Evaluation of Wagon Service as a Feeder Service Potential to Metro-bus Service in Lahore: A Passengers Perspective

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Abstract: The existence of a good quality public transport system is considered as the backbone of transportation infrastructure in densely populated and urbanized cities. The lack of coordination between feeder services and mass transit modes results in an inefficient public transport system which causes problems to the users. The main objective of this paper is to evaluate current wagons service as a feeder service to metro bus service using results of questionnaire survey and applying structural equation modeling approach (SEM). Survey results revealed that people have negative attitudes towards wagon service and such attitudinal aspects can be categorized as service, instrumental and comfort attributes of service quality. Results of factor analysis and SEM showed that instrumental, constructive and service oriented improved dimensions of wagon service quality are important and significant determinants of people's intentions to use it as feeder service to metro service.

Keywords: public transport, mass transit, feeder service, Para-transit, passenger's perceptions, Lahore

1. INTRODUCTION

Rapid growing in urban population is increasing the demand of transportation infrastructure. Public transport system is an important entity of this infrastructure. The economic growth and efficiency of densely urbanized cities heavily depend on performance of public transport system. Wright and Fjellstrom (2003) state that choices on transit systems are choices about a city's future. Public transport system is usually constituted of mass transit systems (e.g. bus rapid transit and rail mass transit), conventional bus system and Para-transit modes. The efficiency and economic viability of mass transit systems is dependent on quality of its feeder service such as conventional bus and Para-transit modes. Moreover, proper modal shift from private vehicle to mass transit modes is only possible if commuters can easily access them via feeder modes. It is believed that to promote more modal shift accessibility issues need to be addressed.

According to TCRP (2009), feeder bus service is a desirable choice for commuters that live very far from transit stations and cannot walk due to various reasons as well as especially for those who do not have private vehicles or cannot afford cost of parking at transit stations. Researchers have recommended the use of Para-transit modes as a feeder

mode to mass transit system just to enhance the mobility of people and utilizing the existing resources in efficient manner (Akkarapol *et. al.* 2009; Okada *et. al.* 2003; Shimazaki and Rahman, 1996). Some of the Para-transit modes in some countries are approved to provide efficient access service to mass transit modes and in some countries are not. This inefficiency of these modes occurs because most of the time they are ill planned and operated without any proper route and schedule. Tabassum *et. al.* (2016) study in Lahore reveals that mainly vehicle based factors of Para-transit feeder service reduces the accessibility, however time and cost oriented aspects have positive impact. Ferro and Behrens (2015) have explained the policy implications of considering Para-transit modes as feeder service to mass transit modes. they considered both business and operational aspects in the model.

In developing countries, only few studies provide the evidences for the significant and important attributes of feeder modes to mass transit system (Tabassum *et. at.* 2016; Akkarapol *et. al.* 2009; Okada *et. al.* 2003; Shimazaki and Rahman, 1996). Still there is need to explore the potential of existing conventional bus and Para-transit modes as improved feeder routes to the mass transit modes in the local context of each city. Therefore, this study aims to diagnose the potential of existing wagon service in Lahore as an improved feeder or access modes to metro bus service. This study explores the user's attitudinal aspects with wagon service and important service quality attributes required to be improved in future. This paper is organized in the following manner. Section 2 describes the characteristics of study area and data collection details are given in section 3. Survey and analysis results are presented in section 4 and last section summarize the key findings and implications.

2. CHARACTERISTICS OF STUDY AREA

The Lahore is the second largest of Pakistan with population of almost 8.65 million and area about 1792 km^2 (JICA, 2012). It is concentrated with educational, medical, and recreational facilities and surrounded by industrial zones which generate huge travel demand. Some of the areas are densely populated and in some areas population density is very low that increase travel time and cost of commuting. The private vehicle ownership is increasing at rate of almost 17% per annum [JICA, 2012] which results in high traffic on road infrastructure. The current public transport system consists of conventional bus system, Para-transit modes and 28 km metro bus route. Public transport modes almost account 20% of the modal share (JICA, 2012). Private modes have major contribution in modal share that results in increase in traffic congestion and related social costs.

