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Use of the analytic hierarchy process to evaluate transit fare system

Carlos David Nassi [a,*], Fabiene Cristina de Carvalho da Costa [b,1]

[a] Transportation Engineering Program – COPPE, Federal University of Rio de Janeiro Technology Center, Bloco H, Sala 106, Cidade Universitária, 21945-970 Rio de Janeiro, Brazil
[b] Rua Conde de Bonfim 211, Sala 813, 20520-050 Rio de Janeiro, Brazil

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ABSTRACT

The transportation fare system influences the mobility of a region and the life quality of its inhabitants. This study aims to evaluate a region's optimal fare system by using the analytic hierarchy process, based on a survey among transportation experts, divided into three categories: operators, professors/consultants and government officials. The results are presented divided by category and overall, and the performance of the most important relative criteria to establish a fare system is determined. The most important criterion according to all the selected experts was the fare price, with 21.5%. The fare system determined as the best was distance/zone (31.1%) and the worst was a flat fare system (7.2%). In addition, we show the influence of the fare price criterion in each fare system through sensitivity charts and highlight its importance for all three groups of experts to evaluate the fare system.

1. Introduction

According to the United Nations Populations Fund, in 2008 more than half the world's people – 3.3 billion – were living in urban areas. Nearly all projections are that the proportion of urban dwellers will continue to grow substantially in coming years. This places a great responsibility on governments to provide public services, such as water, sewerage, health, education and transportation. To ease problems of urban gridlock and air and noise pollution caused by the use of private cars, it is essential to have low-cost and good-quality mass transit systems.

The provision of urban mobility to large numbers of users traveling different distances and routes at varying hours and frequencies is extremely complex and comes at a high cost to society (Morales, 2007). Therefore, the configuration of a transportation system and its scope are fundamental for city dwellers to have an adequate level of mobility.

The transportation system is one of the main factors determining the pattern of urban development, particularly the degree of centralization and the location of areas providing services. A properly designed and fully integrated mass transit system can efficiently cover wide areas, permitting more people to use public transportation. Whether the system is totally operated by the government, by the private sector through a concession system, or a mix of the two, an efficient method of financing must be found. This entails public policy decisions on the proper combination of financing from taxes and fares, so that the costs are borne as equitably as possible by all people benefiting directly and indirectly from the system. The fare system influences peoples' commuting choices: public transportation (bus, subway, tram, etc.), private car, on foot or bicycle. When there is an integrated public transportation system (between modes and lines) that offers good service (in terms of waiting and travel time and information about the system) (Paulley et al., 2006), at affordable fares according to the average income of users and fare integration to facilitate payment, citizens will acquire the habit of using the system. It is also important to notice that the fare policy has a major role in the strategy of the public transportation integration (Bicalho & Vasconcellos, 2007). Clearly, cities that have a fare policy that avoids the payment each time someone use a public transport vehicle is contributing to increase the use of these vehicles (the same mode or not) and so contributing to an integrated operation. A good public system thus makes cities more livable and economically productive by reducing pollution, congestion and travel times.

The fare system influences various aspects of a region's overall dynamic. Mobility, economic and social development and demographic density are the main factors affected by the fare system and that must be taken into account in formulating one.

There is evidence that simplifying fare structures can do more than reduce the fares paid by most users and increase their number (Gilbert & Jalilian, 1991). Well-designed changes in the fare structure can also contribute to greater efficiency, accessibility and safety and reduced pollution (May, Kelly, & Shepherd, 2006).

* Corresponding author. Tel.: +55 21 25628176.
E-mail addresses: nassi@pet.coppe.ufrj.br (C.D. Nassi), fabienecosta@gmail.com, fabiccc@terra.com.br (F.C.C. Costa).
[1] Tel.: +55 21 81162489.

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Because of the relevance of the subject and its direct connection with life quality, this study aims to contribute to the question of evaluating the best fare structure in an area. In Section 2 we review the literature of the Fare Policy which has included Fare Structure, Charging strategies and Payment options. In Section 3 we present an analysis of the fare system of some metropolitan regions in North America, South America, Europe, Asia and Oceania. The methodology using the Analytic Hierarchy Process (AHP) to evaluate the best fare system in a region is presented in Section 4. The results are presented in Section 5. Finally, conclusions are drawn in Section 6.

