**ABSTRACT**

*Today, many cities in the world are facing serious land transport challenges. Increasing traffic congestion has brought with it environmental, social and economic implications. With the proportion of the world’s population residing in urban areas projected to increase to more than two-thirds over the next 20 years or so, and with rising car ownership, more cities will find themselves facing the potentially crippling problems of traffic congestion. Many major cities in Malaysia such as Kuala Lumpur, Penang, Johor Bahru and others are currently facing serious transport problems as other big cities of the world. Traffic congestion remains one of the biggest problems in urban areas. Congestion can be easily recognized: roads filled with cars, trucks, buses, sidewalks filled with pedestrians. Congestion results from various sources on the road system. The interaction between these multiple sources is complex and varies greatly from day-to-day and road-to-road. The sources of congestion also produce another effect: variability in travel time. The latter is defined in terms of how travel times vary over time e.g. hour-to-hour, day-to-day. The increasing demand for travel by highway and public transit is causing the transportation system to reach the limits of its existing capacity. Intelligent Transportation Systems (ITS) can help ease this strain through the application of modern information technology and communications.*

**INTRODUCTION**

Transportation System is a complex, large scale, and integrated open system. It is complex because it involves multi stake-holders and comprises of different infrastructure facilities as well as multi modes operating in different spectrum of regulating environment. It is an integrated open system because it allows the addition of unlimited and different sub-systems into its operating space. All these sub systems are inter-related and loosely ‘integrated’, not in a positive sense but, in a situation that they are mutually affecting one another. It is no longer acceptable for a transportation agency to develop a system without worrying about interfaces with other functions (police, toll concessionaires, public transport operators, traffic signal systems operators i.e., local authorities). Many stakeholders are involved in this nest of interdependencies and additional stakeholders are being created by proactive citizens groups with interests in safety, the environment, handicapped, and specialized transportation services. A good example is the transportation system in Klang Valley where there are numerous multi-stakeholders operating a variety of transportation system infrastructure facilities

Interest in ITS comes from the problems caused by traffic congestion worldwide and a synergy of new information technologies for simulation, real-time control and communications networks. Traffic congestion has been increasing world-wide as a result of increased motorization, urbanization, population growth and changes in population density. Congestion reduces efficiency of transportation infrastructure and increases travel time, air pollution and fuel consumption.

The goal of ITS is to improve the transportation system to make it more effective, efficient, and safe. Building new transportation infrastructure is expensive and can be detrimental to the environment. In most urban areas where more capacity is needed, it is becoming physically impossible to build enough new roads or new lanes to meet transportation demand. By applying the latest technological advances to our transportation system, ITS can help meet increasing demand for transportation by improving the quality, safety, and effective capacity of our existing infrastructure. ITS represents a wide collection of applications, from advanced traffic signal control systems, to electronic transit fare payment systems, to ramp meters, to collision warning systems. In order to apply ITS services most effectively, it is important to understand their benefits and costs. Some applications provide more cost-effective benefits than others, and as technology evolve, the choices available change. Often, several technologies are combined in a single integrated system, providing a higher level of benefits than any single technology. The costs of these technology investments not only the first-time, initial costs, but the costs to operate and maintain them are of interest to transportation agencies

**Definition of Intelligent Transport System (ITS)**

Intelligent Transport System (ITS) encompasses the application of technology such as communication systems, computers, electronics, and information technology to improve the efficiency and safety of the transportation network.

ITS is utilizing synergistic technologies and system engineering concepts to develop and improve transportation systems of all kinds.

The term ITS refers to efforts to add information and communications technology to transport infrastructure and vehicles in an effort to manage factors that typically are at odds with each other, such as vehicles, loads, and routes to improve safety and reduce vehicle wear, transportation times and fuel consumption.

Intelligent Transportation Systems (ITS) have been defined as: 'the application of advanced sensor, computer, electronics, and communication technologies and management strategies—in an integrated manner—to improve the safety and efficiency of the surface transportation system'

As defined by the United States Department of Transportation, Intelligent Transportation Systems (ITS) apply “well-established technologies in communications, control, electronics and computer hardware and software to improve surface transportation system performance.”3 Central to most ITS activities are four categories of technologies:

1. ***Sensing*** – the ability to note the position and speed of vehicles using the infrastructure (e.g. rail lines, roadways, bridges, tunnels);
2. ***Communicating*** – the ability to send and receive information, between vehicles, between vehicles and infrastructure, and between infrastructure and centralized transportation operations and management centers;
3. ***Computing*** – the ability to process large amounts of data collected and communicated so that conclusions can be drawn and assessments made; and,
4. ***Algorithms*** – computer programs which process information gathered by ITS and develop operating strategies for transportation facilities.

