FACULTY OF TOURISM AND HOSPITALITY MANAGEMENT
OPATIJA, CROATIA
Since 1960

Institut for Economic Promotion, Austrian Economic Chamber, Vienna, Austria

T.E.I. Thessaloniki Greece
Department of Tourism Management

UDC 656.13:338.48
Preliminary communication
Received: 29.05.2007

INTELLIGENT TRANSPORTATION SYSTEMS IN IMPROVING TRAFFIC FLOW IN TOURISM DESTINATIONS*

Edna Mrnjavac
Robert Marsanic
University of Rijeka, Croatia[1]

Abstract: The rapid growth and development of motorisation combined with relatively small investments made to improving transportation infrastructure in cities, as well as in tourism destinations, has led to serious problems in the unobstructed movement of vehicles in public traffic areas. Traffic congestion on roadways, in ferryboat ports and at state borders during the summer months and year-round lines of cars going to or returning from work are a regular presence in traffic in most urban and tourism destinations in Croatia, as well as in the rest of Europe.

Intelligent transportation systems (ITS) can be implemented in urban and tourism centres, which, for example, have no opportunity for increasing the capacity of their traffic networks by constructing new, or expanding existing, transportation infrastructure, and no opportunity for increasing parking capacities. The only solution would be to optimise traffic networking by introducing intelligent technologies. Intelligent transportation systems and services represent a coupling of information and telecommunication technologies with transportation means and infrastructure to ensure greater efficiency in the mobility of people and goods.

ITS implementation helps to provide better information to motorists and travellers (tourists); improve traffic and tourist flows, cargo transportation, public passenger-transportation; facilitate the work of emergency services; enable electronic traffic-related payments; enhance the security of people in road traffic; and monitor weather conditions and the environment. To motorists the system provides guidance to roads on which traffic is less intense, guidance to available parking spaces, and guidance, for example, to a good restaurant or interesting tourist attraction.

his paper focuses, in particular, on ITS application in city and tourism destinations in connection with parking problems. Guiding vehicles to the closest vacant parking space helps to reduce traffic congestion, reduce the amount of time lost in searching and increase the occupancy rate of car-parks.

Key words: Intelligent Transportation Systems, city and tourism destinations, traffic and tourism flows, traffic congestion, parking problems.

---

* The research results derive from the scientific project "Logistics Flows Managing in the Tourism Destination" financialy supported by the Ministry of Science, Education and Sports of Republic of Croatia.

[1] **Edna Mrnjavac**, Ph.D., Full Professor, University of Rijeka, Faculty of Tourism and Hospitality Management in Opatija, Croatia, **Robert Marsanic**, Ph.D., Rijeka Promet d.o.o., Rijeka, Croatia.

1. INTRODUCTORY REMARKS

The rapid growth and development of motorisation combined with relatively small investments made to improving transportation infrastructure in cities, as well as in tourism destinations, has led to serious problems in the unobstructed movement of vehicles in public traffic areas. Traffic congestion on roadways, in ferryboat ports and at state borders during the summer months and year-round lines of cars going to or returning from work are a regular presence in traffic in most urban and tourism destinations in Croatia, as well as in the rest of Europe.

Intelligent transportation systems (ITS) can be implemented in urban and tourism centres, which, for example, have no opportunity for increasing the capacity of their traffic networks by constructing new, or expanding existing, transportation infrastructure, and no opportunity for increasing parking capacities. The only solution would be to optimise traffic networking by introducing intelligent technologies. Intelligent transportation systems and services represent a coupling of information and telecommunication technologies with transportation means and infrastructure to ensure greater efficiency in the mobility of people and goods.

ITS implementation helps to provide better information to motorists and travellers (tourists); improve traffic and tourist flows, cargo transportation, public passenger-transportation; facilitate the work of emergency services; enable electronic traffic-related payments; enhance the security of people in road traffic; and monitor weather conditions and the environment. To motorists the system provides guidance to roads on which traffic is less intense, guidance to available parking spaces, and guidance, for example, to a good restaurant or interesting tourist attraction.

For any tourism destination, being accessible in terms of traffic is a precondition vital to tourist arrivals. Nevertheless, today accessibility alone is not enough to ensure tourist visits to a given destination. Modern tourism is inconceivable without the transmission of all relevant information with the help of information and telecommunication technologies. Communication of this type appears in all segments of tourist travel, from pre-arrival communication to booking, personal contacts and information provided during the trip (about roadside services, traffic flow, optimal traffic routes, weather conditions, etc.)

