Chapter 3

Approach for Smart City by Multimodal Transportation

The realization of smart cities is able efficiently to use the mix of transport modes, e.g. public transport, private vehicles, bicycles, pedestrians, and rail. However, many of these modes currently act independently of each other with no information sharing between them. Recent developments and applications of information technology have made it possible to share information among multiple transportation modes and seamlessly connect them as a single transportation mode. This is generally referred to as "multimodal transport." Multimodal transport has relevance to emerging economies which are characterized by inadequate public transport and a large informal sector of transport operators.

This chapter describes the summary of how to realize a smart city through multimodal transport.

Conventional Transportation

Conventional planning mainly supports automobile dependency, which refers to transport patterns mostly focused on automobile travel over other modes [1]. It strives to maximize traffic speeds and minimize congestion using a specifically-developed set of tools. However, in the cities of developing economies like India, increased dependence on private vehicle usage has started causing frequent congestion rendering traffic planning very challenging [2]. Consequently, the environmental impact of urban transportation has been huge creating long-lasting effects like climate change [3].

Accordingly, transportation planning has now expanded to include more emphasis on greener choices of modes like non-automobile modes and public transportation.

A transportation system must handle diverse demands. For example, any conscious rider should have the feasibility to take a greener route if he wants to. Moreover, economically and socially disadvantaged people, in particular, need diverse mobility options: walking and cycling for local travel, public transit or combinations for longer trips, and automobiles (ridesharing) when necessary. As a result, many agencies worldwide are recognizing the diversity of travel demands and the importance of more multimodal ways.

Multimodal Transport

Multimodal transport refers to linking of multiple modes of transport (buses, Metro, auto-rickshaws, bicycle, etc.) to provide a more seamless end-to-end transport from source to destination with within the economic constraints. Multimodal transport planning requires tools for evaluating the quality of each mode, such as Level-of-Service standards which can be used to indicate problems and ways to improve each mode, as shown in Table 3-1.

For example, London's overall public transport network is characterized by a well-established rail network complemented by extensive bus and ferry networks. These networks are integrated by multimodal stations designed to ease interchange for high volumes of passengers. At major stations, purpose-built bus interchanges have been developed to be within walking distance of the railway and underground stations, often operated by bus station staff and furnished with real-time information systems [4].

To facilitate multimodal transportation particularly focusing on needed to encourage public transit usage, a number of different kinds of integration are required:

- Integration with land-use planning: Building public transit links first and then developing mixed land-use commercial/ residential centres around them thereby reducing the need to travel
- Integration within and between different modes of transport
    - Physical Integration: facilitating direct, comfortable, convenient, and safe access to public transport
    - Fare Integration: Enabling the public transit user to pay ONCE for a journey involving different transport
    - Route Integration—Facilitating logical interchange points where passengers are able to transfer from one vehicle or mode to another conveniently and safely
    - Information Integration—Enabling a 'one-stop-shop' for public transit users, cyclists, and walkers to gain information on any journey they wish to conduct using these modes
    - Institutional Integration—Ensuring that different public transit providers see themselves as part of a network and provide links to other types of transit, walking, and cycling

Table 3-1 Multimodal system features

Variable	Indicators
Frequency	• Operating frequency. • Headways (time between trips). • Average waiting times.
Travel Speed	• Average vehicle speeds. • Door-to-door travel time.
Reliability	• On-time operation. • Portion of transfer connections made.
Boarding speed	• Dwell time. • Boarding and alighting speeds.
Affordability	• Fares relative to average incomes. • Fares relative to other travel mode costs.
Integration	• Quality of connections between transit routes. • Quality of connections between transit and other modes
Comfort	• Seating availability and quality. • Space (lack of crowding). • Cleanliness.
Accessibility	• Distance from transit stations and stops to destinations. • Walkability (quality of walking conditions) in areas serviced by transit.
Attractiveness	• Attractiveness of vehicles and facilities. • Attractiveness of documents and websites.
Marketing	• Popularity of promotion programs. • Effectiveness at raising the social status of transit travel.

1: Practical challenges in developing cities

While there is a need to improve the said multimodal transport infrastructure, such interventions are generally constrained by financial resources. Since the transportation system has to handle colossal ridership, it may not result in the expected acceptance of multimodal transport unless the infrastructure additions have good coverage. Hence, the agencies should carefully plan when and where to invest in the infrastructure to target the gradually increasing acceptance of ridership optimally. To complicate matters, the above-mentioned deployments for non-motorized vehicles face geographical restrictions. It may not be possible to create separate weather-protected shelters everywhere as the cities are often ill-planned. Hence, non-motorized pathways may lack the required coverage or quality. Moreover, the hotter temperatures may cause the riders to withdraw from walking or cycling. Thus, within the financial resources, for the agencies to promote multimodal transport, auto rickshaws are generally used as feeder services or for shorter trips.

In this context, the success of multimodal transport lies in the quality of the last mile connectivity. Developing its infrastructure can significantly improve public transportation usage and hence greener mobility. To this end, one needs to analyze the riders' opinions about the current mode transits and last-mile connectivity to improve accordingly.