Considering the severity of transportation problems and public transport systems efficiency, the Punjab Government has constructed 28 km metro bus route between Gajumata and Shahadra. This route has 27 stations and it was opened for public use in February 2013. Figure 1 presents route map of metro bus service with stations details. Almost 8 km section of metro bus is elevated. The system uses e-ticketing and ITS (intelligent transport system) for efficient operation. Currently around 20,000 to 40,000 people use metro bus service daily and it has the capacity to carry around 112,000 people per day. The local government is planning to develop appropriate feeder routes network in order to enhance the efficiency of metro bus service. Some feeder routes are also started for people who don't live close to metro bus route. Some of these routes are on narrow roads which can only be operated by small vehicles such as wagons. The details of wagon feeder routes are given below. This study attempts to evaluate the potential of these available feeder routes.

List of Wagon Feeder Service Routes

- 101 – Mayo Hospital to Kot Abdul Malik (Azadi Chowk)
- 102 – Rang Maal to Bakar Mando (Secretariat)
- 103 – Shah Alam Chowk to Pakki Tahthi (Secretariate)
- 107 – Azadi Chowk to Laiqat Chowk (Secretariat)
- 131 – Bhatti to Shaukat Khanum (Ichhra)
- 132 – Bhatti to Neelam Black (MAO College)

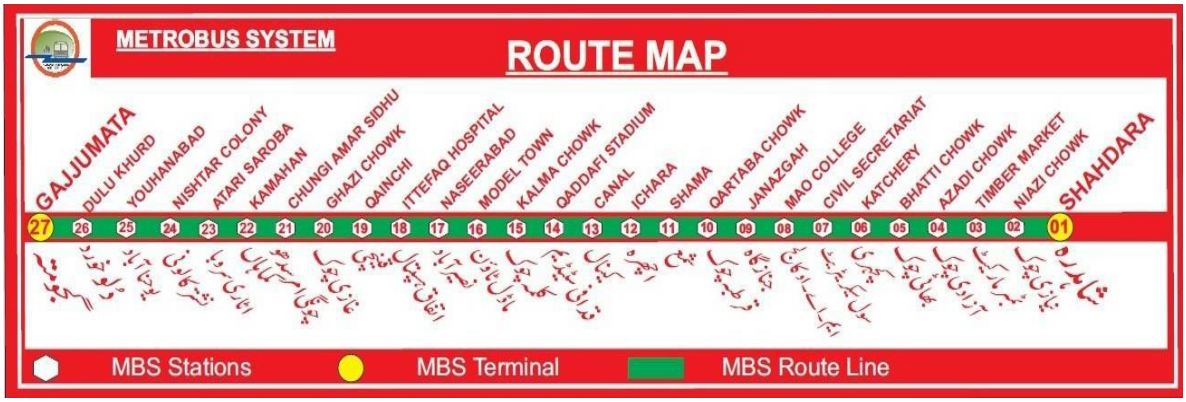

Figure 1: Metro Bus Route Map Lahore
(Retrieved from http://www.pma.punjab.gov.pk/brts_map)

3. DATA COLLECTION

The required data was collected with the help of a questionnaire survey that was conducted in Lahore along metro-bus route at some selected stations and details are given in next sub-sections.

3.1. Questionnaire Design

A detailed questionnaire was designed in this study considering the stated objectives and target population. The target population of this questionnaire survey was the regular and potential users of metro bus service. The potential users are those people who may shift on metro bus if there is improved feeder service. This questionnaire was consisted of four parts. First part was comprised of personal and trip information of the respondents e.g. gender, age, income, car ownership, access mode to metro bus and trip frequency with access mode, travel frequency with metro-bus, etc. Second part of questionnaire was consisted of various attitudinal aspects of wagon (or feeder) service. Various service quality attributes were selected and designed using their opposite adjectives. These opposite adjectives included: late-punctual, slow-fast, unsecure-secure, unattractive-attractive, unreliable-reliable, expansive-cheap, noisy-quiet, uncomfortable-comfortable, and environmental damaging-environmental friendly. All these variables were evaluated using a five point semantic differential scale (i.e. strongly, somewhat, neutral, somewhat, and strongly). This scale was selected for evaluation because it has consistency with attitudes and easy to construct. This scale can be used in coordination with Likert scale data for analysis purpose. In third part of the questionnaire, respondents were asked to report their level of importance for improvements with various selected service quality attributes of stated feeder service. The selected attributes included reliability of service, crew attitude, vehicle physical condition, walking distance between stop of metro bus and feeder service, metro bus schedule