2. IMPACT OF TOURISM ON THE DEVELOPMENT OF TRANSPORTATION INFRASTRUCTURE

In the professional literature, discourse on tourism-development factors attributes a high level of prominence to the development of transportation and its infrastructure. Tourism, as a mass phenomenon, is about moving about, changing residence and using transportation means. The wide-sweeping scope and upward trend of world tourism can best be illustrated by tourist arrivals expressed in numbers: from 25 million tourists in 1950 to 70 million, in 1960; 166 million, in 1970; 285 million, in 1980; and 475 million, in 1990! Expectations for 2008, upward of 700 million tourists, are indicative of a growth rate that has rarely been recorded in other economic

branches. Because the tourism-growth pattern is linked to, and will continue to coincide with, transportation change and demand, it is advisable, in advanced tourism regions, to ensure that tourism-development planning and transportation development are complementary.

At the current level of technical development, in a time of rapid and frequent technological change and favourable political climates around the world providing huge opportunities for the increasing the number of tourist travels and other types of travel, the economic growth of any country is inconceivable without modern transportation infrastructure. In conditions of relatively high living standards and in a century of great scientific and technological advancements, today's life style is not compatible with conventional, uncomfortable, slow and time-consuming transportation.

Seeing how transportation infrastructure influences the quality of transportation services, tourism can impact on intensifying its construction and modernisation, and the road network can be adjusted to the requirements of making tourism destinations accessible in terms of traffic. Modernising transportation facilities and increasing their capacities will result in a greater effect, in terms of traffic, in the field of passenger transportation, as well as cargo transportation.

Tourism, also, has a constraining effect on transportation development. In tourism regions, care should be taken to ensure that transportation infrastructure and equipment do not degrade tourism attractions and nature and that the emission of harmful gasses, substances and noise is monitored to prevent compromising the quality level of tourism services. Hence, tourism destinations require transportation to be organised in a specific way that will make tourism facilities and services accessible and that will contribute to achieving the fundamental goals of tourism development.

The concept of sustainable transportation and tourism development is dominant in countries in which tourism development numbers among primary economic targets. Through its pronounced concern for environmental preservation, this concept focuses on the long-term planning of development, not only in transportation and tourism, but also in those branches with goals that are in collision with the goals of tourism, to ensure that the greatest effects are achieved for society in the long run.

3. ROLE OF INTELLIGENT TRANSPORTATION SYSTEMS (ITS) IN TRAFFIC INFRASTRUCTURE

The multidisciplinary approaches of research and technological development in the field of transportation are brought together in **I**ntelligent **T**ransportation **S**ystems (ITS), which we encounter today in various forms and technological designs. ITS applies modern advancements in the field of computer, information and telecommunication sciences to the traffic system with the aim of enhancing mobility, safety and security, and the quality of environmental factors.

The specific problems of cities and tourism destinations, in most cases reflected in the impossibility of substantially increasing useful traffic spaces, imply the

need to properly manage existing traffic spaces. Today, the diverse and often conflicting interests of various factors of transportation demand are extremely difficult to coordinate without the application of well-formulated concepts and strategy, which is the primary task of any ITS.

ITS involves interconnecting modern traffic systems, the roles and functions of which are complementary:

1. Intermodal transportation systems (travellers use different forms of transportation; generally, they begin from home by car, then take a train, ship or airplane, and finally use a car again to take them to the place they wish to reach);

2. Intelligent traffic-control systems (traffic network management):
   – Traffic lights
   – Public city-transportation systems
   – Parking Guidance and Information (PGI) systems, and others;

3. Navigation systems, enabling motorists/tourists in vehicles to receive information regarding:
   – General information on weather and traffic conditions
   – Real-time traffic conditions in a specific area
   – Alternative directions, if necessary (due to congestion or various incidents)
   – The optimum route to a specific destination with regard to the existing transportation network and real-time traffic conditions.

4. Safety systems: Assisted by weather stations, these systems provide warnings regarding adverse weather conditions. Some systems are built into the latest generation of passenger vehicles, and they range from simple systems that warn motorists of ice, wet lanes and gusts of lateral winds to systems that alert the motorist when the distance between vehicles is too short and cause the vehicle to slow down, relative to its velocity and the safety distance.

5. Variable Message Sign (VMS) system and radio messaging. VMS are generally large panels on which various messages to system users in a town or tourism destination are written out (using LED or optical fibres), such as “Traffic jam”, “Traffic jam at intersection”, “Roadwork”, “Parking” and similar useful information. VMS can also render graphic symbols. This type of information system enables participants in traffic to stay clear of critical areas before they reach the point where the resulting situation is impossible to avoid.

