

Vehicle Accident Report Application for Solving Traffic Problems and Reduce the Ratio of Pollution using Case Study: Kuwait City

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ABSTRACT

Minor traffic accidents have become a major problem facing the road users in the recent years, according to the statistics from the Ministry of Interior (MOI) in Kuwait there were recorded 80,388 accidents by the year 2014. Accidents not only affect the mobility but also contribute to air pollution and slow down economic growth. These effects are the result of the seriously extended trips travel time due to accumulated vehicles queue. In some accidents cases, the lost time waiting for the arrival of the traffic officers and filling up the accident report could take up to 45 minutes. The new idea of Vehicle Accident Report application (I-VAR) concept developed by the research team would reduce the waiting time up to 3 minutes (93% savings), which would increase the level of service of the segment of a roadway. In addition, the study will be discussed four major situations on some of the busiest roads in Kuwait. Specifically, gas emissions and cost estimation. Improve the pollution obviously, by using the (I-VAR) application for the minor accidents there is an amount of 360,776,460 K.D would be saved yearly from the Kuwait government funds. It is a consequence of the huge savings in alleviating traffic congestion and generally produces more saver and efficient travel conditions.

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1. INTRODUCTION

Population increases are accompanied by an increase in road users, causing roads to become more complex to accommodate more vehicles necessarily. Though drivers do not always concentrate on driving and respect traffic rules, inherent flaws in road designs are also a major cause of traffic accidents. Nowadays, there are many organizations that support and seek to increase traffic awareness. In 2013, the World Health Organization [1] stated that an estimated 1.24 million fatal traffic accidents occur every year, as mentioned in Figure 1 represents those accidents, which are the ninth-most common cause of death in the last decade and responsible for 2.2% of deaths around the world.

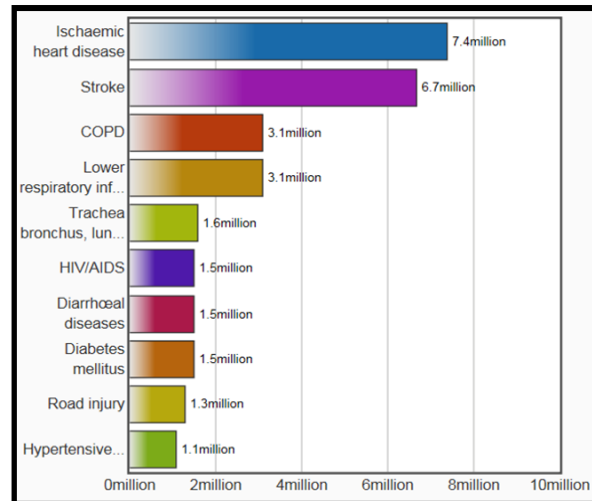


Figure 1. Bar Chart of the 10 Leading Causes of death in the World [1]

2. PROBLEM DEFINITION

Depending on the statistics of the Ministry of Interior (MOI) which instate that the increased number of traffic accidents, the large number of minor accidents that occur on a daily basis and causing a traffic jam and disrupt the functioning leading to the loss of Kuwait government funds, also these accidents affect the environment and causes great damage to it. The dilemma lies in the occurrence of a traffic accident and the congestion associated it while waiting for the arrival of traffic officers to take the details of the accident. The fundamental problem depends on the lost time waiting for the arrival of the traffic officers and filling up the accident report which reduces the street level of service [2].

3. LITERATURE REVIEW

3.1. Accidents collecting data

[3] say that there is no doubt that accidents reduce the carrying capacity of the highways and also disturb traffic operation. In cases where the heavy volume traffic that leads to ease the occurrence of minor accidents. In the study, the features of accidents are studied with exact full accident record. Where recorded in highways on holidays. This study found that accidents raised up through various of holidays.

In this study [4] the idea is by taking or capturing two images for the accident scene, which can be tested through a two-eye vision in a computer. Because of maneuverability of the investigation for the accident scenes, the faults of the photo matching affect the accuracy of rebuilding importantly, so the photo corresponding was capturing based on the association of two arguments into images of the same location in the accident scene.

In the last year in China, the common incidence of secondary accidents, causing major loss of public and economic assets. This study analyses and reviews main secondary traffic accidents in recent years. Firstly, according to a classic case of the second accident, the secondary accident has become a major problem by causing great loss of money through damaging roads, car parts also the signs in the main streets. Moreover, the main part which is affected is the environment by spreading the pollution coming from the cars [5].