2. Conceptual review

2.1. Fare policy

According to a study by the National Association of Urban Transportation Companies of Brazil entitled "Novas tendências em política tarifária" (Associação Nacional das Empresas de Transportes Urbanos—NTU, 2005), the fare structure is an important part of urban planning policies because it has direct effects on the socioeconomic condition of users, land use patterns and the financial sustainability of transportation systems.

In formulating fare policies, three aspects must be considered (Fig. 1):

Objectives: the results expected from applying the policy;

Fare structure: ways of charging for the services, involving the price level, fare collection strategies and payment options;

Payment technologies: tools (equipment, procedures and programs) used for sale of tickets and control of fare payment.

There are three basic objectives of fare policies:

Financial: to cover the cost of services;

Economic: to induce economically optimal user choices;

Social: to redistribute income and foster inclusion of less favored classes.

The existence of a mass transit system adequate to the characteristics of the population (in general and riders in particular) and the existing infrastructure is fundamental for the sustainable development of a local economy.

2.2. Fare structure

According to the policy guidebook on fare structures from the Institute for Transport Studies, University of Leeds, available from the Knowledgebase on Sustainable Urban Land Use and Transport (KonSULT), fare structures are important policy instruments because of their potential impact on:

Efficiency: If a fare structure encourages transfers from cars, then it will affect traffic congestion and increase efficiency of labor markets due to increased access to jobs and possible reduction in unproductive travel time.

Livable streets: Reduced traffic levels make streets more livable.

Protection of the environment: Reduced levels of local traffic cut air and noise pollution, put less pressure on natural resources such as oil and green space and reduce greenhouse gas emissions.

Equity and social inclusion: Fare structures can impact the affordability of public transportation and improve access to key goods and services by socially excluded and less well-off citizens.

Safety: Traveling by public transportation is much safer than by car for passengers and also reduces the number of accidents suffered by pedestrians and cyclists.

Economic growth: If a fare structure encourages transfers from cars, then reduced traffic congestion can stimulate economic growth and improve access to jobs.

Finance: Fare structures can have a significant impact on revenues and also on costs because they can influence the level of capacity required.

The fare structure is composed of three elements, which combined define the bases for charging for transportation services. They are:

Average fare price: the method to determine fares and the procedures for their adjustments over time (in this paper we do not consider this aspect).

Charging strategy: falling basically into two categories – unified and diversified, in the latter case considering questions of integration, discounts and free passes.

Payment options: conditions offered to users to pay fares (single ticket, prepaid electronic card, postpaid billing, etc.).

2.2.1. Charging strategies

The charging strategies are basically divided into two fare structure categories: differentiated and flat fare.

A flat fare is a single price for any trip in a transportation network. A differentiated fare structure means there are different prices depending on the type of user, quality of service, trip length and/or travel timing.

According to the American Transportation Research Board (TRB) and the National Association of Urban Transportation Companies of Brazil, the different types of strategies can be summarized as follows:

Flat fare: a single fare is charged for any trip within the transportation network (Balcombe et al, 2004).

Distance or zone: different fares are charged according to the distance traveled or number of zones covered.

Market: the use of unlimited, weekly, monthly or annual passes, establishing a frequency of use or area-wide tickets, smart cards which allow zonal, distance-based or flat fares to be deducted, cards which offer a discount on standard fares.

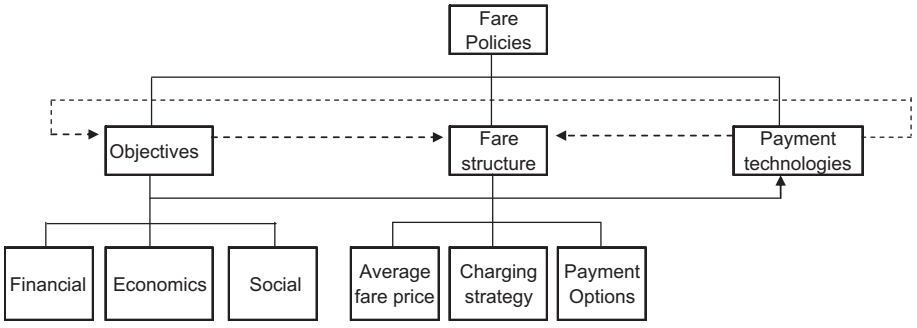

Fig. 1. Elements of fare policy and their interrelationships. Source: Associação Nacional de Empresas de Transportes Urbanos do Brasil.