Journal of Theoretical and Applied Information Technology
15th April 2018. Vol.96. No 7

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

EXPERT SYSTEM FOR GREEN TRANSPORTATION SYSTEM: AN OVERVIEW

[1]HASSAN M ABDELSALAM*, [2]MUHAMMAD NAZRI BORHAN, [2]RIZA ATIQ OK RAHMAT

[1]Sustainable Urban Transport Research Centre (SUTRA), Faculty of Engineering, Universiti Kebangsaan Malaysia, 43600 Selangor Darul Ehsan, Malaysia

[2]Department of Civil & Structural Engineering, Faculty of Engineering, Universiti Kebangsaan Malaysia, 43600 Selangor Darul Ehsan, Malaysia

Corresponding author: Email: Hmg1973.hg@gmail.com

ABSTRACT

Several developing nations, there is a relationship between the variables that affect a trip's duration departure to arrival and the chosen transportation mode. There are a few issues to be considered when reducing travel time to the maximum extent. A trip is considered green if green transportation strategies are followed and green transportation modes are used, such as walking, cycling, or opting for public transport. This paper provides an outline for possible directions of future research. It presents a brief introduction to expert systems, explaining how technology plays a role in the latest approaches to transportation engineering. The purpose of this paper is to summarize the latest outcomes of researches related to the process of engineering, developing, and implementing an expert scheme for a green transportation system. The current expert system does not accommodate the requirements of a green transportation system. Moreover, the paper highlights the necessity to develop an expert system for green transportation. This system enables performance engineers to determine, analyze, and customize information to help relevant parties during decision-making processes. Lastly, a few recommendations are presented for improving the existing expert system in transportation and developing the framework for the expert system for green transportation.

Keywords: *An expert system; green transportation system; alternative transport modes*

1. INTRODUCTION

Transportation, as a regular bearer of large quantities of cargo and travelers, is crucial, and an irrefutable establishment of financial and mechanical advancement. Undeniably, [1], even with progress in building a virtual world, which will is likely to replace physical transportation by virtual transport, cannot reduce the overall dependence; therefore, rapid development is seen [2]. Moreover, this prompts the mastery of street segment CO_2 discharge, where street cargo accounts for 30% to 40% of the aggregate CO_2 emissions. Because of this, it is natural that "Greening" street transportation has turned into a top-positioning mandatory errand. [3]. The records and situations of planned transport reports are good references for the variables and associated databases utilized in the scenarios for long-term prediction of transportation demand in several European countries [4]. Additional transportation contributes significantly to global climate change. It accounts for approximately 23% of the world's total carbon dioxide emissions from fossil fuel combustion. Road transport accounts for 75% of these emissions, and this share is increasing every day. Approximately 95% of all road transportation depends on oil; this corresponds to 60% of the world's total oil consumption [5]. Modern society becoming is increasingly aware that humans and culture are components of the natural environment; and that human health is inextricably linked with environmental conditions. Therefore, it is useful to explore methods and patterns of human settlement and landscape modification for their potential adverse effects on humans and environmental health [6]. Hence, transportation, being a major contributor to greenhouse gas emissions, is the primary target for reducing air pollution and obtaining a sustainable environment. This leads to

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

green transportation, which refers to any transportation practice or vehicle that is eco-friendly and does not have any negative impact on the immediate environment. Green transportation involves effective and efficient resource utilization, changes in transportation structure, and making healthier travel choices. This requires enhanced public awareness & participation, control of private vehicles, and development of vehicles powered by renewable energy sources such as solar, wind, electricity, and biofuels. Therefore, policy documents addressing sustainable development for cities include methods for pollution reduction. [5]. With advancement in software engineering, a product specialist's tools have also advanced, such as routine dialects, fourth-era dialects (abnormal state dialect that generates pieces of code), and master framework improvement devices [7]. This leads to considerable pressure on national governments to devise policies to reduce greenhouse gas emissions and demand for oil. Novice engineers, planners, and diction makers cannot resolve problems only by focusing and relying on conventional manuals and handbooks; and it takes several years for them to obtain expertise in this area. In this regard, transferring domain knowledge from experts and skilled engineers to experienced and novice engineers is necessary and can help in avoiding typical mistakes that have occurred earlier. The knowledge base in the prototype system is represented in the form of production rules. Rules are considered as a suitable form of knowledge representation, and Microsoft Visual Studio and ASP.NET are well-known applications for developing rule-based systems. Hence, for this rule-based expert system, a forward chaining inference engine is used rather than a backward chaining process. In a forward chaining inference engine, the process begins with the facts stored in the knowledge base. IF-THEN statements are commonly used and are useful constructs for building rule-based expert systems. In this form, IF represents a condition and THEN represents a determination. Rules can be aggregated by employing connection terms, including OR, AND, and ELSE to shape combined rules or composite rules.[8]

2. GREEN TRANSPORTATION MODES

The characterizing quality of urban ranges is the density of individuals, exercises, and assemblies. Characterizing a city's transportation characteristics involves adapting to the thickness and making individuals and products mobile. Thickness complicates urban transportation in terms of swarming and framework costs in developed territories.[9].

It leads to certain benefits resulting from economies of scale, i.e., certain transportation activities are cheaper when handled in large volumes. These characteristics show that two important phenomena in city transportation are traffic congestion and mass transit. Green transportation hierarchy consists of the modes of green transportation. Based on the food pyramid, it shows an upside-down approach, with walking pedestrians being one of the greenest and most important, and the single occupant vehicles being the least green with low priority. When possible, single occupant vehicles should not be used [5].

Journal of Theoretical and Applied Information Technology
15th April 2018. Vol.96. No 7

