Utility of Intelligent Transport Systems (ITS) For Traffic Management of Road Traffic

DILIP KHANDU SHINDE [1], PROF. ASHISH PRUTHVIRAJ WAGHMARE [2],
PROF. PANKAJ GAWANDE [3]
[1]*Student M.E. (Construction & Management), Dept. of Civil Engineering Dr. D. Y. Patil School of Engineering and technology, Pune, India*
[2]*PG Coordinator, Dept. of Civil Engineering, Dr. D. Y. Patil School of Engineering and technology, Lohegaon, Pune, India*
[3]*Asst. Professor, Dept. of Civil Engineering, Javaharlal Darda Institute of Engineering & Technology, Yavatmal, India*

Abstract -- India, the second most populated country after China is achieving its heights regarding transportation engineering. With the increase in population, migration from rural to urban and sudden strong economic rise has unambiguously put gigantic pressure on the basic facilities, services and installations needed for the functioning of transportation system. ITS technologies include state-of-the art wireless, electronic, and automated technologies with a goal to improve surface transportation safety, efficiency, and convenience. Reducing energy consumption, while not a primary goal for ITS, is a demonstrated ITS benefit. This paper reviews and summarizes key energy benefits associated with a variety of ITS technologies that have been documented through models. Traffic control has been an issue since humans put the first wheels on the first cart. The modern world demands mobility. Cars represent the main method of mobility, but today's congested highways and city streets don't move fast, and sometimes they don't move at all. Intelligent traffic systems (ITS), sometimes called intelligent transportation systems, apply communications and information technology to provide solutions to this congestion as well as other traffic control issues. Over the past decades, Intelligent Transportation Systems (ITS) have developed and deployed in order to improve transportation safety and mobility, reduces environmental impact, promotes sustainable transportation development and enhances productivity.

Indexed Terms: ITS, wireless, electronic and automated technologies, information systems, communication, sensor

I. INTRODUCTION

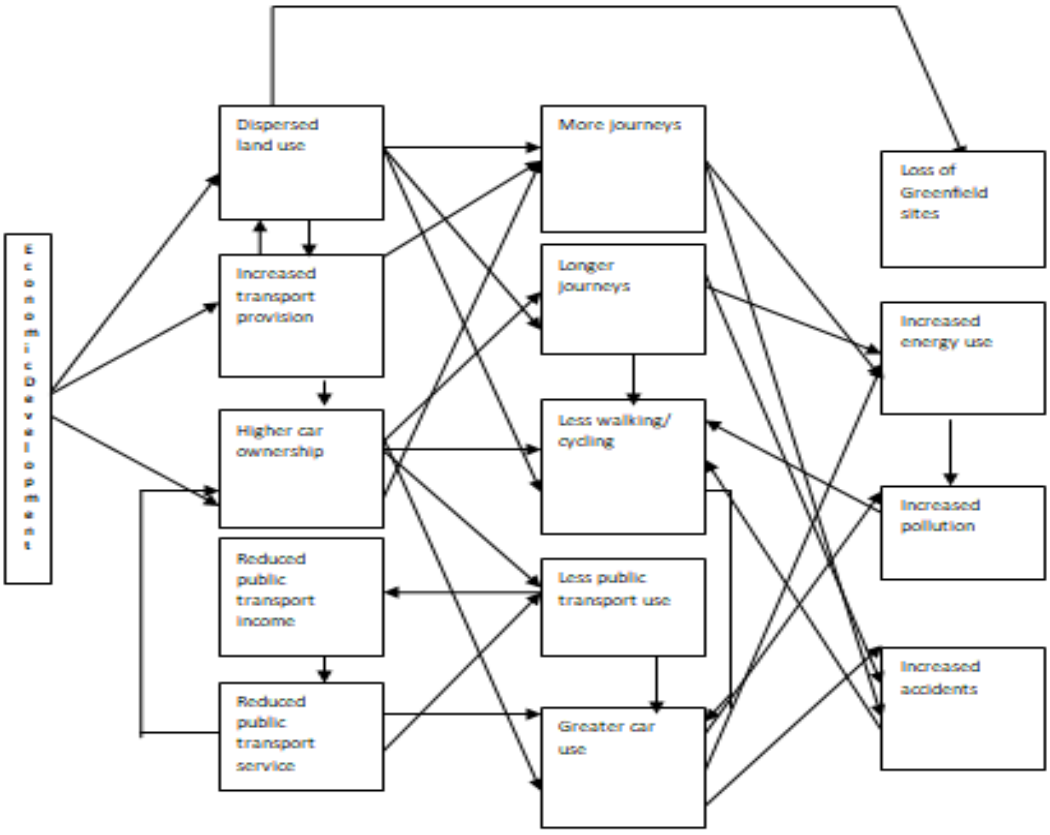
Without the freedom of movement using the vehicles – in road, rail and air, the humanity would not have reached anywhere in terms of progress of the civilization and also the quality of life the humanity enjoys today. The road transport, among all these, is the closest to human civilization from the pre-historic times. However, the proliferation of road transport and travel through its development in the second half of 20th century has raised serious questions regarding sustainability of this mode of transport in view of the damages it cause to the society and environment in terms of air pollution, GHG emissions, ground level PM pollution, loss of land for elaborate road construction, traffic congestion and noise nuisance, road accidents causing loss of life and damage to the properties, and even depletion of energy resources by inefficient use.

