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Review article

THE DEVELOPMENT AND APPLICATION OF INTELLIGENT TRANSPORT SYSTEMS AND THEIR IMPACT ON TRAFFIC SAFETY

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Abstract

Intelligent transport systems (ITS) have data collected from different sources intelligent modern movement systems and indexes should be determined for the evaluation of their impacts based on their data. There are several methodologies for the evaluation of their impacts on the traffic safety system.
When considering Intelligent Transportation Systems (ITS) as one of the applied methods for the safety of the movement in the context of planning the movement through urban environments and other areas, it is clear to us that the efficiency of the ITS should be valued with full confidence.
With the development and application of Intelligent Transport Systems (ITS), the following efficient and effective results are expected in terms of their impact on road safety, such as:

- For a fast and efficient traffic system,
- To increase safety in the traffic system, as well as
- Reducing the number of traffic accidents.

The purpose of this paper is how to introduce an effective and efficient Intelligent Transportation System (ITS), as well as its impact on increasing safety, reliability and reducing the number of traffic accidents.
This paper will analyze the meaning of ITS as well as their impact on the traffic safety system.
At the end of this paper, there will be a conclusion where it is determined how ITS can be applied in the safety system and their impact on this system, which has an impact on safety, reliability in traffic and in reducing the number of traffic accidents.

Keywords: Intelligent Transportation Systems (ITS), safety, security, traffic accidents, security system.

1.INTELLIGENT TRANSPORT SYSTEMS (ITS) THEIR DEVELOPMENT IN THE MODERN WORLD FOR OBTAINING ACCURATE AND TIMELY INFORMATION FOR THE ENTIRE TRANSPORT SYSTEM AND ESPECIALLY FOR TRANSPORT SYSTEMS

Intelligent transport systems (ITS) are advanced applications that aim to enable innovative services related to different transport models and traffic management and to enable users to be informed as accurately and timely as possible, to make their efficient use, and that it be coordinated with all networks of the transport system.
Recently, a series of services from (ITS) Intelligent Transport Systems, enable support systems for the movement of services, the concept that as a single service and only the movement and the service on demand enables a range of integrated transport services as an alternative to owning a single vehicle as well as the ability to access transport in particular.

The ITS solutions already adopted for the management of movement in urban zones that adopt the following elements:

- Interactive traffic management,
- Integrated multimodality passenger services (multimodality information services, tickets and intelligent reservations),
- The services of the Intelligent Systems of Cooperative Transport (K – ITS),
- The control of claims in the road infrastructure,
- Monitoring the behavior of users during movement and
- The management and request for support of the sustainable solutions of the movement.

For this process, ITS should understand that there are three roles associated with movement planning:

- The funds for the implementation of the transport measures and the implementation of the planned policies,
- City infrastructure to enable innovation in transport and beyond,
- Provider of the data for support, development, monitoring, evaluation and evaluation of the plans of the urban real movements - (SUMP - Sustainable Urban Mobility Planning).

Therefore, the role of ITS can be combined with the planned steps of urban real movements to determine:

- The weight of ITS (existing and future) with the actual planning of urban movements,
- How they should be treated by ITS in the process of urban movement planning – SUMP, that is, what should be done during the phase planning to be taken over by ITS and to unlock its potential.

1.1. Intelligent transport systems Intelligent transport systems differ in application technology, from basic management systems such as navigation and vehicles, traffic signal control system, container management system, automatic recognition of tables or speed cameras, automatic accident detection or system to the detection of parked vehicles, to applications that are advanced and that integrate direct data and reactions from a series of other data, similar to information systems and parking instructions, weather information, bridge melting systems and the like. Furthermore, forecasting techniques are being developed to allow modeling and comparison, advanced with historical data. Some of these technologies are listed below:

1.1.1. Hardware TIS – a: The hardware and information system of the transport consists of technical equipment that is installed on the vehicles and creates a connection with the logistics computer of the transport company:

- An on-board computer is an electronic unit that includes software for reading and storing data from the vehicle and/or for reading data downloaded from GPS and controls data transmission. This part of the system can also retrieve data from the terminals and the driver, and can be considered as a personal computer in the vehicle.
- The function of the fuel gauge sensor is to monitor the fuel level in the vehicle.
- An analog tachograph records data related to the driver's activity in tachograph slides. A part of the data for the sheets (name and surname, initial and final mileage, vehicle registration number), supplemented by an independent option (by hand) by the driver. It is possible to keep all registered data on one sheet for 24 hours.
- A digital tachograph is used to monitor the current speed of the vehicle, the engine speed, the position of the gear box, the time spent by the driver. The tachograph is connected to the on-board computer and the communication equipment as a logistics sector enables a different mirror of the speed and the change of the engine torque while driving, the number of kilometers traveled, the driving time and others.

- A GPS receiver is a piece of equipment that is sometimes needed like a radio receiver. It enables, signals the reading of 12 satellites and can determine vehicle positions anywhere in the country from 10 to 12 meters or from 1 to 5 meters if a GPS differential receiver is used. The GPS receiver is located in such a way that they have an open view of the satellites and this is the reason why it is good to place it on the cabin floor of the vehicle or right after the stove next to the windshield (suppliers of the system recommend regarding the configuration of the location of this receiver .
- Communication models is another small part sophisticated in electronics and software. It acts as an intermediary between the equipment in the vehicle and the communication network.
- The driver terminal announces a number of different capabilities that connect to this type of hardware receiver. The main supplier of telematics systems have developed many different terminals, some of them are used with success in vehicles. On the other hand, smaller contractors have developed responsible terminals specifically for transport processes. A large number of PDA equipment (Personal Digital Assistant) have found application in vehicles, because their application depends on the needs of transport.

Driver terminals legally have a screen and keyboard each, or smaller tables with numbers and other specific symbols. Driver terminals enable the following:

  - Examining text messages in two ways,
  - Electronic display of data on the screen, corresponding to the needs, display of errors, mechanical defects and current delivery time.
  - Advice on the choice of a transport route – the itinerary to be used (if there is no navigation equipment in the vehicle).

- **Barcode mirror,**
- **Entering the driver's work data – start of work, loading time, delay, waiting, unloading,**
- **Electronic registration of working time data.**
- **Navigation equipment**, refers to the screen in the driver's cabin or electronic models that allow the driver to communicate with the destination - graphically, verbally or using both methods. This service can also be provided by a mobile phone that has GPS.
- **Plug-in vehicle monitoring equipment,** a separate unit intended for vehicles with a vehicle socket, which is placed in a watertight box and removed and separately insulated. These boxes are independent and have one GPS receiver, one communication module and one electronic control unit and battery. The batteries charge while the tow vehicle is connected to the tow vehicle. Their capacity should satisfy work for several weeks, bearing in mind the trailer can remain empty for a long time.

1.1.2. Intelligent transport applications:

Emergency notification systems

In 2015, the EC (European Community) approved a law that required vehicle manufacturers to equip all new vehicles with "e-Call" equipment, a European initiative that assists the driver in the event of an impact or accident.
In the vehicle, the e-Call device is generated either manually by the passengers of the vehicle or automatically activated with the help of the vehicle's sensors after the accident. It will form a telephone emergency that will send voice and data directly to the nearest point of emergency. The voice call allows the passenger in the vehicle to communicate with the "e-Call" trained operator. At the same time, a set of minimum data will be sent to the e-Call operator receiving

the voice call. The minimum data package consists of information about and around the accident, including the time, the exact place of the event, the direction of the vehicle and the identification of the vehicle.

1.2. Satellite navigation systems

Satellite navigation systems have created a need for places developed and possibly modernized their military technologies, in the direction of fast and accurate information about positions and certain objects in the country. These are space-based navigation satellite systems that provide spatially and temporally reliable data in all weather conditions and anywhere on the earth, provided there are no obstructions to the view of four or more satellites. In recent times, satellite navigation systems have found application in civil society as well.

