

Workshop 6: Better Service Delivery through Modal Integration

Specific mode preferences and system planning in public transportation: an optimization framework

Paul Basnak, Ricardo Giesen and Juan Carlos Munoz

Levels of demand that define which public transport mode is more cost-efficient are usually set by optimization models. According to various studies, Metro lines are recommended if peak hour demand per direction ranges from above 10,000 (Tirachini et al., 2010) to over 30,000 (Daganzo, 2010). However, most of these models have two limitations: first, both total trips and mode share are exogenous, and second, only some variables such as travel times and fares are considered in the generalized cost functions of users.

Research by Mulley et al. (2014) in Australian cities suggests that most users have a better perception of attributes that are usually ignored in optimization models – such as comfort, safety and cleanliness – for guided modes such as Metro. In this case, Metro could be a better option in terms of cost efficiency than other technologies such as BRT or LRT for lower ridership than usually considered, and the contrary would happen if the perception of ignored attributes is better for unguided modes.

Through simple simulations in a 10 km non-stop line, we showed that a difference corresponding to 5 minutes in equivalent travel time between Metro and BRT implies up to 40% difference in the demand threshold that represents the most cost-efficient technology.

In order to estimate the real impact of mode preferences, we will conduct a two-stage study that will provide a better estimate of which transit technologies are more suitable for different demand levels. First, we will perform a demand study in Vicuña Mackenna avenue (Santiago, Chile) which has both Metro and BRT lines running parallel to each other. By estimating latent class models in a revealed preference setting, we will identify the marginal utilities for diverse parameters such as safety perception, crowding, comfort and cleanliness. Second, by incorporating these penalties in the generalized cost function, we will be able to estimate the levels of demand that define which technology is more cost-efficient.

Finally, the advantage of the methodology proposed is that it could be applied to any mass transit corridor if the socio-economic characteristics of users are known. That said, this will be helpful to provide strategic advice for planners when considering different technological alternatives in corridors and networks, particularly in cities that do not have comprehensive disaggregate data required to implement a four-step strategic framework.

Smart Mobility in rural areas: insights and good practices on better service delivery from Europe and beyond

Mark Beecroft, Richard Mounce and John Nelson

Quality of life and social equity in rural areas are highly dependent on people's ability to access all their needs. Ideally, rural areas would have access to an effective, comprehensive and co-ordinated multimodal transport system that maintains efficient linkages between rural communities and also with urban areas. Despite their importance, rural public transport services in Europe are under stress, due to a combination of factors including austerity measures, depopulation and ageing populations. Many rural areas throughout Europe do not have the range of mobility services and connections that are required by the people who live and work there. Mobility is a fundamental freedom that is becoming increasingly out of reach for the young, old and lower income groups in rural areas, as dependency on private cars increases. Mature digital solutions, already flourishing in urban areas, can offer a possible route out of this negative spiral, providing the means to connect people and different shared and collective modes of transport in new ways (although an overreliance on technological solutions should be avoided).

This paper reports on work in a multi-partner EU DG MOVE project entitled SMARTA (Sustainable shared mobility interconnected with public transport in European rural areas) which is developing the concept of 'smart rural transport areas'. The project aims to gain a deep understanding of the nature and the evolution of mobility needs for diverse rural populations and to assess how sustainable, shared mobility systems can help enhance their mobility and travel experiences. The first stage of this work, reported in this paper, has been to undertake a systematic review of rural mobility and good practice in rural mobility solutions across the EU 28 and selected third countries (comprising five additional European countries along with Australia, Canada and the United States). This has been accomplished via a review of the evidence to elicit the identification of the main characteristics of "smart rural transport areas" and to classify and synthesise trends, diversity and practice in rural transport. The identification and analysis of a set of good practice examples of

rural shared mobility has identified a strong focus on Demand Responsive Transport (DRT), an emergence of ICT-based shared mobility as well as numerous cases where ICT is an enabler. Car-based examples are increasingly prevalent as well as a variety of approaches to achieving Integrated Public Transport. There are only a few examples of national level programmes / networks, but this is gradually increasing with the emergence of Mobility as a Service (MaaS). Examples of good practice in smart rural mobility are given while acknowledging that the key to assessing the benchmark of existing evidence and good practice is to consider comparable experiences in terms of context and needs.

This paper will report on the principal findings from this work and offer an assessment of key priorities for policy and solution implementation going forward. Critical to this is an appreciation of the policy and organisational frameworks (including regulatory and financial) necessary for rural shared mobility.

Travel Demand Model for First-/Last-Mile Autonomous Bus Services

Pei Nen Esther Chee, Yusak O. Susilo and Yiik Diew Wong

In urban cities, a metro system is an essential public transport service to move people in and around the cities. Metro service enables people to commute from one metro station to another metro station at a more cost effective and time-saving way. However, the often less-than-satisfactory access to such service, especially for the first-mile and last-mile trip stages, is one of the key factors which affects people to choose driving over using public transport service.

