

SPATIAL TECHNOLOGIES AS A TOOL FOR DEVELOPING SUSTAINABLE URBAN TRANSPORT IN MIDDLE INCOME ECONOMIES

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Abstract

Urban transport is one of the most important elements for the development of sustainable urban areas in middle income economies. In many of these countries, the amount of vehicles on highway facilities in their urban areas is often increasing at such a rapid that is overwhelming their capacity- resulting in such problems as increased air pollution, debilitating congestion and increased depletion of energy resources. Their public transport systems are also under stress due from the influx of low income populations from rural areas added to a significant portion of the population that continues to rely on public transport. Acerbating the problem is the accompanying urban sprawl of most cities in middle income economies. It is obvious that these economies cannot proceed in this manner, but need to investigate appropriate sustainable solutions while continuing to advance economically. Spatial technologies (Geographic Information Systems, Remote Sensing, etc.) and spatial analysis tools are essential instruments for analyzing urban transport problems and the development of sustainable urban transport plans in these countries. The paper discusses the link between urban transport and sustainability of urban areas in middle income economies and demonstrates how spatial technologies can contribute to development of strategies/plans for sustainable urban transport.

Keywords: urban transport, sustainability, middle income economies, spatial technologies, geographic information systems, remote sensing

Introduction

I have lived in two cites in middle income economies, Istanbul (my present residence) and Monterrey, Mexico. Although these two cities are continents away, they both share many things in common related to urban transport. Both have severe congestion, vehicular related air pollution, uncontrolled land use development, uncoordinated public transportation with a significant portion provided by private carriers, limited urban rail systems, growing automobile ownership and inadequate funds for new highways and fixed rail transport system. The challenge for these cities and others like them in middle income economies is to arrive at hybrid solutions that may be divergent from traditional solutions such the construction of new rail lines and highways. The future of these cities must be directed toward reducing air pollution, becoming less dependent on fossil fuels, urban sprawl containment and restriction of automobile ownership similar to developed countries but geared toward the specific situations of middle income countries.

Urban transport has an essential role in the development of any urban area. There are many issues which are directly related to urban transport including land development, economic development, mobility, pollution, and energy. The manner in which urban transport is planned and managed in urbanized areas can be instrumental in its future welfare and stability. In countries in middle income economies (MIE), urban transport is often besieged by the many factors. (The author uses the definition of middle income economies as determined by the World Bank (0).) As disposable income is increasing in middle income countries, many individuals are choosing to buy private vehicles. Often, this is a reaction to inadequate public transport in many urban areas in these countries, which may provide mobility, but at a level that cannot compare with that of private vehicles. Most of these countries have been completely unable to adequately cope with increasing automobile ownership and are now facing severe congestion on their highway facilities often resulting in increased travel times and severe pollution problems. Also, in almost all of the MIE, urban population has been rapidly increasing due to the migration of the rural poor to urban areas. This population is generally not able to afford automobiles and is dependent on public transport for their mobility. In many cases, public transport systems have unable to efficiently handle these increases in transit ridership or use it effectively in solving some of their transport related problems. Further decreasing highway capacity is the growth of trucks in the traffic flow due to the absence of inadequate rail systems for intercity goods movement. Despite the seemingly dire transport situations in these countries, there are cities such as Mexico City which has developed an extensive rail system and has started a complementary Bus Rapid Transit system (0) (0) and Curitiba, Brazil (0) (0) that has an exemplary Bus Rapid Transit system and coordinated transit land use development. The latter examples could prove as models for other countries, but cannot be applied without being altered to local conditions.

Spatial technologies (ST) are essential in analyzing urban transport. ST includes GIS, Remote Sensing and GPS and a host of other related spatial related technologies. They are part of a developing area referred to as Geographic Information Science (GISci.) These technologies in combination with digital spatial data are now considered essential for the study of multiple transport problems at all scales (national, regional, and local.) Combined with travel demand modeling and other transportation analysis tools, spatial technologies represent the chief means of integrating spatial transport data. The field of GIS combined with transport is termed GIS-Transport (GIS-T) and is a sub-set of GIScience and transport. The utilization of ST to study transportation is crucial for these areas to adequately arrive at sustainable solutions for urban transport. To fully utilize these technologies requires a redirection of funds and policies similar to those that will be recommended later in this paper.

1. Urban Transport Problems and Sustainability in Middle Income Economies

Issues in urban transport are a widely diverse including such areas as facility maintenance, travel demand, urban freight movement, demand management and impact analysis. Ultimately, transport infrastructure provides the means for the transport for people and goods between different activity centers either internally or externally. Communication networks have the ability to eliminate some trips, provide traveler information and better coordinate both private and public transport. These areas of study are the same for all countries regardless of their status (lower, middle or high income economies.) There is a wide body of literature concerning each of the sub-categories of urban transport. The problems of urban transport sustainability have been determined to be a grave problem for major cities in MIE (0).

