Research in Transportation Economics 39 (2013) 255–258

Contents lists available at SciVerse ScienceDirect

Research in Transportation Economics

journal homepage: www.elsevier.com/locate/retrec

Workshop 5: Network and system planning

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ARTICLE INFO

Article history:
Available online 19 June 2012

Keywords:
Patronage
Network design
Pricing
Subsidy
Technology
Investment

ABSTRACT

A renewed interest in public transport analysis and development has triggered a debate among policy makers, practitioners and stakeholders regarding technologies, design, pricing, subsidies and contract forms for optimal policy, including social well-being and the financing of public transport reform. Here we present contents and conclusions of workshop 5 of the Thredbo 12 Conference held in Durban, South Africa, where we analysed a series of recent theoretical developments on the links among demand, technology and the design of public transport systems, which we coupled with the examination of several case studies in order to feed the discussion regarding the relations among the strategic, tactical and operational elements that should be considered when designing a public transport policy.

1. Introduction

In recent years we have seen a renewed interest in public transport analysis and development that has triggered a debate among policy makers, practitioners and stakeholders regarding technologies, design, pricing, subsidies and contract forms for optimal policy, including social well-being and the financing of public transport reform. The Thredbo series has also taken part of this discussion by setting specific workshops focussed on supply and demand for public transport; for example, the two workshops discussing factors to make public transport patronage grow, from Thredbo 10 in Hamilton Island, Australia (Currie & Rose, 2008; Macário & Jara-Díaz, 2008), and the workshop on system development from Thredbo 11 in Delft, The Netherlands (Veeneman & Nelson, 2010).

In workshop 5 of the Thredbo 12 Conference, we analysed a series of recent theoretical developments on demand estimation and the design of public transport systems, which we coupled with the examination of several case studies in order to feed the discussion regarding links among the strategic, tactical and operational elements that should be considered when designing a public transport policy. Specifically, we report on eleven papers dealing with:

- Elements in design: frequency, vehicle sizes, routes structure, fare collection systems and bus boarding policy (Chavis, 2011; Clifton and Rose, 2011; Jara-Díaz, Gschwender, & Ortega, 2011; Jara-Díaz & Tirachini, 2011; Rodrigues e Silva, Yamashitade, & de Aragão, 2011; Rose & Clifton, 2011).
- Factors in demand: access, waiting and travel time, perceptions (time and quality), reliability, travel time variability, innovation (Aarhaug et al., 2011; Clifton & Rose, 2011; Li, Hensher, & Rose, 2011; Rose & Clifton, 2011).
- System objectives: social well-being, profit, patronage (Aarhaug et al., 2011; Chavis, 2011; Jansson & Lang, 2011; Jara-Díaz et al., 2011; Rivasplata, 2011; Rodrigues e Silva et al., 2011).
- Optimal pricing and subsidies (Chavis, 2011; Jansson & Lang, 2011; Jara-Díaz et al., 2011; Jara-Díaz & Tirachini, 2011).
- Comparative experiences (5 cases)

When holding the discussions, experiences from several countries emerged beyond those formally presented or used as background for the presentations in the workshop: Australia, Brazil, Chile, Colombia, China, Germany, Kenya, Norway, Russia, Sweden, South Africa, U.K. and the U.S.A.

2. Planning systems and networks: theory and cases

2.1. The design of public transport systems

Chavis (2011) presented a model for the optimisation of fare and headway of bus systems with several operators, under three operation regimes: full competition (max individual profits), cooperation (max total profit) and regulated by the government (max social welfare). An important difference between this model and previous works that compared welfare and profit maximisation regimes for public transport service provision (e.g., Chang

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http://dx.doi.org/10.1016/j.retrec.2012.06.022

& Schonfeld, 1991; Tirachini, Hensher, & Jara-Díaz, 2010) is the consideration of the "no trip" alternative, which is chosen when the bus fare is too expensive. The model is applied to Nairobi and it is assumed that users have no access to private car. As expected, the social welfare scenario results in shorter headways and a higher frequency than in the private profit maximisation regimes.

Jara-Diaz et al. (2011) begun by stating that, after the pioneering studies of Mohring (1972, 1976) and Jansson (1980, 1984), the research on the relationship between optimal pricing and design of public transport services remained somewhat stable for a couple of decades but has resurfaced again with strength. Motivated by the paradigmatic case of Transantiago, the re-designed bus system that started early 2007 in Santiago, Chile, the authors synthesized their research since 2003 on the relation between optimal design (frequency, bus size, lines structure and others), optimal pricing-subsidies and the policy decisions in the area. As a key intermediate result, they show that self-financial policies tend to provoke inadequate designs as users' costs are implicitly assigned less weight, ending up with a smaller than optimal fleet of larger than optimal buses. They show that a feeder-trunk lines structure could be optimal only for relatively low demand.