The presence of small autonomous bus (AB) such as Easymile's EZ10 and Navya's Autonom Shuttle, now operated in some cities, opens up alternatives to the existing first-/last-mile travel options. It can be used to enhance people's first-mile and last-mile travel movements, making public transport more accessible to people. Ideally, people should perceive AB service to be no different from a normal bus service. However, during the present transition period when autonomous vehicles (AVs) are still treated as a new innovation empowered by new, automated driving technology, understanding of people's acceptance towards various AV services and how this technology can fit into the existing transport system is essential.

A detailed literature review was performed in searching for significant external variables including socio-demographics, travel characteristics and travel attitudes that affect people's intention to use AB service. Significant variables affecting intention to use an AV are found to include socio-demographics in terms of gender and age, automated driving technology awareness, acceptance of advanced driving systems, data privacy concerns, experience with Advanced Driver Assistance Systems (ADAS), using multiple modes, and population density in urban areas. As for intention to use an AB service, significant variables are found to include in-vehicle security, waiting time, travel time, travel fare, passenger security especially during night time, and existence of on-board steward.

How would users' attitudes towards an AB service affect their preferences between conventional bus service and AB service? Currently, there is minimal literature reporting model applicable to study potential users' preference to use an AB service for first-/last-mile travel options. Our works aim to construct a travel demand model to evaluate people's acceptability of first-/last-mile electric AB service over existing first-/last-mile conventional bus service, its sensitivity to the associated level of service and users' attitudes towards the technology. A literature review was first conducted on past travel demand models applied to public transport planning before the construction of travel demand model involving first-/last-mile shared AB service. As for modelling, data used in this study was collected from a stated preference survey conducted in June 2018 during the trial operation of a free first-/last-mile shared AB service on a local public road in Kista, Stockholm from January 2018 to June 2018. Selected findings for the trial AB service shall be reported.

Attitudes towards driver-less feeder bus services: evidence from Sydney, Australia

Geoffrey Clifton

Investment in new heavy-rail or metro services in lower-density suburban areas tends to rest on the ability to facilitate intensification of land use on the one hand and transport travel time savings for existing residents on the other. The latter is particularly problematic, without pre-existing large walk up populations, generating transport travel time savings means relying on broad catchment areas of people prepared to catch a feeder service to connect to the line-haul service.

This first and last mile(s) connectivity represents a major barrier to the success of feeder services in lower

density suburban environments. Street networks that are not designed to facilitate walking or cycling (e.g. indirect routes, unpaved footpaths and little or no pedestrian/cyclist priority at intersections) limit the catchment area and suppress demand even for those potential customers nominally within the catchment area.

Furthermore, these issues create constraints in network design. Operators face pressure to sacrifice frequency of service and quick point to point travel times to reduce access and egress times for potential customers. The trade-off is such that, for a given subsidy, customers in lower density areas may either have geographic proximity to services (typically a service that comes near to their home) or temporal proximity (i.e. a frequent service and/or a quick service).

The widespread adoption of driverless buses might represent a cost saving significant enough that services could be designed that are sufficiently frequent, sufficiently direct and sufficiently close to attract passengers to public transport feeder services in lower density environments. However, this will depend on the extent to which potential users will accept a driverless service.

Conversation with operators suggest that the public may have concerns about driverless operation. In terms of safe operation of the vehicles and personal safety insofar as drivers act as a deterrent from crime or anti-social behaviour. This suggests the need to explore attitudes towards driverless public transport feeder services.

This paper does this through a survey of people in Sydney, Australia. Sydney provides a useful case study for this research as driverless public transport services (albeit line haul rather than feeder services) are due to be launched in the form of the North West Metro. This allows the study to consider not only the value to the public of having a driver on board relative to frequency and access distance but also allows for a study of the level of awareness of the upcoming introduction of driverless line haul services.

Respondents to an online survey are divided geographically into those people who will be in the catchment area for the new driverless Metro and those who will not to see if there are differences in attitude to driverless transport. Future research will look at how attitudes evolve after the driverless Metro is introduced and people become familiar with driverless line haul public transport. Preliminary findings suggest that the public have limited awareness of the driverless nature of the North West Metro and are concerned about the personal safety implications of driverless feeder services.

Can multi-modal integration provide enhanced public transport service provision to address the needs of vulnerable populations?

Caitlin Cottrill, Sarah Brooke, Corinne Mulley, John Nelson and Steve Wright

Identification of transport users who are 'vulnerable to exclusion' is not a simple prospect. Myriad factors impact upon how well different groups of travellers are served by transport networks, including those associated with the person themselves, contextual factors such as the geographic and economic environment, and the existing multi-modal transport system. Compounding these influences are spatial and temporal dimensions of service, with particular considerations around how effectively the transport system is able to match users with their preferred destinations at times that are appropriate for undertaking desired activities.