3.2. Accident report program

There is no doubt that there are a lot of programs and system that help in writing accident reports in a fast and short way, the idea of these programs is found because of a large number of accidents and other problems following it.

This is one of the programs that have been applied previously; [6] the idea of this program depends on the presence of the parties disputing party A and party B, then start to write a report of the accident using the same program. Each side should fill personal data and license number and then write the details of the report, with an advantage over what was written the other party could put a comment to improve the final report, then start to send these reports to insurance companies responsible and ultimately the final judgment comes with the detective.

Another idea, programming specific code for each type of accident, if it was a fire accident, clash, or other accidents. Also, there is an easy option to ask for help from the competent authorities by sending the location of the accident through the (GPS) Global Positioning Satellite System. This application directly contributes to solving the traffic problem.

4. RELATED WORK

Big cities usually face the problem of continuously increasing traffic. Therefore, recent studies concentrated on developing and proving the traffic light control systems to solve the traffic problems. Khalil et al. [7] proposed a designed system that is capable of utilizing and managing the controllers of traffic light effectively by the use of Wireless Sensor Network (WSN) and two new algorithms to control the traffic. As for Hajeer [8], he conducted an analytic study on traffic accidents in Kuwait. The result of his analysis indicated the importance of improving the traffic monitoring system and enforcing traffic regulations to minimizing the traffic problem.

In 2014, an automated street light control was proposed by Zhu, J., and C. Raison [9], in order to minimize the cost and energy consumed by the street lighting. The system is based on microcontroller and ZigBee wireless network. Radio frequency identification (RFID) and Wireless Sensor Networks (WSN) were used in the detection of traffic flow. RFID transmits collected data of traffic flow to the control system, and WSN uses a designed algorithm to control the traffic flow. This system was proposed by Chao and Chen [10].

Song and Qin [11] classified and analyzed the features of the traffic flow simulation models in their paper according to scalability, accuracy, and computability into three categories. In addition, they pointed out the advantages and shortages of these models. In Mulung and Andino paper [12], a Systematic Monitoring of Arterial Road Traffic (SMART) signal was proposed in Brunei Darussalam. Artificial intelligence was used in the SMART to help to make the appropriate action to manage the traffic.

In 2016, Uddin et al. [13] proposed the use of HOG and SIFT as a combined future in detecting of an individual object in the crowded area. In addition, Yusupbekov et al. [14] discussed an adaptive fuzzy-logic traffic control systems (AFLTCS) in their paper. The system is capable of dealing with uncertain and unclear information in the scenario of heavy traffic streams.

According to Yuan and Feng [15], a laser scanning data was used in traffic information acquisition platform, which combined the information and communication engineering theory and technology of data traffic detection. The system can execute multiple functions in parallel; detection of vehicle speed, automatic recognition of vehicle type, statistics calculation of traffic flow, and detected data processing. A Fuzzy Intelligent Traffic Signal (FITS) control system was introduced by Jin et al. [16]. The system implemented control based on fuzzy logic, and its main objective is improving the infrastructure of the traffic light.

As for Solangi, et al. [17], a solution for traffic congestion was proposed. Their proposed system is based on Field Programmable Gate Array (FPGA), which optimizes the traffic lights functionality by managing the traffic efficiently. An Android application, based on the intelligent system, was designed on a smartphone. It can recognize the character on vehicle number plate, and it is called Automatic Number Plate Recognition (ANPR) [18]. Jin and Kosonen implemented an intelligent traffic system to control violation and congestion in traffic and to detect stolen vehicle [19].

5. NETWORK SELECTION

Network selection is an essential step for determining the problems associated with accidents. The section that will be studied is "part of 3rd ring road", between Shwaikh industrial and Kaifan – ALKhaldiya intersection as shown in Figure 2, also the road of the airport to the end of Kaifan which is one of the major freeways in Kuwait City, section chosen because of the daily traffic congestion due the important facilities that the road reach and because this road is the most important road.

