Performance Analysis of the Intelligent Transportation Systems

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***Abstract*—Intelligent Transportation Systems (ITS) are not an individual system, which must integrate with Bridge Management System, Communication System and so on. Cooperative management is trend of ITS, the thought of distributed management and agent technology combines with development course of tradition ITS, not only can improve the efficiency of management but also reflected the essence of transportation system.**

ITS are equipped with mobile phone technology and global positioning satellites (GPS) to send data to the car on the pedestrian's location, which developed enormously worldwide. With its broad market prospect, ITS will continue to show high-speed growth tendency in a longer period of time. But our country's ITS far more perfect and needs to be developed in future. This article analyses the current developmental situation and deficiencies of the ITS, and introduces some effective measures which promote the development of the technology of the ITS from different points of view.

***Index Terms*—development thinking, information Technology, integration, intelligent transportation systems**

I. Introduction

To effectively meet the travel needs of urban residents, a balanced approach is required, in which efforts to manage travel demand are complemented with strategic road network improvements to address capacity deficiencies. The key objective is to minimize infrastructure costs and promote sustainability while maintaining an acceptable level of mobility. One way of accomplishing this objective is to increase the efficiency of the existing transportation network through the use of intelligent transportation systems. Such efficiency improvements can also achieve important socio economic and environmental objectives, including a reduction in Greenhouse Gas (GHG) emissions.

Improvements in traffic flow tend to reduce energy use and associated GHG emissions by reducing the amount of fuel that is wasted under congested "stop and go" conditions. However, once the optimal speed is exceeded, fuel consumption and GHG emissions begin to rise. Moreover, if travel conditions become so favorable that induced demand materializes, emissions will increase simply due to the greater number of vehicles on the road network.

Although the environmental impacts of ITS could be significant, few efforts have been made to quantify such impacts in any meaningful way. Given the complex interactions which characterize the urban transport system, a comprehensive modeling framework is needed to fully understand the potential implications of ITS technologies from a climate change perspective.

The remainder of this paper is organized as follows: In the next section, we briefly introduction intelligent transportation systems. In Section III, we describe benefit of ITS. Section IV
evaluates major issues and challenges. Then, we explain environmental implications of ITS (Section V). And so, we delineate existing shortages of ITS of our nation (section VI) and solution to intelligent transportation technique development (Section VII). Finally, Section VI concludes the paper with remarks on the future.

II. Intelligent Transportation Systems

Intelligent Transportation Systems have been defined in many different ways. While some definitions focus on technology, others capture the functional aspects of ITS and the relationships that exist between advanced technology and the various components of the transportation system as [6].

This definition highlights the technologies intrinsic to ITS, and the various transportation system components that interact with these technologies. Other definitions focus on how the technology is applied, and the system operators and users impacted by it. Indeed, ITS are often defined in terms of the user services it provides, which range from traffic control and incident management to the application of advanced technology in the transit and freight sectors.

Clearly, technology and technology integration are key aspects of ITS. However, from [5], ITS are more than just technology, it is an institutional arrangement for applying technology to solve transportation problems, for example, through the formation of joint public private ventures.

ITS can also be defined in terms of objectives; ITS facilitates many activities related to the operation, management, and use of the transportation system, enhancing safety and efficiency, and reducing environmental impacts. Taken together, the above definitions imply the following:

- ITS are concerned with the mobility of people and goods, and more specifically the delivery and management of multimodal transportation services.
- ITS exits as a system, with a web of interactions that both complicate service delivery and lead to important synergistic benefits.
- ITS involves the use of "smart" technology which is capable of dynamic, real-time interaction between various

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system components. Intelligence requires information; ITS facilities information exchange, so that intelligent, informed decisions can be made on the part of both system users and operators.