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

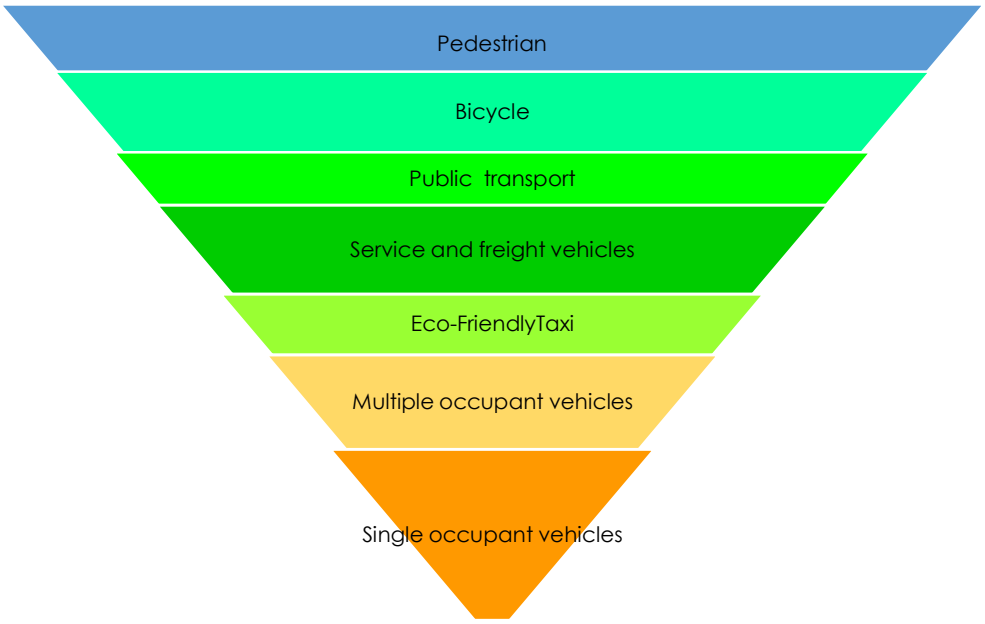

Figure 1: Hierarchy for the modes of green transportation
Reference: http://www.conserve-energy-future.com

2.1 Pedestrians

One should walk to school, work, when shopping for food, etc. Walking involves zero discharge of any greenhouse gas, is free and most importantly, it is a good activity for the body. The person on foot movement arranging stage is a key component of a city's street and transport framework. To identify the ecological issues associated with this issue, we first highlight the issue that affects pedestrians.

2.1.1 Pedestrian Paths

A facility for people who walk on motorways. They are paths that are safe for pedestrians in locations where there are no trees, shades, columns, or unsafe checks. They should be utilized by pedestrians and physically disabled people. Pedestrian walkways must be not be less than 1.525 meters (60 inches) wide, to enable two individuals to walk together. Depending on general population thickness, walkways in business areas and other similar spots may be more extensive.

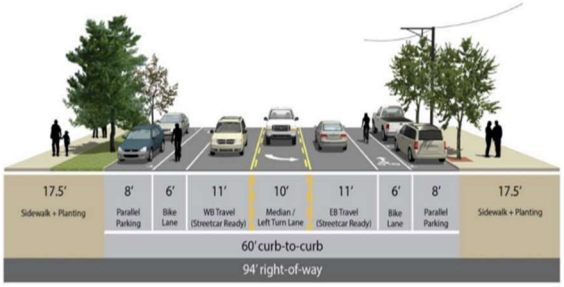

Figure 2: Pedestrian Paths
Reference: http://transportblog.co.nz

2.1.2 Pedestrian Problem

Owing to considerable increase in the number of cars, conditions in urban areas (particularly for pedestrians and open transport travelers) started to deteriorate. This period saw a lack of the following: policies to protect pedestrians and cyclists, construction of extensions and burrows for passerby motorways intersection, and investment in the advancement and overhaul of open transport frameworks policies empowering the utilization of open transport over cars in congested zones. A few proposed Solutions to the pedestrian problem are as follows:

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

a) Converting boulevards in downtown areas into sidewalks.
b) Using thick trees as boundaries between motorways and sidewalks (walkways).
c) Exploring conceivable outcomes to interface recently transformed sidewalks to an open transport stop, and creating parking spaces for cars.
d) Creating separate paths for cruisers (a non-dirty method for transport).
e) The use of open transport and electrically driven transport to reduce ecological contamination and clogging.

2.1.3 Aesthetic Elements for Pedestrians

Improving sidewalks and entries for cars is important for arranging and outlining pedestrian paths. Plants and trees must be placed in appropriate spots. Trees and brambles may be planted on sections that are typically reserved for pedestrians. Nevertheless, planting trees on the sides of parkways or on the middle strips between two-way lanes is not recommended. Trees amidst parkways could be the cause of street accidents because cars may hit these trees [10].

2.2 Bicycles

Using a bike as a form of transport is another green transportation method. Faster than walking, it requires minimal effort and activity. Minor purchase and maintenance expenses are required for an auto bicycle. Recent transport approaches have been given careful consideration to advancing cycling as an alternative to driving because of increasing concern about vehicle contamination and the planet's general well-being. Particularly, several strategic intercessions have been considered with the objective of creating a cycling-accommodating synthetic environment. For example, the supply of cycling offices and spatial arrangements intended to build thickness, differences and destination's availability. Policymakers regularly consider whether such approach intercessions are proficiently advanced by riding a bike [11].

The most recent bicycles offer frameworks that empower clients to determine cycle accessibility and docking station spaces using online maps. These sites regularly determine and supply an application programming interface for other programmers to have access to fundamental information. Moreover, various framework administrators discharge datasets related to individual journeys being set aside within a few minutes in a certain period. Both types of information offer experiences in the use of specific bicycle shares and give a prepared premise to be used in transport research. A small number of past studies have been carried out in the past, most of which are about the attributes of a solitary city's framework, often with specific attention on client demographics [12].

2.2.1 Bicycle Polices

A neighborhood organization should consider the travel needs of all transportation hallway clients while arranging transportation enhancements. Bike offices must consider all federal guidelines, and they should be considered equally for tasks where viable. The following rules may be utilized as a part of the consideration for bike offices' requirements:

a) The roadway or road is assigned as a bikeway on a territorially or privately receiving bicycle arrangement or distribution in a local or privately embraced map as a suggested bicycle course.
b) The course gives essential access to a recreation center, recreational territory, school, or other noteworthy destinations.
c) The course gives access over a man-made obstruction, e.g., spans over streams, roadways, and railways, or under access-controlled offices and roadways.
d) An interstate venture uncooperatively influences the recreational or transportation utility of a free bicycle path or trail. An expressway adversely influences at-evaluation ways and trails where they are separated. This happens when an anticipated roadway activity increases to a level that prevents safe intersections, or where widening of a roadway increases crossing time to a level that makes an intersection unsafe.
e) Procurements should have equal importance in securely allowing for bike activity on thruways where span decks are being installed or restored.

Figure 3: Bicycle path design for an open area
Reference: https://www.theunderline.org

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

2.2.2 Incidental Design Factors

The following should be considered in addition to extra outline variables where appropriate, for the venture:

1) Grates. Seepage grates and utility spreads can be dangerous to bicyclists. All current IDOT waste mesh outlines are suitable for bike travel. Grates and utility spreads situated in a cyclist's way should be flushed with asphalt. With asphalt overlay ventures, install utility spreads and non-acclimating seepage grinds and modify them to be flushed with the new surface. A less attractive option is to outline and develop asphalt such that it flows into waste deltas, to prevent formation of unexpected edges.
2) Bollards. In the event that bollards are introduced over a bicycle way where it meets with a road, a satisfactory clear zone between the edges and the road should be provided.
3) Natural Effects. Examination of the ecological impacts of bike facilities should be proficient and archived along with the natural investigation for related expressway ventures.

