European Online Journal of Natural and Social Sciences 2016;
Vol.5, No.3 Special Issue on Humanities and Social Sciences
ISSN 1805-3602

Economic Analysis of Intelligent systems in Urban Transportation (Smart Cameras)

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Abstract

One of the problems of modern societies in big cities is traffic. Heavy and problematic traffic in big cities arises from the growing number of vehicles and lack of adequate routes for moving vehicles. Traffic congestion problem in urban areas is mainly due to the structure or inappropriate city streets in the lack of capacity for existing cars. However, the fact of the matter is that, there are other factors such as equipment and traffic control systems, which are effective in traffic conditions. In their limit, they can make the desirable and favorable Physical conditions of traffic, inappropriate or intensify the existing traffic problems. Since, installation and use of each of these systems are costly; therefore, this research examined the economic analysis of intelligent transport systems, particularly smart cameras, which is one of the most useful systems in the transportation sector, especially urban transportation systems. This was done according to statistics, between 2011-2016 and statistics prepared by Traffic control companies, General Department of Research and Development Deputy of Naja Traffic Police, a comprehensive company of transport, central insurance of Iran, statistical Center of Iran, and students' perceptions.

Keywords: Smart cameras, passenger transportation, economic analysis

Introduction

With the development of ICT and their benefits in transportation such as reduction of accidents, reduce the duration of help in accidents and emergencies, increasing the capacity of roads, reduction of travel time, reduction of delay time, etc. It is necessary to take serious efforts in the way of distributing investment and decision-making based on new technology and intelligent systems to enhance efficiency and improve the performance of transportation systems. (Ahedy Ali, 2013; Saffarzadeh, 2014) Of course, it should be noted that unnecessary haste that is based on the lack of deep understanding of the traffic management complexities, and I.T.S, in addition to project failure, also leads to the elimination of executive backgrounds in next projects. Therefore, perhaps many intelligent systems that previously have been diagnosed useful and when they have been investigated with correct and scientific method, it turns out that these systems have no effect and even they have negative results. There were many times that the implementation of a specific system in different communities with different cultures has different effects. In this paper, the economic analysis of using smart cameras is investigated.

Intelligent Systems

In order to reduce problems, the construction of more streets, roads and highways were on the agenda of decision makers from the 60s, but the problems did not eliminate. Gradually, transportation planners learned by experience to consider the category of passenger transportation, instead of car transportation, especially in urban areas. Thus, creating huge networks of public transportation such as metro and bus has begun. Gradually, other solutions such as attention to land use and transportation demand management and providing facilities in different areas such as public

services and schools in reducing trips, were taken into account. Since the 90's, the experts have found that consumers have used the capacities and new features in a short time. In addition, due to the competition between "Road construction" and "production of convenient and inexpensive cars", the construction efforts had little effect and road safety was declining steadily.

On the other hand, technological advances of the day, provided favorable conditions for creating uninterrupted communication (Online) between decision-makers, traffic management centers, vehicles and road traffic condition via sensors and electronic devices and thus, the possibility to create an intelligent, targeted and coordinated management was achieved in order to improve productivity and increase network performance. That was in this way that at the beginning of the 90s, intelligent transport systems (ITS) were born in their modern sense. Although, before 90's, which means during the late 70's, projects such as the installation of cameras at the urban intersection and intelligent control of traffic lights' timing according to the traffic volume (Actuated Traffic control systems) has been started in many countries. However, the intelligent transport systems (ITS) term was particularly becoming popular since 1990 for the first time in America and it covered all relevant projects and technologies and especially, the interactive relationship (Transactions) between them in a macro and integrated structure (Donald G, J.(1997).

In fact, the recent features made the difference between ITS set with scattered and island projects, clear. With this view, the main feature of ITS is creating communication and coordination between projects and different applications of transportation technology. Unfortunately, this is a point which had less attention on common uses of ITS in our country (Guozhong et al (2004); Clark, C. (1957)). ITS is an abbreviation for the phrase Intelligent Transportation systems, which contains all the information, telecommunications, control, system engineering technologies, as well as strategies, management decisions and coordinating mechanisms that as a result of using them, improving transportation and traffic parameters such as reducing travel time, fuel consumption and increasing safety will be achieved. There are different definitions of ITS that the common concept of the definitions emphasizes on the targeted and coordinated use of information and communication technology and management strategies with the condition to improve the productivity, efficiency and safety of transport systems (Dittmar, Hank et al. (2014). Unfortunately, in recent years, ITS young fans provided false definitions of the subject as well as shallow performances that have a greater emphasis on the use of equipment and technologies and have caused some traditionalist veterans deny any effectiveness of ITS.