With this definition in mind, it is insightful to consider the main components of ITS. As shown in Figure 1, intelligent transportation systems are comprised of four key elements: the vehicle, the user, the infrastructure, and the communications system, each associated with a range of advanced technologies to support system interaction and control [3]. These technologies have supported the development of a wealth of ITS user services for enhancing transportation system performance. Examples include:

- Traveler information & route guidance
- Incident management
- Traffic control
- Commercial vehicle electronic clearance
- Collision avoidance system
- Electronic payment service
- Fleet management

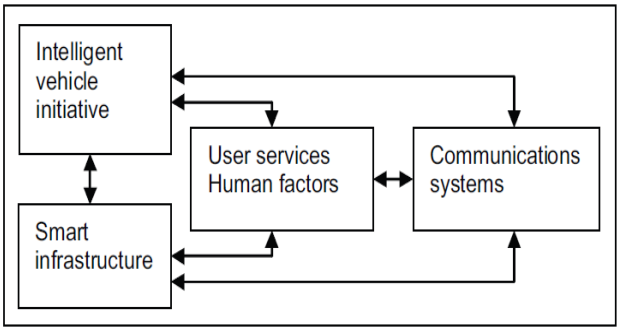

Fig.1 Components of intelligent transportation systems

III. Benefit of Intelligent Transportation Systems

Reference [3] identifies the challenges facing the delivery of transportation services in Canada:

- Congestion in densely populated corridors
- Environmental pressures, such as climate change
- Competing pressures for limited financial resources
- Preserving and improving existing infrastructure to accommodate growing demand
- Ensuring the safety of the transportation system
- Providing services to clients and customers more effectively and efficiently

While it is recognized that no one solution will be sufficient to address such challenges, the application of state of the art technologies is viewed as one means of meeting current mobility needs without jeopardizing important economic and environmental goals.

Although uncertainty exists regarding the magnitude and extent of potential impacts, in general, the key benefits of ITS are expected to include:

- Improvements in safety and mobility
- Reduced traffic congestion, resulting in shorter and more reliable travel times
- Reduced energy consumption and environmental impacts
- Lower operating costs for transportation service providers and vehicle owners

In addition to producing travel time savings, safety benefits, and operational efficiencies, ITS also has the potential to improve the quantity and quality of transportation data, enhancing the planning, design, and management of the transportation system. Other benefits include the creation of new market opportunities for Canadian suppliers, enhanced economic productivity, and efficiency improvements related to toll collection and enforcement.

IV. Major Issues and Challenges

Intelligent Transportation Systems have the potential to yield many important benefits. However, several challenges remain to be overcome before such systems transform the delivery and management of transportation services in Canada. In describing the potential impact of ITS, in [2] distinguishes between “visionaries” and “realists”. While visionaries claim that ITS will lead to dramatic improvements in the efficiency and range of transportation services through the implementation of highly integrated systems with significant synergistic effects, realists view ITS as simply the gradual application of new technology in the transportation industry – technology that will certainly improve efficiency and safety, but to a much more limited extent due to lack of resources, institutional barriers, and inter jurisdictional issues that constrain the delivery of a seamless intelligent transportation systems.

While it is unclear which perspective will prove most accurate, it is true that a number of challenges must be resolved if the benefits of ITS are to be realized. Key issues surrounding the deployment of ITS include:

- System integration & technology deployment issues (interfacing old & new technologies, developing centralized systems, consistency with standards)
- Societal issues (needs of seniors and non-English speaking residents, privacy concerns)
- Institutional issues (integration of ITS into agency activities, resistance to new technologies, jurisdictional barriers, public private partnerships)
- Legal issues (liability, privacy laws)
- Financial issues (project funding, payment for ITS services, market regulation)
- Professional development issues (training and education, sharing of information)

Clearly, the successful deployment of ITS hinges on a number of factors. Barriers related to institutional arrangements must be overcome. Societal issues must be resolved, ensuring that ITS technologies accommodate the needs of all segments of the population without fostering inequity or violating an individual’s right to privacy. Challenges related to systems integration must also be addressed if synergies between ITS technologies are to be realized. In this regard, standardization is essential, not only to facilitate the integration of diverse technologies, but also to lower system costs, promote competition & vendor health, facilitate employee training, provide a common interface for customers, and foster cooperation between various public and private sector organizations with an interest in ITS [1].