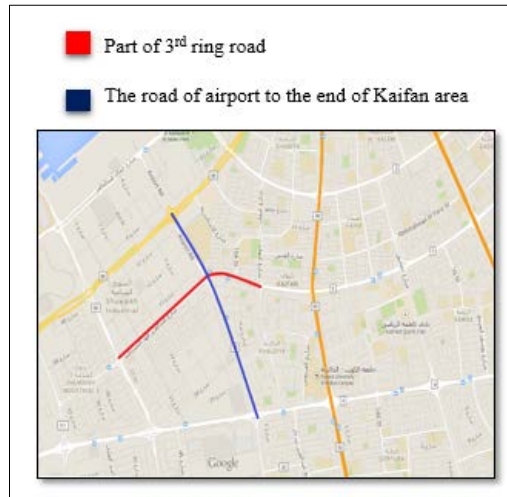


Figure 2. Google Earth Screenshot for the selected intersections

6. TRAFFIC COUNTING

Data were obtained from the Ministry of Interior [20], as shown in Table 1. The chosen times depends on the data accidents.

Table 1. The chosen data accidents for the study

Street Name	Data Date
3rd ring road - Khaldiya	02 March to 31 March 2015
3rd ring road – Airport Rd	02 March to 31 March 2015
4th ring road – Airport Rd	02 March to 31 March 2015
Canada Dry	02 March to 31 March 2015

7. ACCIDENT DATA COLLECTOR

After putting a number of papers that dispersed on different traffic station that has been selected to collect the required data. Sees that the simulations have changed the process of traffic engineering. Evaluating alternatives is much simpler than before. The importance of simulations has increased with the complexity of the roads and the need to frequently change traffic systems. Simulations provide traffic engineers with the opportunity to make geometric changes and estimate roads time plans without disturbing traffic [5].

SYNCHRO is the most popular program among transportation engineers. It uses a simple interface with familiar icons to illustrate roads, including any special specifications such as curvature, road decision, and speed limits. After entering the inputs, SYNCHRO provides information such the level of service, the optimal cycle length of signals, travel time, intersection delays, and intersection capacity. It is able to provide specialized reports on the comparison of the current road situation and the newly enhanced situation.

The current situation is the realistic case for the study area, the data in simulation software "SYNCHRO studio" were collected from the Ministry of Interior in Kuwait, Department of traffic and the data collected from traffic officers. Three types of traffic volume will be chosen peak, and mid-peak gets the level of service, travel time, delay time and the intersection capacity utilization.

8. DATA AND ANALYSIS

These data represent the number of accidents on the part of the 3rd ring road as shown Table 2 and the road from the airport to the end of Kaifan area as shown Table 3. The data were taken for twenty-one days for 24 hours.

Table 2. Accidents collected for 21 days place in the part of the 3rd ring road

Day	Number of Accidents
Sunday	20
Monday	14
Tuesday	15
Wednesday	13
Thursday	16
Friday	5
Saturday	8

Table 3. Accidents collected for 21 days place in the road of the airport to the end of Kaifan area

Day	Number of Accidents
Sunday	10
Monday	11
Tuesday	9
Wednesday	7
Thursday	7
Friday	3
Saturday	5

According to the statistics and data collected seems that the number of accidents on the part of the 3rd ring road is more than the number of accidents on the road of the airport as shown in Figure 3.

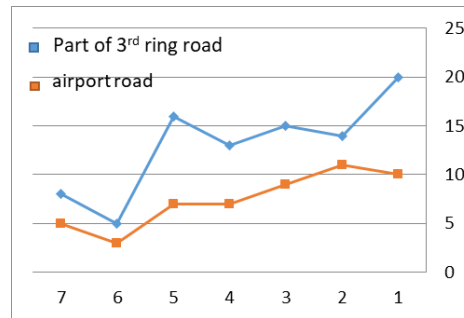


Figure 3. Days vs. Number of accidents

As mentioned previously, the main cause of traffic associated with the accident is the lost time waiting for the arrival of the traffic officers and filling up the accident report, so was this period account for both streets as shown Table 4 and Table 5.

Table 4. A number of accidents compute with an arrival time of traffic officers. (Road of airport to the end of Kaifan area)

Arrival time of Traffic Officers	Number of accidents
Less than 15 min	8
Between 15 min to 30 min	10
Between 31 min to 45 min	21
Between 46 min to 60 min	13

Table 5. A number of accidents compute with an arrival time of traffic officers. (Part of 3rd ring road)

Arrival time of Traffic Officers	Number of accidents
Less than 15 min	11
Between 15 min to 30 min	19
Between 31 min to 45 min	36
Between 46 min to 60 min	25

According to the statistics and data collected seems that the arrival time of traffic officers up to sixty minutes as shown in Figure 4.