2: Last one-mile connectivity

Against this backdrop, we conducted an experiment to analyze the change in riders' opinions with and without seamless last-mile connectivity. The experiment was conducted near the ISKCON crossroads BRT station, which can provide the shortest and eco-friendliest routes using all possible modes. Specifically, the application was to track the modal choice behavior of the riders (Figure 3-1).

Figure 3-1 Auto-rickshaw with a flag of the experiences

Riders getting down at the bus station were approached and briefed about the participants with the help of flyers. Further, they were asked to fill out a questionnaire about their details. Of them, potential participants were selected. With this setup, participants were dropped from station to office in the morning and office to station in the evening for one week. The experiment lasted for two weeks, and the participants were divided into two sets one for each week. Care was taken to ensure that no delay was incurred in the participant's commute. Moreover, all the participants were requested to use the MMA app throughout their rides to analyze their driving behavior.

A questionnaire was taken from the participants on different aspects like ride comfort, and transit delay before and after the experiment to examine the effect of seamlessness on riders' opinions. All the participants were given certificates as a token of appreciation.

Mobility as a Service - MaaS

Mobility as a Service (MaaS) integrates various transport services into a single mobility service accessible on demand. A MaaS operator facilitates a diverse menu of transport options to meet a customer's request, be they public transport, ride-, car- or bike-sharing, taxi or car rental/lease, or a combination thereof. For the user, MaaS can offer added value by using a single application to provide access to mobility with a single payment channel instead of multiple ticketing and payment operations.

This chapter focuses on what MaaS is and how to achieve it in developing countries from the perspective of multimodal transport in the smart city. When we look at the reality of developing countries, it is easy to find many difficulties in improving urban mobility. There is a mismatch between rapid economic growth and enhancing urban nobilities. For example, the growth of vehicle registration is dramatically high because of the rapid growth of its economy. On the other hand, infrastructure development funding is not enough to support such massive demand for vehicle mobility. From this situation, the following negative impact of transportation stands out. (1) heavy traffic congestion, (2) loss of production time, (3) unnecessary fuel consumption, (4) air pollution, (5) increasing accidental risk, and (6) problems with personal health.

Figure 3-2 shows the MaaS system total configuration [5]. Inside of the dark color circle is traffic function as MaaS basic function. And each inside function is related to three major applications–municipal support, life support, and tourism support. The MaaS is a total life support system by mobility assist. Therefore, MaaS has various service applications, and a smartphone application is one of MaaS for navigation, transport selection, and ticketing for transportation.

In terms of MaaS application, several new companies have started a kind of MaaS plant form system using a smartphone application for searching for proper transportation selection. In our program, we also demonstrate a multimodal application (MMA), and some example snapshots of MMA are shown in Figure 3-3. Once residents input their destination, MMA calculates potential transportation selection on their smartphone. Among those transport selections, users can easily find the most appropriate mode based on their interests, such as fast-reaching destinations, economical transportation, or easy access transport. In general, such a MaaS application is suitable for a trial, but there are significant challenges in promoting a business.

Fundamental condition of the MaaS

1: Choice of transportation

The major transportation in India is motorcycles, auto-rickshaws, then private vehicles and local city buses. After this transportation, some major cities will implement BRT or Bus Rapid Transport and Metro railway. It is difficult to define what kind of level is good enough for transportation availability for MaaS. At least, there should prepare some public transportation capability.

Figure 3-2 MaaS system total configuration [5]

