

The opportunities and challenges of applying intelligent transport systems (ITSS) on road transport in egypt: a case study on cairo-alexandria desert road

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Keywords

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Abstract

Purpose - this study focus on the benefits and opportunities of a broad field called Intelligent Transportation Systems, discuss their applications, used technologies and their usage in different areas through a wide range of user services. Furthermore, to investigate the applicability of implementing the Intelligent Transport System ITS in Egypt.

Design/methodology/approach - the research adapted a descriptive case study that was conducted on one of the main Egyptian highways which is "Cairo-Alexandria desert highway". In order to investigate the applicability of the ITS, in-depth interviews were carried out with two parties: the first party was the constructor of the highway "Arab Constructors Company", and the second party are the trucking companies as users of the highway. Moreover, a focus group was conducted with freight forwarders companies in order to verify the current problems on Cairo-Alexandria desert highway and best practice to overcome these problems.

Findings -it shows that there are a lot of challenges to adapt ITS in transport road in Egypt, while others indicated that if it is applied in Egypt that would have a huge positive effect on a lot of sectors.

Research limitations/implications - This study meets some limitations, this is because ITS is a very broad field that consists of several groups of applications with technologies. However, these limitations may be considered as a starting point for further researchers.

Introduction

Road transport industry is the backbone of the strong economy and the dynamic society. It is therefore a vital, indispensable link in the continued economic growth and development of any country. (IRU, 2013). Road transport connects places of production with places of manufacturing. This is considered the backbone of the "Door-to-Door concept" and there are certain requirements that should be adhered to in order to meet both local and international standards when building roads. However, even with all of these benefits, road transport suffers from many problems in Egypt. The poor infrastructure and the increasing rate of vehicles both have a subsequent effect on the traffic congestion and safety, which has seen an increased rate of accidents and death, especially on highways. Consistently statistics show that about (40%) of road accidents are caused by these trucks, which costs the Egyptian economy about LE 20 billion annually and catastrophic damages to lives (Ahramnews, 2014).

Recently, new trends have emerged that assist in solving such problems through the use of applying Intelligent Transport Systems (ITS). Moreover, ITS has several broad fields of different services for the users seen through applications such as Travel and Traffic Management, Public Transportation Operations, Emergency Management, Electronic Payment, Commercial Vehicles Operations, Automated Highways and Advanced Vehicles Control and Safety Systems, Information Management, and Maintenance and Construction Management (Bombay & Mathew, 2014). ITS consists of smart roads and routes, cars, buses, highways, trucks and travelers that are working together within an integrated system.

Although ITS offers a lot of opportunities, certain obstacles can be found in applying these systems, e.g. insufficient infrastructure and lack of awareness of its benefits are among these main obstacles (Bob & Judy McQueen, 1999).

This research try to figure out if the Intelligent Transport Systems (ITS) could be applied on Cairo-Alexandria desert road and to investigate the applicability and the impact of implementing ITS applications on the Egyptian roadways, through conducting a case study on Cairo-Alexandria desert highway road.

Literature review

ITS plays an important role in enhancing and increasing safety, travel speeds, traffic flow, reliability, and on the other hand reducing risks, high accidents rate, traffic congestion, carbon emissions, and air pollution (Qureshi & Abdullah, 2013). However the Commission for Global Road Safety has reported that the global road death was about 1.25 million per year. Also, in 1999, the World Health Organization (WHO) report shows that road accidents were the most significant cause of death (Bombay & Mathew, 2014). This research is divided in to seven main parts to explain and illustrate the ITS concept followed by the benefits and objectives of ITS .

- **Intelligent Transport Systems Concept**

There must be ways to maximize and increase the efficiency, safety and mobility, and decrease the environmental impact of road transport through reduced fuel consumption. However, ITSs provide the opportunity to integrate travelers, vehicles, and infrastructure into a comprehensive system through communication and information technologies for the purpose of increasing the capacity of infrastructure, ensuring safety, providing more efficient and economical transportation (McGregor, 2003). So according to (Wang, 2001) the ITS can be defined as "ITS is the integrated and effective use of the advanced technologies in such fields as information, communication, control, sensing and system interoperation on the basis of compete infrastructure to the surface transportation, so as to provide real-time, precise and efficient transport services functioning on wide ranges".

ITS have relays on a wide range of advanced technologies and applications that were originally developed for solving transportation problems. This group of services generally comprises four distinct areas that categorize ITS as: Multimodal Management and Traveler Information, Commercial Vehicle Operations, Intelligent Vehicle, and, Advanced Rural Transportation Systems.

