Spatial-Science-based approach in Planning Framework for Multimodal Public Transport: Case Study of Melaka, Malaysia

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Abstract

The massive growth of movement due to urbanization process increases the challenge to manage a transportation system efficiently. An efficient management of transportation is vital for Melaka as a tourism state of Malaysia. The growth of tourism industry is thriving by the increasing number of travelers. Melaka has different types of travelling modes to cater different trip purposes and traveler groups. A mixed traffic imposes certain types of difficulties for users as well as planners. The different modes (multimodal) of travelling (i.e. public or private transport) provide options for a traveler to plan the journey. Unfortunately, different transport modes without synchronization strategies caused difficulties in planning a trip in advance. This paper focuses on multi-modal planning of public transport. A mixed traffic imposes certain types of difficulties for users as well as planners. In reality, the public transport use pre-planned and experienced-based route approach in transport planning process. This paper investigates and proposes the use of spatial technology into the planning framework of multimodal public transport system for planning and decision-making purposes. As a result, the planning framework acts as a tool to improve planning and management in public transport. The use of spatial technology under different phases of the framework enables to see the spatial heterogeneity of the elements and the processes involved. In addition it promotes synchronize, strategic and collaborative approach to planning.

Keywords: Spatial-Science-based technology, Planning Framework, Multimodal Public Transport, GIS

Introduction

A transport planning is an integral part of the modern world urban planning. The rapid urbanization leads to an increased number of inter and intra-city movements (e.g. vehicles, peoples) for various purposes (Rodrigue et al., 2009). Hence, transport planners are facing a challenge to efficiently manage the traffic situations on the limited space of city roads. Modern cities have different types of travelling modes to cater different trip purposes and traveller groups (CTRE, 2007). Many travellers prefer and switch to use personal vehicle rather than public transport especially for the familiar trips. Traveller's perceptions to the quality of public transportation are identified as a barrier to include such modes in the choice sets of travelling (van Exel & Rietveld, 2010).
This paper presents the problems in implementation of multimodal public transport system in Melaka - a tourist state of Malaysia. It aims to highlight the need to adopt spatial-science-based approach to implement an efficient public transport planning. A synchronized planning of different travelling modes is possible using geographic information system (GIS) and Remote Sensing technologies in order to formulate better-informed policies. For that purpose, a framework for planning and decision-making process supported by spatial technologies is described in this context as a systematic approach for decision-making process. The use of spatial technology under different phases of the framework is presented to enable to see the spatial heterogeneity of the elements and the processes involved.

**Case Study in Melaka - a Tourism State of Malaysia**

**Public Transportation challenges in Melaka**

To date, the uses of public transport in Malaysia are disappointing. The Level of Service (LoS) quality in the public transports could be determined if the services are able to fulfil the people requirement (quality gap) through their perception. The Service Quality (SQ) in the public transports can be measured by SERVQUAL dimension (Zakaria et al., 2010). SERVQUAL method is inspired from Zeithaml, Parasuraman and Berry (Valarie A. Zeithaml et al., 1990). In 1988, the components of SERVQUAL were refined to five dimension which bring the acronym RATER; Reliability (R), Assurance (A), Tangible (T), Empathy (E), and Responsiveness (R). The poor SQ of public transport in Melaka is a major factor to the mode of public transport choice. There are several factors which caused the lack of LoS for public transport in Melaka which we called the lack of RATER in existing system. In order to overcome the weaknesses, we proposed a Framework of Multi-Modal Transport Systems in Melaka using spatial-science-based approach.

**Methodology of Spatial-Science-based Planning Framework**

The phases of planning framework process are divided into three (Figure 3). The figure describes the way how spatial science approach can be applied for different processes for each phases, namely: problem identification, designing alternatives and decision-making process. For each phase, use of GIS technologies would be described further in details.

*Problem Identification*

Defining and describing the system by perceiving problem or opportunities in terms of content, environment, boundaries, space, and time involved is essential in any planning process. The current situation needs to be assessed before formulating the objectives in order to make the design and decision phases operate on the right problem (Sharifi et al., 2004).
As a part of the problem identification process, it is essential to identify the major stakeholders such as user groups, local municipalities, planning authorities, traffic police department. The objectives of a planning team would be to remove the problems in the system. Spatial-science-based GIS technologies can help to identify these problems by providing information of related characteristics with spatial and temporal dimensions.