ITS has been in use in major European cities and tourism destinations for many years. Traffic-light management systems appeared as early as the 1950s, followed by systems for supervising and managing public city-transportation. Of a later

date are PGI and VMS. In recent years, major efforts have been made in bringing together the existing technological units in terms of a selected traffic policy for:

- Enhancing mobility and the quality of transportation
- Increasing safety and security
- Achieving the desired usage ratio of public to private transportation
- Improving the environment
- Other traffic-policy objectives.

4. *ITS* IMPACT ON TRAFFIC FLOW IN TOURISM DESTINATIONS

The primary function of roadways and other transport lines is to ensure accessibility and mobility. During peak loads, this basic function is jeopardised on major roads in almost all large cities in Europe, including Croatia. A distinct problem arises in tourism destinations during the tourist season when seemingly endless lines of tourist vehicles 'forge ahead' towards their destinations. Traffic congestion occurs on a daily basis in almost every city and appealing tourism destination throughout the tourist season due to the lack of and failure to build adequate roads and parking spaces.

The unconstrained and spontaneous expansion of car traffic has comprised the fundamental purpose of roads and the overall quality of life in urban and tourism centres. In large cities, these problems are not limited only to rush hours but also extend across increasingly longer peak periods, incurring high costs to individuals, companies and society at large. The cost of traffic congestion in European cities has reached about 2 percent of their GDP[2], while the total damage caused by traffic incidents, stress and time wasted has not yet been fully realised. The average transportation time to the workplace, school or to tourism destinations and other destinations is increasingly longer and uncertain. This is the result of an insufficiently holistic approach to solving traffic problems in which the focus has been on constructing or expanding roads.

ITS represents the efficient and effective application of management and IT technologies in improving the performance of transportation systems and enhancing the overall quality of life. The ITS concept stands for a comprehensively developed system that includes providing traveller/motorist information, enabling automatic toll collection (no stopping), managing transportation demands and flows, managing fleets and city logistics, ensuring the safety and security of motorists and travellers, etc.

A benefit/cost analysis shows that the effects of a comprehensively designed, developed and applied ITS are demonstrated in:

[2] Surveys conducted in several major cities (Frankfurt, Turin, etc.) show that the introduction of PGI systems has achieved the following effects: reduced transportation time by car through the city (by 30 – 40 percent); reduced fuel consumption (approx. one million litres/year in Frankfurt); reduced number of kilometres spent in searching for parking space (10 million km/year in Frankfurt). (For details cf.: Bosnjak, I., Poboljsanje prometa primjenom inteligentnih prometnih sustava, *Journal Ceste i mostovi*, Vol. 3 - 4, Zagreb, 2004, pp. 84– 90).

- increased traffic flows on existing roadways
- the effects of managing demand through traveller/motorist pre-arrival communication
- greater personal mobility within the available time intended for travelling
- enhanced security in travelling
- greater safety of motorists and travellers in public transportation
- reduced fuel consumption
- reduced environmental pollution
- increased productivity of individuals and companies due to fewer losses caused by waiting
- an improvement in the tourism offering by providing optimum routing to tourism facilities
- less stress and better prediction of transportation system behaviour

and, perhaps most importantly, the satisfaction of residents and visitors/tourists with the total quality of the city or tourism centre, which cannot be expressed by concrete measurable elements.

Today, the extensive development of private transportation has made the application of these systems a necessity. A decade ago, telematical solutions commercially applied through ITS in city transportation, were looked upon as an "upgrade" to the existing infrastructure, something that only the richer cities could afford, something not really needed.

Today, city ITS represent a fundamental factor in providing an efficient, safe and environmentally-acceptable city system.

4.1. Intelligent parking-management systems in improving traffic flow in tourism destinations

An element of ITS is the parking management system with its PGI (Parking Guidance and Information) subsystem. The parking management system should be made to support a number of functions that improve the usage of and operations connected to street or off-street parking (in open car-parks and multi-storey garages). Guiding vehicles to the closest vacant parking space helps to reduce traffic congestion and the time wasted in searching, and it increases the occupancy rate of parking lots. It is estimated that motorists seeking parking space cause about 30 percent of downtown traffic in European cities and that PGI helps to save an average of 6 minutes from each trip.