**MAIN COMPONENT OF ITS**

**Safety**

ITS can help to reduce injuries and save lives, time and money by making transport safer, help the driver of trucks, busses, and cars avoid getting into crashes and help keep them from running off the road, maintain safe distance between vehicles and safe speeds approaching danger spots, improving visibility for driver, especially at night and in bad weather and also providing information about the work zones, traffic congestion, road conditions, pedestrian crossings and other potential hazards.

ITS can detect the crashes that do occur, determine the severity of the crash and likely injuries, and help emergency management services provide assistance. In addition, ITS also will help select the closest and most appropriate rescue unit to respond and adjust traffic signal to clear the way for emergency vehicles. The ITS will connect responding units to medical care facilities to help provide initial care for the injured and help medical care facilities prepare to deliver more complete treatment when injured people arrive.

**Security**

In security aspects, ITS will help prepare for prevent and respond to disaster situations, whether from natural causes, human error or attacks. ITS will also help to keep watch over transport facilities and help to provide personal security for people using the public transport system. Moreover, the ITS will monitor freight especially hazardous materials, through the entire supply chain and help transport and safety/security agencies coordinate their activities and their information so they can respond more effectively to incidents of all kinds. ITS will help identify the best routes for evacuating people at risk and directing emergency services to incidents and disaster sites. The transport system and all the other parts of the economy that depend on transport, to return to normal as rapidly possible following a crisis, through better management of the transport system, more efficiency interagency communications, better and more timely information to the public with the ITS.

**Efficiency/Economy**

The ITS will save time and money for travelers and the freight industry, because the ITS will deliver fast, accurate and complete travel information to help travelers decide whether to make a trip, when to start, and what travel modes to use. The ITS also will provide information that both prior to a trip and as the trip proceeds. Drivers can select and follow safe, efficient routes to their destination and paying tolls without having to stop with the ITS. ITS will help freight move swiftly and reliably using the right combination of ship, truck, train and plane and enabling its owners to know where it is at all times and when it is due to arrive at its destinations and allowing for better planning and scheduling of critical processes. ITS will enable more reliable and timely commercial vehicle management. The ITS also will automatically keep track of safety-related information about vehicle, its driver and its cargo and also ITS will help to communicate this information to the authorities so that, as appropriate, vehicles can be cleared through checkpoints without stopping.

**Mobility and Access**

ITS provide travel opportunities and traditional travel choices for more people in more ways, whether they live, work and place regardless of age or disability. Travelers can plan and take trips that use the best and more convenient combination of travel modes such as private car, public transport, passenger rail not to forget, walking and cycling too. Opportunities of new employment and recreation can be opened with the ITS and make time travel more productive. Travelers can get where they need to get regardless of age or disability and regardless of where they live. Better information on available services for travelers who choose not to drive including to those who are mobility or sight impaired. ITS also will help make it easier to pay for transport services. The future will include a single electronic payment mechanism to pay for fuel, tolls, public transport fares, parking and a variety of other charges. ITS will convey the needs and interest of transport system customers to the people who manage the system customers to the people who manage the system, helping to ensure a transport system that is responsive to those needs and interests. Management of transport system for safer services and simultaneously available for motorist, cyclists, pedestrians, and users of public transport can be gained with ITS.

**The Environment**

ITS can help to make the transport faster and smoother, eliminates unnecessary travel, and reduces time caught in traffic congestions. This is because, the ITS will help to keep traffic flowing in urban freeways, on tolls roads at commercial vehicle checkpoints and elsewhere. Reducing delays due to congestions and incidents means that energy waste, wear and tear, and the pollution caused by stop and go driving are also reduced. ITS will help vehicles operate more efficiently. ITS will provide location specific information about the whether and road conditions. Vehicles can anticipate danger spots and hills and to smoothly adopt appropriate speeds. Preparation of plan efficient routes and guiding the drivers along these routes can be done with the ITS that help to reduce consumption and emissions. Public transport can be more reliable, effective, attractive, providing better information on schedule and connections, and stay in touch with their employers and their families while in transit.

**A Transport System for All**

ITS affects the way everyone lives, works and plays and its benefits will increase in the future and helping to make transport services available and affordable for everyone, getting people and goods to their destination safely and efficiently. Customer satisfaction can be improved with transport and help make it more environmentally friendly and more secure. People can manage and operate the transport system to provide better, safer and more responsive service to all its users while helping to safeguards the environment. ITS has been demonstrating its value for over 10years and it is now beginning to mature and meeting its promise to make real difference to society as a whole.