information inside vehicle of feeder service, seat availability in feeder service, environmental friendly service, safety and security, service punctuality, service frequency, comfort, and schedule integration between two services. Level of importance was asked on a five point Likert scale i.e. not important (1), slightly important (2), moderately important (3), important (4) and very important (5). Last part was consisted of few questions on people intentions to use improved feeder service and metro-bus service. These questions were evaluated on five point scale (i.e. never (1), almost never (2), sometimes (3), almost every time (4), and always (5)). All the questionnaire items were designed in such a way that they should be easily understandable for all kind of respondents as literacy level of some people was low in target population.

3.2. Survey and Sampling

Intercept survey technique was used in this study. It is usually done on street, and commercial areas where people are intercepted and asked survey questions. The purpose of intercept survey is to gather more and deeper information from the respondents. One benefit of intercept survey is a high response rate of people, as people are more likely to readily answer live questions. Moreover, people actual behavior and attitude can be observed. Major disadvantage of intercept survey is that usually take longer time. This survey was conducted at four stations along metro bus route where wagon feeder service is available and has potential for improvements in future. Figure 2 shows the selected stations for survey i.e. Azadi chowk, Kalma chowk, Qartaba chowk, and Qainchi Chowk. Here, Chowk is a local term which means intersection. At these locations, survey was conducted during morning and evening peak hours. Respondents at each location were approached randomly and interviewed individually. To ensure the reliability of data, the respondents were initially instructed regarding the objectives and contents of questionnaire. A low response rate was observed and only 214 usable samples were obtained.

4. RESULTS AND ANALYSIS

4.1. Distribution of Respondent's Socio-Demographics

Table 1 presents the distribution of respondent's socio-demographic features. Almost 85% of the respondents are male and most of them students and working in private organizations. This distribution shows that most of the target respondents belong to low-middle income category and almost 32% used wagon as access mode to metro bus.

Table 1: Distribution of respondent's socio-demographic features

Feature	Distribution (%)
Gender	Male (85), female (15)
Age (years)	Under 20 (27), 21-30 (30), 31-40 (23), 41-50 (8), 51-60 (10), more than 60 (2)
Education	Below high school (2), High school (17), College (31), Bachelor (36), Master or higher (14)
Occupation	Student (43), Private Employee (24), Government Employee (4), Others (29)
Personal income (PKR)	Non income (30), Below 10,000 (18), 10,000-20,000 (20), 21,000-30,000 (1), 31,000-40,000 (12), 41,000-70,000 (10), more than 71,000 (9)
Vehicle ownership	Motorcycle (31), car (32), None (37)
Mode used to arrive metro bus station	Walk (15), Bicycle (1), Wagon (32), auto-rickshaw (14), motorcycle rickshaw (10), bus (2), motorcycle (12), car (14)
Trip purpose	Work (38), Study (29), Shopping (5), Recreational (4), other (24)