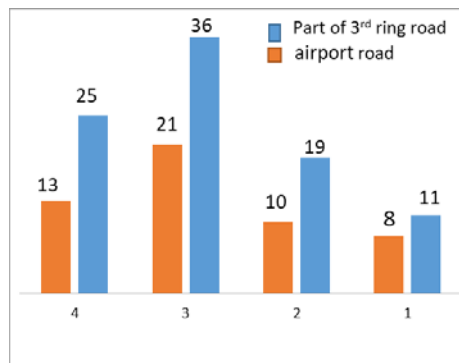


Figure 4. Arrival time of traffic officers vs. Number of accidents

8.1. Results

The day with the highest number of accidents in Part of the 3rd ring road is 'Sunday' and day with the highest number in airport road is 'Monday.' To get the average time for arrival the traffic officers during an accident can be calculated from the equation.

$$\text{Average time} = \frac{n1(X1)+n2(X2)+n3(X3)+n4(X4)}{N} \tag{1}$$

where n1, n2, n3, and n4 = Number of accidents at given time.

X1, X2, X3, and X4 = Time for arrival the traffic officers.

N = Total number of accidents.

Example, for the part of the 3rd ring road:

$$\text{Average time} = \frac{11(15)+19(30)+36(45)+25(60)}{91} = 42 \text{ minutes.}$$

Example, for the airport road:

$$\text{Average time} = \frac{8(15)+10(30)+21(45)+13(60)}{52} = 41.125 \text{ minutes.}$$

9. DATA ANALYSIS USING SIMULATION SOFTWARE

One of the major advantages of SYNCHRO is simulations streets to measure the level of service, travel time and the total delay.

9.1. Current Situation 1

In the first case the street's level of service, travel time and the delay time will be considered. This accident will take place once at the peak hour between 4:30 pm and 5:30 pm; and again, at the mid-peak hour between 6:00 am and 7:00 am. The result shown in Table 6 and Table 7 will be compared with results that counted in the workaround.

Table 6. Level of service, travel time, and the total delay for accident one at the Mid-Peak

LOS	Travel Time (hr.)	Total Delay (hr.)
F	732.7	609.8

Table 7. Level of service, travel time, and the total delay for accident one at the Peak

LOS	Travel Time (hr.)	Total Delay (hr.)
F	2871.6	2726.7

9.2. Current Situation 2

In the second case the street's level of service, travel time and the total delay will be considered. The selected accident took located as shown in Figure 11. This accident will take place once at the peak hour between 4:30 pm and 5:30 pm; and again, at the mid-peak hour between 6:00 am and 7:00 am. The result shown in Table 8 and Table 9 will be compared with results that counted in the workaround.

Table 8. Level of service, travel time, and the total delay for accident two at the Mid-Peak

LOS	Travel Time (hr.)	Total Delay (hr.)
F	629.2	503.9

Table 9. Level of service, travel time, and the total delay for accident two at the Peak

LOS	Travel Time (hr.)	Total Delay (hr.)
F	2689.5	2533.4

9.3. Current Situation 3

In the third case the street's level of service, travel time and the total delay will be considered. This accident will take place once at the peak hour between 4:30 pm and 5:30 pm; and again, at the mid-peak hour between 6:00 am and 7:00 am. The result shown in Table 10 and Table 11 will be compared with results that counted in the workaround.

Table 10. Level of service, travel time, and the total delay for accident three at the Mid-Peak

LOS	Travel Time (hr.)	Total Delay (hr.)
F	660.2	573.5

Table 11. Level of service, travel time, and the total delay for accident three at the Peak

LOS	Travel Time (hr.)	Total Delay (hr.)
F	2707.2	2651.7

9.4. Current Situation 4

In the third case the street's level of service, travel time and the total delay will be considered. The selected accident took located as shown in Figure 13. This accident will take place once at the peak hour between 4:30 pm and 5:30 pm; and again, at the mid-peak hour between 6:00 am and 7:00 am. The result shown in Table 12 and Table 13 will be compared with results that counted in the workaround.