2.2.3 Requirements for Bicyclist Traffic Control Devices

Asphalt checking and marking of bicycle ways should be according to the ILMUTCD and other pertinent neighborhood mandates. Bike courses should be marked if they meet the following criteria, are ceaseless, and are not less than 1 mile (1.5 km) long:

1) The course allows for direct bike passageways.
2) The course interfaces irregular portions of shared utilized ways, bicycle paths, and/or other bicycle courses.
3) An effort should been made to change movement control devices (stop signs and other signs) to give importance to bicyclists on the course, rather than on roads. This could incorporate arrangement of bike delicate finders where bicyclists are relied upon to stop.
4) Stopping in the street should not be allowed or should be confined to basic width ranges to enhance wellbeing. It may be appropriate to design shorter bike courses for cases where they may cross another marked bicycle.

2.3 Public Transportation

Public transport prices may range from the full price to free. The current condition in most European countries is 'between the two extremes that implies a fractional cost recovery [13]. The report extensively recognized as "the Black Book" acknowledged many factors that impacted demand, and, where possible, provided data limitations for analysis and calculated their effects. Later, the Black Book proved to be of great value to public transport operators, transport planners, and policy makers [14]. Public transport usage is continuously increasing in most of the world's cities; and the increase is more common in large cities than in smaller towns. We categorize public transport as follows:

2.3.1 Trolley transport

Most general guidelines relevant to utilization of customary transports on the trolley transport however do not happen at the point of interest as clamor does not bring contaminated air during the walk. This is because of it depends on electricity. It does not have adaptability, which is specific to swarmed urban areas.

2.3.2 Tram

It is a railroad line with a width of 1 to 1.5 meters. The first cable car was manufactured in England in 1850, and progress in development turned it into a real transportation method inside urban areas for a substantial period. Numerous developments started to be the real urban communities changing over to Metro.

2.3.3 Metro

It is a railroad line that relies on electricity. It is completely detached from the surface by activity or overhead, particularly in focal zone burrows. The passages of an urban zone will be discussed in detail for monorail railroads.

2.3.4 Buses

Before 2020, it is normal for new advancements, such as stop-begin, gentle cross breed, and flywheels to have mixed frameworks. Full crossovers might offer lower total cost of ownership compared to diesel transport under certain obligation cycles by 2020. Organizations that offer immaculate Electric Vehicle "EV" transport will develop depending on strategy, instruments, and subsidized plans. Conductive transport quits charging and the use of plug-in hybrid electric vehicles will progressively increase as clients drive exhibition ventures. The use of

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

biofuels is increasing. However, the requirement is to be fundamentally mixed inside of the standard transport fuel inside of the present EN fuel measures. Conventional gas-fueled transport will increase with enhanced motor effectiveness (and thus financial matters) and CO2 emissions will reduce because of an increase in bio methane use.[15].

The indication is for minibuses, customary transport, transport pivots groupings, etc. The advantage is that it does not require unique offices, from high-60-100 traveler limit. What is important as far as transportation is concerned is the upgrading of the transports' utilized to be assigned on account of its own out and about system ways. A few nations distributed these open activity courses transposition, or make exceptional passages for transports, which is unreasonably momentary.

2.3.5 Train

Revised plans have recently revealed that 300 miles per hour. The Maglev bullet train, which can travel at 300 miles per hour, can transport travelers from Washington D.C. to New York City in only 60 min. Driven by powerful electro-magnets, the train is elevated, which reduces resistance and enables it to travel at high speeds with rapid acceleration. Increasing attention in the area of applying high-speed technologies to public transport, such as hyper loop, has led to the reinstatement of this project. The following lessons can be learnt from this example: high travelling speed and resultant savings in time, and usage of electromagnetic energy.

Figure 4: Train driven by powerful electromagnets Reference: http://www.clarin.com

2.4 Town with Electric Vehicles

Hakone, which is well known for hot springs, gets more than 20 million local and foreign tourists annually. Furthermore, Hakone plans in making an EV showcase and change Hakone into a low carbon group. One of the major aspects of this plan is that K.P.G., Hakone, and private associations are working with lodgings, organizations, touring spots, historical centers, greens, eateries, etc., to introduce EV chargers (200 V) for their visitors. Moreover, Hakone will include a tourist EV taxi administration and EV and e-bicycle rental and sharing projects [16].

Figure 5: The HAKONE EV Town Project Reference: IEA. 2012. Electric Vehicle City Casebook.

2.5 Service and Freight Vehicles

Benefit and cargo automobiles represent approximately 9% of the aggregated greenhouse gas emissions. Utilizing biodiesel and power area options to energize administration and cargo transport, travel request supervision, and giving more travel choices will play a key role in introducing green transportation in this segment. A window of chance opens during transport:

1) Mileage levels for new light duty vehicles improved by up to 55%, demonstrating considerable potential for enhancing productivity through arrangement. Mileage upgrades accelerate the execution of efficiency models and other arrangement measures have been scaled up. The pace of change in a few locales demonstrates considerable potential for introducing fuel-sparing technologies, most of which are currently monetarily accessible, into the business sector through strategic activities.
2) Worldwide biofuel generation, including that of bioethanol and biodiesel, was static in 2012. Regardless of 7% improvement in biodiesel yield in the United States (4 billion liters) and Latin America (7 billion liters), worldwide volumes remained approximately 110 billion liters.
3) The progressive biofuels segment includes approximately 30% of the limit in 2012. More than 100 plants are presently functioning,

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

along with business scale ventures, with a total limit of 4.5 billion liters toward the end of 2012. In addition, there were other large scale undertakings [17].

2.6 Eco-Friendly Taxis

Certain Hybrid and fuel-efficient taxis are considered eco-friendly; they are one of the green transportation options. Several taxi companies are actively involved in reducing their fleet emissions through gradual fleet replacement schemes, fueling choices, and practices that encourage fuel saving.

Another method that taxi administrators can use to reduce emissions is a formal and facilitated traveler sharing arrangement for reducing vehicle usage. This framework could reduce discharges and offer potential changes in activity blockage. To gain complete natural advantage, neighboring authorities might need address neighborhood activity and to introduce extra measures to prevent usage of accessible street space by others. Neighborhood authorities might likewise intercede in the authorization of taxi fleets, through the stipulation of vehicle age. For example, several neighboring authorities can confine the age at which a taxi may be initially authorized and the last age of a taxi. This strategy supports an improved fleet substitution by removing established vehicles and introducing of fresh vehicles. Taxi operators and taxi administrators have the option to utilize carbon balancing plans to moderate their greenhouse gas emissions. It is proposed this is employed through a discussion amongst the most legitimate associations suggested in this report, and the utilization of the system should be as an expansion (instead of substitution) of the immediate measures as specified. Several other auxiliary measures (fuel decisions, changes in driving styles, etc.) may be utilized, which can reduce emissions and enhance neighborhood air quality [18].

