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Seamlessly integrated public transit

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Rail and bus transportation are two major modes in an urban transit system. For passengers, rail provides reliable, rapid and quality services, while buses offer great accessibility and ease of use. However, rail network is usually constrained by many factors, and costly relocation or redevelopment are normally required, while bus transportation normally suffers from impacts of traffic congestion. Therefore, the integration of rail and bus is an important step in the promotion of a public transportation primacy policy, which is adopted by many metropolitan cities worldwide, as it provides a sustainable way for continuous development. The seamless integration of rail and bus not only eases the transfer between the two modes, but also creates a public transportation network that provides quality and reliable services to the passengers, as well as penetrates deep into people's homes or destination.

There are five dimensions of integration between rail and bus transportation in the formation of a seamlessly integrated public transit system. To further enhance the connectivity between different modes, other modes such as taxi, private cars, walking and biking, can also be incorporated into the integration, but by far the most important integration to be achieved is between rail and buses. As shown in (Figure 1), the five dimensions are: network, infrastructure, schedule, information and fare, which represent the five key elements associated with the successful development and operation of a sustainable public transportation system, covering different aspects of integration starting from planning, design, construction, systems to operations. For example, multi-modal public transportation interchanges are not simply facilities co-locating stations of different modes and just to achieve shorter transfer distances between modes. These facilities are, in fact, only the visible part of an overall strategy in providing a seamless public transportation system. This strategy is an important means to attract people to use public transport, for captive riders, or drivers, as a choice, with the objectives of relieving congestion, reducing emission of green house gases, and reducing energy use, etc., catering for sustainable development of an urban area, and globally, reducing the contribution to climate change.

Figure 1: Sustainable Public Transportation System.

Network integration is to consider at planning stage relations between rail and buses, as well as with the applicable urban plan. This is best to be considered at an early stage of the development of the plan for an urban area, or its transit systems, although it is also necessary to go into greater depth of such plan subsequently at different stages. Considering integration of rail and bus network at this stage facilitates the provision of physical space and a high degree of integration with residences and activity centers, which also allows for transit-oriented development. This can be instrumental for the implementation of a public transportation primacy policy. Usually, such considerations are multi-disciplinary and require the participation of various stake holders in the planning process.

Infrastructure integration is to look into design details to reduce transfer distances and to ease the transfer processes. This usually requires the integration of transportation infrastructure with surrounding developments, physical connection between different lines and bus routes, through railway stations and bus stops/stations. The main consideration is to reduce, or minimize, walking distances and walking times, of the transfer. Depending upon the topography and the transfer distances required, there can be various possibilities of the provision of infrastructure, which can be walkways, travelators or escalators. They can also be in the form of public transportation interchanges by co-locating railway stations and bus terminals, so that all transfers can take place at close proximity.

Schedule integration is to minimize or reduce waiting times for passengers during transfer by synchronizing timetables of different modes, mainly rail and buses. With the advances in communication and locating technologies, schedule integration is becoming more possible now, as more and more operators nowadays have capabilities of real-time locating of their fleet of vehicles. In addition, this can be more achievable if the different modes are operated by a multi-modal transportation operator, as integration of schedule may require an integrated consideration of operations, involving the utilization of assets and resources of the operator. If more than one operators are involved, there may be a need for regulators to facilitate the integration through policies or regulations.

Information integration is to provide integrated multimodal information to travelers, during or prior to their trips, to promote better use of the facilities. Worldwide, many operators or regulators have already developed systems that can convey real-time information about different public transportation modes. Some also provides integrated multi-modal travel information with detailed information about journeys to be performed by travelers. Most of these systems provide information *via* internet through various platforms such as smartphones, computers and TV, etc. The multimodal travel information should also incorporate the private modes with the goal of enticing mode switching of car drivers, as shown in.[1,2]

Fare integration is to have a common payment system between different modes, allowing ease of payment, as well as central clearance of fares among different operators involved in multi-modal journeys made by passengers. To facilitate this integration, there must be interoperability of different payment medias, or a single unified payment media or standard. The payment medias can be fare cards, bank cards, mobile phones, etc. For regional travel, these medias may be offered by operators in different regions, and they need to integrate their payment systems to allow the transfer of fares and associated information along with the various transfers made by travelers in their trips. Another issue of integration of fare systems or medias is the provision of incentives for special groups, such as students, elderly or disabled persons, in their multimodal trips involving several operators. In such cases, regulators may need to pre-scribe policies or schemes to resolve any possible conflicts in provision of the incentives.

In conclusion, an integrated multi-modal PTI is an essential element of the policy of public transportation primacy. The implementation of the five dimensions of integration, namely network, infrastructure, schedule, information and fare, represent a strategy to support this policy, and end-to-end satisfaction of passengers making multi-modal journeys in an urban area, i.e., the provision of a seamlessly integrated public transit system. The strategy has direct impacts on the utilization of public transportation in an urban area, and can produce far-reaching longer term benefits for the sustainable development of a city or a region, and to the environment and climate. With urban areas becoming more and more densely populated, and travel demand increasing significantly, an integrated public transit, as a corner stone of such strategy, becomes increasingly necessary to facilitate urban developments in a more sustainable way, benefiting the environment and climate in the long run.

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