**GIS Technologies Usage in First Phase**

In a daily trip, a passenger may use two or three modes of travelling. In order to create a multi-modal plan, the first challenge is to find out the existence of connecting network used by different modes or existence of the infrastructural facilities like bus depots, bus or taxi stands close to train stations, airport. The second challenge is to observe the quality of related characteristics (i.e. potholes on the road or encroachment of the road) of the networks to ensure their usability. In this case, high-resolution multi-spectral imageries (i.e. less than one meter spatial resolution) could be used to
observe the missing links between networks used by different modes. Similarly, it could be used to observe related characteristics such as measuring the distance between a train station and a bus-stand, monitor the condition of roads, footpaths and other infrastructure. With the real time GPS tracking, bus delays at each bus stop or any other mode can be traced. The number of passengers retrieved from web server is linked to bus fare collection information (i.e. per day/trip on all and particular routes). The information then would be attached to the GIS layers (e.g. zones and network) to make related queries. Therefore, once planners have transport infrastructure, traffic and user related information in a spatial manner, GIS system can identify the problem areas or zones. For example, specific details related to a missing link or infrastructure in a particular zone can be identified. This phase also helps to identify the stakeholders who spatially and non-spatially interact within the area of interest. Once the planning process completes the problems and stakeholder identification, it leads to define the objectives. On the basis of this process, data collection takes place which may include various forms such as GPS survey for locations or networks, satellite imageries or aerial photographs, landuse / landcover, Digital Elevation Models (DEM) and slope raster.

**Designing Alternatives**

A very significant part of decision-making process is the generation of alternatives. The design phase involves generating, developing and analysing possible courses of action. Initially, the current state of system is studied to identify the alternative ways in order to improve the performance of the system in terms of action, time and space. In this phase, a model of the problem is constructed, tested, verified, and validated. Depending on the selected paradigms for decisions making, different type of models could be applied (Sharifi et al., 2004).

In Melaka, bus is the most popular means of public transport to get people from one location to another. There are several bus companies offering services to commute with different fare rates, locally or interstate. All public transports in Melaka depart from Melaka Central Terminal which is located around four kilometres outside the city centre. The terminal plays an important role as the major transportation hub from which passenger can get various public transports in one place such as intercity express bus, domestic bus, and taxi.

**GIS Technologies Usage in Second Phase**

Once the spatial and non-spatial data are prepared, several alternatives can be designed by developing new scenarios. Optimization of public transport services from a transportation hub like Melaka Central Terminal requires a modelling effort based on public transport assignment. However, the presence of different public transportation modes caused a multi-modal planning
challenge. For instance, different scenarios using different modes, fares charged, network width and speeds can be generated. Current version of core transportation modelling software such as CUBE helps to define certain conditions specific to a public transport scenario. The conditions are based on the data collected during the problem identification and objective defining phase.

**Decision Making Phase**

Decision Making phase is the most important and final phase of planning process. Planning process starts with a set of alternatives and ends with a decision. After selection of the best or acceptable solution, the solution has to be explained and well presented. The result should be in a suitable state to put together and produce a well-argued decision report. Thus, presentation and explanation of the decision is one of the most important phases in a decision-making process. For that purpose, visualization of the results is an important tool to increase the acceptability and desirability of the choice (Sharifi et al., 2004).

**GIS Technologies Usage in Third Phase**

Visualizing transportation networks, especially involving multiple modes is very cumbersome in a non-graphic environment. The spatial arrangement of transportation demand and supply of transportation facilities are perfectly suited for a GIS environment for visualization purposes. This spatial arrangement also suits for the data management requirements associated with both demand and supply characteristics (Regenold, 2007). In the end, it helps to make a rational choice based on the observed factors and constraints.

Figure 3 shows an example of a loaded network based on the results of a traffic assignment model. The different widths of the network reflect the different result values on each road segment. With simple visualization, it can be easily identified which areas are going to receive more traffic due to certain activities. Such GUI based results can be obtained using the current versions of core transportation software. This kind of results can be converted to GIS formats.

![Figure 3: Results of a Traffic Assignment Model](image-url)
Conclusion
Transport planning is an integral part of urban planning. In developing countries such as Malaysia, tourist regions like Melaka are experiencing public transport problems with a rapid development of the area. Spatial science based technologies are capable of providing a mechanism to deal with such issues under a planning framework. The approach defined under different phases helps to break down the planning process and to conclude it with a monitoring mechanism regarding implementation of the choices made.

Recommendations
It is recommended that with growing transportation needs, along with local authorities, the research organizations and other professional agencies from national and international level should be roped in to create a viable solution within time. The expertise of such organizations should be in local knowledge, database management, core modelling, and planning issues to provide an effective vision plan for the area with practical mechanisms. Spatial science can be used effectively in different phases of planning to enhance the performance of such plans.

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