Figure 6: Eco-friendly taxis
Reference: http://www.greencab.me/category

2.7 Multiple Occupant Vehicles

Carpooling is a favorable mode of green transportation. Groups of coworkers, associates and others utilize one vehicle when traveling in the same direction regularly. Instead of five people driving individual vehicles in the same direction, it is considered cost-effective and environmentally friendly to have one car transporting everyone to their destinations. Moreover, it is an excellent way to save petrol and money.

2.8 Single Occupant Vehicles

Using green vehicles controlled by option fills and propelled vehicles innovations puts less weight on Earth, as compared to conventional internal combustion motor vehicles that run on petrol or diesel. Driving individual electric transport vehicles was introduced in Milton Keynes, which is a city north of London. It has been reported that arrangements are introducing one hundred mechanized "case autos" to keep city's focal station running between and the downtown area. These ultra-personal electric transportation pods move along the stages at speeds of up to 12 miles per hour. Costing USD 104 million, this is a five-year pilot arrangement anticipated to be completed in 2017. Through ultra-personal electric transportation pods, pedestrians will be able to experience the future through savvy versatile applications. This application was initially utilized at London's Heathrow Airport in 2011. However, the British government is presently investigating its application in open transport frameworks, with a specific end goal to free the contaminated streets transmitted by transports. The cases are PC driven vehicles, and each case can transport up to four travelers with luggage. They are battery-driven, have elastic tires, and can explore complex courses with a lightweight framework. While running, the ultra-personal electric transportation pods create no sound or commotion, have zero discharges, and no outer vibrations. The following lessons can be learnt from this example: safety, use of electricity, privacy, and protecting the earth from pollution.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Figure 7: Single occupant vehicles Reference: http://inhabitat.com/100-self-driving-ultra-personal-electric-transportation-pods

3. VARIABLES AFFECTING IN URBAN TRANSPORTATION

The crucial characteristic of city locations is density, which refers to the number of people, activities, and structures within a particular area. Urban transportation should have the ability to cope with dense areas while transporting people and goods. Density creates problems for urban transportation as it leads to crowding and increases the cost of building infrastructure in built-up areas. It also generates specific benefits due to economies of scale: certain transportation activities are cost effective when carried out in large volumes. These traits imply that two of the most important phenomenon in urban transportation are traffic congestion and mass transit [9]. The environmental impacts of particular transportation modes can be revealed in particular cases. Then, the discrete-choice model based on these data can forecast and test how and in which way travel time, cost, and passenger characteristics influence the selection of specific transportation modes [19].

3.1 Population Growth

From the 1960s, as global ecological problems started increasing, emphasis was laid on the sheer number of people and their potentially negative impact on earth. Ehrlich and his colleagues mentioned that in an agricultural or technological society [eminent from a collector's society], human individuals, in the process of attaining the requisites of survival, can impact an environment negatively [20]. Population is an important variable in the statistical analysis of transportation and traffic, and it is one of the factors that influences the total daily traffic mobility. Population is more dynamic than all the other variables, as there is a direct association between the population and density in a particular area and the number of road trips per day in that area. Furthermore, studies on urban transportation show a clear correlation between the increase in the number of family members and the increases in the number of road trips, and daily trips increase at a rate of 0.8 daily trips per additional family member. Studies also reveal that the number of road trips increases with an increase in the number of employed members in a single family[21].

3.2 Family's Average Monthly Income

A link exists between the socio-economic traits of a population and traffic movement in general. Most transport-related urban planning studies underline the correlation between a family's average monthly income and the number of road trips taken by its members per day. This is because the higher a family's income, the greater is its purchasing power, with varied needs. Hence, a greater of number of trips are required to satisfy family needs [22]. Another pertinent evidence is that the proportion of household income being expended on transport and travel holds continuously over time once the car ownership has reached around one per household[23]. In Britain, the expenditure on transportation has oscillated around approximately 16% for the past 25 years (National Statistics, 2004; Metz, 2005). This does not agree with the idea that travelers are inspired to lower their expenses on travel, at least in the long run.[24].

3.3 Vehicle Ownership

Cities are planned at the individual scale via a combination of clear planning strategies to allow both high-quality convenience and a superior environment. The purpose is not to forbid the usage of a car, as this would be complicated to achieve and would be viewed as against the ideas of freedom and choice. The intention is to design cities with such superiority and at an appropriate scale that people would not see the need of having a car [25].

There is a marked growth in the use of private automobiles today. The ownership of private vehicles is one of the important factors affecting daily trips. It contributes to traffic congestion on urban roads and is the cause of many road accidents. In most countries, the per capita share of private vehicle ownership has increased. Private vehicle ownership is one of the indicators used in estimating future urban transport demand.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

3.4 Energy and Transportation

A recent study of Harvard University discovered that 22% of the population of the largest cities in the U.S. live within a three-mile radius from the city center (the main commercial and industrial areas), and almost 80% of the population live at a distance of up to 30 miles outside the city borders. Obviously, this leads to a high rate of energy consumption. In Europe, on the other hand, one can finish a day's work in Geneva, Switzerland and arrive in central Paris, France in less than 2 h, getting off the train before the doorstep of the destination (hotel or company). This is because most European cities are dependent on a model rail network that connects all European city centers [26].

Energy consumption is a necessity for socio-economic development. Transportation (the sector that consumes the most energy) is one of the major challenges facing sustainable development because it is a source of pollution that is harmful to both the environment (globally, regionally, and locally) and human health. This predicament has long puzzled countries across the globe [27].Urban planning techniques, or methods, are among the most important factors affecting the urban transportation system and the amount of energy consumption. European urban plans are based on transportation systems that depend largely on railway networks and urban developments concentrated around city centers, whereas U.S. urban plans depend on wide highways and horizontal urbanization. The planning of most U.S. cities makes automobiles indispensable to the life of their inhabitants, and these cities grow and expand horizontally for tens of miles.