In this paper, we draw on work completed as part of the EU-funded Horizon 2020 INCLUSION (Towards more accessible and inclusive mobility solutions for European prioritised areas) project to reflect on the challenges and opportunities associated with providing adequate and efficient transport services for vulnerable populations and areas, which we term "prioritised areas". By analysing results from a European-wide review of experience we describe such areas with reference to area types; user segments; mobility options; transport infrastructure and service provision; key societal trends affecting mobility and accessibility (including first and last mile connectivity); inclusivity and equity; and the impacts (potential or experienced) of such trends on vulnerable users. From this initial analysis, a total of 15 candidate "prioritised area" types are identified based upon the literature reviewed and with consideration of known practical concerns expressed by transport providers, authorities and agencies. Of note is that these areas are designed to represent a mix of geographies and population types; in addition to representing the multi-dimensional influences of mobility access, equity, and provision.

In the next part of the paper we align the requirements of prioritised areas with an overview of potential ways for addressing or mitigating identified gaps with reference to new models of transport service provision and the additional incorporation of a range of technological levels and solutions. In this context we consider different modal and multi-modal solutions including demand responsive and flexible transport services and

other shared transport solutions, improved passenger information, potential first- and last-mile solutions, and various aspects of Mobility as a Service (MaaS). The review considers how multimodal solutions, as compared to unimodal solutions have provided solutions in their application.

The overall objective of the paper is to demonstrate the complexities associated with provision of effective transport services to the 'mobility poor', as well as identifying potential methods, and the relevance of multimodal solutions, to overcome these challenges. This is achieved via discussion of findings from the reviewed literature and examples of good practice, as well as an assessment of the suitability of different mobility interventions for addressing these challenges.

From workhorse to thoroughbred: Review of bus rapid transit and branded bus service performance in Australia and future opportunities

David Hensher, Yale Wong, Loan Ho and Geoffrey Clifton

Bus rapid transit on dedicated right-of-way and branded bus services with a distinct visual identity have been implemented in various forms around Australia over the past 3 decades. A major public policy debate has surrounded the relative success of these bus priority and branding measures as compared with generic route services in attracting patronage. In this paper, we devise a metric known as a (gross) performance ratio to quantify the success for each of 7 bus rapid transit systems and 20 branded bus services as compared with regular route buses across 5 Australian capitals. A regression analysis is conducted to determine the statistical significance of various bus priority and brand identity initiatives which are used as inputs into a normalisation procedure to determine the net performance ratio of each service offering. This allows an informed comparison between systems and cities, controlling for operating environment and other service characteristics. The results reinforce the merits of upgraded bus services both as standalone initiatives and also as an alternative to expensive, rail-based infrastructure investment. We conclude with a discussion of future technologies which are fusing bus and rail characteristics as well as best practice from abroad in terms of network legibility and brand identity—all helping upgrade the image of the bus from workhorse to thoroughbred.

Integrated Transit System: Case of Kochi

Dennis Jose and H.M.Shivanand Swamy

The present public transport system of unintegrated and multiple stand-alone operations by different operators representing alternative modes has made the users of the system to be choice based. The person then makes the choice based on his or her ability to pay for reaching the destination. An integrated transit system would bring different operators and modes as a single entity and operate for the betterment of users in terms of varied choices offered by the system and increased revenue to the operators. This study takes Kochi – a coastal city in the state of Kerala, India – as a case wherein there is an existing fairly good public transport system. A study of hypothetical events is articulated wherein the possibility of attaining benefits of transit integration between different modes and thereby the possible challenges of transit integration are being analysed. The existing operational characteristics of each public transport mode were analysed in terms of the revenue and expenditure thereby deducing a total deficit of Rs34.7 lakhs per day considering every system to be a single entity. The demand and supply analysis reveal out the operational inefficiency of the bus system with excess supply at city centres and undersupply at outer part of the city. The existing generalized cost for a passenger was found to be Rs61 per trip. A new fare structure was set with metro fare being reduced from Rs2.7 to Rs1.2 per km, bus and ferry fare to be at 80 paise per km, and the access fee of all modes was kept unchanged. Along with the new fare structure the bus routes were restructured based on the trunk and feeder concept. It was observed an increased overall ridership of 10% with metro seen with 3.03lakh passenger boarding, the generalized journey cost was seen a reduction to Rs43 per passenger trip. In an alternative scenario every public transport mode fare was set at bus fare i.e. 80 paise per km and an access fee of Rs4.5. Even with the drastic reduction of fare an overall 10.3% increased passenger boarding and a reduced generalized cost of Rs33 per passenger trip (-54.1%) was observed. In the unified bus fare cum route restructured scenario a mode shift of 12% from two wheelers was observed to the increased boarding. The revenue and expenditure of operators were recalculated and was observed that a 76% of debt (i.e., Rs26.4 lakh per day) can be reduced, a lesser cost at Rs33 for a passenger trip with lesser operated kilometres of system, increased reliability with lesser waiting times and increased passenger comfort with the choice of different modes available at same fare are found to be attained with unified fare as bus fare and route restructuring. The study would also be considering the integration effects of the major access and egress mode. The challenges arise mainly because of differential characteristics of each mode such as operational timings, cost and labour. The study even though loomed with some limitations of student

concessions being not considered but tries to attain the better service delivery for the user with increased revenue to the operators.