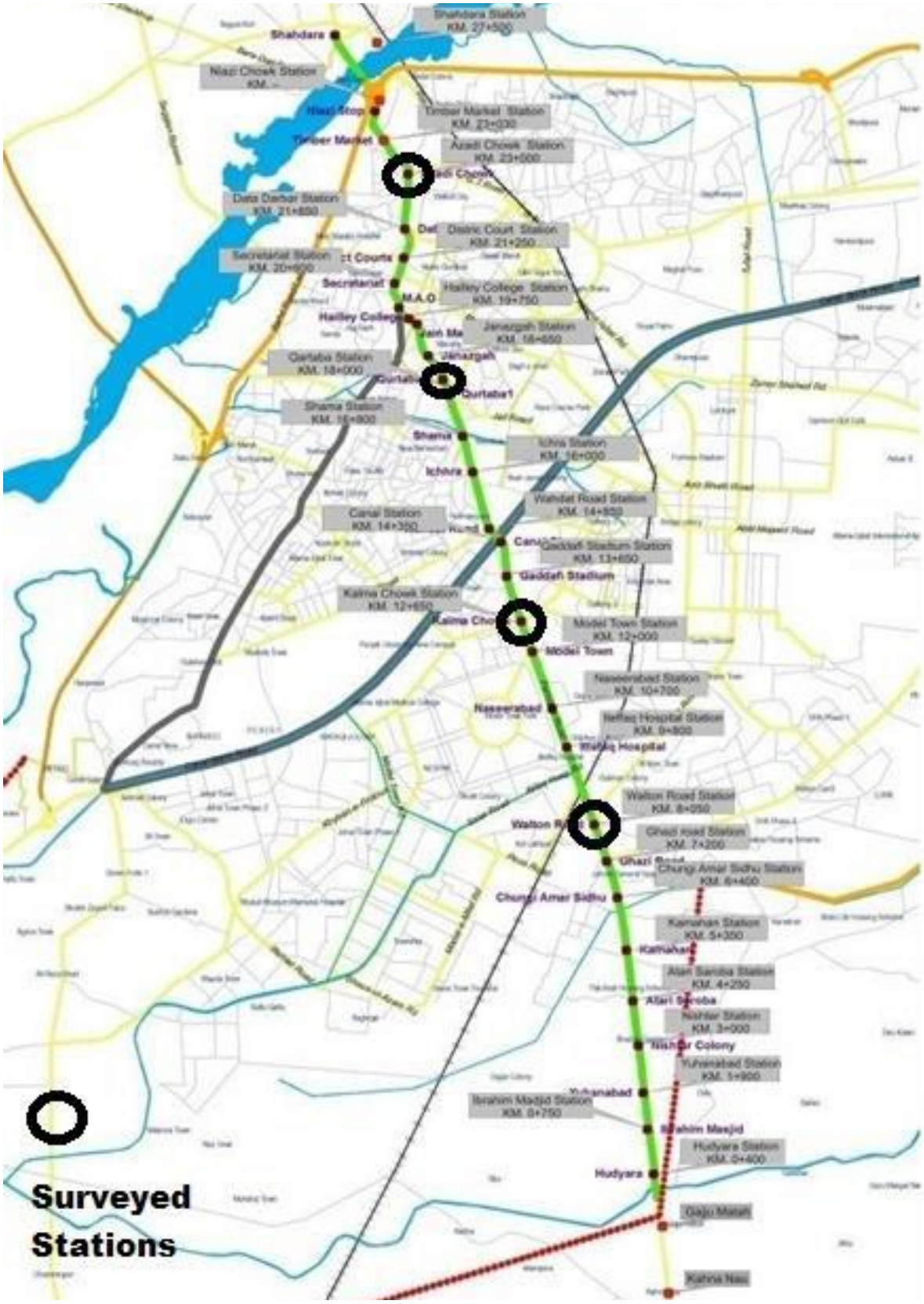

Figure 2: BRT route and survey locations

4.2. Average Response and Factor Analysis

Average response was calculated by coding the response from semantic differential scale to bipolar scale i.e. strongly (-2), somewhat (-1), neutral (0), somewhat (1) and strongly (2). The results of average response in Table 2 show that most of the respondents are not satisfied with attitudinal dimensions of service quality of wagon. Exploratory factor analysis was conducted on attitudinal dimensions and three factors were extracted. These factors were named considering the tendencies associated with their indicators from user's perspective such as service attributes, instrumental attributes, and comfort attributes. Cronbach's alpha values were also calculated for each factor. The factor loadings and alpha values depict significant internal consistency among respondents in evaluating their corresponding observed variables. The factor loadings for attributes late-punctual, slow-fast, unattractive-attractive, unreliable-reliable and noisy-quiet are high that predicts more respondent's consciousness for them. All these results imply that some major improvements are required in all attributes in order to make positive attitudes of people towards this service.