Table 12. Level of service, travel time, and the total delay for accident four at the Mid-Peak

LOS	Travel Time (hr.)	Total Delay (hr.)
F	730.4	576.2

Table 13. Level of service, travel time, and the total delay for accident four at the Peak

LOS	Travel Time (hr.)	Total Delay (hr.)
F	2700.9	2544.7

10. DATA ANALYSIS AND RESULT USING SIMULATION SOFTWARE

To improve the level of service and the pollution, the trajectory file was exported after the network was illustrated and simulated using SYNCHRO. The runtime was chosen according to the accident data collected for each simulation to verify that if there is any improvement after using I-VAR application.

In this case, the street's level of service, travel time and the total delay will be considered. The selected accident took located as shown in Figure 5. This accident will take place once at the peak hour between 4:30 pm and 5:30 pm; and again, at the mid-peak hour between 6:00 am and 7:00 am. The result shown in Table 14 and Table 15 will be compared with results that counted in the workaround.



Figure 5. Screenshot from Google Earth after using the application

Table 14. Level of service, travel time, and the total delay at the Mid-Peak (Alternative solution)

LOS	Travel Time (hr.)	Total Delay (hr.)
E	603.1	576.2

Table 15. Level of service, travel time, and the total delay at the Peak (Alternative solution)

LOS	Travel Time (hr.)	Total Delay (hr.)
F	2700.9	2544.7

11. COMPARISON BETWEEN ACTUAL STATION AND CONTROLLED STATION

Next, the fourth selected accidents and the alternative solution will be compared. A well as a summary Table and chart that will represent the differences between the travel time and the total delay, these comparisons will be achieved once for the Mid-peak hour and again for the peak hour as shown in Table 16 and Table 17.

Table 16. Comparison between accidents and the alternative solution at the Mid-peak

	C situation 1	C situation 2	C situation 3	C situation 4	Alternative Solution
Travel Time	732.7	629.2	660.2	703.4	603.1
Total delay	609.8	503.9	573.5	576.2	476.9

Table 17. Comparison between accidents and the alternative solution at the peak

	C situation 1	C situation 2	C situation 3	C situation 4	Alternative Solution
Travel Time	2871.6	2689.5	2707.2	2700.9	2602.4
Total delay	2726.7	2533.4	2651.7	2544.7	2446.8

11.1. Results

In this place, the percentage of improvement will be measured for each travel time and the total delay. These percentages will be measured during the Mid-peak hour and the Peak hour as shown in Table 18 and Table 19.

Table 18. Percentages of improvement for the travel time and total delay at the Mid-peak

	C situation 1	C situation 2	C situation 3	C situation 4
Travel Time	17.68%	4.15%	8.64%	14.26%
Total delay	21.79%	5.36%	16.84%	17.23%

Table 19. Percentages of improvement for the travel time and total delay at the peak

	C situation 1	C situation 2	C situation 3	C situation 4
Travel Time	9.37%	3.24%	3.87%	3.64%
Total delay	10.27%	3.41%	7.73%	3.85%

While the use of the I-VAR application will be shown that the street level of service will improve. For the Mid-peak hour, the level of service improved from F to E. but for the Peak hour the level of service was F, and the F has not changed.

12. ENVIRONMENT AND CONSTRUCTION MANAGEMENT

Although this report studied other factors associated the traffic accident, roads come the risks of harming the environment, the economy, and most importantly people. In this section, some of the specialties are studied related to the environment. The first factor, gas emissions which related to the public health. The second specialty is construction management, were total delay cost.

12.1. Environment

The environment one of the major concerns the civilized people carefully considerable about. This topic discusses the environmental problems related to the project, especially gas emission. One of the consequences of the use of vehicles is the emissions of NOx. The value of this gas measured for 4 cases of accidents and after workout solution "uses the application." The chosen values at peak and the mis-peak as shown in Table 20 and Table 21. Values change approach stands for the period length of congestion.