The construction of car-parks/garages does not solve all the parking problems in the centres of city and tourism destinations; it is often the case that all parking spaces are taken in those locations that are appealing to motorists, making them seek other locations with vacant parking spaces and causing additional traffic in the already overloaded network. An added problem is the line of vehicles waiting to enter a car-

park or garage, further reducing the security and flow of traffic. At the same time, parking facilities nearby that motorists are less familiar with remain under-utilised.[3]

The above stated points to the necessity of putting in place an information system that will enable all facilities to be used equally, and, above all, serve as a source of information to motorists telling them the total of parking spaces and the number of currently available ones and guiding them there through the network of roads. Because this information is not static but changes over time, the need arises for variable traffic signs and variable message signs (VMS).

The first application level of parking-related VMS is providing information at car-park/garage entrances regarding occupancy and vacancy numbers. This manner of communication is sufficient at the parking-facility level, but at the city or destination level, it is inadequate for the previously stated reasons; hence the need of setting up a Parking Guidance and Information system.

By using variable traffic and message signs, PGI provides motorists approaching a specific city or tourist area with information on vacant parking facilities in that area, how far away they are and how they can be reached. This gives the motorist enough time to decide which location to choose, without fear that it will fully occupied when he gets there. After that, the system assumes the guidance function and guides the motorist to the selected location with the use of VMS. If the parking system is divided according to parking rates, statistical signalisation is usually used to notify motorists of the various rate zones, letting them select the rate and service level they desire.

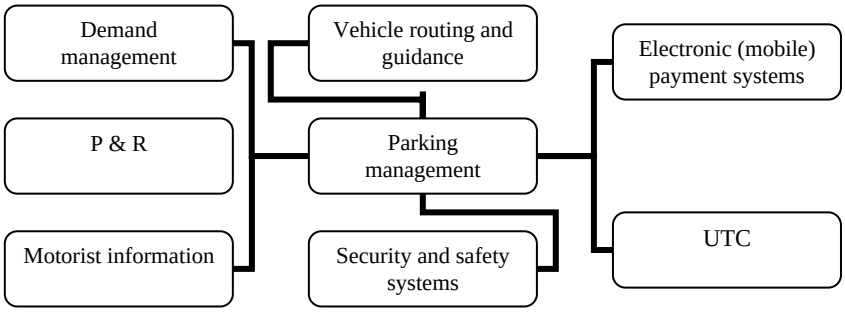
The main PGI tasks involve:

- providing the motorist with information on vacant parking spaces
- guiding the motorist to the location he has selected
- assisting motorists/tourists unfamiliar with the city road network to arrive easier and faster to a given location (which does not necessarily need to be connected to parking)
- reducing the amount of traffic caused by motorists looking for parking, and thus directly heightening the quality of life in a city or tourist destination

[3] How great is the need for introducing PGI systems is illustrated in practical examples of two Croatian cities. In 1998, for the elaboration of a "Traffic Study for the City of Zagreb, a survey was conducted in Zagreb in which so-called idle driving was measured (in search of vacant parking space, vehicles are recorded two or more times at survey points). In the same year, the survey was carried out in Rijeka for a "Study on Automatic Traffic Management in the Town of Rijeka". Idle driving in the morning hours in Zagreb amounted to 30 percent and in Rijeka, 17 percent, confirming the necessity for introducing PGI solutions to these city destinations. These examples, translated into the language of traffic models, indicate that the unnecessary load on traffic space in the morning hours in Zagreb amounts to 6.4 km, and in Rijeka, 2.2 km. These values correspond to an average occupation of six metres of space per vehicle. The environmental effects of this can easily be measured – noise: the number of times a vehicle passes through a particular part of the network is reduced; fuel consumption and exhaust emissions – reductions result from shorter transportation times and improved traffic flow. (For details cf.: Gudac, V., *Uputni garazno-parkirni sustav u gradu Rijeci, Korema, Automatizacija u prometu*, Congress Proceedings, Zadar, 2003, p. 26).

- reducing the amount of traffic in downtown areas of city or tourism destinations by previously separating motorised traffic and referring motorists to use the "Park & Ride" system[4] (providing such exists)
- enhancing the occupancy rate of parking facilities.

Figure 1: The association of parking management with other ITS parts and services



The basic working principle of PGI is to gather data from all parking lots involved, process the data and present it using VMS. Input data include the number of parking spaces (total and per individual location) and the number of vehicles entering and exiting parking facilities (the most accurate way of obtaining this information is by using a boom gate). A computer is used to correlate the data captured and to add a contingent time-space reserve depending upon the rate at which the various parking facilities fill up and empty out. The processed data is sent to VMS displays placed at various locations in the city zone. Motorist information can be provided in two ways:

- in written form, such as SPACE /FULL /CLOSED
- in numerical form, showing the exact number of vacant spaces.