Generally the viability of a transport system project, in most cases, is determined by an economist on economic principles. Rarely any transport development project is considered with social, environmental and transportation goals as the prime objective for selection or choice from the options. The concept of sustainable transport system aims to preserve the environment to provide the future generations the same living right that we have now. ITS can help in many ways making the road transport efficient and enforcing the legitimacy of road travel. Any difference that can be brought about by its road user costs, externalities and VOC will be nothing but societal benefits. It is expected to alleviate the constraints on sustainable growth. Currently, there are several challenges in approaching sustainable transportation, such as

- High dependence on motorized vehicles
- High fuel consumption
- High vehicle emission
- Urban congestion

- Low planning and coordination in public transport
- Undesirable travel behavior
- Expansion of city sizes

The interactions of these factors contribute to sustainability, particularly in urban travel as shown in figure bellow:-



Sustainable transportation, no doubt, consists of technology, economy as well as social and environmental management. But social change is the vital element for success of sustainability. For example, developing a more efficient and less polluting vehicle will result in production of more vehicles and longer travel on roads. Human behavior has always offset the benefits generated from technologies. Only social solutions by changing travel behavior can bring community benefits. That is where ITS can bring in lot of innovative solutions. For example, economic intervention by road pricing (road user charges) or charging for emission using intelligent systems are capable of changing the behavior of the road users. It will contain the illegitimate demand; because marginal cost (in VOC) exceeding the social cost will reduce the level of demand.

II. WHAT IS ITS?

Intelligent transport system represents the application of advanced computing and communication technology to transport management and operating systems to achieve increases in efficiency, safety and reductions in negative environmental impacts. ITS tools are based on three core features – information, communication and integration, that helps operators and travelers make better and coordinated decisions.

These tools are useful in saving time and lives, improving the quality of life and environment and also productivity of commercial activities.

2.1 Intelligent Transport Systems may be best categorized as:

2.1.1 Advanced Public Transportation Systems (APTS):-

APTS represents the use of advanced technologies for the improved safety, efficiency and effectiveness of the public transportation system. Benefits for the public transport user include the minimization of halting time, ticketing convenience and security, and precise and up to date route and schedule information. Most ITS applications can be grouped in one or more of the following six broad areas.

2.1.2 Advanced Traffic Management Systems (ATMS):-

ATMS is concerned with the overall management of traffic. Advanced Traffic Management Systems deploy ITS technology in projects that endeavor to reduce traffic and freeway congestion and enhance safety. ATMS includes the advanced technology applied to traffic signaling systems, traffic safety and route and congestion management.

2.1.3 Advanced Traveler Information Systems (ATIS):-

ATIS concerns the use of ITS technology to better inform the traveler regarding road, environment and traffic information. Advanced Traveler Information Systems incorporate the use of advanced information and navigation technology to enhance driver safety and plays a role in minimizing freeway and traffic congestion.

2.1.4 Commercial Vehicle Operations (CVO):-

CVO are involved with the management and operation of commercial vehicles. ITS technology is deployed to better manage and service the freight industry and minimize on route interference a halting time whilst still maintaining the highest level of safety and cost efficiency. CVO plays an important role in the management of truck fleets to improve efficiency. This strategy can be adopted for any advance fleet management system (AFMS), such as operational management of bus fleet in urban area.

2.1.5 Advanced Vehicle Control systems (AVCS):-

AVCS are providing improved road safety by allowing the vehicle to assist the driver. Vehicles have been developed which range from monitoring the ever-changing driving conditions and taking necessary measures to avoid accidents through to complete driverless vehicle traveling at high speeds.

2.1.6 Electronic Toll Collection (ETC):-

ETC utilizes ITS technology to provide a cost effective way of collecting vehicle tolls. Electronic Toll Collection deploys ITS technology to provide the most up to date and cost efficient method of collecting road tolls whilst working to minimize halting time thus reducing traffic congestion. This is also known as electronic road pricing (ERP) system.

