Intelligent transportation systems for a sustainable city

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Abstract

The present paper investigates the impacts of “Intelligent” Transportation Systems (ITS) towards sustainability goals. It is a high level analysis identifying “positive” and “negative” impacts of “intelligent” systems being introduced in the transportation field. The new technologies influence both private and public transportation modes, planning as well as operational levels. The use of Traffic Management Centres (TMCs) attempts to coordinate the activities in all modes and requires new technologies itself. It is a major operational and data collection tool for ITS. At the planning level we have more accurate information about origin destination tables and mode choice characteristics. At the operational level we have better travel detection in real time and more ways to influence traffic patterns. Many of the elements and strategies used will contribute towards a more sustainable city and work synergistically with other city operations. These synergistic patterns towards a more sustainable city are a desirable first step, while we keep investigating how far we need to go in order to achieve true sustainability. The installation and effective use of intelligent systems in transportation can create a “seamless” personalised service and helps in the tracking of the conditions and impacts of city life. The identification and early installation/use of intelligent transportation systems providing “positive” impacts towards sustainability should be part of the general plan and coordinated with other related fields including land-use, housing, employment and public safety through the use of compatible Geographic Information System (GIS) and Global Positioning System (GPS) technologies.

Keywords: Intelligent transportation systems, smart growth, transportation management centres, personalised transportation services.
1 Introduction

With the definition of sustainability still receiving a fair amount of scrutiny it may be premature to develop precise calculations of “allowable” activities within a city contributing towards an “acceptable” total impact. The composite impacts of different elements, policies and activities are in many cases known to be different than the arithmetic sum of their parts. In anticipation of a better understanding of how far we need to go and how composite impacts and synergies can be used, we can start moving in the proper direction in all fields including transportation.

Preservation of conditions on earth that will be suitable for human life in the future has been a popular objective [2] for quite some time. Opportunities of future generations for equitable to us quality of life, is a refinement of the objective. Several groups and international bodies pursue this topic under the notion of sustainability. The most commonly used definition of sustainability is the one from the Brundtland report: “Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs.” Simplicity is the most attractive feature of this definition. However, it lacks clarity on what exactly we can and cannot do as individuals as well as at different group levels. It challenges us to measure the impacts of development at different scales and over long periods of time, which is a non-trivial task. Additionally, we have to define needs for today as well as tomorrow, a tricky definition. A cursory look at sustainability web sites will identify several supportive of sustainability groups who have interpreted the requirements as a call to live the way people lived fifty or one hundred years ago. While this approach has some romantic appeal to it, the global implementation is not realistic.

Turning to transportation as a major contributor to sustainability success, we find most of the literature [1,3] discussing the need for higher development densities and use of public transportation. The main sustainability-related impacts that are influenced by transportation policies and activities, are energy use, land-use/availability, global warming and localized pollution. The manufacturing sectors [4,5] that are influenced by transportation will also have impacts that need to be taken into account. In this paper we will be discussing impacts at the city level and focusing on direct impacts of transportation policy.

2 The assumptions/biases

Summarizing the main assumptions/biases that will control the discussion we have the following:

- Sustainability is good for everybody (over space and time) on this planet.
- Sustainability needs to be achieved at individual but more importantly at group level. The bigger the group the more effective the results and the more complex the analysis. For this analysis the group level is the city.
• Time travel is not feasible: We cannot return back in time and make every city in the world look like Sienna! Even more, we cannot rebuild every city today in a “form” that we like.
• We (humans) are very different from each other. This results in “very specific” semi-tyrannical solutions not being realistic/feasible.
• Changes need to respect the “human rate of change” natural constant. Most humans like to follow routines that they are familiar with. Changing routines takes a long time.
• Transportation policies introduce “rate of change” modifications for a city. We have to study adaptability and equity issues.

3 Intelligent transportation systems contributions

The two questions we have to address are:
• How much are we using (resources) or what is our impact?
• What is our allowance?

Traditional “sustainable development” literature referring to development asks for higher densities [1,3,5] and more pedestrian as well as public transportation. These are good baseline objectives but we have to be more open-minded for innovative solutions. While a significant number of city dwellers like higher residential and commercial densities, recent experience in the U.S. as well as other industrialized nations shows that lower densities will appeal to several groups. Lower densities and less compact development reduce the feasibility of a sustainable provision of city services to all citizens. While this is true for almost all services including water, power and sanitation, the impacts are more pronounced in the case of transportation. Such impacts are multiplicative in the cases where the single occupant automobile is the predominant transportation vehicle. Both the physical dimensions of infrastructure as well as operational energy needs are significantly higher.

“Intelligent” are defined as transportation systems that have capabilities of accurately identifying needs and/or vehicles over time and space; and using available networks efficiently by deploying more strategic control of traffic compared to conventional systems. Example technologies include Transportation Management Centres (TMCs), Advanced Traveller Information Systems, Advanced Detection Technologies as well as Advanced Traffic and Vehicle Control Systems. The Deployment of Intelligent Transportation Systems can help towards sustainability goals in the following ways:

• Reduce the number and/or the length/duration of vehicle movements.
• Organize traffic, increase speeds and reduce emissions.
• Improve safety/security and reduce incident/accident traffic disruptions.
• Provide data in order to estimate overall sustainability performance/attainment.
• Work synergistically with other city service providers for more efficient service and activity recording procedures.
Examples of specific sustainability related short-term benefits include:

1. **Improving area and/or city parking efficiency.** By detecting unused parking spots and parking availability in different areas, users will be able to reserve a spot and/or be guided to the lot with availability. This approach will reduce searching and idling time for vehicles as well as consequent traffic congestion and delay. Parking efficiency is also increased resulting in reduced need for additional parking lots. Although pilot programs have been tested in different cities, a comprehensive system integrating many lots and a substantial number of users has not been implemented yet. The benefits of such a comprehensive system are substantially more compared to the sum of benefits of individual smaller systems in the same city.