Interviews with local authorities and domain knowledge will be used to establish important parameters and factors that affect trip time and travel scenarios when choosing green transportation modes by examining environmental, transport, economic, and socio-economic factors. We will determine the framework for an expert system for a green transportation system, and highlight the domain knowledge for green transportation, as shown in Figure 8.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

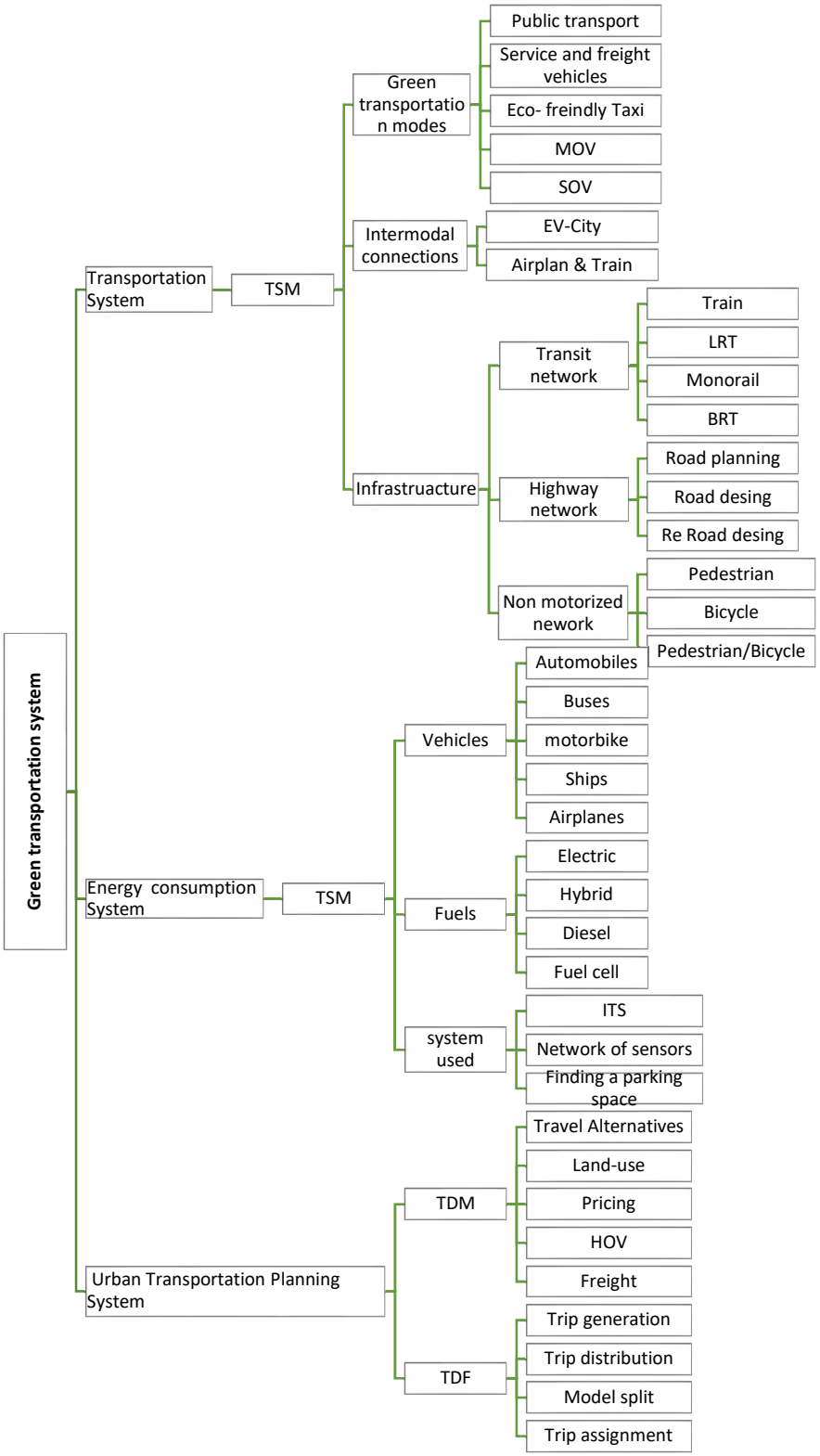

Figure 8: The framework for expert system for green transportation system

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

4. OVERVIEW OF EXPERT SYSTEM

The expert system acts as an interface between the customer and reenactment program. The client can profit by the force of reproduction examination without being a reenactment master. A few cases have been recognized over the span of framework improvement and depicted in the paper. A case is presented to show the application of the framework. Conceivable future upgrades and expansions have also been recommended.[28].

4.1 Expert System Components

Expert systems are computer-based programs that are aimed at mimicking the decision-making process of human experts with the intention of solving complex problems and providing commendations and rationalizations. Expert systems are developed to execute actions in a similar manner to human experts in every aspect. Expert systems are developed to act as an intelligent assistant to engineers or professionals in other fields. The main elements of expert systems are working memory, inference engine, knowledge base, and user interface [29]. We can divide the systems according to the categories of complication highlighted. The groupings are as follows:

Diagnosis/monitoring: a precise case or a set of cases that can be used to develop solutions, i.e., identifying the problem. Monitoring is believed to be an actual analysis. They are similar with regard to the issues highlighted and the complexities involved in developing an expert system.

1) **Interpretation/classification:** This system's class compares a condition with different identified situation and searches for matches. Expert systems that resolve issues locally are designed to model the pattern matching capability of someone who is an expert in recognizing features or traits in the problematic area.
2) **Prediction/forecasting:** The objective of the system class is to predict future conditions based on current conditions and the knowledge of previous circumstances.
3) **Design/planning:** The system's goal is to obtain a requirement on how certain elements need to be designed or arranged in a group of actions to meet a goal (planning). Most examples developed until now consist of delivering comprehensive conditions for a generic design or program.

The knowledge base of an expert system comprises facts, principles, and knowledge associated with expert system domains, which are proposed to be utilized in developing decision-making processes and thinking. The common guidelines of an expert system are described in IF-THEN accounts. Utilizing AND and OR instructions helps knowledge engineers to cite domain knowledge intricately and in more details [30].

4.2 Apply expert knowledge to solving problems

Nowadays, managers in an organization use computerized support while making daily decisions. Expert systems can improve the quality of diction. Expert systems are often used to solve critical strategic problems, but they have also saved significant amounts of time and money for many organizations in addition to preserving and distributing valuable expertise [31]. Very little, if anything, has been written on the strategic implication of an expert system for managers. Managers are preoccupied with those facets of their business that they hold to be strategic. Having a good strategy or being a good strategist signifies power and great foresight and anticipatory skills. [32].

An expert system is a software program that encodes the knowledge of an expert, and use techniques other than conventional computer languages to represent that knowledge. In most cases, an expert possesses knowledge that is extremely valuable to a company, but cannot be expressed easily through conventional computer programs. Their knowledge often relies on experience from past situations that is re-applied when necessary to deal with similar situations. This knowledge is often represented in the form of rules or heuristics. In the early 1980s, people expected that expert systems would revolutionize computing and displace conventional computer systems. When this did not happen, the general consensus was that expert systems had failed. In fact, the exact opposite had happened: expert systems have become another tool that software engineers use to solve problems. Instead of revolutionizing computing, expert systems have actually helped in the evolution of computing in general. Tools used by software engineers have

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

evolved with the evolution of computer science: conventional languages, fourth-generation languages (high-level language that generate blocks of code), and expert system development tools [7].

