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Reducing the Traffic Congestion and Road Accidents by using Expert System for Sustainable Urban Transportation [ESSUT] in Tripoli-Libya

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Abstract: The sustainable urban transportation is found to be as one of the various efforts for sustainable development worldwide. The objective of current research article is to identify the transportation problems in Tripoli, Libya and their effect on economic issues. The key aim of the study is to analyze two out of the many transportation issue in Tripoli which are "traffic congestion" and "accident damages". Furthermore, there found to be a lack of experts in sustainable urban transportation in Libya and the real experience is limited to several experts. Hence, the need comes for computer system development which offers expert consultation in the domain of sustainable urban transportation. In the current study, the Expert System for Sustainable Urban Transportation (ESUST) is described. This is a computer tool that is used for creation of expert system in web-based expert system by using PHP with MySQL. This system is developed with the help of experts in specific references and transportation, not just to solve the transport problems but also to provide recommendations and solutions. The outcomes of this evaluation process have demonstrated that the efficiency, usefulness and credibility of this system seem to be promising for the upcoming future.

Key words: Expert system, sustainable urban transportation, traffic congestion, road accidents, ESUST, MySQL

INTRODUCTION

Recently different developing as well as developed countries worldwide began to be automobile-dominated, therefore, less sustainable because of the fast growth of challenges in transportation that arise from environmental factors as well as extremely poor accessibility to the urban areas. The automobile restriction concepts were implemented in various urban areas all over the world supported by different international organizations (Jacobs, 2015; OECD., 2002). As such urban road traffic congestion charges were implemented on the transport at some time intervals in order to reduce the traffic congestion which further helps in managing driver's choice of transportation mode and as well achieving its purpose in easing the supply and demand contradictory, reducing the pollution, ensuring economical energy and safeguarding traffic safety to lead to transportation and city sustainable development (Ye, 2012).

Due to the increase of the number of motor vehicles and vehicle-mile of travel worldwide, the population exposure to traffic accidents has increased. It was estimated that in Libya in 2010 around 2375 people died and approximately 14025 were injured in Road Traffic Accidents (RTA). Daily the number of deaths from Road Traffic Injuries (RTI) grow and it reached to be the highest compared to other Arabic countries in accordance to the number of residents which does not to exceed 6.5 million. Based on the RTA recording and analysis made in whole Libya and the most crowded cities, particularly Tripoli City, there was lack of attention from the concerned authorities until only the last few years. According to traffic statistics, made by the Ministry of Public Safety and Traffic Management as demonstrated in Table 1 there has been a growth in the number of deaths, especially in recent years.

Among the various causes of traffic accidents inside the city, according to the traffic department records in

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Table 1: Number of road traffic accident cases from 2001-2010

Years	Vehicles	Fatalities	Injuries	Total accident
1995	109.750	1296	7703	8419
1996	134.750	1080	7750	8419
1997	165.771	1119	8076	9278
1998	203.575	1224	8343	9393
1999	411.543	1204	8394	9370
2000	675.257	1504	9617	10667
2001	809.056	1598	10033	10895
2002	1,008.528	1751	11058	12017
2003	1,126.90	1744	10502	12154
2004	1,225.704	1785	10746	11643
2005	1,310.530	1800	11541	11898
2006	1,508.359	1866	12164	11982
2007	1,826.533	2138	13497	13165
2008	2,052.679	2332	13725	13352
2009	2,342.536	2301	13851	13664
2010	2,424.385	2375	14025	15655

Traffic Office and Licensing of Tripoli in 2011

Tripoli are lack of attention, speeding, improper way of stopping and turning, driving under the drugs, not following priority of way, violating traffic laws, mobile phone usage. Moreover, other reasons are increase in the number of population and vehicles as well as limited area in comparison to some of the major cities in Libya.