Sustainability of urban transport is a relatively new area, but draws from past experiences and literature (0). Sustainability of urban transport equates to the concept of a balanced transport system, the ability of transport systems to be coordinated with appropriate land use development, demand management strategies, and the impact of transport systems and their ability to adequately reduce vehicle emissions and energy consumption to arrive at stable level which will not bring about a global environmental and economic crisis. Sustainability is somewhat of an enigma to countries have been operating on economic, political and environmental philosophies which were geared toward the modern world and not the post-modern realities. There are no standard definitions for sustainability and applications will vary by country (0) (0). At this stage, sustainability may be more of a goal and may not be completely possible in reality. Nevertheless, it is evident, that the global community cannot keep following the same path as in previous centuries and sustainability is the only rational direction to follow regardless if the methods to arrive at such a future state are somewhat elusive.

The problems related to urban transport systems in MIE are the result of multiple factors. The primary factors in these countries are: 1) inadequate and/or poorly enforced and uncoordinated land use regulations suitable for the transport infrastructure; 2) increasing number of people in urban areas who own their own private vehicles; 3) inadequate capacity in existing highway infrastructure to adequately handle the increased traffic resulting from the increased amount of vehicles on them; 4) inadequate pollution control measures on private vehicles; 5) uncoordinated or non-existent freight movement policies with other modes (rail, shipping, air); and 6) increasing demand for public transport due to the influx of low income individuals migrating to urban areas. The combination of all these factors leads to an urban transport system that is unsustainable and inadequate for its present and future needs (0).

To make the transition to sustainable urban transport systems, there needs to be adequate urban and regional planning geared toward compact urban development coordinated with public transportation and regulatory methods applied such as congestion taxes. In other words, the strategies need to focus on both the supply and demand aspect of urban transport, while avoiding the acquisition of extensive debt. Supra-regional organizations such as the World Bank and the European Union must be sought out for consulting and limited financial assistance. The inability of inter- governmental and national governments to adequately deal with the transport problems of these urban areas could result in them continuing to be the shadows of major centers in high income economies and not rising to new heights as vibrant and strategic centers. Ultimately, it is in the best interest of the global economy and environment that these countries be assisted to be sustainable while continuing to achieve other goals such as raising their standards of living.

2. The Role of Spatial Technologies for Urban Transport Sustainability in Middle Income Economies

Essentially, spatial technologies are tools that enable greater spatial analysis. These are generally considered GIS, Remote Sensing, and GPS, but could also be any device that uses geographic data (i.e., vehicle navigation systems.) Spatial technologies (ST) acquire, store, manipulate and display geographic information. The geographic databases are either raster or vector indicating the objects' (polygon, lines, points in vector database) or a pixels' (in a raster GIS) spatial address or coordinates (i.e., x, y; latitude, longitude, UTM etc.) In the vector model, information about points, node, lines, and polygons is encoded and stored as a collection of x, y or z coordinates. A raster model is used to model continuous features and is comprised of a collection of grid cells rather those found in the cathode ray tube of a monitor or television screen. In a vector GIS, the objects are defined in the database, such that there is information stored about the surrounding objects to conduct complex spatial operations. This geographic characteristic contained in a GIS is referred to as topology. However, the structure of raster database could be important if one is interested in layering a remotely sensed image within a vector GIS. The overriding discipline for spatial technologies is Geographic Information Science, which concerns all aspects of spatial analysis of which ST are integral parts (0).

A particularly unique feature of ST is that they can store information about a collection of layers that can be linked together using coordinates and identifiers. This characteristic allows for complex operations and modeling. In a vector GIS, these layers can contain point, lines (i.e., networks) or polygons. The development of spatial analysis tools can be set in the backdrop of mankind's need to understand space and analyze it for the improvement of operating within the spatial realm. The map, whether it was on stone or paper was a major technological tool in making spatial relationships understandable. ST are fascinating and powerful

tools, but still part of an overall continuum and are intrinsically linked with the Information Revolution. With the advent of the PC this changed the accessibility of GIS such that GIS has become the most widely used for spatial analysis by both the private and public sector for numerous tasks from emergency management, urban planning, store location, resource development, transportation planning, gas and water line planning and numerous other tasks. The Internet has allowed for unprecedented sharing of geographic data. These technologies in combination with digital spatial data are now considered essential for the study of multiple problems at all scales (national, regional, and local.) In the public sector, most agencies and local governments in developed and developing nations consider ST as an integral part of their organization. In many areas of the private sector, ST has become an important element in their operation. The private sector is relying heavily on the public sector for the standardization and creation of spatially related data. The accessibility of spatial data is increasing rapidly due to the developments in the technological sector. The public, while not aware of the exact nature of ST, are increasing relying on its ability to provide information. A good example is the popularity of Google Earth. There is an increasing public demand for accessible and reliable data from the public sector of which ST often plays a key role.

It is expected with the increasing affordability of technology and its diffusion into the global society that the demand for digital spatial data will increase. The potential of ST is presently just being realized by those in all segments of society. The transition from an analog to a digital world has mostly occurred in the developed world in all segments of society. Their problems now reside in areas of methods of delivery, integration, standardization, reliability, accuracy and The problem is that many public agencies in many countries (particularly developing countries) are having difficulties grasping that the era of analog data, protection of 'sensitive data' is useless with the entry of readily available satellite data.