The feasibility of using expert systems for highway applications has been proven. This is clearly demonstrated by existing operational systems such as FRED (Freeway Real-time Expert System Demonstration), a component prototype real-time expert system for managing non-recurring congestion on urban freeways in Southern California, or ERASMUS, an expert system for pavement assessment and rehabilitation that is operational at thirty-five sites in France. Other developed systems, such as FASTBRID, (Fatigue Assessment of Steel Bridges) and WZTS (Work zone Safety Training System), show that fully integrated decision aid / training systems are both possible and practical. With an increase in the number of current senior professionals approaching retirement age, expert systems can be useful in the near future [33].

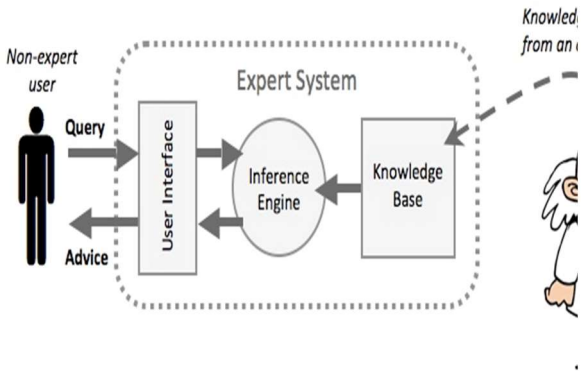

Figure 8: The main components of expert system
Reference: http://www.igcseict.info/theory/expert

4.3 An Expert System applied in transportation field

Summarizing newly developed approaches and theories in the emerging direction for application of artificial intelligence applications to transportation, including evolutionary computation, neural networks, fuzzy logic systems, expert systems, reasoning, classification, and learning, in addition to chaos theory, cuckoo search, firefly algorithm, knowledge-based engineering, and simulated annealing. The key investigation tendencies are also smoothed out in the end. The paper provides an indication of advances in artificial intelligence and the practicality of expert systems in the transportation field.

4.3.1 E-ACTIVERANS

Improvements in specialist systems are intended to prepare youth experts to actualize portability administration methodologies with a specific end goal that impacts a movement from latent to dynamic transport decision, which is cycling and strolling. One of the procedures included in the knowledge obtained from dynamic transport methodologies is to understand the perspectives of transportation specialists with regard to the most suitable techniques with respect to the movement from mechanized transport to dynamic transport [34].

4.3.2 CALMSYS

This expert system helps beginner transportation engineers to manage wellbeing issues related to activities in private neighborhoods and private gatherer lanes. In CALMSYS, activity wellbeing issues have been classified into diverse categories, and end clients are empowered to locate their own issues. Accordingly, the system will provide significant counsel. CALMSYS is intended to cover arrangements and suggestions that can be connected to diminish the negative effects of mechanized vehicles, much of the time mischance focuses and trip generator regions [35].

4.3.3 ES-CCPRHP

Highway construction faces complex issues, which are influenced by various variables whose arrangements are unimaginable without help from an expert. Diagnosing such development issues and proposing the most suitable cost proficient arrangement requires huge building mastery, which might not be accessible at all development destinations because of insufficient resources and remote areas [29].

4.3.4 E-ASSIST

Since the Expert system shell module utilized as a part of this task taking into account the target in executing TDM as the info, tapping the on the Advisory System catch drives client to nine principle goals actualizing TDM. Selecting one that matches the issue the client is experiencing in existing circumstance keeping in mind the objective to see the full target depiction [36].

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

4.3.5 USLIMITS 2

This expert system is relevant for all types of streets, ranging from rustic streets to urban interstates. The easy-to-understand interface enables its use by neighborhood groups, offices, and structural specialists to set rate limit without access to experienced specialists. This framework computes data by considering different components, for example, 85th percentile rapidity, movement capacity, accident history, and roadway attributes, that clients are required to fill.[37].

4.3.6 DATLCES

This expert system coordinates with a reproducing model, which comprises of six distinct models to offer the framework some assistance with examining movement issues. This master framework can reproduce the between landing and between vehicles takeoff time at convergences and suggest control and dramatization of modification for activity illuminations. With respect to the information obtained from RFID, the observations and outcomes from the movement reproduction model, the cycle span of activity illuminations are enhanced and streamlined for best execution [38].

4.3.7 TRALI

Proposing a model expert system helps movement engineers to set an activity signal for disengaged convergences. The learning base of this expert system is dependent on creation rules. Experts of activity volume that could be allocated to the system are not restricted. Additionally, the number of methodologies and movement path can be modified by boulevards [39]

4.3.8 Expert System for Work Zone Traffic Management

The objective of this expert system is to oversee movement and regulate deferral reasons at work zones. The information base of the expert system contains information from handbooks and actual meetings from important organizations and human specialists. The system has the capability of self-evaluation, which surveys the effects of movement administration being arranged at work zone [40].

4.4 Table of Summary

Among the expert systems in the area of transport manufacturing listed in the table below, some expert systems were designed to handle pavement. These expert systems were advanced to handle traffic flow and ensure better traffic safety on urban roads. Expert systems were developed to operate traffic lights. Furthermore, systems were designed to solve geometric design problems and also operate public buses.

Table 1: Expert systems in the transportation and civil engineering fields

No	System name	Refernce	Scope of work
1	E-ACTIVERANS	(Salleh et al. 2015) [34].	Mobility management strategies
2	CALMSYS	(Falamarzi et al. 2014) [35]	Traffic safety problems
3	ES-CCPRHP	(Mosa. Et al. 2013)[29]	Highway pavements problems.
4	E-ASSIST	(Mansory et al 2006)[36]	System shell for TDM
5	COMIX	(Abdullah,& Mattarneh 2008)	Concrete mix design
6	CONCEX	(Kaetzel & Citton 1999)[41]	Concrete mix design
7	ESCON	(Kaetzel&citton 1999)[41]	Design concrete
8	Bridge Rating Expert System	(Kushida et al 1997)[42]	Regulate bridge serviceability
9	CRACK	(Wang et al. 1989)	Foundations walls and tanks
10	Concrete Mix Designer	(Malasiry & Maldonado 1988)[43]	Mixing proportion of concrete
11	TSST	(Ooshaksaraie et al 2012)[44]	Temporary soil stabilization
12	Maintenance of Highway Concrete Bridge	(Chassiakos et al.2005)[45]	Highway concrete bridges
13	CWQM	Chassiakos et al. (2005)	Highway concrete bridges
14	BESTCOMP	(Joyawardhana et al. 2003)[46]	Solid waste composting
15	RCDES	(Peter 1996)[47]	Reinforced concrete diagnosis
16	ESDE	Yang et al. (2003)	Designing retaining walls
17	RES	(Malasiry & Maldonado 1988)[43]	Evaluate the properties of rocks
18	RP3CA	Leila Ooshaksaraie et al. (2012)	Water pollution during highway construction