ITS has revolutionized the transport industry world over. While developed countries have reaped the benefits from it, many developing countries have gainfully used ITS technologies to maximize the systems outputs. Hence It is necessary that India also should exploit ITS solutions to improve the quality of traffic movement on highways. However, all the ITS technologies applied in the developed nations of the world may not be practical for Indian conditions. Only by carefully selecting suitable ITS systems, which can provide immediate and long term benefits to traffic situation in India, the specific applications should be developed.

III. STAKEHOLDERS OF ITS APPLICATION

The transportation-planning process generally involves identifying the problem, developing alternative solutions, analyzing the options, and choosing the best alternative. It is complicated by the difficulty of identifying what "best" means, since different stakeholders in the system have different definitions. Private sector providers of transportation technology need to make a profit to remain in business, while the public sector is charged with the responsibility of maximizing public welfare. Wealthier consumers desire ever-increasing levels of comfort, convenience, and safety. The less affluent need basic transportation in order to participate as productive members of society. In short, each individual person or organization has his, her, or its own needs.

Much of ITS implementation is dependent upon interactions of the public and private sectors. Examples include anything that requires public infrastructure, vehicles, technology, information, or service along with private versions of any of these. Indeed, it is harder to think of ITS that do not include extensive public-private sector or multi-organization interaction or decision making. Moreover, many ITS applications directly involve the consideration of societal issues. These include, for example, safety, noise, economic equity, and accessibility of the system. By having a process that incorporates the opportunity for people to introduce their disparate views into the process, the likelihood of minimizing objections to ITS implementations is decreased, and the opportunity to yield benefits to society is increased. One of the key societal issues in the implementation of almost any ITS-related technology is that of "equity," that is, "who benefit and who pays?" Because issues of equity invariably involve tradeoffs, which are often between highly polarized sides of the issue. Also social acceptability is to be ensured in each case.

Rapid advances in computing power, telecommunications technologies and internet based products are transforming the way in which our society undertakes commercial, recreational and educational pursuits. Within the business sector, both "new" and "old economy" companies are seeking to harness these developments to promote new services and products, enhance personalized customer service and secure market share globally. Within the transport sector, parallel developments under the banner of Intelligent Transport Systems (ITS) are underway through electronic tolling involving private/public sector partnerships, transport logistics and in-vehicle features that promote convenience and efficiency such as navigational aid systems.

In-vehicle ITS technologies have several important roles to play in society: to calibrate drivers to use the road transport system within its limits; to reduce undesirable driver behaviors which are impossible to handle within a safe system, and to make safe driving easier and more comfortable. But, at all times, the driver is in control of the vehicle and must accept responsibility for his or her actions in accordance with the prevailing road rules and regulations. This responsibility cannot be relinquished on the assumption that the vehicle will assume control when high-risk situations arise. Such advanced driver assistance systems are as follows:

- Intelligent Speed Adaptation (ISA)
- Seat Belt Reminder System
- Forward Collision Warning System (FCW)
- Breath Alcohol "Sniffer" System
- "May Day" Emergency Response System

In-vehicle ITS technologies have several important roles to play in society - to calibrate drivers to use the road transport system within its limits, to reduce undesirable driver behaviors that are impossible to handle in a safe system, and to make safe driving easier and more comfortable. ITS has been adopted with different focus in different countries worldwide.

IV. PLANS FOR DEPLOYMENT OF ITS

For Intelligent Transport Systems, also referred to as "e-transport". This strategy provides a basis for the accelerated integration of these technologies within the vehicle to enhance safety and security.
The European Commission has ongoing commitment to ITS in the EU as follows:

- 50% of major European motorways are to be equipped with congestion and incident management systems by 2002, and
- Start to introduce active safety and Driver Assistance Systems in all new vehicles sold in Europe by the end of 2002 and to achieve by 2010:

1. 50% reduction of road accidents
2. 20% reduction of time spent travelling
3. 50% increase in effective road capacity through ITS
4. 20% increase in vehicle ITS utilization and a significant reduction in vehicle CO2 emissions

Intelligent Transport Systems (ITS) are being developed and deployed across the world to improve the performance of transportation, providing improved social outcomes for communities and increased economic dividends for governments and

markets. The benefits to community and business implicit in the use of ITS are being produced in tangible and measurable ways in the many locations where ITS systems have been deployed. ITS typically return a benefit/cost of 10:1. These gains provide the political justification for investing in or supporting such technologies.

The National Strategy for Intelligent Transport Systems in Australia had ten strategic goals of e-transport which are shown below.

- Improved transport safety and security.
- Improved transport efficiency, performance and quality for the movement of people (by public and personal transport) and goods, by covering all transport modes and their linkages.
- Reduced congestion and travel times, and improved travel demand management.
- Improved effectiveness of use of transport infrastructure.
- Improved transport environmental outcomes, including reduced environmental and energy (including greenhouse) impacts.
- Improved contribution to Australia's economic development, including regional, rural and remote area development.
- Improved transport contribution to sustainable development.
- Improved transport accessibility and equity.
- Enhanced transport planning, policy-making and delivery.
- Achievement of a growing share of the world's ITS market for Australian-based business.