The most advanced systems for navigation are:

1. GPS – Global Positioning Systems (American Systems and Global Positioning).
2. GLONAAS – Global Systems and Navigation Spunikovar (Global System and Russian Navigation)
3. GALILEO – Global Systems and Satellite Navigation (Satellites and Global Navigation European System)

1.2.1. Times GPS – Systems and Global Positioning: GPS - Systems and Global Positioning (Global Positioning System) is a global satellite American navigation system that is fully functional. It is composed of 24 satellites installed in earth orbit that send a microwave signal to the earth's surface.

Based on the radio signals, the GPS receiver can determine their exact altitude, latitude and longitude of any place on the planet day and night, in all weather conditions. GPS is widely used as a global service in various fields for commercial and scientific purposes (swimming at sea, land and air, the earth map, formation of geographical maps, determining the exact time, as well as the detection of earthquakes, etc.).

It was developed in the US Department of Defense under the name NAVSTA GPS in the agency DAPRA (Defense Research Projects Administration). At first it was used exclusively for military purposes and later it was made available to everyone for free, as a good example. The annual cost of maintaining the systems is about 750 million US dollars.

The GPS system is composed of three components:

- Ingredients in the cosmos,
- Control components,
- Components for use.

The space component is made up of GPS satellites in Earth orbit. The number and arrangement of satellites has changed over time, and technical performance has improved since GPS evolved. The Block I satellites were put into operation from 1978 to 1985, and to this day they are out of service. Satellite Block II represents 24 GPS satellites moving in 6 orbital planets, in the manner of equality divided reports with the earth, in which at an angle of 55 degrees in the reports in the equatorial plane.

2. THE MEASURES OF ITS AND THE RESULTS OF THEIR IMPLEMENTATION OF ITS SYSTEMS

2.1. The measures of the ITS: And further, 15 types of ITS measures are lined up, while products or services are processed, from honors throughout the cities such as the management and control of reactive traffic until it is solved with new and with complexes, as a service on the move:

- Traffic management and control,
- Management and control of traffic forecasts,
- The advantages of urban transport and emergency vehicles,

- Information for passengers,
- Parking management and information,
- Implementation of red lights and parking,
- Maps for location information,
- Dynamic road directions,
- Data on floating objects,
- Tariffs for using the road,
- Fleet management systems,
- Responsible transport according to needs,
- Electronic tickets,
- Electronic payments,
- The movement of services.

2.2. Results of the implementation of ITS: This section presents a description of the main services of the ITS that, in principle, can contribute to the achievement of the objectives of sustainable urban movements.

The tables on the following pages are intended to be the first tool for planners and decision makers to select their measures according to the intentions and priorities they pursue. In the lines, there are 13 lenses that are legitimate in sustainable urban movements, ranging from the most general, such as repair and sustainability, to those specific, such as collecting better data:

- The improvement of living in cities,
- Reducing CO2 and improving air quality,
- The reduction of noise emissions,
- Improving access to transport,
- Improving security,
- Fueling economic growth,
- Unblocking spatial possibilities,
- Activation of safe and problem-free journeys,
- Increase in urban travel,
- Initiating active trips,
- The increase in electromobility,
- Better transport data.

3.THE OPPORTUNITIES AND CHALLENGES OF THE USE OF ITS AND C-ITS

3.1. Options: While many cities in Europe are taking advantage of ITS services and C - ITS are real-world projects, many benefits are known from their use for a real urban movement.

While solving ITS and C – ITS can be appropriate for cities, as well as for the needs and priorities of different covering factors, the final exact benefits depend on special findings on the ground or reality.

One example of a service that provides intermediate benefits is Green Light Optimum Speed Advisory (GLOSA), which allows the driver to have in-car information about the optimal speed to adjust while approaching a signalized intersection. in a way to avoid the difference due to a single red light, or to stop and then again for modular acceleration, thus reducing fuel consumption and increasing comfort.

In general, ITS and C – ITS can increase transportation system efficiency and operational efficiency.

Examples are:

- Predominance of Green at signalized intersections for emergency services or urban transport vehicles,
- Information on the exact time for off-road parking, which can reduce overcrowding and pollution as a result and reduce the time lost for a vehicle searching for a parking space.