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

19	ES-DFMP	(Deprizon et al.2009)[48]	Designing flexible pavement
20	ES-APAM	(Ismail et al .2009)[49]	Maintenance of airport pavements
21	COPRBU	(Mosa et al. 2013)[29]	Public transportation system
22	USLIMITS2	Srinivasan et al. (2008)	Speed limit in US roadways
23	DATLCES	Wen (2008)	Pavement rehabilitation
24	ES-HG Design	Syamsunur et al. (2010)	Highway geometric design
25	PMDSS	(Sainfort et al.1994)[50]	Pavement management
26	PARES	Ross et al. (1990)	Design pavement rehabilitation
27	Micro PAVER	(Ismail et al. 2009)	Pavement management
28	Trans DASS	(Choi 1995)	Transportation planning and modeling
29	STAMPP	(Malashekie 1986)[51]	Pavement
30	TRALI	Zozaya,&Hendrickson (1987)	Traffic signal for isolated intersections
31	Work Zone Traffic	(Suttayamully 2002).	Traffic management

5. DISCUSSION

Expert system shells are easy to use and inexpensive. Developers find prefabricated expert system shells to be convenient and timesaving. Shells are suitable for developers who are not familiar with artificial intelligence and for non-professional computer programmers. As opposed to high-level computer languages, expert system shells are not flexible, and hence, developers do not have the freedom to make changes in the display formats provided by the shells. An expert system shell has some disadvantages compared with high-level programming languages, including maintenance problems, and weak documentation. In addition, sometimes a knowledge base or the inference engine of a system cannot be modelled in an expert system shell; hence, two or more shells must be used. These conditions lead to unsatisfactory systems with unclear results and significant maintenance and training problems. Developers of expert systems must select an appropriate building tool that can be implemented within existing constraints such as money, time, and available hardware. In addition, the nature of the intended expert system is an important factor for choosing a building tool. An expert system that requires a complicated structure and user interface must be developed using high-level building tools rather than using expert system shells. Moreover, the quality and availability of support facilities, maintenance, and level of reliability must be taken into account. Microsoft Visual Studio is powerful applications that have tools that non-technical employees can use to build windows or web-based applications for expert systems quickly and efficiently. To store and keep expert knowledge in the knowledge base, the data must be transformed into the form of symbols, conditional statements, logical expressions, logical operations, and logical variables that are recognizable and applicable to computer systems. In the future study, Microsoft Visual Studio and ASP.NET will use to construct the proposal expert system.

6. CONCLUSION & RECOMMENDATION

Although expert systems have gained acceptance in other fields, it application in highway design in engineering and operations do not seem to have increased. However, highway design is conducted by obtaining information from the above expert systems for numerous operation and development stages. From the viewpoint that represents only a percentage of expert systems were essentially established. The systems involved in confidential functions are classified into four broad groups and are identified as Traffic Management and Control, Traffic Impact and Safety, Highway Design and Planning, and Highway Management. The possibilities of utilizing expert systems have been proven for highway applications. This is obviously confirmed by current operational systems, e.g., System for Maintenance of Highway Concrete Bridge, CWQM, and USLIMITS 2. A component prototype of a real-time expert system is used to manage non-recurring congestion on urban roads, e.g., E-ACTIVERANS, CALMSYS, E-ASSIST, and COPRBU. Moreover, an expert system for pavement valuation and reintegration is operational at specific sites. Other developed systems, such as ES-CCPRHP, ES-DFMP, ES-APAM, and DATLCES showed the possibility and usability of completely combining decision aid / training systems. The most important strategies and modules to be used in the expert system for green transportation should be determined.

With the increase in the number of existing senior professionals reaching retirement age, expert

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

systems can be beneficial in the near future. These systems may include Traffic Impact and Safety systems to evaluate ways to reduce the impacts of traffic, noise control, safety work zone layout, and accident investigation. The most important strategy that may be followed by expert system to reduce transport and traffic problems are as follows:

1) Conducting investigation and sketching area of the transport sector to determine requirements for planning purposes. It should reflect the reality of urban development in cities such as changes in population density and traffic accidents census information.
2) Review of traffic laws and analyze the strengths and weaknesses in order to enhance and expand existing urban development.
3) Separate pedestrian areas from vehicle movement areas and pedestrian crossings. The infrastructure is designed according to the standards of health, safety, and environment.
4) Promoting public transportation and developing its own systems to suit modern technologies and applications and to meet the actual needs of the city, so that interest in the public transportation sector plays a big role in easing traffic congestion, which, in turn, will lead to a reduction in environmental pollution and energy consumption.
5) Optimum review of parking spaces and vehicles used.

ACKNOWLEDGEMENT

The authors would like to acknowledge the Sustainable Urban Transport Research Centre (SUTRA), Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia (UKM) for providing research facilities.

REFERENCES

[1]. Crist, P., *Greenhouse gas emissions reduction potential from international shipping*. 2009, OECD/ITF joint transport research centre discussion paper: Crist, Philippe (2009) : Greenhouse gas emissions reduction potential from international shipping, OECD/ITF Joint Transport Research Centre Discussion Paper, No. 2009-11. p. 49.

[2]. Kiesmüller, G., A. De Kok, and J. Fransoo, *Transportation mode selection with positive manufacturing lead time.* Transportation Research Part E: Logistics and Transportation Review, 2005. **41**(6): p. 511-530.

[3]. Litman, T., *Introduction to Multi-Modal Transportation Planning Principles and Practices.* Victoria Transport Policy Institute., 2011.

[4]. Transport Research: APAS, . *Strategic transport, databases and scenarios for European Transport. Luxembourg: Office for*
Publications of the European Commission. Luxembourg: Office for Publications of the European Commission., 1999.

[5]. Future, C.C.E. *modes of green transportation* 2013.

[6]. Jackson, L.E., *The relationship of urban design to human health and condition.* Landscape and urban planning, 2003. **64**(4): p. 191-200.

[7]. Kaewert, J.w., *development Exeter systems for manufacturing* 2006. 20.

[8]. Hassan M Abdelsalam, M.N.B., Abdalrhman Milad, and R.A.O.R. Hamza Imhimmed, *developing a web-based advisor expert system For green transportation system.* Journal of Theoretical and Applied Information Technology, 2017. **95**(13): p. 9.

[9]. Small, K.A. and J.A. Gomez-Ibanez, *Urban transportation.* Handbook of regional and urban economics, 2008. **3**: p. 1937-1999.

[10]. Serrao-Neumann, S., et al. *Climate Change Impacts on Road Infrastructure Systems and Services in South East Queensland: Implications For Infrastructure Planning And Management'*. in *State of Australian Cities Conference 2011 Proceedings, State of Australian Cities National Conference*. 2011.