For most of the existing problems of transportation have solutions from ITS technologies, if they are adopted carefully. Some of these are highlighted here.

4.1 Road Safety:-

The existing efforts have shown diminishing returns over the years. ITS solutions may provide better returns: Traction control, Over speed warning, Automatic crash notification, Adaptive cruise control, Fatigue detection, Intelligent speed adaptation, Breath alcohol interlocks, Active suspension control, Reversing sensors, Collision warning, Collision radar, Adaptive airbags, Adaptive head lighting, Pedestrian injury abatement, and others.

4.1.1 Vehicle Security:-

ITS solutions: Vehicle immobilizers, Remote entry, Keyless entry, Smart card access and ignition, Automatic theft notification systems, Vehicle disabler systems and others.

Motor vehicle theft remains a significant social and economic problem.

4.1.2 Vehicle Emissions:-

ITS solutions: Car navigation, Telemetric, Driver information systems, Adaptive cruise control, Exhaust monitoring, Exhaust microwave, Engine management systems, Hybrid power, Low energy starters and alternators, and others.

V. SOCIETAL BENEFITS FROM ITS

The ITS offers many potential advantages to its different users and stakeholders.

- To the population as a whole, ITS will improve the safety of our highways and roads, resulting in reduction of human tragedies and also less demand on the medical system.
- To the commercial users, ITS provides direct savings in travel time and vehicle operation cost that can be shown to provide high economic payback. Commercial users are the first major users of ITS, and through improved economics of their operation will sustain and improve the competitive position.
- To the taxpayer, ITS provides long term savings in the cost of road building and huge cost of maintenance; this alone justifies investment in ITS.
- To the electronic industry, ITS provides a major new market opportunity for positive input to the national economy and also increase in employment.
- To the consumer (Road user), ITS can ensure less stress and shorter travel times, particularly during the peak periods.

There has been frequent reference made in Traffic Engineering principles to the four E’s of road safety, security and emission control. In fact, these are also achieved through the adaptation of ITS.

5.1 Enforcement:-
(e.g. detection, punishment and deterrence of unsafe/ illegal behavior such as speeding and drink driving, noise and smoky vehicles and theft)

5.2 Engineering:-
(e.g. making vehicles more crashworthy through design and futures such as seat beats, airbags, collision avoidance, and more secure through immobilizers and tracking and importantly less polluting through engine management and exhaust technology)

5.3 Education:-
(e.g. provision of information on how to reduce risk and exposure)

5.4 Encouragement:-
(e.g. promotion of behaviors and actions that reduce risk such as wearing seatbelts, using child restraints, avoiding drink driving). Enforcement and engineering measures have probably contributed most to reductions in crashes, security and emission abatement over the years as they provide more certainty and less variability than educational and/or encouragement approaches. Additionally, educational and encouragement programmers not tied to behavioral measures such as enforcement or to engineering measures are seldom cost effective and have little influence on road user behavior. ITS provides all these opportunities to make the transport systems to be most user friendly, productive and environmentally least intrusive.

VI. CONCLUSION

Intelligent Transport Systems (ITS) is a revolution or phenomenon which is sweeping the world, developed and developing, alike. The traditional TSM techniques which were popular in post 1980s have been replaced largely with ITS concepts and their implementations. It has been seen that the developed world had best of the transport infrastructures, and therefore, ITS could provide significant benefit to that system. Therefore, it is believed that ITS will generate multi-fold benefits in the developing world where transport systems are otherwise not fully developed. Thus, ITS is more beneficial to the poorer countries which are not able to afford transport intensive land uses and their transport implications.

REFERENCES

[1] Roberts, J., Transport, the Environment and Sustainable Development, 1993, p. 235.

[2] 2. Sikdar, P. K., Reddy, T. S., Velmurugan, S. and Sivanandan, R., Intelligent Transport System, Area Review Paper, Indian Roads Congress, 62nd IRC Session, Kochi, January 2002.

[3] 3. Smith, N., Ferreira, L. and Mead, E., Transport Impacts of e-Business, Working Paper 3, National Transport Secretariat, Australia, June 2001.

[4] 4. World Road Association, Intelligent Transport, XXI World Roads Congress, Kuala Lumpur, 1999, p. 39.

[5] 5. Intelligent Transportation System (ITS): Concept, Challenge and Opportunity, 2017 IEEE 3rd international conference

[6] 6. Intelligent Transportation Systems, book, Reference Module in Earth Systems and Environmental Sciences

[7] 7. Intelligent Transport System-A Review, research gate, Danish Fayaz, Birla Institute of Technology and Science Pilani.