V. Environmental Implications of Intelligent Transportation Systems

The literature on ITS often alludes to the environmental benefits of adopting advanced technology in the transportation industry, particularly technologies aimed at improving the driving environment. However, a reduction in congestion

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brought about by ITS does not necessarily translates into environmental benefits. While improvements in traffic flow are generally considered to reduce vehicle emissions, in some cases, emissions could increase if drivers are encouraged to deviate substantially from their vehicle's optimal speed range. Moreover, if improved traffic flow results in induced demand, emissions could increase simply due to the increased number of vehicles on the road network.

The environmental impacts of ITS largely stem from the ability of advanced technology to improve the efficiency of the transportation network by reducing traffic congestion. Not only do such changes in traffic operations have significant environmental impacts, but by reducing the need for network expansion, the negative environmental impacts associated with road construction can be avoided.

From a climate change perspective, it is generally anticipated that ITS measures will reduce energy consumption and associated GHG emissions by improving traffic flow and minimizing vehicle delay. With a reduction in traffic congestion, less fuel is wasted under stop and go travel conditions, leading to important energy efficiency gains. However, unless preventative measures are taken, any reduction in GHG emissions could potentially be offset by changes in travel behavior triggered by the ITS initiative.

If traffic is diverted to longer routes to minimize travel time, emissions may increase. Likewise, if travel conditions become so favorable that induced demand materializes (either from a shift in existing travel towards more remote destinations, reduced use of public transit, or the release of latent demand), emissions will increase. In general, the overall impact on climate change will depend on both the speed characteristics of the resulting traffic flow and the corresponding vehicle kilometers of travel activity – two parameters that are difficult to predict on a system wide basis. Depending on the relative magnitude of the shift in these two parameters, GHG emissions could actually increase following the introduction of ITS.

Improvements in traffic flow can also encourage urban sprawl and more dispersed land use patterns, which in turn can result in increased fuel consumption and emissions [6] . With a reduction in vehicle congestion, commuting distances typically increase as people take advantage of the travel time savings by moving farther from their place of employment, creating an incentive for communities to spread continuously outward. Not only does urban sprawl consume valuable farmland and natural habitat, but the suburban communities engendered by sprawl are highly inefficient in terms of the provision of urban infrastructure and services.

While ITS has the potential to encourage urban sprawl, at least in theory, it is important to keep in mind that there are a number of factors that influence housing decisions. Indeed, reference 4 argues that "ITS standing alone pales in comparison to other more influential factors affecting land use". There are also those who claim the opposite – through technologies such as advanced public transit systems, ITS not only supports sustainable living, it actively promotes it. By making transit oriented communities more feasible, ITS plays an important role in meeting sustainability objectives.

Given the wide range of environmental impacts associated with ITS technology – impacts that can shift from positive to negative depending on the application – it seems clear that careful evaluation is needed before any ITS initiative is pursued. Indeed, each ITS project under consideration should be thoroughly assessed in terms of its potential social and environmental implications. Only then can informed decisions be made, incorporating a realistic assessment of the project's full benefits and costs.

VI. Existing Shortages of Intelligent Transportation Systems of our Nation

After more than a decade's development, the Transportation Research and Development Department of our country has achieved huge progress in the field of intelligent transportation. Due to some reasons like short period, weak technical basis and limitations in development stages, the development of our intelligent transportation is still at the initial stage. According to the analysis of the development and research condition of our intelligent transportation systems and relevant working facts launched in our province, the author considers the existing shortages are as follow:

1) Being lack of unified deployment, each province and region establish its own system without essential connection and coordination. For example, the unification of all-purpose card and electronic toll collection (ETC) system. Once the direction and criterion are in nation-wide power network interconnection under such condition, it must bring significant loss and waste.

2) It is enslaved to inherent research and productive pattern, and several advance up to date technology of intelligent transportation cannot be generalized and applied which cause some waste in labor and material resource in some certain degree.

3) Intelligent transportation systems, developed in recent a few years, are not accepted by tradition transportation industry. At present, ITS are not included when the main industries and cities are being planned, and quite a number of urban areas and industries just put it in technical developing plans which is not beneficial to promote the generalization of
ITS.