[11]. Zhao, P., *The impact of the built environment on bicycle commuting: evidence from Beijing.* Urban studies, 2014. **51**(5): p. 1019-1037.

[12]. O'Brien, O., J. Cheshire, and M. Batty, *Mining bicycle sharing data for generating insights into sustainable transport systems.* Journal of Transport Geography, 2014. **34**: p. 262-273.

[13]. van Goeverden, C., et al., *Subsidies in public transport.* 2006.

[14]. Paulley, N., et al., *The demand for public transport: The effects of fares, quality of service, income and car ownership.* Transport Policy, 2006. **13**(4): p. 295-306.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

[15]. Author Steve Carroll, T.S., Cenex, *Green Fleet Technology Study for Public Transport.* Prepared by Cenex for the Public Procurement of Innovation in Action Network (PPIA), 2015: p. 64.
[16]. IEA, *EV CITY CASE BOOK.* 2012.
[17]. IEA, *Tracking Clean Energy Progress.* IEA Input to the Clean Energy Ministerial, 2013.
[18]. Latham, S., et al., *A best practice guide for reducing emissions from taxis in London*. 2008: TRL.
[19]. Ülengin, F., et al., *Are road transportation investments in line with demand projections? A gravity-based analysis for Turkey.* Transport Policy, 2013. **29**: p. 227-235.
[20]. Newman, P., *The environmental impact of cities.* Environment and Urbanization, 2006. **18**(2): p. 275-295.
[21]. Ali, D.Z.E.A., *Mabade' takhteet al naql* Dar safa'alelnashrwa al tawzee3, Amman, Jordan, 2000. 2000.
[22]. Hussein, W.H.A., *A sustainable planning approach to resolving transportation hub problems in Egyptian cities "proposed measurement matrix".* American Journal of Environmental Protection, 2015.
[23]. Schafer, A. and D.G. Victor, *The future mobility of the world population.* Transportation Research Part A: Policy and Practice, 2000. **34**(3): p. 171-205.
[24]. Metz, D., *The myth of travel time saving.* Transport reviews, 2008. **28**(3): p. 321-336.
[25]. Banister, D., *The sustainable mobility paradigm.* Elsevier, 2008.
[26]. Dr. Abdallah Ibrahim Al Fayez, *"Takhteet al modon wa moshkelat al etemad ala altaqa ".* (http://www.aleqt.com/2207/01/28/article_7726.html), 2007.
[27]. UN.Org. *World Summit on Sustainable Development (WSSD)* publications – Johannesburg, South Africa, 2002; (http://www.un.org/arabic/esa/desa/aboutus/keyissues.html)].
[28]. Touran, A., *Integration of simulation with expert systems.* Journal of Construction Engineering and Management, 1990. 116(3): p. 480-493.
[29[. Mosa, A.M., et al., *Expert system to control construction problems in flexible pavements.* Computer-Aided Civil and Infrastructure Engineering, 2013. 28(4): p. 307-323.
[30]. Chen, L., C.D. Nugent, and H. Wang, *A knowledge-driven approach to activity recognition in smart homes.* Knowledge and Data Engineering, IEEE Transactions on, 2012. 24(6): p. 961-974.
[31]. Kaewert, J.w., *development Exeter systems for manufacturing* 2006. p. 20.
[32]. C.BEEREL, A., *EXPERT SYSTEMS STRATEGIC IMPLICATIONS AND APPLICATIONS* 1987.
[33]. Wentworth, J., *Expert systems in transportation*. 1993, AAAI Technical Report WS-93-04.
[34]. Salleh, B.S., R.A.O. Rahmat, and A. Ismail, *Expert System on Selection of Mobility Management Strategies towards Implementing Active Transport.* Procedia-Social and Behavioral Sciences, 2015. 195: p. 2896-2904.
[35]. Falamarzi, A., M.N. Borhan, and R.A.O. Rahmat, *Developing a web-based advisory expert system for implementing traffic calming strategies.* The Scientific World Journal, 2014. 2014.
[36]. Mansyur, R., et al., *Decision Suport System For Transport Demand Mangement: Object Oriented Approach Using Kappa Pc 2.4 Expert System Shell.* 2006.
[37]. Administration, f.H., *Methods and Practices for Setting Speed Limits: An Informational Report*. 2004. p. 120.
[38]. Wen, W., *A dynamic and automatic traffic light control expert system for solving the road congestion problem.* Expert Systems with Applications, 2008. 34(4): p. 2370-2381.
[39]. Zozaya-Gorostiza, C. and C. Hendrickson, *Expert system for traffic signal setting assistance.* Journal of transportation engineering, 1987. 113(2): p. 108-126.
[40]. Suttayamully, S. *Expert System for Work Zone Traffic Management in Thailand*. in *Proceedings of the 4~(th) International Conference on Road & Airfield Pavement Technology*. 2002.
[41]. Kaetzel, L.J. and J.R. Clifton, *Expert/knowledge-based systems for cement and concrete: state-of-the-art report.* Contract, 1991. 100: p. 206.
[42]. Kushida, M., A. Miyamoto, and K. Kinoshita, *Development of concrete bridge rating prototype expert system with machine learning.* Journal of computing in civil engineering, 1997. 11(4): p. 238-247.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

[43]. Malasri, S. and S. Maldonado, *Concrete mix designer.* ACI Special Publication, 1988. 111.

[44]. Ooshaksaraie, L., N.E.A. Basri, and A. Mardookhpour, *TSST: an expert system for temporary soil stabilization on commercial and residential building sites in Malaysia.* Polish Journal of Environmental Studies, 2012. 21(2).

[45]. Chassiakos, A., P. Vagiotas, and D. Theodorakopoulos, *A knowledge-based system for maintenance planning of highway concrete bridges.* Advances in Engineering Software, 2005. 36(11): p. 740-749.

[46]. Jayawardhana, L., et al., *BESTCOMP: expert system for Sri Lankan solid waste composting.* Expert systems with applications, 2003. 24(3): p. 281-286.

[47]. Peter, P.F.C., *An Expert System For Diagnosis of problems in reinforced concrete structures*. 1996, Royal Melbourne Institute of Technology.

[48]. Deprizon, S., D. Amiruddin, and R. Atiq, *Development of knowledge-based expert system for flexible pavement design.* Journal of Applied Sciences, 2009. 9(13): p. 2372-80.

[49]. Ismail, N., A. Ismail, and R. Rahmat, *Development of expert system for airport pavement maintenance and rehabilitation.* European Journal of Scientific Research, 2009. 35(1): p. 121-129.

[50]. SAINFORT, F., et al., *A pavement management decision support system.* Production and Operations Management, 1994. 3(1): p. 2-20.

[51]. Malasheskie, G., *Development Of Condition Surveys And Inventories For Guide Rail And Drainage Facilities*. 1986.