Hence, expert systems were created in the transportation and safety field such as USLIMITS2 which is a web-based expert system that aims at facilitating the engineers in the safe and proper speed limits selection in speed zones on all American roads (Srinivasan *et al*., 2008). Another system is COPRBU which is a knowledge-based expert system created to solve the issues related to routes and schedule, level of service and reliability of public buses (Wen, 2008).

Problem statement: Due to the economic growth that have occurred in recent years in Libya, there is a large number of vehicles which leads to a large increase of traffic incidents. The traffic accidents in Libya are economic and social problem that leads to the death of 6.5 people per day which is a high statistic considering the small population of the country. If the government of Libya will not take the required actions to reduce the traffic accidents on the roads, this will lead to larger increase of accidents and injuries in the coming years (Castro *et al*., 2011). The poor public transport system in Libya and particularly Tripoli has led to the problems such as high traffic congestion, growth in road accidents bad influence on the environment and unbalanced land use characteristics (Ismail and Elmloshi 2011). Furthermore, according to the study, there is a lack of the experts in Libya in the subjects of sustainable development and sustainable urban transportation. The real experience is also found to be limited to few experts. To redesign the transportation system such as roads and public transport (buses, rail), it is required for the authorities to base on the previous experience of other countries and ensure that where practicable, the design of transportation to minimize barriers for accessibility for all users, especially, the elderly and those with disabilities.

The importance of an expert system (ESSUT): The advisory expert system is required to be developed in order to facilitate the classification of the strategies and solutions in sustainable urban transportation subject. The strategies and solutions can be classified in accordance to physical, nonphysical and combined categories. The advisory expert system is able to help the engineers find appropriate sustainable urban transportation strategies toward transportation problems. This can facilitate the users and engineers in employing the proper solutions.

MATERIALS AND METHODS

As prescribed by Gilmore the development language for the system main engine has been used (Preprocessor Hypertext-Processor) PHP and MySQL as the backend database. In developing a web-based application was selected these two sources are based on their modularity, capabilities and flexibility as recommended by Lerdorf *et al*. The system development by used the software version used is Adobe Dreamweaver CC 2015 release is used to build the expert system. For building an expert system, developers need to build several items or pages in PHP environment. Each item is composed of two windows including design page and code page. In design pages, elements of the expert system including frames, checkboxes, text boxes and other graphical tools are located and in the code page, they are code related to each element. ESSUT has been used PHP is a widely used open-source server-side scripting language for web development and can be embedded into HTML. PHP pages contain HTML with embedded code. PHP offers several. Most of the applications using MySQL are written in PHP. MySQL is a database server is ideal for both small and large applications. It supports standard SQL and compiles on a number of platforms. PHP is an influential presentation containing all the essential facilities in building a windows or web-based applications, for example, expert systems swiftly and competently and tools.

Toolbox of problem and solutions: In the toolbox for problems and solutions, a list of transport problems which were described previously is presented to users. On this page, users can select the problems they have faced. Keywords of problems are highlighted which can facilitate the process to finding the right problem for users of the expert system. Descriptions of problems can help users

and engineers know the problems and their effect on sustainability. For example, if problem and solutions are selected, users will be directed to the categories with the problem also with the solutions all of them on one page. Therefore, accident damage selected related to the transportation problems which describes the results and negative effects of speeding on road-users. As well as we selected traffic congestion problem with users have to select the problem to show the description of the problem, category, strategies and solutions which can solve the problem. Therefore, accident damage problem is selected, the traffic congestion problem, the category is economic and the strategies.

Accident damage problem description: The traffic crashes on the road are found to be the main cause of high mortality worldwide as well as the large problem and priority in the sector of public health. Taking into the consideration the global importance of traffic, special attention needs to be paid to the road safety and providing the standards which are important for assuring the efficiency and safety of the commuters. Without the implementation of the safety regulations, accident crashes can be the leading cause of death all over the world, reaching the number of more than two million annually.