Although PGI can also operate as a separate system, it has a considerably greater role and potential as part of a broader ITS, where it interacts across several levels with the system's other elements (traffic-light management, guidance and supervision system for public city transportation, and others). The levels at which it interacts can range from the lowest (exchange of information) to the highest (exchange of system's basic operational parameters and the operational strategy of the city traffic network).

[4] "Park & Ride", an intermodal transportation system, has found broad application worldwide, and it involves driving by car from home to a public-transportation terminal. When applied in tourism purposes, "Park & Ride" allows tourists arriving at a hotel to temporarily park their vehicle in the hotel's parking lot to settle check-in formalities and unload their luggage, upon which they leave their vehicle in a garage located in the outskirts of the city. Having parked their vehicle ("Park"), they take public transportation ("Ride") to arrive at a destination in the city (their hotel) or to the next means of public transportation (for example, the city railway – tram, underground or city bus).

A particularly important contribution of this system is displayed during tourist arrivals to a city-tourism destination. It cuts back on the needless cruising of tourists, as well as residents, in search of a vacant parking place. This enhances the quality of a destination, and makes it easier for tourists to adjust to a situation they are familiar with because they have already encountered the same system in their home countries. Most tourists arrive at a tourism destination they are unfamiliar with and have a hard time of getting around. These types of intelligent systems can make it easier for them to find vacant parking spaces.

Considering that all advanced European countries (from which come most of Croatia's inbound tourists) generally have ITS, this will minimise confusion and disorientation. Many such systems can also be upgraded with various subsystems (for example, a subsystem for directing tourists to cultural and historical monuments and sights, museums, art galleries, attractions, etc.) that can further contribute to increasing destination quality. PGI with its subsystems should not be viewed through the fairly highly cost of this investment, but rather through the benefits that such a system can bring by enhancing the quality of city-tourism destinations.

5. CLOSING REMARKS

Today, ITS concepts and strategies provide transportation development in cities and tourism destinations, throughout the entire year and during the tourist season, with the best possible response to the diverse requirements of transportation demand. In advanced countries, motorists in traffic increasingly depend upon the information they receive while driving. Before leaving for vacation, motorised tourists are greatly in need of information concerning traffic and weather conditions, the optimum route to their chosen destination, etc.

The strong desire of people to use private transportation is at odds with the need to increase the mobility, security and quality of life in cities and tourism destinations. ITS helps to create the preconditions needed in achieving the goals of traffic policies by improving the quality of public transportation, minimising the use of private transportation (driving in search of parking space, getting to one's destination using longer transportation routes with heavy traffic) and properly managing traffic areas (reducing and preventing congestion, providing timely information on extraordinary situations in the network).

ITS represents the efficient and effective application of management and IT technologies in improving the performance of transportation systems and enhancing the overall quality of life. The ITS concept stands for a comprehensively developed system that includes providing traveller/motorist information, enabling automatic toll collection (no stopping), managing transportation demands and flows, managing fleets and city logistics, ensuring the safety and security of motorists and travellers, etc.

During the tourist season, traffic congestion is a daily occurrence in almost every attractive city and tourism destination. A parking management system should be made to support a number of functions that improve the usage of and operations

connected to street or off-street parking (in open car-parks and multi-storey garages). Guiding vehicles to the closest vacant parking space helps to reduce traffic congestion and the time wasted in searching, and it increases the occupancy rate of parking lots.

REFERENCES

Bosnjak, I., Poboljsanje prometa primjenom inteligentnih prometnih sustava, *Journal "Ceste i mostovi"*, Vol. 3 - 4, Zagreb, 2004.

Gudac, V., *Uputni garazno-parkirni sustav u gradu Rijeci, Korema, Automatizacija u prometu*, Congress proceedings, Zadar, 2003.

Lanovic, Z., et al., Suvremene koncepcije i tehnologije vodenja prometa u gradovima, *Journal "Suvremeni promet"*, Zagreb, 1999.

Marsanic, R., *Garazno-parkirni objekti kao elementi kvalitete destinacije u primorskim mjestima*, Master's thesis, Faculty of Tourism and Hospitality Management, Opatija. 2002.

Mrnjavac, E., Meduovisnost ucinaka pojedinih prometnih modaliteta i turizma, *Journal "Suvremeni promet"*, Zagreb, 2001.

Pasalic, Z., *Razvojna meduovisnost i konfliktnost prometa i turizma*, Presentation at the 9th International Conference "Promet i turizam", HZDP, 2001.

Pasagic, S., et al., Turisticke informacije sudionicima u prometu, *Journal "Suvremeni promet"*, HZDP, Opatija, 2000.