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Is fare increment desirable for ensuring operational viability of private buses?

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ABSTRACT

The paper reports an investigation on the requirement of fare increment for achieving the operational viability of private buses in the context of an emerging country. Taking an existing route in Kolkata city which is served by private buses, several scenarios were investigated to achieve the viability of service through interventions in fare, design of service, and supply of buses. A simulation framework was used for the evaluation of various scenarios. The study brings out new evidences to question the conventional approach of increasing the bus fare to satisfy the operational viability. It is shown that the fare and the revenue requirements are distorted due to the oversupply of buses and non-optimal service. The analysis shows that even with the present fare, it is possible to resolve the viability issue by optimizing the service and supply. The results presented in the paper are case specific but are likely to encourage policy makers to carry out similar investigations in other cities in India as well as in other developing countries to improve urban bus service without putting an additional burden on the users.

1. Introduction

The role of public transport is well recognized for sustainable mobility in urban areas. Although the urban public transport system includes both bus and metro rail/subways, the bus is the predominant mode in emerging countries such as India as it requires lower investment and offers a greater degree of access (near to door service) in comparison to rail. Several cities in India have extensive bus network, which is served by Government and/or private buses (Badami and Haider, 2007). The buses owned and operated by the Government authorities are hereby termed as Government buses, while the private buses are owned and operated by the private operators. The Government controls the fare and administers the operation for private buses but does not provide any subsidy. Therefore, the operational viability is an extremely important aspect for sustaining these individually owned and operated private bus services plying on the public route. On several occasions, there has been a conflict between the Government and the private bus operators regarding the fare. Private bus operators demand a higher fare to sustain the service with the minimum required revenue. On the other hand, the Government wants to keep the fare low, as the private buses are used extensively by the socio-economically weaker section of the community, and an increase in fare is likely to overburden this community. The conflict has remained unsolved, and the bus fare continues to remain as the focus without any attention to the service and supply. Such conflict exists not only in Kolkata but also in many other cities in India as well as in other developing countries. With this background, an investigation is carried out in the present study on the requirement of fare increment giving due consideration to the service characteristics (say, headway, crowding inside the bus) and the supply of the buses.

Several studies have been reported in the literature on optimal design of bus network (Cipriani et al., 2012; Lee and Vuchic, 2005; Zhao and Ubaka, 2004; Zhao and Zeng, 2008; Baaj and Mahmassani, 1995; Ceder and Wilson, 1986), optimal scheduling of bus service (Fu et al., 2003; Chakroborty et al., 1995), optimal transfer (Shafahi and Khani, 2010; Bookbinder and Desilets, 1992), etc. However, most of these studies included a network level analysis and are not applicable directly in the present context. This is due to the fact that the bus network in Indian metro cities is fully developed and is operational for several decades. Information Technology enabled bus information system is yet to be developed in most of these cities, and any change in existing established routes may cause significant inconvenience to the bus users and, therefore, is unlikely to be socially acceptable. Hence, the challenge is to create interventions for improvement of service without changing the existing bus routes. In addition, it is also necessary to give due consideration to the requirement of both bus users and bus operator during any intervention. In the present work, the requirement of fare increment is

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investigated keeping in mind the dual objectives of enhancing benefit to the bus users and ensuring operational viability to individual operators through optimal service characteristics and supply of buses. A typical private bus route in the Kolkata metro city, India was selected for the study. The city is presently served by more than 8500 buses operating on around 237 bus routes (CYP, 2016), and approximately three-fourth of these routes are served by private buses.

Hereafter, the paper is organized in 3 Sections. In Section 2, the methodology followed for the study is discussed. While Section 3 demonstrates an application with reference to a bus route in Kolkata city, the outcomes of the study and policy implications are summarized in Section 4.

2. Methodology

User benefit and operational viability are the two key aspects of the bus service. A bus service is said to be viable when it is able to generate revenue which is equal to or higher than the required cut-off revenue (i.e. the revenue required to recover all fixed and variable costs along with an expected minimum profit). At the same time, an efficient bus service should maximize the benefit or minimize the cost to the users. The user cost is a measure of disutility that is perceived by the users due to direct and indirect costs associated with the bus service. Therefore, both aspects (viz. operational viability and the user cost) of the bus service were duly considered during the investigation. A scenario based analysis was carried out to study the present operation of bus service and to investigate various policy interventions necessary to achieve the operational viability. At first, the present bus service (i.e. the Base Scenario) was analyzed to examine its operational viability. Based on the findings from the Base Scenario analysis, several other scenarios, as shown in Table 1, were formulated, and in each case, the requirement of fare increment, if any, was investigated while minimizing user cost and satisfying the operational viability of the service.