**THE BENEFITS OF IMPLEMENTING MITS**

The benefits of implementing MITS is reduced lag and congestion, fair and efficient treatment of traffic, increased safety, improved planning capability and maintenance for

municipalities and overall improved traffic flow. MITS provides the ability to monitor and control traffic light controllers from a control center. However, it was designed such that individual traffic control is still contained at the intersection controller allowing distributed intelligence to provide reliable operation even when communication fails. The MITS control center workstation communicates with controllers, detectors and signs passing control messages, generating control data, collecting and analyzing responses from the controllers and analyzes fault information. Among the main features of MITS are remote real time monitoring and control, data collection, report generation and special features. Provides features such as intersection operation status, current active phase, actual running green time, alarm status, vehicle actuation mode, multiplan mode, online clock and date settings, green wave link monitoring, police control and remote activation. Data collection provides features such as average green time with time stamping, fault logging data, lamp failure detection, conflict detection, loop status, power failure and communication failure. Report generation provides features such as current alarm status report, historical alarm status report, average green time data, cycle time data, green time vs transition time per cycle, traffic throughput efficiency graphs and traffic study reports. The special features of the MITS provided are customized to individual traffic layout interface, responsive local support, designed for maximum technology transfer, continuous development opportunity, repetitive training programs and remote online diagnostic

**BENEFITS OF ITS INFRASTRUCTURE**

**Arterial Management Systems**

Arterial management systems manage traffic along arterial roadways, employing traffic detectors, traffic signals, and various means of communicating information to travelers

**Freeway Management Systems**

Freeway management systems employ traffic detectors, surveillance cameras, and other means of monitoring traffic flow on freeways to support the implementation of traffic management strategies such as ramp meters, lane closures, and variable speed limits (VSL).

**Transit Management Systems**

Transit ITS services include surveillance and communications, such as automated vehicle location (AVL) systems, computer-aided dispatch (CAD) systems, and remote vehicle and facility surveillance cameras, which enable transit agencies to improve the operational efficiency, safety, and security of the nation's public transportation systems.

**Incident Management Systems**

Incident management systems can reduce the effects of incident-related congestion by decreasing the time to detect incidents, the time for responding vehicles to arrive, and the time required for traffic to return to normal conditions. Incident management systems make use of a variety of surveillance technologies, often shared with freeway and arterial management systems, as well as enhanced communications and other technologies that facilitate coordinated response to incidents.

**Emergency Management Systems**

ITS applications in emergency management include hazardous materials management, the deployment of emergency medical services, and large- and small-scale emergency response and evacuation operations.

**Electronic Payment Systems**

Electronic payment systems employ various communication and electronic technologies to facilitate commerce between travelers and transportation agencies, typically for the purpose of paying tolls and transit fares.

**Traveler Information**

Traveler information applications use a variety of technologies, including Internet websites, telephone hotlines, as well as television and radio, to allow users to make more informed decisions regarding trip departures, routes, and mode of travel. Ongoing implementation of the designated 511 telephone number will improve access to traveler information across the country.

**Information Management**

ITS information management supports the archiving and retrieval of data generated by other ITS applications and enables ITS applications that use archived information. Decision support systems, predictive information, and performance monitoring are some ITS applications enabled by ITS information management. In addition, ITS information management systems can assist in transportation planning, research, and safety management activities. As deployment of ITS information management matures, quantitative information on the benefits of these systems should become more readily available.

**Crash Prevention & Safety**

Crash prevention and safety systems make use of sensor technology and active warning signs, including flashers, beacons, and dynamic message signs (DMS), to warn drivers of dangerous curves, excessive speed on downhill road segments, at-grade railroad crossings, and other dangerous conditions.

**Roadway Operations & Maintenance**

ITS applications in operations and maintenance focus on integrated management of maintenance fleets, specialized service vehicles, hazardous road conditions remediation, and work zone mobility and safety. These applications monitor, analyze, and disseminate roadway and infrastructure data for operational, maintenance, and managerial uses. ITS can help secure the safety of workers and travelers in a work zone while facilitating traffic flow through and around the construction area. This is often achieved through the temporary deployment of other ITS services, such as elements of traffic management and incident management programs.