Developing a Seamlessly Integrated Public Transit in Macao

Soi Hoi Lam, Weng Keong Ku and Kun Pang Kou

With urban areas becoming more and more densely populated, and travel demand increasing significantly, an integrated public transit, as a corner stone of a primacy-of-public-transport strategy, becomes increasingly necessary to facilitate urban developments in a more sustainable way. The strategy has direct impacts on the utilization of public transport 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. An integrated multi-modal public transit system is an essential element of the policy of primacy in public transport. In this paper, the implementation of the five dimensions of integration, namely network, infrastructure, schedule, information and fare, representing 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, will be presented. In addition, the development strategies and plans currently adopted in Macao, a small but compact city of close to 700,000 residents and more than 30 million visitors annually, will be used as a base for the discussion. The potential of implementation in the Greater Bay Area at the Pearl River Delta will also be envisaged in the paper.

Does the expansion of transit networks enhance accessibility in a metropolis? An empirical evidence from Seoul Metropolitan Area

Keumsook Lee, Yena Song and Jong Soo Park

In a metropolitan area the accessibility provided by the public transportation system plays an important role in people's everyday life as well as on the land use patterns. Public transportation system of Seoul metropolitan area consists of two modes, bus and subway and they account for two-thirds of passenger journeys generated by more than 25 million people. With free transfers between and within transit modes, transit users can enjoy comprehensively integrated transit system in Seoul metropolitan area and the high modal share partly reflect this transit-friendly environment.

In this study, we analyse the effect of changes in the traffic environment and demand on the time - distance accessibility provided to the public transportation passengers. For this purpose, smart card, often called T-card, transaction data for one week in 2011, 2013, and 2015 respectively, is used. It is a big data that contains the time-space information of individual passengers' travel trajectories in terms of times and locations of entry and exit per journey. Indeed, a passenger can start a journey by bus and end it at a subway station or can use several buses. We calculate the time-distances of links between subway stations and bus stops of the public transportation system at each time based on the actual travel time extracted from the T-card transaction databases. In this calculation we construct an integrated public transportation network by linking all the adjacent bus stops and subway stations in the Seoul metropolitan public transportation system with weights of walking journeys between stops. The time-distance accessibility of each stop or station is computed by the defined equation from the shortest time-distance matrix on the integrated public transportation network. The result is the time-space accessibility of the integrated public transportation network and our longitudinal approach reveals the changes by year and also by day of a week.

The results indicate that the time-distance accessibility tended to decline over time despite of the addition of new routes. This is possibly due to the increase of traffic volume and the complexity of the transportation network, which slows down the vehicle speed in general and the speed of buses. The time-distance accessibility also differs according to the day of the week: it tends to increase during the weekend compare to other days, which can be explained by the traffic as well: buses can run faster on weekends than weekdays. Spatial patterns of the time-distance accessibility can be found by mapping the results to real space. Generally, the central areas tended to have high levels of accessibility and the fringes show low values and this pattern has not significantly changed over time though minor differences are noted. Our results provide an empirical evidence that the expansion and complication of networks do not necessarily enhance transit accessibility for users.

An examination of disabled people's perception of safety and willingness to make transfers in a public transport network

Recently, transport authorities are investing in their public transport infrastructure to make it more inclusive for those with disabilities. Integrated public transport systems rely on users to make multi-modal transfers to reach many destinations. However, for people with disabilities, this means more interaction with the urban environment compared to a direct route. As such, an integrated system can actually hinder the travel experience of a disabled person. To determine the needs of people with disabilities for making transfers, this study investigates the trip attributes which influences their decisions. Furthermore, a considerable portion of disabled travellers can drive a car, so the factors that determine their willingness to use public transport will be different from those who do not have this option. This study included both car drivers and current public transport users. A survey was undertaken in three major cities in New Zealand. The data involved 196 participants with disabilities who travel independently via car or public transport. The results showed that transfer waiting time had the most influence on car driver's decision. They were 3.6 times more likely to make transfers with a 5-minute transfer waiting time and 2.3 times more likely with a 5-minute transfer walking time. Personal safety was the most significant factor in public transport users' decision to make transfers. Without the presence of security guards, the proportion of users willing to make transfers decreased from 82.8% to 58.6%. The study concludes with recommendations for practitioners to make integrated systems more accessible for people with disabilities.

The first- and last-mile transport of university students between stations and campuses located on the hillside

Nobuhiro Sanko

This study investigates university students' transport mode choice between railway stations and campuses. Four campuses of the Kobe University (Kobe, Japan) are chosen for the analysis. In Kobe, three railway lines are running parallel to each other, i.e. from the north the Hankyu, the JR (Japan Railways), and the Hanshin. Students commute to/from the university usually use one of the following three stations: Rokko on the Hankyu, Rokkomichi on the JR, and Mikage on the Hanshin.