Recently, with Mobility-as-a-Service, thanks to the technological evolution (mobile) and digitalization in the public domain, it is now easier while collecting detailed data on the behavior of road users. This, on the other hand, can be used to optimize policy and initiate passengers towards sustainable transport options, while giving users a hassle-free travel experience.

C – ITS represents for the city a vehicle to facilitate the realization of the measures for planning the real urban movement in an integrated and cost-effective way, by adapting to the vision and ambitions of the city. They also help form the preconditions for a longer movement fully integrated by investing in ITS architecture that will allow innovation to the desired degree. Both C – ITS and ITS conventionally provide the city with an opportunity to increase awareness of the impact of new technologies in bringing about the movement of citizens, while the risks are treated that relate to privacy and cyber security.

3.2. Challenges

Because every city is unique, (C – ITS) solutions need to be adapted to the local context and align with the city's vision and ambition to serve larger policy intentions.

Expertise from different fields is required to address the social, economic and environmental challenges that characterize urban movements, as well as technical expertise to understand the impact of the selected implications (C – ITS).

This fosters an important need for the construction of local knowledge bases, as well as for the exchange of information and cooperation between professionals, such as ITS in cities and at all levels of governance, as well as across cities, regions and national borders. Help and referrals should be available.

C – ITS often have roof agglomerates and their acceptance mobilizes planned processes by majority.

Identification and effective acceptance of these stakeholders is a challenge regarding the aspect of organizing (the roles and responsibilities of each stakeholder), the business model, taking into account the levels of subsidization in power and financial mechanisms, often available at the national level and European.

Another important aspect is to understand the legal staff and to ensure, for example, that the defense legislation on data protection is implemented in the correct way. In the same way, open architectures and interventions are the basis for ensuring the mood of public figures that should be based on the clear functional requirements that determine the results - what the end product should do and not on any specific way in which the solutions should be accepted , giving suppliers maximum flexibility for innovation.

It is also of great importance that all items purchased should be adapted to the open standards and function in the open platform, in such a way that closing the risk with the sale is minimized and subsequent purchases are not limited in any case. While the number of installed products grows, it is always becoming more important to ensure that the main data items are used in as many ways as possible and each new system does not take over the cost of the existing system that provides the data that is currently available.

To make the system more flexible and cost-effective, the use and union of services is proposed, something that makes the connection easier is one new system at a time on the same C–ITS platform, for the same infrastructure needs.

Conclusion

In the developed world, migration from rural to urban areas moves differently. Many zones in the developing world are urbanized as well as substantial motorization without the formation of peripheries. A small part of the population can face the vehicles, therefore the vehicles increase the overcrowding in these multi modal transport systems. They also produce air pollution, pose a significant security risk, and exacerbate feelings and inequality in society. The increased density of society can be supported by a multimodal system of movement, transport by bicycles, mopeds, buses and trains.
So, TIS can play an important role in the rapid massive evacuation of people from urban centers, where a large part of the infrastructure includes the planning of Transportation Intelligent Systems that have an impact on the safety of urban locations.
With the development and application of Intelligent Transport Systems (ITS), the following effective and efficient results are expected, as well as their impact on traffic safety, such as:

- For a fast and efficient traffic system,
- To modernize and more efficiently inform the traffic system,
- To increase safety in the traffic system, as well as
- Reducing the number of traffic accidents.

As well as enabling better and effective control of negative impacts on the protection of life in urban areas.

References

[1]. Cerovac, V., Tehnika i sigurnost prometa, Zagreb 2001.
[2]. Županović, I., Tehnologija cestovnog prometa, Zagreb 2005.
[3]. Fantela N., Telematički sustavi u vozilu, Rijeka 2009.
[4]. Dadić, I., Kos G., Teorija i organizacija prometnih tokova, Zagreb 2007.
[5]. SoftCOM: Inteligentni transportni sustavi, Split 1999.
[6]. Bošnjak, I., Inteligentni transportni sustavi – ITS , Zagreb 2006.
[7]. Dr. Danislav Drašković, Inteligentni transportni sistemi, Travnik 2017.