Jansson and Lang (2011) introduced a theoretically sound social welfare maximisation model for the charging of rail tracks and allocation of slots in Sweden, a market which is characterised as an oligopoly for both freight and passenger transport. It is argued that optimal rail charges should take into account three effects that are external from an operator standpoint: (i) external benefits and cost for the operator's own customers, (ii) profit for competing operators and (iii) external benefits and costs for customers of competitors. A special feature of this model is that congestion is accounted for, as it is assumed that delays proportional to the sum of frequencies (departures in a time period) of all operators would arise if there is scarce capacity; in this way the model departs from the usual assumption of considering rail not subject to congestion. It is found that optimal charges should be set below marginal costs when all externalities (i, ii and iii above) are considered. Finally, if a higher charge is imposed for financing of government expenditure, then operators would choose a frequency lower than optimal and therefore it is concluded that welfare is less affected if the extra charging is imposed on segments where there is a high frequency, demand is low, external costs are large and/or customers have a low value of waiting time.

Beyond frequency, fleet size and fare, Jara-Díaz and Tirachini (2011) incorporate the fare collection technology and the bus boarding policy as decisions to consider in the optimisation of public transport services. With an analytical model, it is shown that it is optimal to reduce boarding and alighting times as demand increases by investing in technology and infrastructure to speed up the boarding and alighting process, which on the other hand reduces cycle time and optimal frequency. Most importantly, improving the process of loading and unloading passengers should be aligned with a reduction of the optimal fare and increase of optimal bus subsidy, because the marginal user cost (in part given by the extra travel time that one user boarding a bus imposes on everyone aboard) is reduced.

The planning and operation of privatised public transport markets was analysed by Rivasplata (2011) who described and discussed the paths followed by transport authorities in three cities – Bogotá, Santiago de Chile and Manchester- in deciding about new and innovative forms of public transport provision. The case of the two South American capitals is quite illustrative of how different decisions regarding scope of the intervention and investment can have deep implications on the quality of service provided, size of the subsidy required for operation and ultimate operational and financial success of the system as a whole. Transmilenio started in 1999 in Bogotá as a high-standard set of bus corridors with rail-like stations and high running speed in segregated busways, in which authorities have decided for a phased intervention; it was noted that most of the city is still served by unregulated bus services characterised by low quality and polluting buses. In Santiago on the other hand, a more ambitious system in scope was launched in February 2007, the Transantiago plan, which changed the ownership, network design and fleet size of the bus system across the whole city (without increasing fare at the beginning of the plan), by implementing a new feeder-trunk network design fully integrated with the metro lines, but in which an initial reduction of the number of buses and lack of necessary infrastructure to improve travel times caused severe problems in terms of increased waiting times and transfers (bus–bus and bus–metro) for users, and the need for a permanent subsidy from the government that was not originally considered in the design of the system. Subsequent increases in the fleet size, renegotiation of contracts and the implementation of compliance measures that provide pecuniary incentives to bus operators to increase the frequency of service, have significantly improved the operation of the system (Beltrán, Gschwender, & Palma, 2011).

Rodrigues e Silva et al. (2011) describe the importance of intercity bus transport in Brazil, in particular the connection that should exist between the objectives of the network planning and public policy regarding the degree of social economic development of each specific area, the level of national integration and domestic tourism. Problems in the integration of local and interurban services arise if the different levels of government (municipal, state, federal) do not collaborate in the design and regulation of bus transport services (for example, incompatible fare structures between intercity and interstate bus systems). A general systems model is proposed to have a consistent definition and design of the bus transport network across the country, which is structured in four steps: (i) Understanding the relationships between systems and their environment, (ii) Identifying the main actors involved, (iii) Identifying systems' borders and limits and (iv) Identifying the main actors' needs (including users, operators and the public authority).

The paper by Dementiev (2011) explores the role of hosting a sport mega-event on the decision to invest in socially desirable and economically viable public transport infrastructure projects. He states that different objectives of a public authority and infrastructure monopoly decrease the probability of adopting welfare improving policy. In the investment option game, he shows how the strategic decision to 'burn money' and to bid for hosting a mega-event resolves the problem of indeterminacy and lack of coordination. Due to the shadow price of public funds, the private financing of total investment outlay proves to be socially optimal and can be rationally chosen by the monopoly if the bid initiated by the authority is credible.

2.2. Demand

Aarhaug et al. (2011) focused on innovation and infrastructure in order to analyse differences in terms of patronage and efficiency of long-distance coach services in Norway and Sweden. In spite of the political and cultural similarities between both countries, there are striking differences in the composition of the coach markets, as the number of passengers in Norway is roughly three times that in Sweden, but the average trip length in Norway is only one fourth that in Sweden, which is mainly explained by differences in the institutional setting and subsidies that shape the competition between bus, rail and air travel in both countries. For example, in Norway coach services are characterised by cross-ownership and cooperation, as enforced by 1990's regulation that made mandatory for bus companies in different jurisdictions to cooperate in order to run express through-services, whereas in Sweden coordination among different companies is much more limited. In both countries