All of these benefits could not be achieved without real-time information which would allow the transportation network and stakeholders (owners and managers of transportation systems, fleet operators, and road authorities) to act together based on the integrated information and communication for the sake of increasing safety, efficiencies, productivity, and mobility (Giannoutakis & LI, 2012).

Benefits and Objectives of Intelligent Transport Systems

Intelligent Transport Systems can deliver a wide range of significant benefits and objectives to the transportation field. Moreover, it can help meeting increasing demand through applying latest advanced and communication technologies in improving safety and making the most effective use of existing roads. Since the researchers suggest 6 main benefits and objectives of ITS such as: Safety, Mobility, Efficiency, Productivity, Energy, and Environment. (Vanderschuren, 2006), (Mitretek Systems, 2001)

Types of Intelligent Transport Systems

The ITS is a very broad field since the innovations in communication technologies, allow the appearance of various structures to implement ITS in different ways. Therefore, many structures has appeared to clarify the ITS applications and their services. Starting with, The National Architecture for ITS has developed a structure by the ISO TC204 working team. This structure gives a complete overview of the ITS applications and services, and is divided into eight main applications and 32 sub-system services (as shown in table 1): (Breen & Ward, 1999).

Table 1: ISO ITS User Services

Application	Sub-System Services
Traveler Information	<ul style="list-style-type: none"> • Pre-trip information • On-trip information • On-trip public transport information • Personal information services • Route guidance and navigation
Traffic Management	<ul style="list-style-type: none"> • Transport planning support • Traffic control • Incident management • Demand management • Policing/ enforcing traffic regulations • Infrastructure maintenance management
Vehicle	<ul style="list-style-type: none"> • Vision enhancement • Automated vehicle operation • Longitudinal collision avoidance • Lateral collision avoidance • Safety readiness • Pre-crash restraint deployment
Commercial Vehicle	<ul style="list-style-type: none"> • Commercial vehicle pre-clearance • Commercial vehicle administrative process • Automated roadside safety inspection • Commercial vehicle on-board safety • Commercial vehicle fleet management
Public Transport	<ul style="list-style-type: none"> • Public transport management • Demand responsive transport management • Shared transport management
Emergency	<ul style="list-style-type: none"> • Emergency notification and personal security • Emergency vehicle management • Hazardous materials and incident notification
Electronic Payment	<ul style="list-style-type: none"> • Electronic financial transaction
Safety	<ul style="list-style-type: none"> • Public travel security • Safety enhancement for vulnerable road users • Intelligent junctions

Source:(McQueen & McQueen, 1999).

The following structure was clarified by the European Road Transport Telematics Implementation Coordination (ERTICO) which is a partnership of around 100 companies and institutions that are involved in the production of Intelligent Transport Systems. ERTICO has classified another structure that clarifies the ITS. That structure is divided into three main groups and seven sub-system services (as shown in table 2): (Vanderschuren, 2006).

Table 2: The European Road Transport Telematics Implementation Coordination (ERTICO) ITS Structure

Application	Sub-System Services
Intelligent Traffic Management Systems	<ul style="list-style-type: none"> • Highway and traffic flow management • Incident management • Intelligent speed adaptation
Intelligent Passenger Information Systems	<ul style="list-style-type: none"> • Passenger information system • In-vehicle route guidance system
Intelligent Public Transport Systems	<ul style="list-style-type: none"> • Intelligent vehicle • Electronic payment

Source: (Vanderschuren, 2006)

The most recent framework, that has been developed according to the National ITS Program Plan, highlights the ITS services and features based on the latest innovations of communion technologies. This structure is composed of a number of user services and is based on the perspective of sharing information between various services and applications. This framework is divided into eight main applications and 28 sub-system user services (see table 3): (Bombay & Mathew, 2014)

Table 3: The National ITS Program Plan

Application	Sub-System Services
Travel and Traffic Management	<ul style="list-style-type: none"> • Pre-trip information • In-route driver information • Route guidance • Ride matching and reservation • Traveler information services • Traffic control • Incident management • Emissions testing and mitigation • Highway rail intersection
Public Transportation Operations	<ul style="list-style-type: none"> • Public transportation operations • In-route transit information • Personalized public transit • Public travel security
Electronic Payment	<ul style="list-style-type: none"> • Electronic toll collection
Commercial Vehicle Operations	<ul style="list-style-type: none"> • Commercial vehicle electronic clearance • Automated roadside safety inspection • On-board safety monitoring • Commercial vehicle administrative process • Hazardous materials incident response • Freight mobility
Advanced Vehicle Control and Safety Systems	<ul style="list-style-type: none"> • Longitudinal collision avoidance • Lateral collision avoidance • Intersection collision avoidance • Vision enhancement for crash avoidance • Safety readiness • Pre-crash restraint deployment • Automated vehicle operations
Emergency Management	<ul style="list-style-type: none"> • Emergency notification and personal security • Emergency vehicle management
Information Management	
Maintenance and Construction Management	

Source: (Bombay & Mathew, 2014)

Therefore, it is concluded that ITS has many applications with different services that can be offered to the users depending on the latest innovations of communication technologies, and the applicability of implementing some or few of these applications in a country.