Table 2: Rotated factor loadings for altitudinal aspects of feeder service

Description of observed variables	**Mean**	**Service attributes**	**Instrumental attributes**	**Comfort Attributes**
Late – punctual	-0.55	0.903		
Slow - Fast	-0.64	0.888		
Unsecure – secure	-0.85	0.649		
Unattractive - attractive	-0.57		0.936	
Unreliable – reliable	-0.62		0.841	
Expensive – cheap	-0.28		0.645	
Noisy - quiet	-1.05			0.870
Uncomfortable – comfortable	-0.75			0.691
Environmental damaging–environmental friendly	-0.81			0.670
Factor mean		-0.68	-0.49	-0.71
Cronbach's Alpha		0.843	0.796	0.748

Table 3 shows the results of average response and factors analysis for respondent's level of importance for improvements with various attributes of wagon as feeder service to metro-bus. Most of the respondents placed high importance for most of the attributes such as crew attitude, service reliability and punctuality, safety and security, comfort, and walking distance between stop of wagon and metro station. The attribute of information of bus schedule inside feeder service vehicle got less importance from the respondents. Again three factors were extracted using exploratory factor analysis approach and named as instrumental attributes, constructive attributes (attributes that make travelers trip more constructive) and service-oriented attributes. The results of factor analysis and Cronbach's alpha values show higher level of internal consistency among respondents in evaluation. Higher factor loadings for attributes; reliability of service, crew attitude, information of bus schedule, environmental friendly service, safety and security and service punctuality of service depict high internal consistency and importance among respondents for these attributes. Almost 77% of the respondents showed willingness to pay higher fare for increased wagon service. Respondents stated high intentions to use improved wagon service if it becomes more convenient and inexpensive [i.e. never (0%), almost never (11%), sometimes (30%), almost every time (34%), and always (25%)]. Similarly, respondents also showed their preferences metro bus service if wagon service is improved. Out of total surveyed people, 25% said they will travel almost every time, 28 % said they will travel every time and 38% agreed that they will travel sometimes, 5% said almost never.

Table 3: Rotated factor loadings for important attributes of feeder service

Description of observed variables	Mean	Instrumental attributes	Constructive attributes	Service-oriented attributes
Reliability of service	3.88	0.835		
Attitude of crew	4.00	0.800		
Physical condition of vehicle	3.39	0.734		
Walking distance between stops	3.80	0.649		
Information of bus schedule inside vehicle	2.90		0.886	
Environmental friendly service	3.32		0.854	
Availability of seat	3.49		0.636	
Safety and security	4.02			0.804
Punctuality of service	4.23			0.712
Integration of schedule between feeder and main service	3.42			0.693
Service frequency	3.73			0.613
Comfort	4.15			0.590
Factor mean		3.76	3.24	3.91
Cronbach's alpha		0.816	0.805	0.794

4.3. Structural Equation Modeling

A structural model was developed using structural equation modeling (SEM) technique. It is a powerful technique for multivariate analysis and it has many advantages over conventional regression analysis. In transportation research field many researchers have used SEM in different aspects (Tabassum *et al.* 2016; Javid *et al.* 2016; Javid *et al.* 2015a,b; Akkarapol *et al.* 2009) Results of factor analysis on level of importance for improvements were used to construct a structure. Some observed variables on personal and travel characteristics of respondents were also included in the model. All these variables were coded as 1, 0. For example, 1 if age is 30 or below, 0 otherwise; 1 if access mode is wagon, 0 otherwise; 1 if own a car, 0 otherwise; 1 if gender is male, 0 otherwise, 1 if have willingness to pay more for improved wagon service, 0 otherwise. Two endogenous observed variables were also include to construct the required structure i.e. '*I would prefer to use wagon service if it becomes more convenient and inexpensive*' and '*if feeder service is improved would you prefer metro bus over private vehicle*'. The structure in figure 3 shows positive and significant structural relationships between constructive and service-oriented attributes with endogenous variable of '*I would prefer to use wagon service if it becomes more convenient and inexpensive*' whereas instrumental attributes factor has negative relationship with it. These results imply that user's importance for constructive and service oriented attributes are highly valuable to make improved wagon service more preferable for them. However, the improvement in instrumental attributes may not result significant change in intentions of respondents to use wagon service as feeder mode to metro-bus. The relationships of defined variables of age, access mode, gender and willingness to pay are positive and significant, whereas relationship of car ownership variable is negative with intentions to use improved wagon service as shown in figure 3. These results imply that male, young people and current wagon users have more propensity to use and willingness to pay for improved service. A significant and positive structural relationship between '*I would prefer to use wagon service if it becomes more convenient and inexpensive'* and '*if feeder service is improved would you prefer metro bus over private vehicle*' reveal that improvements in service quality of wagon as feeder service would result more usage of metro-bus service.