Table 20. NOx Emissions value at the Mid-peak

	C situation 1	C situation 2	C situation 3	C situation 4	After workout solution
NOx Emissions (g)	6320	6304	6377	6399	5778

The average NOx Emissions for the four situations at the mid peak is:

$$\text{NOx Average} = \frac{6320+6304+6377+6399}{4} = 6350 \text{ g} \quad (2)$$

$$\text{The ratio improved of NOx Emissions} = \frac{5778}{6350} * 100 = 9\%$$

Table 20. NOx Emissions value at the peak

	C situation 1	C situation 2	C situation 3	C situation 4	After workout solution
NOx Emissions (g)	9188	9127	9050	8668	8044

The average NOx Emissions for the four situations at the peak is:

$$\text{NOx Average} = \frac{9188+9127+9050+8668}{4} = 9008 \text{ g}$$

$$\text{The ratio improved of NOx Emissions} = \frac{8044}{9008} * 100 = 10.7\%$$

12.2. Constructed management

Constructed management project is not a simple task, and it becomes even more complicated when there are dozens of parts involved in the construction process. In this project focus on traffic delay charges.

Travel late charge is the cost acquired to passengers due to the delay produced by traffic accidents. Accident may somewhat or completely block the roadway. Even if there is no jam, some passengers may cut down the speed or may stop to offer help. Traffic jam may be caused after traffic investigation and after cleaning up the accident scene.

According to the General Traffic Department, there are some issues found to disturb traffic accident travel delay costs which are level of road blockage, traffic flow conditions, and clearance and emergency response time. The travel delay cost can be calculated from the equation.

$$Ct = T^2 x = \frac{V}{60} x L x O x \frac{W}{60} \quad (3)$$

where,

Ct = travel delay cost for each accident (KD/accident).
 T = travel time lost (minute)
 V = traffic flow (Ve/Hr/lane)
 L = level of blockage (Lane)
 O = Occupancy rate (Passenger/vehicle)
 W = average wage rate (KD/hour).

According to the General Traffic Department, 70% of accidents accrued in highways and 25% of accidents accrued in major roads, while 5% of accidents will be neglect.

The average travel time lost due to each accident in highways is 25 minutes and on major roads is 15 minutes. Average traffic flow in highways is 1800 Vehicle/Hr/lane and 1100 Vehicle/Hr/lane. The average occupancy rate for highways and major roads is 1.4 passenger/Vehicle and level blockage (lane) for highways major roads are two lanes. Average wage rate is estimated by dividing earning per day by 8 hours (daily hour work), and it required 6.80 KD/hr.

By using equation:

Traffic delay costs for each accident on highway (Ct1) = 5,944.29 KD/accident.

Traffic delay costs for each accident on major roads (Ct2) = 1,307,745 KD/accident.

Traffic delay costs on highways:

$C = 0.7 \times (Ct1) \times \text{number of accidents}$

$C = 0.7 \times 5,944,29 \times 80,388 = 334,494,709,164 \text{ KD}$

Traffic delay costs on major roads:

$C = 0.7 \times (Ct2) \times \text{number of accidents}$

$C = 0.7 \times 1.307.7.745 \times 80,388 = 26,281,751,265 \text{ KD}$

13. DATA FLOW DIAGRAM (DFD) FOR I-VAR APP

Explanation of the I-VAR App’s data flow diagram in Figure 6: When the application starts, the user will be asked for the login information (username and password). If the username and password are wrong; an error message will be displayed to make sure that the information is right. On the other hand, if the username and password are right then the user will login to the home view screen. Through the home view user can make a new accident report, then the map view for the nearby police departments will pop up include the user’s location. On clicking next then the user should fill up the report fields and upload the plate number photo and the ID image by taking a new photo or from the phone’s gallery. After filling up the report fields then a unique Code will be generated for the user. For linking the code, another user should do the steps mentioned above and then from the home view by clicking on Report code verification then type the generated code. If the code is correct, then the second report will pop up for user2 to complete the accident report. If the code is incorrect, an error message will show up.

The last thing by using the I-VAR App; users can add accidents on the map with their current location but for that to happen will be in the future work for the application with a brand-new update.

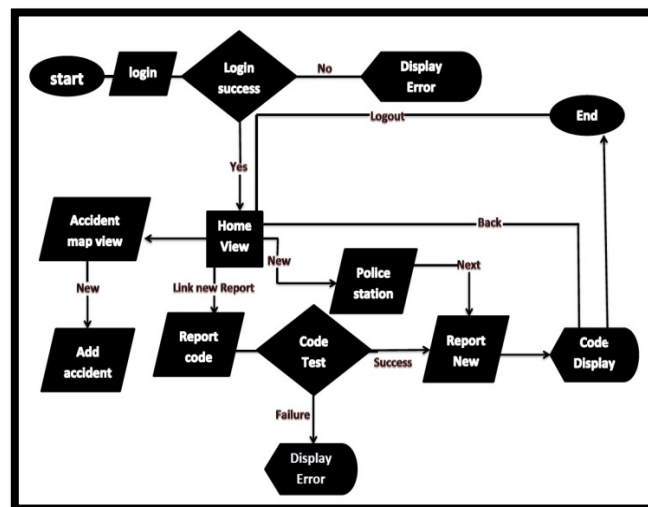


Figure 6. I-VAR App Data Flow Diagram (DFD)