ITS applications as described before are designed to solve transportation problems. The ITS are implemented in several countries all over the world, some of them are from the developed countries, such as Japan, the United States, the United Kingdom, Europe, and Canada, while others are from the Arab world, such as Dubai. On the other hand, there are some of the developing

countries, such as India. The next section will give a brief background about the applicability of ITS in some countries.

Japan

Japan, is one of the first countries that have started the ITS research in its early beginning in 1960s and 1970s. Japan has greatly contributed to developing ITS to solve traffic congestion and other transportation problems, such as traffic accidents and environmental pollution (Tokuyama, 1996). Japan has started implementing the ITS project in four phases. In the first phase (1960-1984), it started applying the in-vehicle navigation system for the route guidance and electronic payment. The second phase (2005) provided updates and improvement of information services based on the errors discovered in the first phase. In addition, one of the core areas of development of the second phase is applying the emergency management system which encompasses rapid rescue and emergency activities for the travelers and users.

The third phase (2005-2010) includes improvements of new and existing infrastructure and onboard vehicle equipment. The last phase, which was after 2010, includes integrating all information technologies which are used by travelers, installed onboard of the vehicles, and established on road sides, and applying them in a fully functional ITS. (Vanajakshi, et al., 2010).

The Japanese government has invested with the private sector in implementing the ITS applications, which resulted in decreasing congestion percentage from 60.3% to 29.3%, tunnel entrance from 20.8% to 7.3%, congestion during passing tolls from 32.1 % to 0.1%. (Ministry of Land, Infrastructure, Transport and Tourism, 2004).

Dubai

After the success of the ITS, which was inspired by traffic efficiency and road safety in several countries like Japan, the United Arab Emirates was the first Arab country that started implementing the ITS in Dubai in 2002. The implementation of the ITS started in Dubai for two main reasons: firstly, to serve the rapidly growing population and to solve related traffic problems; and secondly, to attract investors from all over the world after the potential economic growth. Since mid-2002, the ITS project by the Government, started the construction of new roads and enhanced road networks, before implementing "Travel and Traffic Management application". The government started with installing CCTV cameras, radar and infrared sensors, along road sides, bridges, and tunnels and established a traffic control center for storing, processing, and distributing data among users. After applying this application, many benefits have been achieved as follows: in case of traffic congestion, the users are automatically advised with alternative routes; diverting traffic away safely from accident induced blocked lanes; applying speed limits warning during accidents or congestions; easy and rapid approach to accidents locations and reaching injured drivers and passengers as soon as possible; and automatic traffic management during special events to reduce traffic congestion. In 2013, the government started the testing phase of applying Public Transportation Operations application in Dubai, and it was also considered to be the first Arab country to enable users to use their mobile phones in booking tickets for several means of transport like metro stations, buses, and taxis. (Vanajakshi, et al., 2010).

India

After the success of the ITS in developed countries, India, started its early stages in applying some of the ITS applications on a small scale, such as Travel and Traffic Management, Public Transportation Systems, and Electronic Payment applications, aiming to improve safety, eliminate traffic congestion, and ensure fast and reliable transportation to cope with the fast growing population. However, all of these applications have been applied on a trial basis in some cities like Delhi, Chennai, Mumbai, Ahmedabad, Pune, and Bangalore since September 2009.

India has started the trial implementation with Travel and Traffic Management application, in Delhi, Mumbai, Chennai, Pune, and Bangalore. This application was funded by the government

and a financial aid from the World Bank. With the help of this financial support, the government started installing CCTV cameras, wireless towers, radio beacons, infrared and radar sensors along road sides in the mentioned cities; to monitor the traffic flow and advice users with alternative routes in case of congestion, and warn the drivers who violate the rules.

