Sig the level for all dimensions of the traffic study (increasing accident rates, increasing traffic congestion, increasing traffic tariff, reducing trip time, increasing depreciation of roads, increasing numbers of trips) is less than 1%. Hence, the authors reject the null hypothesis, which means there is a significant difference between the effect of public transport and auto-rickshaw on the dimensions of the traffic study from the respondent's point of view. The mean effect of public transportation for all dimensions of the traffic study is higher than three, which confirms that passengers tend to disagree on the effect of public transportation on these dimensions, in contrast to the effect of the auto-rickshaw.

Conclusions

From the current research, the following conclusions may be drawn:

- The tuk-tuk caused losses (social, environmental, traffic, and economic to the Egyptian community). Travelers and society do not welcome it, because it has many negatives that go beyond the positives that it is entitled. But in the absence of safe means of transportation, especially in slums, the high rate of unemployment among young people, the low cost of purchase, and the non-compliance of fees or taxes by the owner of the tuk-tuk to the Egyptian government, this leads to a very rapid spread of it.
- For every operating hour of the tuk-tuk, it produces gases and pollutants that are harmful to the environment, especially when operating ineffectively and owning a two-stroke engine. When tuk-tuks are replaced with alternative vehicles, the ratios to CO₂ (33.22%), NO_x (40.19%), CO (78.40%), and HC (50.62%) per hour.
- Tuk-tuks affect trip times by other means of transportation and increase the trip time by (20-50%). (Scope of the study area)
- The percentage of tuk-tuks worked by clean energy in Egypt (0%), while all of them run on gasoline.
- Tuk-tuks hurt the traffic tariff of the trip, with an average increase of (75%) over public transport, and the rate reaches (90%).
- Tuk-tuk hurts the traffic congestion rate on main roads, which is (67%) higher than the rates without Tuk-tuk. (Scope of the study area)
- The inventory and statistics executed by the work team proved that the tuk-tuk has one of the reasons (dropping out of education - increasing the cost of labor - reducing the number of workers - increasing accident rates - increasing addiction and smoking rates - increasing traffic congestion rates - reducing demand for other means of transportation - losing and reducing fees collected from the government).
- (59.33%) of the passengers are not satisfied with the age of the tuk-tuk driver. And (72%) of the passengers reject the presence of the tuk-tuk on the roads. And (32.33%) have a fear of the safety rates inside the tuk-tuk Compared to (13.3%) for public transport, (48.83%) of tuk-tuk drivers do not comply with the regulations and laws set by the government. (Scope of the study area)

Recommendations proposed by the research team to solve this problem

- 1- Cancellation or partial ban of this phenomenon in preparation for its final abolition and dispensing with other alternatives. However, it must be considered consideration when gradually banning this phenomenon, that there are (3) million tuk-tuks responsible for spending on 18 million individuals in Egypt (among owners, leaders, technicians, merchants, and dependent families), as tuk-tuks are a major source of income for them.
- 2- Restoration of urban divisions to increase traffic flow in the study area. And studying the cases of demand for transportation and opening the door for competition to introduce alternative vehicles with clean energy.
- 3- In the current situation, an attempt should be made to increase the chances of legalizing this phenomenon through:
 - Reducing the fees imposed by the state on licensing.
 - Adding services to the owner of the tuk-tuk is implemented in the case of a license and the involvement of non-governmental organizations in the attempt to legalize.
 - Attempting to educate the drivers of those vehicles about the necessity of legalizing insurance services and benefiting from them.

- Benefiting from the previous experiences of some countries that are socially and negatively compatible with the characteristics of Egypt in the experience of legalization.

- 4- Attempting to remove the tuk-tuk from the main roads, by providing alternative means that compete with the traffic tariff.
- 5- Benefiting from the experiences of countries that use this means of transport, such as India, and using advanced models for this vehicle, Such as (electrical model 1), (electrical model 2), and (multi-operated model).
- 6- Attempting to close the vehicle's windows and place the air conditioning in them may prevent harm to the driver and passenger, but it will not prevent harm to the rest of the surrounding environment.

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