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Short abstract:
Travel using public transportation offers financial benefits to the people. However, reaching a destination by using a single mode of public transport seems to be difficult in metropolitan cities. Need to change more than one transportation mode by taking transfer at an interchange becomes necessary in such cases. As a result, the transfer facilities and their characteristics affect city dwellers' perception to ride using Public modes of transport. With this background, the present study aims to understand the factors influencing people's behavior to use public transport, including transfer for the Surat city. Based on 752 non-transit users' responses, the Structural Equation Model was developed using AMOS software. The Results revealed that factors like 'monthly income,' 'in-vehicle time,' 'crowding at the interchange,' 'frequency of others mode at the transfer station,' 'travel time reliability' and 'customer guidance at interchange' play a crucial role for attracting people to use public transport with transfers.

***Keywords*:** Structural Equation modelling, Non-transit user's perception, Public transport system

1. INTRODUCTION

In the present era, the transport systems are more challenged with the need to streamline the use of existing assets and minimize environmental impacts while sustaining or improving current service levels to support economic development. Promoting more use of public modes of transport is among the most preferred approach to accomplish this objective. One of the principal issues for public transport policy failure is replacing trips using a motorized individual transport mode with trips using a transit service. From the viewpoint of individual differences, one of the well-known strategies consists of classifying groups of persons who have different attitudes and/or behaviors regarding travel to define a set of policy actions (rules enforcement, economic incentives, awareness campaigns, and so on) that is directed for each group of users[1]. Beyond individual physiognomies, the probabilities of diverting trips are also affected by physical constraints, relating to the pattern of activities across different locations and the transport network's related structure. Hence, trips made using transit services involve transfers at an interchange. This apparent inconvenience caused by transfers has been shown to influence travelers' decision to use Public Transport for their destinations. Along with it, trip characteristics like propose of the trip, travel time of the trip, trip length, travel cost, frequency of trip and demographic characteristics such as age, gender, monthly income level, and so forth assumes an influential role in mode choice selection[2]. It is reported that users prefer the private mode of transport because of comfort and luxury [3]. Number of studies are attempted to comprehend the impact of socio-economic characteristics, travel characteristics, psychological characteristics, demographic characteristics, public transport system characteristics, and road characteristics on the mode decision choice of a people[4]–[7]. The mode shifts behavior of an individual from private to the public mode of transport has been studied. However, the microscopic investigation regarding requirement of to the person's demeanor towards utilizing Public transport, including Transfers, i.e., Integrated Multimodal Public Transport System (IMMPTS) since to be less reported in literature. The previous literature uncovers that; when a user is asked to change its mode from private to public transport, their reactions relies upon (I) Easiness to travel and (II) the psychological factors, i.e., their perception about the level of service of the transport system which can be governed by providing an efficient IMMPTS. Subsequently, for an individual traveler to move their means of transport, both the inspiration to change and how to encourage such change is required [2]. In this manner, the idea of the present investigation is not to find the factors affecting the mode choice behavior of an individual; but to investigate and recognize the variables influencing the user's decision to utilize an integrated multimodal public transport system, which is less reported in the literature in context of the developing countries. The components influencing the traveler's groups were distinguished and has been portrayed into five classifications precisely as Socio-economic and travel characteristics (SET), Travel time characteristics (TT), Transfer characteristics (TR), Public Transport characteristics (PT), and Resistance to use Multimodal Transport system (RMMT).The study's primary aims are (I) To identify the factors affecting user's willingness to use coordinated multimodal public transport system. (II) To understand the user's perception to ride an IMMPTS using the structural equation modeling approach.

2. STUDY AREA

The present study was carried out for the Surat city, located in the western part of India in Gujarat. The city is situated on the bank of river Tapi and is divided into seven major administrative zones encompassing area of 234 km^2. As per the census 2011, the city's population is 4.5 million, with an average population density of 301 persons per hectare. Surat city has been experiencing rapid growth in population with a decadal growth rate of 55.29% as per census 2011. Presently, Surat city's vehicular population stands at 2.4 million (RTO Surat, 2015). About 90% of the total vehicles registered consist of private vehicles like two-wheelers and four-wheelers.

The city has public transport mode share of 3%, against the desired share of 40% to 60%. Surat's present public transportation system consists of 48 routes (36 routes of City Bus and 12 routes of BRTS). The BRTS system buses run in dedicated lanes, and the whole network of BRTS buses is spread in the periphery of the city centre. While the City bus system is spread all over, the city with most of the routes passing from the CBD area and the whole system is running in mixed traffic conditions. The routes are designed in radial, linear, and circular manner based on the demographic and geographical variation. Buses are operated by a special purpose vehicle (SPV) named SITILINK, which runs both city buses and BRTS. The city bus system's total coverage area is 276.13 km^2, with an overlapped area of 101.6 km^2. The usage of an automatic fare collection system and an advanced public transport system is installed in buses and at stops to provide real-time information regarding the arrival and departure of buses.

3. DATA COLLECTION

A 24 attributes questionnaire covering the five components (mentioned above) was designed and circulated among non-transit users for the present study. Respondents were required to indicate their perception concerning the significance of each chose variable in context to IMMPTS. A seven-point Likert scale technique ranging from 1-' No significance' to 7-' Very Extreme significance' was adopted for conducting the survey. The questionnaire was sent to 900 people, of whom 752 reacted, a response rate of 83.50%. The entire survey was carried out using Google form and telephonic interview technique. Table: 1 gives insights regarding the descriptive analysis of respondent.