On the parallel sequence, the government has customized and applied the Public Transportation System on Pune, Ahmedabad, and Chennai cities. The government has applied this application on bus stations, depending on the GPS in that application, to track and monitor the buses, then informing the passengers on display boards that are provided at bus stations with the time of arrival for the coming bus so that passengers can utilize their waiting time at stations and avoid long waiting hours for buses.

The third applied application was the electronic payment. This application was applied for two services. The first is Electronic Toll Collection (ETC), which was designed for a faster toll collection on highways. ETC consists of several technologies like Automatic Vehicle Identification (AVI), Automatic Vehicle Classification (AVC), and Vehicle Positioning System (VPS). ETC was deployed on highways of Kharagpur, Delhi, and Chennai cities, operated and owned by the private sector. The second service is Advanced Parking System (APS), The government has also applied that service for electronically collecting parking fees, and guiding users with a long range of sensors, lights, signboards, and directional displays. This service is applied to Palika parking in Delhi, that is operated and owned by the government. (Vanajakshi, et al., 2010).

The Indian government has invested about €1.6 million to implement the ITS applications, which resulted in improving traffic regulations, reduction of road accidents and congestion by 52%, new roads infrastructure by 26%, and road upgrade by 17%. (Sengupta, 2014).

Finally, the success of ITS depends on the integration between transportation means, modes, and users through advanced communication technologies in order to provide real-time information for all the users. That integration will result in offering many benefits like: enhancing public safety, efficiency, mobility, accessibility, and intermodal connections.

Intelligent Transport Systems consists of a group of 8 applications with several user services introduced for each application. These applications are: Travel and Traffic Management, Public Transportation Operations, Electronic Payment, Automated Highways and Commercial Vehicles, Advanced Vehicle Control and Safety Systems, Emergency Management, Information Management, and Maintenance and Construction Management. Through these applications, many services are introduced in which many transportation problems can be solved in an efficient and effective way and many areas will take advantages as mentioned in the last part that includes examples from developed and developing countries .

Research Methodology

The inductive qualitative study will be conducted through two research approaches: a case study interview and Focus Group. These methods were selected in order to identify and clarify the main transportation problems on "Cairo-Alexandria desert road" (as a single-case study) that will be conducted in order to understand the main reasons behind the current problems, and finally to recommend a framework for the applicability of implementing the most appropriate type/s of ITS on Cairo-Alexandria desert road, for solving the identified problems.

The data that was collected for this research are done through secondary and primary data. Secondary data are collected from documented records. While, the primary data are collected through semi-structured interviews with "Arab Contractors Company" as a constructor of the highway, and trucking companies. The second stage is the exploratory stage, in which opportunities and challenges of ITS for the trucking companies as users will be assessed through semi structured interviews as well.

The previous interviews show that the recent developments have helped in enhancing traffic mobility and safety on Cairo-Alexandria desert highway. However, there are several common

problems that face the trucking companies related to the *transportation of goods* on the highway as follows:

1. The twin lane services:

These lanes are on both sides along the highway and are specialized for commercial vehicles to avoid the occurrence of accidents. It was found that these lanes are not developed enough for efficient and productive transportation as any accident either by human error or bad weather has a direct negative effect on the traffic mobility.

2. Traffic congestions during passing tolls:

A lot of time is being wasted during passing tolls. This is due to the undetermined tariff for the overloaded commercial vehicles (that exceeds 55 tons). Moreover, it takes long time of negotiations between the vehicle's driver and the highway authorities to determine tariff. This problem leads to increasing traffic congestion, immobility besides the waste of time and money for the users.

3. Lack of information:

The lack of information on the highway is another variable of traffic congestion e.g. *notifying users for slowing down speed in case of accidents, congestions, or bad weather conditions.

4. Lack of quick response in case of accidents:

Due to the lack of communication technologies, in case of the occurrence of any accident on the highway the information would not be delivered to the appropriate emergency needed except by users through telephone.

Moreover, there are other common problems related to the *fleet management* of the trucking companies. It was found through the interviews that some companies use communication and technologies (ETIT) in managing their fleet and monitoring drivers such as TGL, NOSCO, and El-halmoushi. On the other hand, some Companies are not using these technologies, but they are willing to implement them such as ESCIT, Mirage, AGL, and Ibrahim El-basha. Finally, one company, Egytrans Company, does not apply these technologies and is not willing to implement them. However, there are common problems between these companies related to fleet management as follows:

✓ ***Companies that apply information technologies:***

Although some companies can manage their fleet and monitor drivers electronically (as discussed before), they cannot determine or gather any information about the current road condition (traffic conditions, congestions, bad weather, road maintenance,... etc.) either before starting or during the trip. This information could support operators for better decision making; for example, choosing the shortest or alternative route in case of congestions or accidents. Moreover, it is concluded that these companies face some problems related to the unqualified drivers as they cannot deal with advanced technologies inside vehicles like the GPS devices. Thereby, operators depend on communicating with drivers through telephone.

