Energy Usage and Green Public Transportation in Future Smart Cities: An Innovate Teaching Program for Students, Stakeholders and Entrepreneus
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Detail info about Module 5

Module-5 *"Intermodal Green Public Transport Planning"*

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In most cities, continuous dynamics are recorded in the planning and operations of different transport modes. Often, controversial goals and competition relationships intervene in the mobility system. Users' subjective preferences in choosing their travel modes, pressures from industrial groups promoting individual modes, and even limited focus of some transport companies on a single mode generate negative impact and poor efficiency of the overall mobility system. The essential controversy is related to "cars vs public transport". Intermodal solutions can ameliorate the modal split in favour of public transport. However, significant efforts are necessary to ensure seamless journeys in an integrated mobility system. This module focuses on the core concepts of intermodal public transport, criteria to assess options for intermodal mobility services and measures to increase the attractiveness of intermodal public transport.

Mobility brings many benefits for its users, but with costs for our society. These include greenhouse gas emissions, air, noise, water pollution, road crashes, congestion, and biodiversity loss – all of which affect our health and well-being. The European Green Deal calls for a 90% reduction in greenhouse gas emissions from transport. The EU will become a climate-neutral economy by 2050 while working towards a zero-pollution ambition. To achieve this systemic change, it is necessary to (COM 2020):

- Make all transport modes more sustainable,
- Make sustainable alternatives widely available in a multimodal transport system, and
- Put in place the right incentives to drive the transition.

According to these three pillars of future actions, cities with a high proportion of individual motorised travel need to:

- Redesign their mobility systems (defined by the set of infrastructures, travel patterns and related services, as well as the offer of parking spaces) to become more orientated towards public transport.
- Integrate the travel value chain to encourage smooth, intermodal mobility and increase public transport's overall attractiveness by service extension.

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Mobility requirements are evolving all over the world. People's travel habits are changing, and a mix of transport modes and services are offered. Public transport is only one option that can be chosen to satisfy mobility demand. Transport operators must meet the needs for increasingly convenient, fast, and predictable services. At the same time, users must become more concerned about the sustainability of their mode of travel. In this framework, the mobility solutions must encourage balanced and integrated development of all modes to improve the overall mobility system's quality, security, safety, accessibility, and cost-effectiveness. Consequently, intermodal public transport (IPT) plays a significant role in the development of sustainable mobility systems.

Terms such as intermodal, multimodal, and door-to-door mobility are used for different meanings for the movement of people and goods. According to the most representative European documents regarding sustainable urban mobility, this module uses the term "intermodality" for trips made with more than one travel mode (Eltis 2019), e.g., walking, bus and metro (Figure 1).

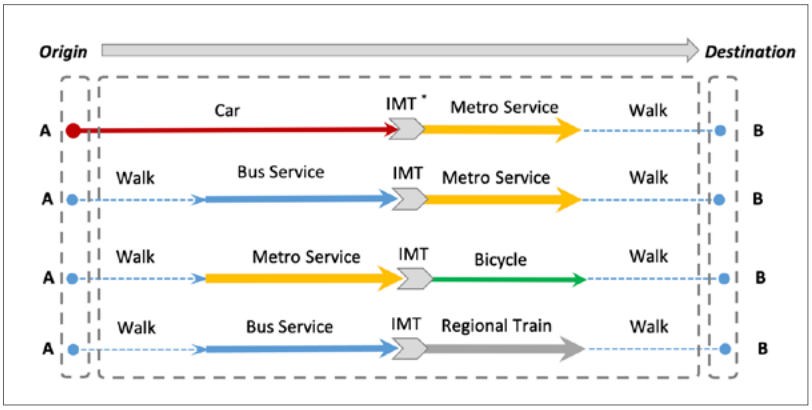

Figure 1. Intermodal transport solutions for a trip from A to B

IPT aims to combine the strongest elements of different mobility options in terms of accessibility, mode of transport, and travel preferences to accomplish an optimal efficiency level. Considering the functions of public transport (Costescu et al., 2021), intermodality has an essential role in (Figure 2):

- making public transport more efficient
- making non-motorised trips more competitive and attractive for users
- enhance the quality of the urban environment.

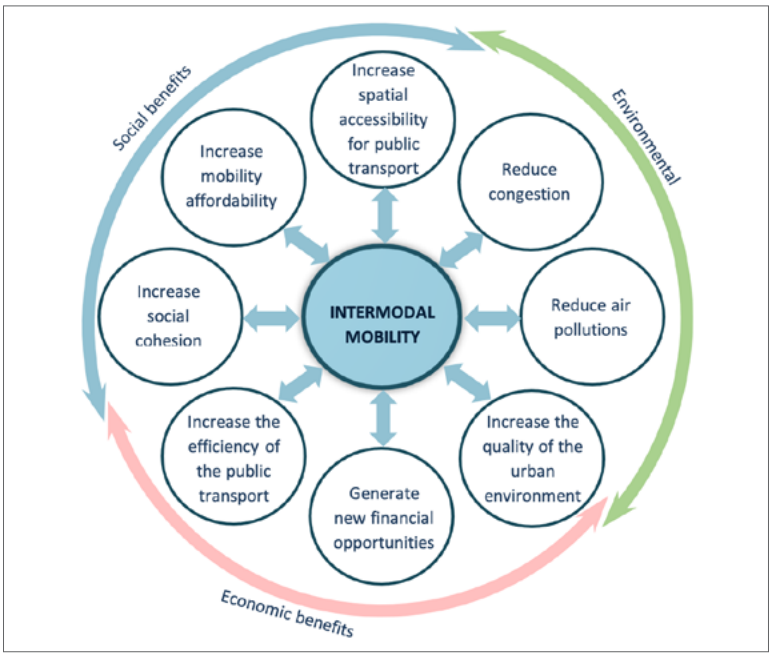

Figure 2. The role of intermodal public transport (Costescu, 2022)