Scenario-I relates to increment in fare for satisfying the operational viability without any change in the present service characteristics and supply of buses. This scenario replicates the demand of private bus operators for fare increment only for satisfying operational viability without any change in the service characteristics and supply. In Scenario-II, the frequency of buses and fare were allowed to vary while minimizing the user cost and satisfying the operational viability for sustaining the service. So, in this case, the supply of buses was decided as per the requirement of the service. Scenario-III is similar to Scenario-II except for the fare. In Scenario-III, the fare was assumed to remain same as the present fare (i.e. the fare in the Base Scenario). Scenario-II is expected to generate a superior solution to Scenario-III as the fare is also optimized. While it is interesting to investigate Scenario-II in a route specific context, it may not be possible to deploy different fare models for different private bus routes in the same city. This was the motivation for formulating Scenario-III. All three scenarios resulted in operationally viable services but with different user cost and supply of buses.

As mentioned earlier, while analyzing all four scenarios, due consideration was given to operational viability and user cost. Researchers have accounted the user cost in terms of disutility considering different quantitative factors such as transfer time (Jansen et al., 2002), travel time (Byrne, 1976), access time, waiting time, and in-vehicle time (Chang and Schonfeld, 1991), access time and in-vehicle stopping time (Li and Bertini, 2008), waiting time at bus stop and transfer point (Deb and Chakroborty, 1998; Chakroborty et al., 2001), waiting time and travel time (Furth and Wilson, 1981), etc. However, in the context of emerging countries such as India, the qualitative attributes of bus service were also found to be important (Maitra et al., 2015; Dandapat et al., 2014). Therefore, in the present context, both qualitative and quantitative attributes of bus service were considered for accounting the user cost in terms of generalized cost (GC).

The waiting time of the passenger and crowding inside the bus at a point of time largely depend on the arrival distribution of the passenger and/or the frequency of bus service. Therefore, a simulation based approach is used advantageously for obtaining user cost for an input headway of buses. For each scenario, several such simulation runs were taken to identify the scenario specific solution which will minimize the user cost and satisfy the operational viability.

The optimization framework, used in Scenario-II and Scenario-III to identify the optimal services, is shown in Fig. 1. In Scenario-II, various combinations of bus service characteristics (trip frequency and fare) were investigated, and a bus service that offered a minimum GC to the passengers while maintaining the operational viability was identified as the optimal bus service for the study route. In the simulation model for Scenario-II and Scenario-III, the solution space for the trip frequency was defined based on the capacity of the bus and the passenger load on the critical link (maximum link load). The lower limit of trip frequency was defined based on the assumption that the buses are operated with the fully loaded condition, i.e. each trip carries a maximum number of passengers at the critical link. On the other hand, the upper limit of the trip frequency was defined with the assumption that the buses operate with a passenger load equal to the half of its seating capacity. Similarly, a domain was also defined for each component of the fare model. The fare model adopted to estimate the fare (F_{nij}) to be paid by a passenger, n, who is traveling a distance, d_{nij}, from a bus stop i to j, includes three components as shown in Eq. (1).

$$F_{nij} \begin{array}{ll} = F_{min}, & if\ d_{nij} \le d_m \\ = F_{min} + (d_{nij} - d_m)^* F_{inc}, & otherwise \end{array} \quad (1)$$

where, F_{min} is the minimum fare upto a journey distance d_m, beyond which the fare increases at the rate of F_{inc} per kilometre.

2.1. Simulation of bus service

A simulation-based model was used to evaluate various scenarios of alternative bus services and also to select optimal bus service

Table 1
Strategies for policy intervention.

Scenario	Strategy	Service characteristics		
		Frequency (trip/h)	Number of buses	Fare model
I	Increase the fare	Present (C)	Present (C)	Variable
II	Select optimal service	Variable	Variable	Variable
III	Select optimal service without changing the present fare	Variable	Variable	Present (C)

(C): constrained as per Base Scenario.

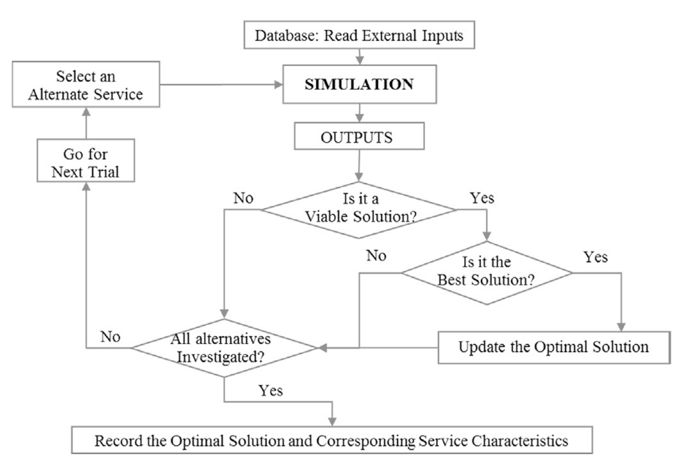

Fig. 1. Optimization framework.