4) Serve shortage of intelligent transportation talents. Intelligent transportation technology is the combination of traditional transportation technology and information technique (IT), hence intelligent transportation talents should be compound talents which not only know transportation but also understand IT. Nowadays, we are in urgent need of this talent which is disadvantageous to further development of intelligent transportation research.

VII. Solution to Intelligent Transportation Technique Development

In the present, intelligent transportation technique of our country is just in the developing stage, what can be approved is that, nevertheless, the establishment of intelligent transportation systems can improve the efficiency of transportation highly, guarantee smooth and safe transportation efficiently, enhance travel amenity, ameliorate environment quality, modify energy resource availability. Therefore every nation all over the world should attach more attention to the research and generalization of intelligent transportation construction and development and give full support to it. Finally, establish a new modern transportation management system which focuses on IT by promoting the full development of ITS.

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Under the general background, our government should promote the research and development of intelligent transportation technique actively which is accord with the direction of world new technical development, establish the concrete requirement of people orientation technique of our country is just in the developing stage. Thus, corresponding measures should be taken to solve every limit factor existing in intelligent transportation development, and we should promote the research and development process of intelligent transportation techniques, our government also should create a beneficial environment for the development of this new technique.

1) Establishing nationwide unified intelligent transportation development leadership institution and sound relevant standard, integrating industry resources efficiently. States in the world whose intelligent transportation techniques are well developed all have state level intelligent transportation leadership organization, such as American ITS America, Japanese VERTIS and European ERTICO and so on. These organizations take on the responsibilities of making ITS development strategies, aims, principals and criterion for the states and accomplishing ITS techniques and guaranteeing commonality, compatibility and interchangeability, strengthening government's macro control, reducing partial conflict of interests and waste of limit budget. There is no such kind of organizations in our country, and due to our transportation system are in segmentation, that is to say, railway, highway, civil aviation, public security and construction department are managed separately which enable disunity in technical standard and do harm to the development of intelligent transportation. Therefore, state level intelligent transportation technique leadership institution should be found, industry resources should be integrated so that our state's intelligent transportation technique can develop properly.

2) Making great efforts to train and incorporate technology talents for intelligent transportation technology. We should meet the demand of the intelligent transportation technological development to talented person. With the further development of intelligent transportation, there will be a tremendous change for transportation in 21st century, what will be corresponding with it is the entire differences with the formers to the different level professional demand situation. For this reason, the exchange and cooperation should be strengthened between the domestic universities and the research institutions with abroad in the field of transportation, and the newest intelligent transportation technology should be merged in the specialized course content and the scientific research of the transportation subject, then, in order to meet the demand for talents of intelligent transportation technology, we should actively cultivate and attract outstanding professionals in intelligent transportation technology.

3) Promoting intelligent transportation techniques to industrialization. Our country should strengthen the industrialization of intelligent transportation techniques. Some new techniques which are already sophisticated and have a ready market should be generalized and applied, and turned into economy and social effect as soon as possible. We also should provide a conversion stage for research achievement which aims at achievements generalizing and conversing system of intelligent transportation techniques.

VIII. Conclusion

According to a decade or longer time of development, our intelligent transportation systems, developed from nothing to something and from small at beginning to sophisticated, founds its own standard system gradually and researches and develops achievements in its own intellectual property, as well as demonstrates in demonstration cities. Due to the management system and concept limitation brought by tradition, the further development of intelligent transportation systems have restricting factors like lack of unified deployment and essential connection, low achievements conversion efficiency, and lack of talents in this field, and existing mechanism should be improved by establishing unified management institutions, integrating industry resources, emphasizing on training talents and providing stages for achievements conversion. At present, the development of our intelligent transportation systems are still at the initial stage. What can be approved, nevertheless, is that every nation throughout the world including our nation will attach more importance to the research and generalization of intelligent transportation techniques in the near future, and regard it as the priority area of future transportation development to support. Our government should take full post advantages of it and explore development mode actively, which provide a powerful guarantee for healthy development of the new technical field intelligent transportation systems of transportation industry.

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