IPT in smart cities can be itemised into three main categories of components: (i) supply and operations of infrastructure and modes of transportation, (ii) service characteristics: quality, safety, security, convenience, sustainability, affordability, (iii) development of additional value-added services next to core mobility services (Van Audenhove et al. 2014). From the user perspective, an integrated mobility system has powerful advantages due to:

- an extensive set of public transport modes across various mobility operators
- one tool facilitating planning and booking of the whole trip across all transport modes and mobility services
- buying only one ticket and paying one bill for the entire trip,
- real-time responses to changing customer needs (meeting delays) and travel obstacles (traffic jams, weather) and opportunities (discounts).

Five integration levels are necessary to achieve such interoperability and these advantages (Table 1) (Bernal 2016, Booz 2012, Luk & Olsewski 2003).

Integration level	Characteristics
1. Physical integration	- associated with a complex scheme of intermodal facilities ensuring easy access to modal interchanges; the design of pedestrian ways facilitating modal transfers and minimising distances for access to stops.
2. Transport network integration	- modal service networks (bus, tram, metro, etc.) should be integrated network that is complementary in relation to their modal characteristics. Metro and tram services should be designed to ensure high-capacity corridors and rapid services.
3. Fare integration	- involves developing a common fare collection system for all modes through a single shared payment media.
4. Information integration	- complete and easy-to-use information and guidance systems are critical for encouraging intermodal travel. Signage at metro and bus stations should be designed to deliver passengers' information effectively. Intelligent Transport Systems (ITS) have an essential role in information integration in particular.
5. Institutional or administrative integration	- involves developing only one institutional scheme to plan, coordinate, manage and control a set of transport networks (e.g., a common metropolitan entity).

Table 1. Integration levels required for IPT development

Physical integration is strongly related to network integration. Both support the integration of infrastructure (Figure 3). Fare integration and information integration require strong cooperation between urban public transport operators and other mobility operators (national and regional - rail companies, or local - as taxi services providers, sharing and rental companies).

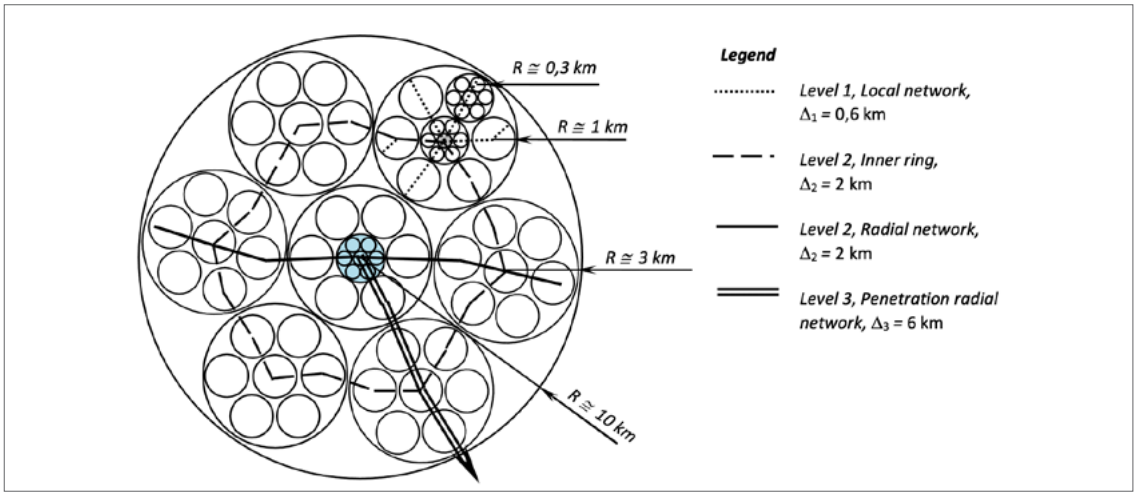

Figure 3. Multilevel urban public transport network based on the hierarchy in spatial structures (Δ1, Δ2, Δ3 – average interstation length) (after Van Nes 2002)

All levels of integration must be supported and encouraged by public authorities. Experience shows that the strong support of city management is critical for establishing broad partnerships and, thus, the successful implementation of an integrated urban mobility system.

The topics of this module mainly highlight transport network integration issues. In order to design appropriate intermodal solutions correlated to local circumstances, it is required to identify the correct competition and complementarities between different travel modes. In this regard, the main particularities of urban transport modes in terms of capacity and speed are discussed. The problems of the design of intermodal networks are analysed. Different measures to increase the attractiveness of intermodal urban mobility complemented by case studies are argued.

Dorinela Costescu

Dorinela Costescu is a full professor at the Faculty of Transports, Polytechnic University of Bucharest. Her teaching has covered Transport Systems, Geographic Information Systems for Transport (GIS-T), Transport Geography, Public Transport, and Management of Transport Projects. As a researcher, she has worked on studies concerning intermodal transport, city logistics, and transport terminals. In the period 2012 – 2016, she coordinated a multidisciplinary research team for studies regarding road safety in the urban environment and traffic risk estimates. Since 2017 her primary interests have focused on sustainable technologies for urban transport systems (mobility and public transport solutions for passengers and city logistics). In 2021 she achieved habilitation in the Transport Engineering domain.

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