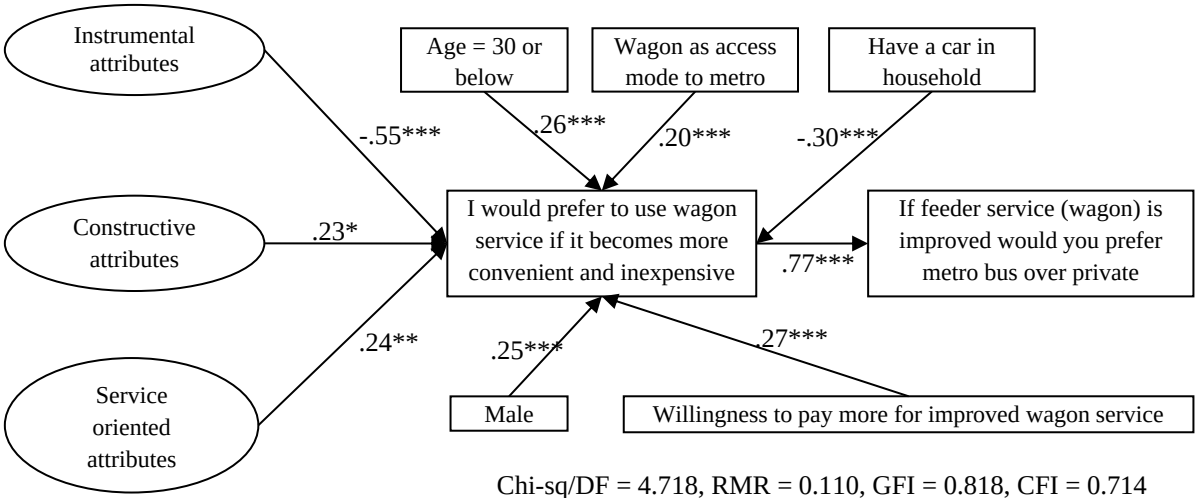

Figure 3: Structure of commuter's perceptions for service improvements

5. CONCLUSIONS AND SUGGESTIONS

The survey results revealed that most of the respondents have negative attitudes with all service quality attributes of wagon feeder service. Factor and reliability analysis results showed that there is significant internal consistency among respondents in evaluation. These findings imply that people do not prefer to use this service to approach metro bus because they are not satisfied with it. There is need to make major improvement in the service quality of wagon service in order to make it an efficient and productive access mode to metro bus. Respondents showed high level of importance for the improvements in service quality attributes of wagon feeder service to metro bus. The results of SEM revealed that the instrumental attributes, constructive attributes and service-oriented attributes are significant determinants of people intentions to use improved wagon feeder service and consequently to use metro bus service. In addition, male and young people have more propensity to use improved wagon and metro bus service. It is found that people who own cars would not prefer to use improved wagon service as well as metro bus service. Respondents showed positive intentions to pay more for improved feeder service. All these findings implicate that there is serious need to improve wagon service in order to make it an efficient, convenient and comfortable. The improved wagon feeder service would help in enhancing the use of metro bus service and make it viable from operational and economic perspective. Proper integration between mass transit service and its feeder services is essential from schedule and routing aspects as it will help in making them efficient and successful. The findings of this study would be helpful for local planners and decision makers in making appropriate improvements in feeder modes to metro-bus.

ACKNOWLEDGEMENT

This study was conducted at National University of Computer and Emerging Sciences, Lahore Campus. Authors are thankful to all those people who helped in conducting the questionnaire survey.

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