From the perspective of the subject and technologies, the ITS is divided into two main categories of intelligence infrastructure (ITS Infrastructure) and intelligent vehicles.

Intelligent infrastructures mainly consist of projects that are executable as infrastructure projects in urban and suburban roads by municipalities in cities or by the Ministry of Road in suburban roads and freeways. Such as the installation of intelligent control systems at intersections or installation of variable traffic signs that are installed on the road. Intelligent car part also includes new technologies in the car such as alarm systems prevent accidents, night vision systems, as well as navigation Systems and other projects that its implementation is mainly the responsibility of car manufacturing.

This division brings us to the immediate conclusion that successful implementation of ITS at the national level requires major coordination in the first step between the Ministry of Industry and a ministry of Municipalities. It should be noted that ITS planning in Japan has been established with coordination and participation of five ministries (Kenneth thenson. (1980).

In our country, ITS was followed initially with urban attitude at the beginning of the 70s in Tehran and now, it is widely welcomed by stakeholders and authorities of urban, road and railroad transportation and each of the projects is designing and implementing separately. Although this

chance is a positive approach and a forward movement, but in the future, the lack of ITS strategic plan at the national level will cause vulnerabilities in the progress of projects and not achieve the necessary result. Since the correct use of ITS requires the knowledge and understanding at the same time, in transportation and traffic expertise as well as information and communication technology and attention to strategies and organizational and management planning, therefore, it is necessary to give the design and implementation of projects to the right combination of experts in related fields. With regard to the issue in Journal of Highway Technology, it should be noted that many ITS services will be realized via telecommunications infrastructures, including fixed and mobile communications. ITS telecommunication requirements include the following communications:

1. between two fixed points (roadside equipment such as a camera to control center)
2. between a fixed point and a moving point (such as AVL and electronic toll collection)
3. between the moving points (Car Connection)

This means that the provision of telecommunication platform for launching ITS projects includes a wide range of technologies and telecommunications and especially optical fiber, wireless and cable systems.

The discussion of supplying ITS telecommunication requirements is the most challenging issues of ITS and now, it is a major obstacle in the development of ITS in Iran. The financial double burden in launching many ITS projects is due to the lack of communication platform required for the project. That is why traffic Control Company of Tehran spent a huge part of its budget to establish a dedicated fiber-optic communications platform that, however, it is inevitable from the perspective of the project owners, but it is clear that in the national and macro scale, creating dedicated infrastructures means wasting or at least lack of efficient use of resources and represents a part of the hidden losses of the public sector monopoly and the inability to provide timely and needed services to applicants.

ITS is composed of several systems that its components are intricately interwoven. Although the consolidation and integration of these systems are considered as unique and inherent advantages of ITS and the prerequisites for its effectiveness, but the same feature can turn into one of the ITS growth and development obstacles in our country due to the need for coordination and cooperation organs and different components. Aggregation and integration of systems require an activity that can be defined as the system architecture (Architecture). Studies of system architecture show that how the system components affect each other and act as a unit. System architecture is the ITS development necessities that without prescribing specific technologies, it gives system designers the freedom to design the systems interface in a definable and standard way that involves benefits such as increased competition, reducing the risks and the costs. The main strength point of system architecture is providing the framework and the strategic basis that is integrated through the activities of the different stakeholders (Donald G, J. (1997).

One of the advantages which are emphasized in various articles and reports are synergies features of intelligent transportation systems. Synergy feature teaches us that simultaneous use of ITS projects has more advantages than their separate and distinct application of each. For example, the electronic toll collection system (ETC) can be used to manage traffic. The information on Bus Fleet Management System can be used to evaluate traveling time in different directions and guide drivers to more suitable routes. It makes us realize that right selecting of projects and the development of project planning can be very effective and useful (1).