Solution: This means that the rates of per capita traffic crash grow in accordance to per capita vehicle travel and strategies of mobility management can bring important safety advantages. The strategies that tend to reduce per capita vehicle travel or lead to a shift travel from automobile to alternative transportation modes can reduce overall risk of crash. The shift of the vehicle travel to less congested conditions lead to reduction of crash frequency, however can also lead to increase of the crash severity due to higher traffic speeds. The use of the policies of smart growth land found to reduce severity of crash and rates of fatality, even though the crash frequency can grow due to high traffic density. The strategies that facilitate the reduction of traffic speeds reduce crash frequency and severity. The analysis on conventional traffic risk minimizes many of these impacts. Figure 1 shows a screenshot of the problem for accident damage.

Traffic congestion problem description: The traffic congestion has always been another big problem in the urban transportation system. Among the numbers of impacts of road traffic, the congestion is probably found to be the first problem that has been picked up by both road users and the city hall. Thus, all the existing transport policies have focused disproportionately on this major and probably over-emphasized problem.

There are various kinds of strategies which can be used to reduce the traffic congestion on the roads in cities. Depending on the adequate differential of the road capacity, the capacity is referred to the maximum number of passengers or vehicles, per unit time which can be accommodated under certain conditions with a reasonable expectation of occurrence. Some observations which are found from this definition are further discussed. The capacity is an independent subject of the demand. It refers to the physical number of passengers and vehicles that a road can handle. However, it does not depend on the vehicles demanding service total number. It rather depends on matters such as conditions of traffic, geometric design of the road etc. For instance, a curved road is proven to have lesser capacity in comparison to a straight road. The capacity is can be viewed in terms of units of some specific thing such as car, people, etc. Therefore, it also depends on the composition of traffic. Additionally, the capacity analysis also does depend on

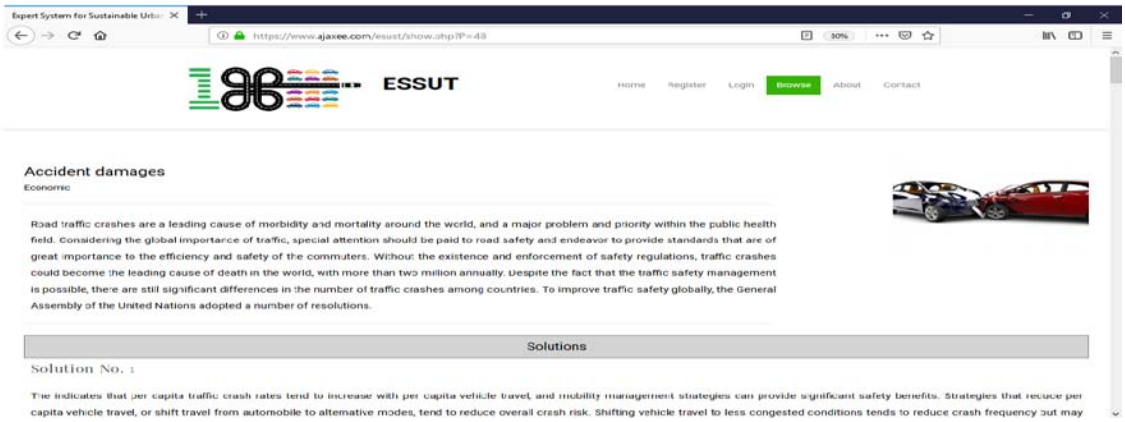

Fig. 1: A screenshot of the problem for accident damage

Fig. 2: A screenshot of the problem and solutions for traffic congestion

the conditions of the environment. The capacity is defined as a probabilistic measure and it tends to vary in accordance to time and position. Hence, the used measures facilitate in optimization of the highway capacityand traffic-light management. Therefore, it is not often possible to analytically fully determine the capacity. In large number of cases, it is obtained via. field observations. Figure 2 shows a screenshot of the problem and solutions for traffic congestion.