**Road Weather Management**

Road weather management activities include road weather information systems (RWIS), winter maintenance technologies, and coordination of operations within and between state DOTs. ITS applications assist with the monitoring and forecasting of roadway and atmospheric conditions, dissemination of weather-related information to travelers, weather-related traffic control measures such as variable speed limits, and both fixed and mobile winter maintenance activities.

**Commercial Vehicle Operations**

ITS applications for commercial vehicle operations are designed to enhance communication between motor carriers and regulatory agencies. Examples include electronic registration and permitting programs, electronic exchange of inspection data between regulating agencies for better inspection targeting, electronic screening systems, and several applications to assist operators with fleet operations and security.

**Intermodal Freight**

ITS can facilitate the safe, efficient, secure, and seamless movement of freight. Applications being deployed provide for tracking of freight and carrier assets such as containers and chassis, and improve the efficiency of freight terminal processes, drayage operations, and international border crossings.

**Collision Warning System**

To improve the ability of drivers to avoid accidents, vehicle-mounted collision warning systems (CWS) continue to be tested and deployed. These applications use a variety of sensors to monitor the vehicle's surroundings and alert the driver of conditions that could lead to a collision. Examples include forward collision warning, obstacle detection systems, and road departure warning systems.

**Driver Assistance Systems**

Numerous intelligent vehicle technologies exist to assist the driver in operating the vehicle safely. Systems are available to aid with navigation, while others, such as vision enhancement and speed control systems, are intended to facilitate safe driving during adverse conditions. Other systems assist with difficult driving tasks such as transit and commercial vehicle docking.

**Collision Notification Systems**

In an effort to improve response times and save lives, collision notification systems have been designed to detect and report the location and severity of incidents to agencies and services responsible for coordinating appropriate emergency response actions. These systems can be activated manually (Mayday), or automatically with automatic collision notification (ACN), and advanced systems may transmit information on the type of crash, number of passengers, and the likelihood of injuries

**BENEFITS OF IMPLEMENTATION ITS IN URBAN AREAS**

ITS provide a new set of tools for achieving urban local transport policies. These systems provide services using modern computing and communications technologies. The systems collect information about the current state of the transport network, process that information, and either directly manage the network (e.g. traffic signals), or allow people to decide how best to use the network (e.g. incident detection, travel news). ITS systems have an important role to play in delivering policy objectives, including tackling casualty reduction, traffic congestion and pollution, as well as improving accessibility, providing integrated transport solutions and making best use of existing infrastructure. They can deliver noticeable economic benefits through reduced journey times and increased journey time reliability, as well as improvements in safety and reductions in pollution. They increase the economic viability and vitality of rural and urban areas alike, making them attractive areas for future inward investment. The benefits of using ITS include:

* Making travel more efficient (safer, less polluting, cheaper, better informed travel);
* Helping to achieve ‘Best Value’ within network management as a result of greater information gathering and improved decision making;
* Simplifying public transport use by providing accurate real time information about services;
* Reducing the effects of pollution from vehicles by better traffic management;
* Reducing the number of accidents by providing drivers with more information about conditions on the roads they are using;
* Helping drivers find the best route to their destination, and changing that route if major incidents occur on it;
* Improving the security of public transport passengers and staff by providing extra communications,
* CCTV and better information;
* Helping to monitor and evaluate network performance by automatically collecting and analyzing data;
* Protecting vulnerable road users such as children and the disabled;
* Improving planning decisions by making more historic information available; and
* Integrating different systems by providing a mechanism for sharing information between systems and co-coordinating strategy across different organizations.

An important benefit of ITS is that it can be developed/modified relatively easily. ITS can be modified as situations or objectives change, which means that authorities can adapt a system to a new environment at a relatively low cost, when compared to modifying traditional infrastructure. Societal level benefits due to Travelers Information Services will only accrue if a sufficient number of the general public uses the service to modify their travel and hence reduce traffic congestion. However, consumer-driven ITS technologies such as Travelers Information Services are more likely to be affected by perceived consumer values than by any rigorous benefit-cost analysis. The benefit-cost analyses are based on the standard monetary values society assigns to these benefits. Whether or not these values reflect individual traveler’s preferences is unclear. As a result, one cannot accurately forecast the consumer response to the cost and benefits of in vehicle equipment and determine, with any certainty, whether private benefits would be sufficient to induce vehicle owners to equip themselves with Information Services. As only the level of public response will determine whether the societal benefits due to Information Services are achieved (i.e., congestion reduction with the attendant benefits of travel time savings, averted or deferred infrastructure capital investments, reduced emissions, and decreased fuel consumption), it is desirable that a campaign be conducted to increase public awareness of these benefits.

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