This is a mistake to simply consider ITS as mechanizing traditional transportation operations. This definition summarizes the concept of ITS in using hardware and equipment, while I all sources, it has been emphasized in the service-oriented of ITS operation. In other words, prioritizing and selecting ITS projects should be done based on their useful effectiveness in

improving traffic index and solving problems and transportation network needs. With this approach, installation of equipment, even by using the most advanced does not necessarily mean doing the right and suitable thing and certainly, because of the financial burden arising from the application of new technologies and failure to observe its effects, it can cause paranoia to ITS projects in transportation decision-makers.

The research history

The beginning of traffic control returns to car history in the 1860s in London when a traffic light was installed for the safety of parliament members at an intersection near the parliament. In America, there are still some basic forms of traffic control of the old lights that were installed in the 1910s and the first traffic lights in its present form was used in 1920 in Detroit and Michigan. From this simple beginning, traffic control systems created, which include a wide range of equipment such as smart camera control at intersections, variable signs, speed control systems, etc. Over time, the traffic control cameras promoted from a primitive form with fixed timing to its present form, which means transport and traffic control.

Economic and financial variable in the transportation industry

The transportation industry is an intermediate, sensitive, strategic and economic dynamic industry in the service sector that reduces costs in it, undoubtedly along with the growth of other industries, increasing per capita GDP and development (5). Transportation, work, traveler, materials (raw, industrial, agricultural, food, pharmaceutical, health, chemical, etc.), machinery, equipment, imported, exported and transit products are important factors that can be improved as much as possible in the form of spending time and energy indicators (McGeehin, p, 2000).This improvement can be done with controllable variables on an ongoing basis when knowledge and awareness can serve the strategic thought.

Today’s knowledge-based economy that knows knowledge as the foundation of preparation, production, distribution and consumption, requires strong and intelligent transport industry to use the modern knowledge, coordinate and integrate with other sectors and meet today's diverse needs of the world. In the knowledge economy, intermediaries must increase their value and while, in today’s service sector, intelligent systems have the fastest accelerating growth; this value-adding requires wider factor. As it was listed, technology is the most practical form of knowledge that its use is very useful in implementing integrated networks, reducing the cost and time and energy, especially in the transport industry. According to different functions of information technology and the combination of its capabilities, despite intelligence agencies and analyzing and convergence of information in conversion, processing and data exchange, the field of design and implementation of intelligent software in most of locating and positioning systems and smart cameras is easily provided which implies the accountability of technology, comprehensive plan as the main and a strategic supporting role in the productivity of transportation organizations game, economically.

Research Methodology

In this paper, the technique of benefit / cost (B / C) that is applied in the economic studies related to the construction or reconstruction of roads will be used. However, the results obtained from the above method lead to important economic decisions. Transportation has many benefits for individuals and society and also imposes a lot of costs.

Recognition of effective factors in the benefits B), recognition of effective factors in costs (C) and the assessment of investment and finally, (B / C) evaluation can facilitate decision-making.

Variables have been prepared according to statistics, between 2011 to 2016. The statistics have been gathered from traffic control companies, General Department of Research and Development Deputy of Naja Traffic Police, comprehensive company of transportation, central Insurance of Iran, statistics center of Iran, and perceptions of students and they are classified and used according to their applications.

Research findings

In the last two decades, due to the wide use of smart cameras in the world, for application of this technology in Iran, in various sections, applicable projects have been exploited to improve the city's traffic and transportation issues. Although, Iran's share is very small in comparison with other countries, but the performance of this technology in measuring the ratio of benefits to costs can determine the acceleration in the comprehensive and complete situation of using this technology in solving the transportation and traffic problems in the cities with construction and maintenance index to the ITS of Iranian Society. Table 1 provides an example of applying projects with their useful lifetime.

Table 1: The project costs of intelligent transportation cameras, implemented in Tehran Highways

The applications in highways	number	The cost of construction and installation or launching (million years)	The annual maintenance cost (million Toman)	The useful life (years)
Traffic control cameras	400	16000	2400	15
Speed control cameras	200	5000	800	15

Estimating the benefits of smart cameras

Estimating the benefits

- **Achievement coefficients** out of the country and estimation of smart cameras achievements based on the performance were studied and for each evaluation index, the minimum average yield of each is represented in table (2).