✓ ***Companies that do not apply information technologies but are willing to implement them***

It is concluded that companies that do not apply information technology in monitoring drivers and managing fleet, suffer from some problems related to the unqualified drivers, such as waste of cargo during transportation, exceeding speed limits, use of drugs, and waste of time and money due to inability of monitoring drivers through advanced technologies such as GPS, and lack of information between the vehicle and operators. Therefore, these companies have the intent to invest in such technologies in order to save costs, time, and waste of cargo.

✓ ***Companies that do not apply information technologies and are not willing to implement them***

It was found that these companies face the same problems (as discussed before) with drivers. However, they are not willing to invest in such technologies to avoid payment of a large amount of taxes.

From the analysis of the semi structure interviews, the challenges were classified into seven challenges, eight candidates were selected to verify the results of the interviews, which demonstrate the main dimensions of the challenges that face the trucking companies and the constructor of the highway. The focus group was conducted with freight forwarders who are experts from different companies, the current problems on Cairo-Alexandria desert highway were addressed as follows:

1. Undeveloped twin lane services
2. Undetermined tariff
3. Lack of information related to the current road conditions
4. Lack of quick response in case of accidents
5. Unqualified drivers
6. Waste of goods and time during transportation
7. Lack of shared information between vehicles, operators, and users

The focus group confirmed the current problems on Cairo-Alexandria desert highway. That focus group was done with a group of managers and operators from different freight forwarding companies; as many freight forwards do not own a means of transportation, but they depend on using the means of the trucking companies for transporting goods. A framework was concluded to explain the most appropriate ITS application in order to overcome the addressed challenges (see table 4).

Table (4): Framework for Implementing ITS on Cairo-Alexandria desert highway

Problem	Overcome
Traffic congestion while using twin lane service	<ul style="list-style-type: none"> • Pre-trip Information • Real-time Information • Route Guidance • Maintenance and Construction management
Undetermined tariff	<ul style="list-style-type: none"> • Commercial vehicle operations • Electronic payment
Lack of information related to the current road conditions	<ul style="list-style-type: none"> • Travel and traffic Management
Lack of quick response in case of accidents	<ul style="list-style-type: none"> • Travel and traffic Management • Emergency notification
Unqualified drivers	<ul style="list-style-type: none"> • Monitoring the driver's condition
Waste of goods and time during transportation	<ul style="list-style-type: none"> • Monitoring the highway through communication and information technologies.
Lack of shared information between vehicles, operators, and users	<ul style="list-style-type: none"> • Integrated real-time information between users, operators, and vehicles.

A Framework for Implementing ITS on Cairo-Alexandria desert highway

Source: (El.Husseiny, Hussein 2016)

Conclusion

This paper has highlighted the current problems on Cairo-Alexandria desert road from the constructor's and trucking companies' point of views. Although Cairo-Alexandria desert road is one of the main Egyptian highways as 85% of internal trade is transported through it; that road faces many challenges as discussed before. Besides, there are some problems related to the road maintenance in which there is no means of communication (not even a camera) that can monitor the highway infrastructure or deliver any information about any accident or damage that happens on the highway and it was found that commercial vehicles are the main reason of accidents on the

highway. Therefore, in order to overcome these problems, it is concluded through the descriptive study that the implementation of ITS on Cairo-Alexandria desert highway requires public-private relation (between the government and the industrial sector). This is because the government already supports some tracking and monitoring services to the users through the Egyptian Tracing and Information Technology (ETIT), and most of the trucking companies apply these technologies, while others are willing to implement and develop. In order to solve the traffic congestion problem and avoid the waste of time and cost, it would be more reliable to support users with pre-trip information, real-time information, unifying tariffs and electronically inspecting commercial vehicles and collecting payments through electronic payment and commercial vehicle operations that will improve the traffic mobility and productivity for the users. The maintenance and construction management for supporting the operator with the related information about the highway infrastructure condition and processing and sending this information for users in case of damage is also significant. Besides, monitoring the driver's condition and as well as the commercial vehicle to avoid waste of goods during transportation. In addition, integrating the whole transportation system through information management system, through collecting, processing, and sharing real-time information among users is of paramount significance. Emergency management for improving safety and ensuring quick response through the integrated information between the emergency respondents and users also counts.

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