ST are an integral part of urban transportation analysis. It is used in a variety of manners from facility maintenance, project management, public transport management and planning, traffic forecasting, impact analysis, traffic management/engineering and land use planning. When GIS is applied to transportation it is referred to as GIS-T. However, GPS systems and Remote Sensing when applied to urban transportation should also be considered part of GIS-T. Those who are professionals in the urban transport planning must now expected to be an expert GIS user and transport analyst.

3. Recommendations for Sustainable Urban Transport in MIE

Transportation systems in the MIE can be viewed at various scales. In addition, the inspection of the role of all modes, not only highway transportation, is necessary. To achieve the long range and short-term goals for transport sustainability requires

coordination and planning. GIS-T and ST must be regarded as integral to the achievements of these goal of establishing sustainable urban transport in MIE.

Steps that are recommended to achieve sustainable transportation systems for MIE are:

A. Establishment of coordinating bodies

This should include major bodies involved at both a national and regional level including representatives for the United Nations, European Union, the World Bank and other relevant organizations to study, recommend and monitor the progress of urban areas in pursuing sustainable urban transport systems. The financial assistance of international funding organizations should be directly linked to the progress made by MIE in achieving sustainable urban transport systems.

B. Development of comprehensive transport plan for sustainable urban transport

This would involve the accurate inventory of all the transport networks by mode. The establishment of a region-wide GIS is essential. In addition, travel demand modeling including goods movement should be accomplished. The result of this needs analysis would be a plan with a list of potential projects.

C. Establishment of a set of realistic projects that the implementing agencies are committed and schedule of projects

Crucial to making the transportation plan a reality is committed funding for the projects. This would involve the participating bodies programming and coordinating projects for the region

D. Implementation of projects

Once the projects have been determined, the implementing bodies have to decide which projects should be implemented.

E. Monitoring of projects

This is an on-going process. Planning for transportation is insufficient without the monitoring of the projects.

4. **Recommendations for Integration of ST in Urban Sustainability in MIE**

However, regardless of the robustness of ST and the ability of these technologies to assist in decision-making, it cannot be a viable tool in urban decision making before certain conditions are met.

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Some of the conditions that are needed are:

Standardization and transparency of geographic data.

One of the problems in the GIS community worldwide is interoperability-the exchange of data among different spatial technologies. However, these problems have eased in the last few years. The ability to access to data and the level of quality is commonly referred as transparency. Much urban GIS data in the MIC is not

readily available for use in research and other analysis. By the creation of Internet portals, many parties could have access to urban spatial data

Development of Urban Transport GIS databases

This would involve using existing databases and the creation of new ones. This is a prerequisite for any GIS analysis. These databases should be configured so that they can be used for multiple purposes and exclusively strictly project oriented. At this time, it would appear that only a few cities in the MIE have fully developed GIS. There are some agencies and universities that have GIS databases, but the interchange of data between different levels of government appears to be fragmented or non-existent

GIS and transportation education in higher education institutions.

Before GIS can be an integral part of urban analysis, there has to a sufficient number of professionals that are qualified to be able to develop and maintain GIS systems. At present, very few university that offer GIS programs in the Middle income economies. There needs to be more universities and other institutions providing training for both professionals and technicians who are experts in ST. The education of urban transport planners who are versed in sustainable transport strategies and analysis tools are also required.

Regional and national ST coordinating associations and institutes

There are many organizations that could coordinate GIS activities. There are organizations in the Europe that are presently dealing with the use of spatial technologies such as the European Umbrella Organization for Geographic Information (EUROGI). It should be noted that none of the countries in Southeast Europe are included in this organization. There are others such as the Network of Associations of Local Authorities from South-East Europe (NALAS) which are dealing with common problems such as waste water management and other urban issues. \

Adequate funding for hardware, software, infrastructure and GIS projects.

There are also numerous organizations that are funding projects to aid urban areas. One of the most prominent is the European Bank for Reconstruction and Development who gives assistance in public infrastructure and other capital needs of cities. The European Union also is contributing substantial financial support for projects. It is not apparent if funds are being allocated for the infrastructure, data collection, and software, training and technical assistance for the use of ST in these projects by other organizations.

5. Conclusion

The countries in MIE are coping with common urban transport issues. Spatial technologies are essential in analyzing these complex issues and assisting decision making. There are multiple funding agencies including the World Bank, and the European Union that are involved in the previously mentioned urban issues. However, in a preliminary review of some of the funded projects, there was an absence of the mention of the utilization of ST. These are the most appropriate institutions for assisting the integration of GIS in appropriate projects and programs. Most essential is constant funding for qualified ST professionals, hardware and software and the related infrastructure.

In urban areas, ST is not a luxury or a frill but an essential element in urban analysis and management. For the MIE to be able to deal with urban transport problems, the use of GIS must go beyond a project-oriented tool to one which is integrated with the urban decision making process. This will not happen overnight as there has to be serious efforts by regional, national and regional institutions to ensure that ST plays an integral part of every project and program.

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