Table 2: Achievement coefficients in any field of study for each evaluation index

Field of study	Safety	Movement ability Crossing	Productivity	Users' satisfaction	Energy and Environment	Total benefits of each system
Speed control cameras	18%	33%	17%	19%	18%	18%
Traffic control cameras	17%	16%	17%	19%	15%	17%

Value measuring of benefits

According to achievement coefficients in any field of study about each evaluation index on the table (2) and also the costs (Rial monetary value), the evaluation index in each field of study has been presented. The calculation of benefits for each of the indexes in the cities of Iran can be seen on the table (3).

Table 3. The calculation of benefits for each of the indexes in the cities of Iran

Field of study	Safety	Movement ability Crossing	Productivity	Users' satisfaction	Energy and Environment	Total benefits of each system
Speed control cameras	4.3	298.29	86.67	77.59	297.45	764.3
Traffic control cameras	8.5	244	61.66	76.60	322	712.7

The ratio of benefits to costs

After estimating the invested costs and converting them into value (vehicle - Rial / min) in Table (5) and then estimating the benefits and converting them into value (vehicle - Rial / min), the ratio of benefits to costs comparison (B / C) will be done in each of them. Figure 1 represents the value of (B / C) in each of the projects and comparing the projects with each other.

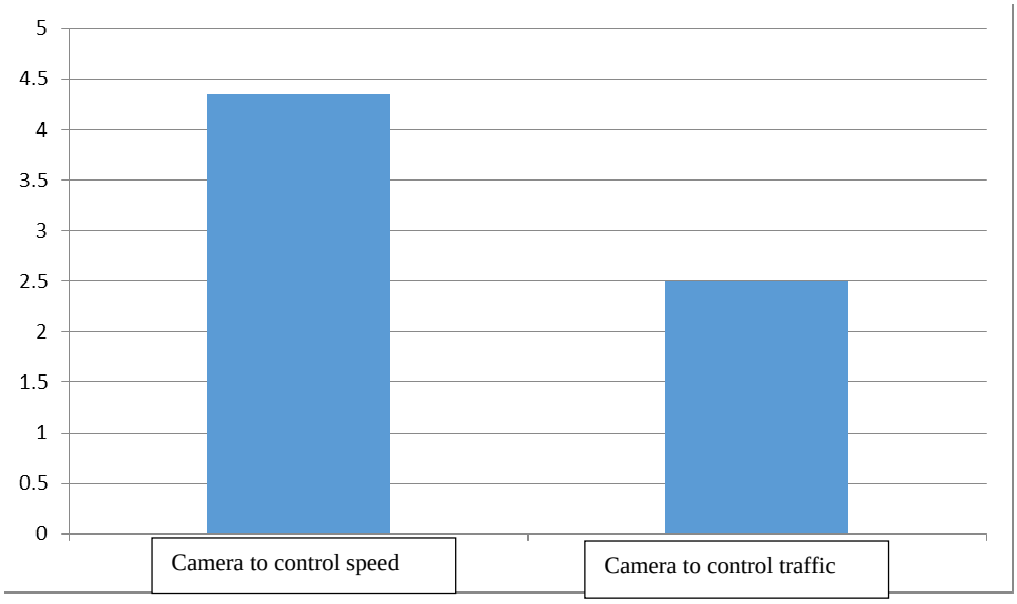

Figure 1. The ratio of (B / C) in ITS projects

Conclusion

From the perspective of Engineering Economics, intelligent transportation systems are the pillars of this research by using the method of evaluating the benefits to costs. Among them, the methods of planning, shaping, and transportation systems operation were conducted after the

formation of the study. Therefore, in this research, the economic analysis of intelligent transportation systems especially, intelligent cameras have been examined as one of the most practical systems in the transport sector, especially urban transportation.

With the development of ICT and their benefits in transportation such as reduction of accidents, reduce the duration of help in accidents and emergencies, increasing the capacity of roads, reduction of travel time, reduction of delay time, etc. It is necessary to take serious efforts in the way of distributing investment and decision-making based on new technology and intelligent systems to enhance efficiency and improve the performance of transportation systems.

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