A notable geographic characteristic of the study area is differences in altitude. Altitude of the four campuses ranges between 120 m and 210 m, while altitude of the three stations ranges between 10 m and 60 m. Therefore, students must climb around 60–200 m. The distance between the stations and the campuses ranges between 1.0 km and 4.0 km. Therefore, the issues addressed in the present study is a typical first- and last-mile transport.

Transport modes chosen by students between the stations and campuses include: walking, bus, taxi, and moped. Walking is attractive for travelling less than a mile but waling uphill for 20–30-minute is not easy for all students. A good bus service is provided between the stations and campuses, which runs less than every ten minutes during morning peak hours and costs JPY 210. Another public transport is taxi, which is more expensive than the bus, but it costs reasonable when students use it with their friends. The moped is more popular than the bicycle. Uber is not allowed to provide service in Japan.

Issues addressed in the present study are as follows:

- How do modal shares differ among pairs between stations and campuses?
- When do students use different transport modes even in the same direction?
- Do students use the same transport mode in both directions?
- What are students travel behaviours under hypothetical conditions?

Online questionnaire survey was conducted in November 2017, and the number of respondents surveyed was 287.

Some of the findings are as follows:

- The most important factor in students' mode choice was cost. Students who have bus season passes always use the bus, while students who pay the fare for each boarding choose transport mode every time.
- Students choose different transport modes even in the same direction by considering weather, temperature, physical conditions, time constraint, and baggage. An interesting finding is that students who usually use the bus walk when they meet their friends who walk.
- A large proportion of students chooses the same transport mode on both directions, while some of students use the bus to the campus and walk from the campus.
- Binary choice models, where alternatives are bus and walk, are developed. The data is collected by stated preference survey. The value of time for students is calculated.

Before the conference, more policy implications will be discussed.

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Integrated multimodal public transport contracts for better service delivery

Nathalie Sasssan

In France, Keolis has acquired solid knowhow in operating networks that combine several modes of transport (metro, light rail, bus, ferry, bike-share, on-demand, car-pooling, walking). Our multimodal expertise is increasingly being shared worldwide, particularly in Australia where Keolis Downer has started to operate the country's 1st multimodal contract (bus, ferry, on-demand and soon light rail and autonomous shuttle) in Newcastle.

The ambition expressed by the Public Transport Authorities which have chosen to have a single multimodal operator is to deliver better modal integration to their community. Based on our experience, we do believe that an effective public transport plan relies to a large extent on efficient integration between modes and seamless connections.

This plays out on a number of levels – which all need to be addressed to increase the attractiveness of public transport.

In any multimodal transport network the 1st level of integration is achieved with robust, efficient and creative Network Planning. We have developed a bespoke network design methodology that focuses on bringing together a full range of transport solutions, that both meet the needs of the communities and deliver value for money to our stakeholders. This is the work we have just completed in Newcastle where we have carried out a complete overhaul of the network. It now features 4 main bus lines each with a 15-minute frequency, making the network more attractive and easier to use. We work hard with every transport authority to build tailored solutions that increase the liveability of communities, in a mode agnostic and customer-centric way. Shortening bus routes to offer better connections to light rail is an easier process when both modes are managed by a single operator. This encourages us to offer the right transport solution, at the right time, at the right place.

But there are many other layers to be achieved in order to deliver a seamless passenger experience.

Modal integration is about:

- Passenger information – consistent wayfinding and signage, reliable multimodal journey planners, easy-to-navigate interchanges, real-time information about connections, trained customer service officers.
- Operational performance – making sure the bus is on time at the interchange to allow passengers to connect.
- Integrated fares and ticketing – ensuring it is effortless to switch from one mode to the other.
- Having a customer-centric workforce, proud of the network they operate and eager to deliver the best possible passenger journey.
- Inclusion – striving to make the network accessible to all.
- Modal integration is also enhanced when there is a single operational control centre, from which all modes are supervised – giving us a 360 view of the network and enabling us to better manage disruptions.

To convince citizens to leave their cars behind, we work to provide more enjoyable and more human ways of getting around.

We would like to share examples of some of the concepts we have rolled out in our networks to improve modal integration and network connectivity and the results we have seen (customer satisfaction, patronage increase...).

Competence distribution and policy implementation efficiency towards sustainable urban transport: a comparative study

Takeru Shibayama

From sustainability and urban living quality perspectives, provision of well-functioning public transport systems as well as ensuring a higher level of public transport's modal share is one of the most important

policy goals, besides provision of high quality of walking and cycling environments as well as ensuring higher share of these active travel modes. While the infrastructural service level of these active modes as well as cars can be highly determined and implemented by the public authority alone by themselves, the public transport has its particularity in that much wider range of stakeholders are involved for decision-making in its basic service parameters such as operating hours, frequency, network density, and so on. As a result, implementation of policy measures to encourage the use of public transport becomes a much complicated matter in comparison to the ones for cars, bicycles and pedestrians.