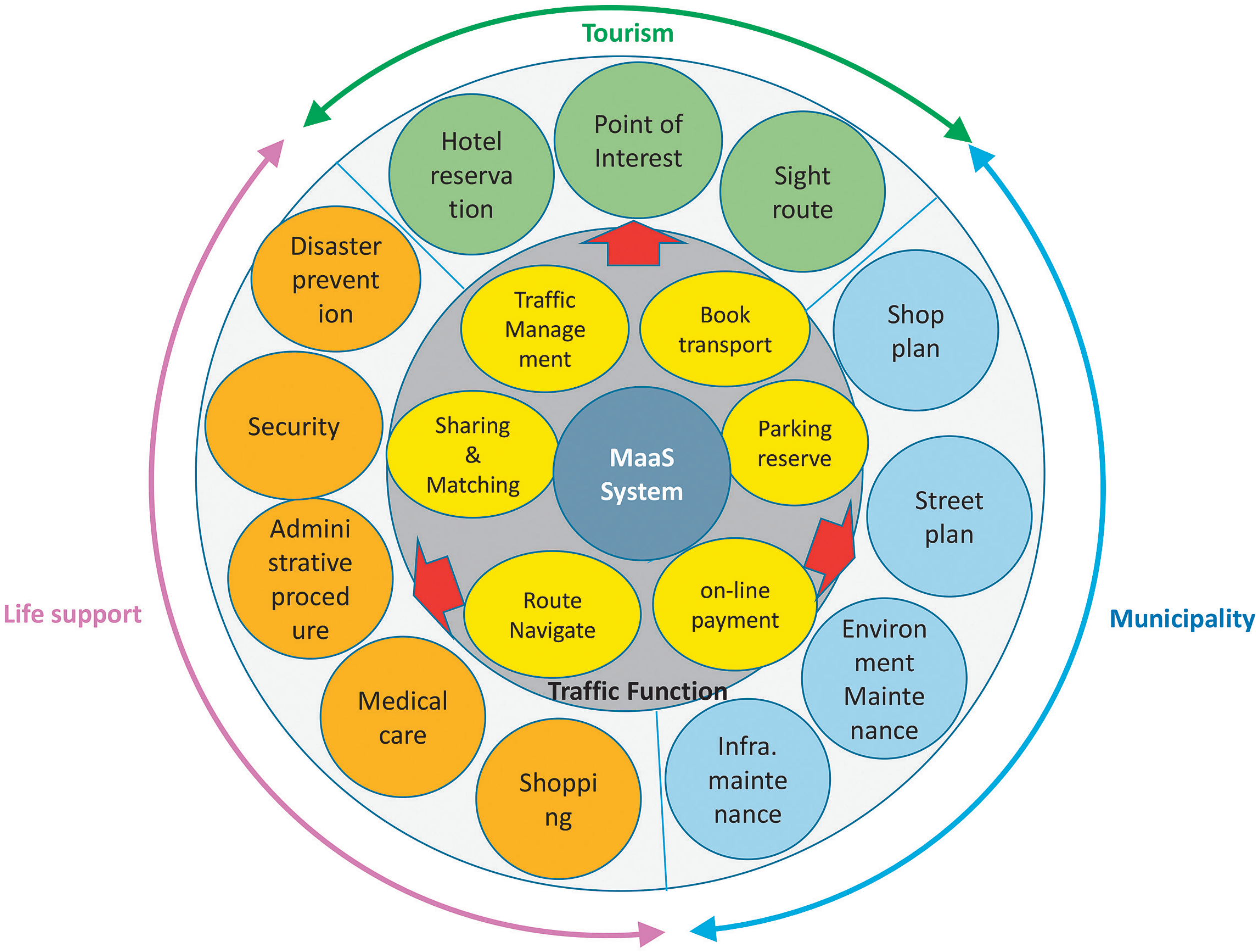
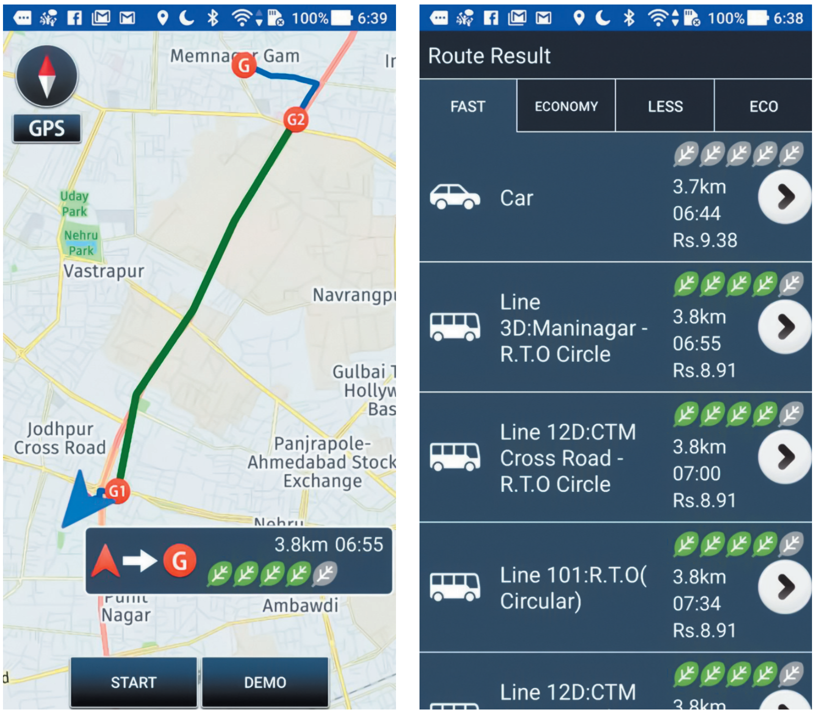


Figure 3-3 MultiModal application example



It is famous Delhi Metro and that of other major cities such as Chennai, Gurgaon, Mumbai, Jay poor, Pune, etc. In Ahmedabad, there are two lines under development. Public transportation is so-called mass transit which means it carries a lot of passengers' transport capability. There are some operation management points for these mass transit expansion and usability.
(1) time punctual operation, (2) easy ticketing, (3) connectivity with other transportation, including last one-mile connectivity, and (4) comfortability. Those operational management points can manage by a smartphone application.

2: Traffic Management

Traffic management is a crucial function of urban mobility services. There are two main parts–one is traffic information distribution, and the other is traffic control such as traffic signals–and all management items should be under traffic policy.

In general, several methods will support traffic information in each region. Variable Message Signs (VMS) will be one of the traffic information delivery systems.

Figure 3-4 VMS in Downtown, Ahmedabad

Figure 3-4 shows an example of VMS in Ahmedabad. There are also other several methods such as traffic information radio and/or broadcast television service. And smartphone application is generally widely used with navigation system.

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