The outcomes of the research aim at identifying the seven strategies which can be adopted to reduce traffic congestion. The strategies are adequate road capacity, delivery services, livable communities, transportation demand management, transit services, walking and cycling improvement and determining the three strategies which can lead to reduction of road accidents. The strategies are crash prevention, crash protection, transportation demand management. This is the implementation plan of sustainable urban transportation.

RESULTS AND DISCUSSION

System evaluation: Evaluation of the system was carried out by questioning two groups of experts. The first group consisted of three computer professionals who are highly skilled in Computer science and can give recommendations or comments for the improvement of the system the second group consisted of five transportation experts. For verifying the system, two different questionnaires were distributed among them. In these questionnaires, the computer experts and domain experts were asked to rank the parameters in the questionnaires according to a 5-point Likert scale (I strong disagreement to 5 strong agreement) using Microsoft Excel 2013. The questions asked of computer professionals cover important items including the quality of user interface, ease of use, the speed of running commands having no bugs, correctness of computer codes and accessibility to different parts of the system. The questions asked of experts in urban sustainable transportation included the quality of user interface, ease of use, speed of running commands, expression of problems, clarity of solutions, organization of strategies, description (or design) of measures and usefulness of the system.. As shown in Table 2 and 3, the average of answers was compared and measured using mean, SD and p-value to evaluate the system. As shown in Table 4, shows no significant difference between the groups was found the average of the result was higher than 4 (agree and strongly agree) which means that the computer professionals and experts are satisfied with the system.

Table 2: Responses of computer professional to the system evaluation

Questions for experts computer professionals	Scores 1	2	3	4	5	Average
The user interface is user friendly				√√	√	4.30
The system is easy to use				√	√√	4.67
The system runs commands quickly			√√	√		3.33
The system has no bugs			√	√√		3.67
The system has correct codes				√√√		4.00
Access to different part of the system is easy				√	√√	4.67

Table 3: Responses of sustainable urban transportation experts to the system evaluation

Questions for experts sustainable urban transportation professionals	Scores 1	2	3	4	5	Average
The user interface is user friendly			√√	√√	√	3.8
The system is easy to use			√	√√	√√	4.2
The system runs commands quickly			√√	√√	√	3.8
The problems are well defined			√	√√√	√	4.0
The solutions are clear				√√√	√√	4.4
Strategies are well organized			√	√	√√√	4.4
Measures are well described and designed				√√√	√	4.2
The whole system is useful to transport engineers				√√	√√√	4.6

Table 4: Responses for evaluation statistically

Groups	Mean	SD	p-values
EXCP	4.10	0.54	0.38
EXTP	4.17	0.29	

EXCP: Experts Computer Professionals; EXTP: Experts Transportation Professionals

As shown in Table 4, the mean value for computer professionals is 4.10 while for sustainable urban transportation experts was 4.17. Whereas SD for computer professionals is 0.54 while for sustainable urban transportation experts was 0.29 and the p-value for both groups was tested and is the result was 0.38 which means the answers of both groups was similar and significant because the p-value was more than 0.05.

CONCLUSION

The current study provides the concept of how knowledge-based solutions found in different documented publications can be used for sustainable urban transportation. It is proven that, the psychological and social-economic effects of the traffic congestion and accidents damage problems are very significant and therefore, the strategies must be implemented to address these problems. Nowadays there are no existing strategies for sustainable urban transportation in Libya. And it requires large amount of effort to enhance the road safety. The authorities and government must adopt and implement the strategies of sustainable urban transportation in this Expert System for Sustainable Urban Transportation (ESSUT) that can facilitate to eliminate the traffic congestion and road accidents. The expert system advice strategy can be used to help the young engineers to aim their efforts towards the adoption and successful of sustainable urban transportation. The expert system without the reference to any urban transport experts is expected to help young professionals to make decisions prior to the implementation of the sustainable urban transportation in their transportation system.

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