In this research, aiming at understanding relationships between competence distribution related to public transport among various stakeholders such as local and regional authorities, public transport operators etc. and implementation efficiency of policy measures aiming at increasing modal shares of public transport, cycling and walking, an international comparison is made in three pillars. The comparison is made in terms of trend in modal share and travel volume change, priority setting in transport policy observed e.g. in transport master plans and mobility strategies, and competence distribution related to public transport. The comparative study covers several large cities in the world, including London, Paris, Vienna, Montreal, Osaka and Tokyo.

A preliminary result shows that the extents of authority's competence in public transport are different from city to city, and thus the portfolios of implementable policy measures differs to a large extent within a good controllable reach of the public authority. Cities with more integrated competences for public transport at regional or local authorities tend to make clearer policies towards the modal shift from automobiles to the other modes, and to reduce the modal share of automobiles successfully while increasing the modal shares of public transport, cycling and walking. On the contrary, cities with more disperse competence distribution among different stakeholders tend to show less clarity in modal shift in its policy manifestation, and to be less successful in shifting the modal share towards public transport, cycling and walking. In the planned full paper, the full results will be presented.

Transport integration as a contribution to better service in the Old Town and suburban areas : A perspective from e-bike and community mobility services

[Ting Sun, Xiaofang Wei and Junfeng Jiao](#)

Rapid urbanization in China leads to an increase in demand for mobility. As in developed and emerging countries, metro project encouraged by government generalizes to answer new mobility needs subjected to rhythms and scales of the metropolis: people are more autonomous in their location strategies; sociability is more fragmented geographically; urban growth supports the phenomenon of suburbanization. The effects of metro on the sustainability of development require questioning the new way of integration of all travel modes including community transport and e-bike with rapid expansion in recent years.

This paper takes the case of Suzhou (south-eastern Jiangsu Province of East China). Our research aims to explore the effect of e-bike and community transport connected to metro as a factor to influence the system of urban transport in the Old Town and the suburban areas. We also discuss the user's satisfaction and their expectation to find designing opportunity to improve the current integration. It is the author's view that e-bike and community transport services will irrigate the Old Town of Suzhou and allow to answer to mobility needs of residents on suburban areas.

Development of a conceptual model for assessing the level of performance of integrated public transport networks

[Roy van Kuijk and Niels van Oort](#)

The current provision of public transport services is under discussion, given its high costs which are specifically an issue when serving low demands. This is a threat for maintaining network coverage and sets limits for improving the Level of Service (LoS). The latter is a necessity to shift away from private car usage in order to lower spatial, environmental and accessibility related impacts (Veryard, 2018). The emergence of new transport services, driven by sharing trends, real-time information technology, and the Mobility as a Service paradigm provide opportunities to tackle these problems. The modal integration of public transport and complementary transport services, such as shared cars, shared bikes or demand responsive transport could have a positive impact on the coverage area and the LoS of public transport networks (Chowdhury, 2016). Olofsson (2017) argues that current research predominantly focusses on the value of modal

integration regarding the direct interests of travellers – such as travel time outputs – rather than on the value of modal integration with respect to system performance which represents wider impacts on urban environments.

There is a scientific challenge to understand and optimize the structure of what we refer to as integrated public transport (IPT) networks, representing conventional public transport networks, complemented by other (emerging) transport services. This paper aims to provide a better understanding about the function of IPT networks and the factors which drive the performance of IPT networks and its impacts on passenger experience. In addition, it will provide a first step towards the design and optimisation of IPT networks. Our specific interest regarding its impact includes efficient space usage and equity.

This paper introduces a conceptual model which describes the relevant characteristics of IPT networks by means of the number of included services and resources available and reveals the main relationships between these characteristics and performance indicators, such as operational costs, land use impacts and travel times. In order to reflect the impacts on transport equity, the latter factor is differentiated for a multitude of special user groups. The full paper will provide a demonstration of the conceptual model by means of a case study of the Province of Utrecht, the Netherlands. One of the main observations reflected in the conceptual model is that complementary transport services can be used for both direct transport as an access/egress mode for public transport trips. This makes IPT networks more complex but provides opportunities for the viability of complementary services and the enhancement of the system performance. The conceptual model describes relationships and interactions between the supply of transport services, its LoS and the demand for transport services. The model processes input regarding the public transport system configuration, the number of available transport resources and population to indicate demand trade-offs between transport services. The model also provides insights into operation costs and space usage.

The authors believe that the conceptual model is a first step towards a better understanding of the performance of IPT networks and the contribution to transport systems and urban environments.

Measuring the quality of the first/last mile connection using a user-calibrated audit approach

[Christo Venter](#)

Interest is growing in the first and last mile of the public transport trip as an important component of the overall quality experienced by a transit user. Although the walking and waiting components have long been acknowledged as important aspects of the generalised cost of travel, other aspects of the out-of-vehicle experience, including safety, connectivity, and ease of use, have not received equal attention in terms of their role in attracting people to public transport (or the extent to which they act as barriers to transit use), and providing a whole-trip perspective to the planner. The work that has been done on the out-of-vehicle experience has tended to focus on specific components in isolation, leading for instance to various indicators for measuring the level-of-service of the walking environment, or bus stop quality. However, given the multiplicity of the first/last mile environment, accurate assessment of its quality requires more than this: it requires the integration of the various components into a coherent framework that can be useful for comparing cases, identifying gaps, and prioritising action across a variety of different situations.