14. RESULTS AND DISCUSSION

As shown in Figure 7-a, Home screen has three buttons:

- Report Accident: where the user can add an accident, and fill in personal details and add accident's photo and personal identification card's photo shows in Figure 7-b and Figure 7-c.
- Continue Accident Procedures: where the user types the Confirmation Code to add other user's personal information.
- View Current Accidents: where the user can locate a nearby accident.

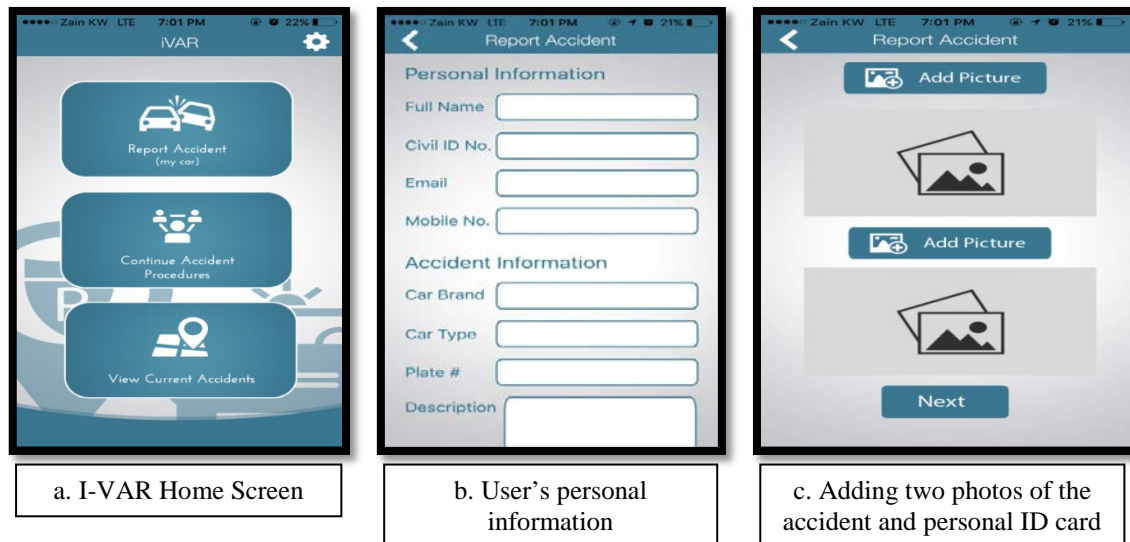


Figure 7. I-VAR App

15. CONCLUSION AND FUTURE WORK

As we mentioned, busy and crowd streets have become a major problem in Kuwait causing by many reasons, but the main reason is accidents. However, pollution has been increased because of that, and that is for sure the environment will be harmed. I-VAR App is a new idea to solve these problems. Therefore, it reduces lost time by awaiting the arrival of the traffic officers and filling up the accident report will improve the level of service (F TO E) and pollution obviously. By using the I-VAR App within 3 minutes will reduce the time of arrival of the traffic officers 93%. In addition, the street level of service will be improved. For a mid-peak hour, the level of service improved from F to E. the average percentage of improvement for the travel time and total delay at the mid-peak after using the application 11.2%, 15.3% respectively. The ratio improved of the NOx emissions at mid-peak equal to 9% after using the application, but at the peak equal to 10.7%.

Using the application will save yearly 360,776,460, K.D represented by cost delay from Minor traffic accidents only.

For the future work, using a large network will help to learn more about the effect of using the I-VAR App and will offer more data. A new update to add accidents on the map with current location to avoid the crowd by collecting a list of current accidents and display them on the map and it must be dynamic from the ministry of interior servers.

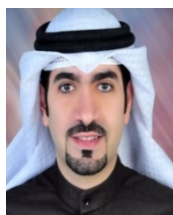
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