Table 1: Descriptive statistics of respondent

Variables	Respondents

Gender	
Male	61%
Female	39%
Age variation	
Minimum	17
Average	33
Maximum	75
% of Households having Monthly Income (INR)	
<20,000	47
20,000-40,000	33
40,000-60,000	10
>60,000	10
% of Respondents using	
2W	42
IPT	30
Car	28
Trip Purpose (%)	
Work	42
Education	19
Shopping	14
Recreational	11
Others	14

4. STRUCTURAL EQUATION MODEL (SEM)

SEM consists of two components, namely, a measurement model and a structural model. The factor analysis gives the measurement model, which tells how, observed variables measure latent variables. The developed structural model and regression coefficients are shown in the figure 1:

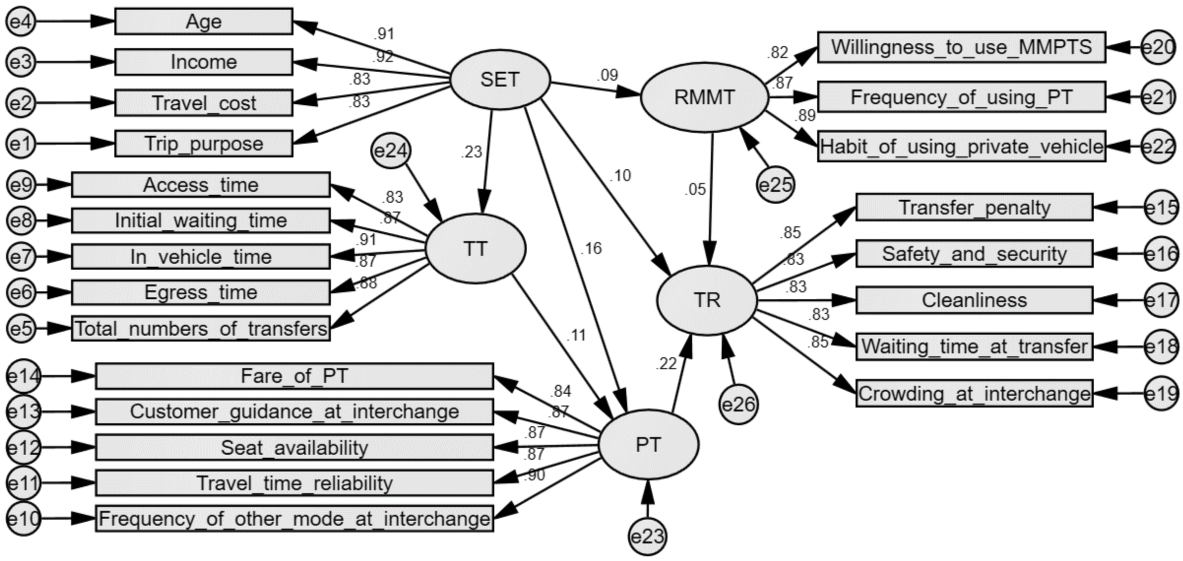

Figure 1: Structural Model obtained for the hypothesis between construct

The model has a 202 degree of freedom with the value of goodness of fit index (GFI), adjusted goodness of fit index (AGFI), Comparative fit index (CFI), Normal fit index (NFI), and Incremental fit index (IFI) as 0.955, 0.944, 0.986, 0.972, and 0.986, respectively.The model reveals that PT has the highest influence on TR, followed by SET and RMMT. The TT and SET indirectly affect TR. Result reveals that the indicators like 'monthly income

(0.92)’, ‘in-vehicle time (0.91)’, 'crowding at the interchange (0.85)', 'frequency of other modes at the transfer station (0.90)', ‘ Customer guidance at interchange(0.87)’ and 'habits of using private vehicles (0.89)' have greater influences on passenger behavioural intentions to use PT system. Monthly income was seen to have a greater influence on non-transit users than the operational characteristics of public transport. While, factors like ‘willingness to use multimodal transport system (0.82)’, ‘travel cost (0.83)’, ‘trip purpose (0.83)’, ‘access time (0.83)’, ‘fare of public transport (0.84)’ and ‘cleanliness (0.83)’ had lowest weights.

5. POLICY INTERVENTIONS

The significant outcomes of the present study are as follows:

- The study recommends that public transport operators need to focus on developing attractive transfer routes (e.g., reduced total travel timesaving) with comfortable transfers, from a user perspective, to encourage ridership of PT. In addition, the designing and operation of transit services need to be tailored based on the desired level of service expected by the traveller’s group.
- Policy measures like Speed up vehicle boarding by use of off-fare collection system optimize stop design by reducing number of stops, public transport priority at the traffic signal to reduce delay at traffic signals, use of real-time data to control public transport operations are recommended to reduce in-vehicle time and improve travel time reliability.
- Providing real-time information to passengers, designing transfer areas to ensure continuity between transport modes, operational integration of all the transit services, management of transit services by single operators, and unified fare payment system can help the city to cater to more transit demand.

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