The objectives of the paper are twofold. Firstly, it offers a brief overview of empirical issues associated with the measurement of the first/last mile quality of public transport trips, in a way that is both methodologically sound and practically implementable by transit agencies, while retaining sufficient flexibility to be adaptable to different local contexts. This last point suggests the need for an approach that combines both subjective and objective data, reflecting both the needs and preferences of local users, and objective measures of the quality of various first/last mile components. The second objective of the paper is to explore and test a methodology for addressing some of the identified gaps. We collect subjective data from both bus and rail users in Tshwane, South Africa, and use an importance-satisfaction rating to identify the preference weights to be attached to various components of the environment. Unsurprisingly safety and security emerge as the most important aspects of the first/last mile experience. We then adopt an infrastructure audit approach to rate the quality of the identified components against a consistent set of requirements, derived mostly from previous work on walkability and transit infrastructure design. Along the way methodological issues such as the extent of the catchment area to be considered and the definition of first/last mile modes are addressed. Finally, a combined indicator is developed that captures the quality of the first/last mile environment on a route, station precinct, or area-wide basis. We demonstrate its use in comparing precincts and modes with each other and identifying potential areas for intervention.

Improving the First-Last Mile Connectivity as Part of the Integrated Transport System

Modern transport systems are towards to promoting a variety of more sustainable modes and their seamless integration. In many high-density cities, multi-modal transport led by the transit system is even more critical, since limited land space is a physical constraint to the reliance on private cars and the subsequent building of more transport infrastructures.

Compared to private transport, public transport needs to be more seamless, reliable, and inclusive so that it could become a more attractive mode choice. However, as the immediate leg of public transport, the First-Last Mile Connectivity (FLMC) which is to move people between their homes or work places to main transport nodes such as MRT stations, bus stops and bus interchanges (or even to nearby amenities) continues to remain a challenge.

Improvement measures has taken place in many cities to enhance travellers' experience of the FLMC. For example, in last year, Singapore has hit the target of building 200 km covered walkways, which linked major transport nodes to residences and amenities with larger catchments. Moreover, Singapore Land Transport Authority Masterplan 2013 (LTMP 2013) vision is a people-cantered land transport system with more connections, better service and a transport system that supports a liveable and inclusive community. One of the LTMP 2013 targets in 2030 is "8 in 10 households living within 10 minutes' walk from a train station". Additionally, by the year of 2030, there will be a total of 700 km of cycling paths across the whole country. In the future, Mobility-as-a-Service (MaaS), including on-demand services like Grab and Uber, will provide even more dynamic, efficient services to cater for the FLMC of travellers. In the next LTMP, some of the broad ideas include "How might we make Walk Cycle Ride your preferred way to travel?"; "How might we make Walk Cycle Ride easier and more inclusive for all?"

However, how to make the FLMC more efficient and satisfactory is not an easy task, it needs integrated planning of land uses, urban design, network typology, together with the public transport system, and some even go to the extent of studying human behaviour. Moreover, how to evaluate the traveller's experience and satisfactory on the FLMC, in additional to its efficiency such as travel time and waiting time is still yet a major focus. As the primary modes of FLMC, walking and cycling, there are evaluation approaches for them such as the 5D walkability model (Density, Diversity, Design, Distance to transit and Destination Accessibility), therefore, it is important to integrate the evolution of FLMC into the assessment of the entire public transport system.

This paper will focus on the topic of how to improve FLMC and its evaluation approaches. Firstly, case studies from worldwide for the design of FLMC will be explored and presented; secondly, an evaluation approach of FLMC, which will be part of the assessment framework of the public transport system, will be proposed.

A framework of transport demand management packaging: The integration of perceptions, institutions and measures in a Chinese city

Wei Yang, Wijnand Veeneman and Martin de Jong

Transport demand management (TDM) measures are widely regarded as essential tools to deal with traffic issues. Their effectiveness has been under scrutiny. Packaging of TDM measures has recently received much attention from researchers and governments, because it can achieve more complex policy goals and resolve the negative effects of single TDM measures. Many studies have examined the concept of policy packaging, the ideal packaging process and potential barriers at the theoretical level, and even the effectiveness and acceptance of several specific combinations of TDM measures. However, the way TDM packaging as a concept works in a real-world context has received little attention.

This study regards TDM packaging as a generalized concept rather than the simple combination of measures. We propose a TDM packaging framework including three levels as a whole: the integration of perceptions and visions, the integration of institution and organization, and the integration of specific TDM measures. An effective and feasible TDM packaging process should achieve the integration of these three levels.