2. **Improving flow around maintenance and incident/accident bottlenecks.** Quicker detection, better information and direct guidance on how to navigate around short and medium term network bottlenecks result in reduced congestion and delay costs. Reduced congestion will also improve energy consumption and localised air pollution.

3. **Coordinating private and public transportation modes towards reduced vehicle trips and better overall system efficiency.** Providing better car-pooling opportunities is one area of improvements. Transfer options between modes is another area of opportunity. This includes information about mode availability and real time schedules as well as intersystem pricing. This can evolve into a “seamless” transportation system/service.

4. **Better information to users during trips resulting in a safer and more effective system.** System knowledge about the location and identity of users can result in better system security as well as additional safety gains. Some fear that this will degrade personal privacy and individual rights. While these are valid concerns proper system administration and public oversight can avoid these stumbling blocks. Several (public and private) agencies keep personal information databases without a major public outcry. A transparent, integrated, accurate, intelligent system can serve effectively public and private transportation needs without compromising personal freedom.

5. **Advice to drivers or partial vehicle control improving safety and efficiency.** Warning or advice to drivers in conditions during which human errors [7] are possible. Partial control of private or public transportation vehicles during docking or emergency conditions will improve performance and system safety.

Examples of longer-term benefits include:

1. **Better system accounting and evolution.** According to many economic analyses, the sustainability problems are a result of inaccurate accounting and allocation of generalized costs. This rationale supports
that many of the pollution or city evolution costs today, are either underestimated or not charged to the appropriate groups or both. As a result of this market distortion we are moving towards “unsustainable development.” Part of the problem is that some of the costs we do not know and others that we know are difficult to measure accurately or politically infeasible to allocate to users. A better more accurate accounting and costs allocation system will correct part of the “inaccuracy.” In the area of transportation this would be reflected in a fair and accurate user cost system. To deploy this system we need precise time space trajectories of vehicles as well accurate network costs and conditions records. Intelligent Transportation Systems contribute greatly towards that goal. With the more accurate allocation of user costs, the single user automobile use will be discouraged with an active and fair way. Alternative modes of transportation will become more competitive and successful in providing services for most trips.

2. Integration with other city services for greater overall efficiency. Geographic Information Systems mapping (and Global Position Systems recording) will tend to unite databases and records for transportation as well as other city services. This more accurate accounting and cost allocation of city activities and services (coupled with corresponding policy decisions) should partially correct some of the forces inducing urban sprawl and provide data for the estimation of overall sustainability.

The concept of evolution applies to all city services and transportation is no exception to this reality. However, new transportation technologies, policies and operations usually introduce profound changes to the way a city looks as well as changes in the routines of daily lives of citizens. As we attempt to introduce Intelligent Transportation Systems and consequent changes in transportation services and technology, citizens will have to change their routines. This switch to the use of ITS and the proper instrumentation equipping of vehicles and infrastructure takes considerable time. Several technologies are ready [8] for both private as well as public transportation but market penetration of even ten year-old systems is still low. Benefits for the individuals as well as the city are marginal at these low levels of participation.

Another concern delaying ITS implementation (particularly in the U.S.) has been public resistance to the concept of vehicles or individuals tracked and guided through the system. The fear of loss of privacy is always present in certain population groups. On the other side of this argument are the gains in safety, security and effectiveness resulting from what can be called “personalised” service. The system cannot provide the optimum service until it knows the “person” and the specific needs it is dealing with. Evidence from less complex transformations shows that careful planning with public participation needs to be followed with extensive information campaigns and very clear
implementation schedules. Implementation schedules should allow for ample delay and retrofitting times as first time project success rates are usually low.

Finally a clear specification of public and private system components (and corresponding governance) needs to be present from the beginning of the implementation period. The ITS implementation is an excellent facilitator of innovative public/private partnerships that are necessary in the city of the 21st century. It provides opportunities for private service providers to assist in basic city operations and at the same time create markets for enhanced products using the same infrastructure. The contributions towards sustainability can be successfully used as a corporate strategy [7] and results shown through detailed system accounting will be an effective public relation tool. If the initial terms are clear and the accounting is fair the partnership is a win-win experience for both parties.

4 Conclusions/recommendations

While the return to 19th century transportation technologies and city look is romantically attractive it is not in everybody’s preferential list and it is unrealistic as a universal solution to current transportation sustainability problems. We have to use experience from older problems/solutions as well as advantages that today’s technologies can provide. It is a “new” engineering problem and it needs to be addressed accordingly. Integration of city services and functions under common objectives and use of advanced data collection and analysis can help us organise measurements and determine how close we are to sustainability goals. Intelligent Transportation System technologies and methods hold promise for contributions to the solution of the puzzle. Most of the ITS technologies are now mature and ready to be deployed in the field. Off the shelf technologies include smart transit vehicles, TMCs, parking system assistance, traveller information systems, incident/accident detection and others. Technology alone cannot provide the answer to all the problems and should be used prudently in conjunction with meticulous planning and respect of human needs and capabilities. The ITS enhancements have the potential of creating a “personalized” and “seamless” service for all city residents; but special attention is needed in the handling of individual citizen information. Transparency and institutional responsibility are also basic ingredients of a successful deployment of ITS. Public/private partnerships are facilitated but the terms and agreement evolution need to be examined so that basic services are available to all segments of society. The sustainability concept and definitions need further refinement and the elements and structure of ITS can contribute towards this refinement with better accounting and accurate system control.

References