Next, we examine the TDM packaging framework in one Chinese city, Jingmen, which locates in the centre

of China. It is a typical Chinese prefecture-level city with the population of 3 million and the urban district area of 273 square kilometres. Compared to super large cities like Beijing and Shanghai, most Chinese cities are just like Jingmen, which reach the similar level of transport development and face the similar transport problems.

We conduct semi-structured interview to the officers from several different transport-related bureaus in the local government to collect their perceptions of sustainable transport in order to detect whether different bureaus share the similar visions and perceptions in transport management; to record the cooperative activities among them in order to know the degree to which the organizations are integrated; and to ask them assess the effectiveness and feasibility of a bunch of TDM measures in order to form the possible packaging of TDM measures.

The result shows that firstly the perceptions of different bureaus are distinct, especially between the plan-oriented bureaus and the executive-oriented ones; secondly, the cooperation is lack and only happens under the formal institutional arrangement and temporary orders from municipal government; at last, the bureaus that share the similar perceptions tend to have similar evaluation of effectiveness of TDM measures, and the bureaus assess one TDM is highly feasible when its design and implementation involve the other bureaus which they have built good partnership.

Therefore, this study concludes that the clear consensus and the formal or informal institutional cooperation are essential for an effective and applicable TDM packaging.

Using big data to identify if an off-peak fares policy within a multi-modal system can influence travellers' boarding time preferences and improve modal integration: the case of South-East Queensland, Australia

[Barbara T.H. Yen, Corinne Mulley and Wen-Chun Tseng](#)

Peak hour congestion, and peak loading are pressing issues for public transport agencies around the world. In multi-modal public transport systems, the fare system can help create an efficient system with good modal integration. An off-peak fare discount of 20 per cent discount for travelling outside the defined peak period has been introduced in South-East Queensland, Australia which has a multimodal transport system. However, this has not been successful in persuading travellers to travel outside the narrowly defined peak hour thus not providing congestion or crowding relief nor increasing customer satisfaction on these attributes. This paper investigates the time effects and passengers' departing time preferences of the fare policy, including the off-peak discount, using big data in the form of smart card data from automated fare collection systems. Choice models are estimated with public transport service characteristics to measure passengers' time preference to provide greater understanding and a quantification of the potential to shift passengers out of the peak. Cross-sectional smart card fare transaction data for the entire system for March 2013 is used to identify individual-specific travel behaviour patterns. The influence of different factors affecting the choice of passengers' time preference is analysed in detail, with elasticity analysis being used to understand the impact on the model result when variables changed in the model. The results show greater propensity for multi-modal trips in the off peak and peak shoulder as compare to the peak period. Using the outcome of the models, the paper concludes with suggestions for more sophisticated off-peak policies to reduce congestion and peak loading.

How does an open-system bus rapid transit (BRT) facilitate inter and intra-modal mobility? A visual analytic analysis of Brisbane, Australia

[Min Zhang, Barbara T.H. Yen, Corinne Mulley and Neil Sipe](#)

Interchange or transfers for passengers in large multimodal public transport networks are more or less inevitable. A zone-based fare system has the potential to ensure that there is no financial penalty for interchange. In South East Queensland, Australia, there is a zone-based fare system in place which does not penalize transfers within the same zone but does charge a full fare for an inter-zone transfer in a single journey. In South East Queensland, Australia, there are more than half of public transport users using BRT bus as their major mode in Brisbane. In this study, the open-system BRT in Brisbane, Australia is used to explore the multi-modal mobility issue associated with BRT design. Is an open or closed BRT system better at providing a seamless user experience? In order to investigate the performance of BRT system, this research employs a visual analytic approach to show how an open-system BRT in Brisbane facilitates daily mobility using Brisbane's public transport smartcard data. We first visualise the trajectories of all the BRT passengers to provide an overview of catchment areas and passenger volumes. The Cesium framework

based on WebGL is employed to produce 3D web maps of BRT passenger flows to and from Brisbane Central Business District (CBD). This visualisation shows that the feeder liner service (whereby a passenger boards a vehicle off the BRT infrastructure but does not have to change vehicle as the BRT service can join the BRT infrastructure) plays an important role in Brisbane's open-system BRT. 85% of daily passengers board a feeder bus line to access BRT main corridor without transfer. To consider how this might be affected if there was a closed-system BRT system in Brisbane, we also produced comparable maps assuming a closed-system BRT. The results are presented in the web with four 3D maps based on WebGL Virtual Globe for inbound and outbound flows of BRT passengers in open and closed system BRT, respectively. We found the coverage and volume of passengers are significantly reduced in the closed system scenario, especially for inbound routes. This is due to the fact that far fewer passengers in suburban areas would have direct BRT services. In the open BRT system case, there are less opportunities for multi-modal trips because vehicles travel off and on the BRT infrastructure whereas the closed BRT system requires vehicles to interchange between BRT and non-BRT/rail services. This analysis is of interest to urban transportation agencies with BRT systems wanted to optimise system operations and provide better public transport services. Besides, the implementation of Web-based 3D Visualization described in this study has the potential for broader application in large geo-spatial data visualisation across other urban planning contexts.