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FACTORS IMPROVING BUS TRANSFERABILITY AS THE CHOICE-MODE OF PASSENGERS AT BAMBALAPITIYA RAILWAY STATION

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ABSTRACT

Inadequacy and inefficiency of public bus transport as a mode of transfer at railway stations has led passengers to switch other modes to reach their destinations. This has led to increased traffic congestion on urban roads and heavy economic cost to society.

The main objective of this study is to identify the factors influencing the improvement of bus transferability at the Bambalapitiya Railway station. This study considered sixteen attributes of quality: accessibility, waiting time, cleanliness of the bus stop, facilities of the bus stop, occupancy level, safety of driving, traffic conflict, harassments, courtesy of bus crew, bus route coverage, bus frequency, availability, bus quality, privacy, cleanliness and travel time.

The findings of the descriptive analysis clearly showed overcrowding and increased travel time as crucial factors for not using the existing transfer bus service. As per the results of factor analysis, the six factors which contain the sixteen attributes are network design, convenience, and safety, quality of buses, background factors, and time consumption.

Prioritising the deployment of additional buses during peak hours, introduction of new bus services with integrated scheduling, the assurance of quality, and efficient service are imperative to enhancing bus transferability at the railway station.

Keywords: *Transferability, Quality Attributes, Bus Transit, Factor Analysis, Mode-Choice*

1. INTRODUCTION

Public bus transport is one of the integral transfer modes in an integrated transport system that facilitates an efficient and effective service by increasing economic and social benefits. Public transport probably the most up-to-date answer to the growing need for relieving traffic congestion, associated environmental problems, and continuously increasing cost of transferring passengers [1]. Bus transit provides accessibility to fulfil the daily requirements of people facilitating regional connectivity. A transport journey links different modes as per the choice of passengers. According to Castiglione [2], people consider the choice of travel modes according to their trip purpose that required to be fulfilled. This reveals that mode choice varies according to expectations and satisfaction of passengers on the level of service provision.

In Sri Lanka, the majority of people use public bus transport for their daily movements and this is shown by the mode share of bus transport which accounts for 46.6% including private and SLTB buses [3]. However, the non-availability of proper transport connectivity between different modes has created a long journey time with many discomforts to the passengers. Bus transport is a cost-effective transfer mode that could make proper connectivity between road and rail. The lack of a rail-bus integrating system in Sri Lanka has caused people to choose private vehicles as their transfer mode to reach their destinations. This has led to increased traffic congestion mainly on urban roads whereas creating a heavy economic cost to society. In the Sri Lankan context, many people use rail transport to fulfil their work trips and trains are more crowded during peak periods due to congestion on roads. People attract rail transport as it provides affordable service with shortened travel time compared to buses and other private transport services. Thus, facilitating bus transferability at railway stations to capture transfer passengers is timely imperative as it minimises externalities on roads whereas making passenger access to destinations easier and more affordable.

At present there is no coordinated effort for intermodal transportation and hence there is a breakdown of inter-modalism between trains and buses [4]. Since rail-bus integration and development of public transport services are key aspects of transport policy priorities in Sri Lanka, the study provides guidance to the transport policymakers and planners to improve passenger accessibility by improving transfer bus services. In the global context, many kinds of research have ascertained the factors of mode choice and passenger satisfaction to develop the public transport system. But, in the Sri Lankan context, research conducted to identify the determinants of transfer mode choice for improving bus transferability or rail-bus integration is deficient. Hence, determining the factors of transfer mode choice is imperative to upgrade the prevailing transfer bus services at railway stations as well as introducing new transfer services.

The main objective of this study is to identify the influential factors of improving bus transferability as the choice mode of passengers at the Bambalapitiya Railway Station. Accordingly, the main motivation of this study is to determine which service attributes in public bus service (private/government) make people use them as their transfer mode and identify the user requirements for satisfaction of prevailing transfer bus service. The study focuses on the group of passengers who are currently not using the transfer bus service commencing at the Bambalapitiya Railway Station to ascertain the causality for their non-usage. The study first assesses the causalities of passengers for not choosing bus transit. Second, the study examines the important quality aspects that influence passenger transferability. Finally, the study evaluates the quality attributes identified and ascertains the most influential factors to determine the quality improvement priorities to upgrade the prevailing bus service at the Bambalapitiya Railway Station.

2.   LITERATURE REVIEW

A transfer allows the rider of a public transportation vehicle who pays for a single-trip fare to continue the trip on another bus or train [5]. Facilitating transfer service is a key element of an integrated transport system. Previous studies on bus transferability focused on the planning of a proper timetabling system to minimise passenger transfer time while improving the efficiency of rail-bus integration. The determinants of improving transfer bus services depend upon passenger mode choice and passenger satisfaction. According to Mintesnot and Shin [6], travellers' satisfaction is an important performance measure for the transport service providers and a determinant factor affecting the mode choice. The factors of transport mode choice can be classified as characteristics of the trip maker, characteristics of the trip, characteristics of mode as well as many latent factors like comfort and convenience [7]. Cheng et al. [8] analysed factors that affect passenger satisfaction during the bus transfer process at HSR stations based on the passengers' perceptions of convenience, comfort, safety, service, and economy. The results of analysis show that economy and convenience are the critical influential indicators of passenger satisfaction, among which bus fare preferential policy and transfer distance are the most significant factors.

Researchers is generally focused on improving the quality of bus service that connects with the perceived value, and satisfaction of public transport. Nielsen et al [9] mentioned that public transport quality denotes regularity, direct connections, convenient terminal layout, high and fixed frequencies, and short travel times. They further noted these quality aspects are important for the choice of public transport vs private transport. The factors influencing bus transferability can be ascertained through the viewpoint of users on mode choice, exploring the reasons and their level of satisfaction on service quality. Berkley [10] mentioned that customers could supply

excellent sources of information and, according to the feedback from customers, governments and companies could improve service quality by distinguishing the areas of services most needed improvement. According to Leonard et al. [11], the only judge of the service quality is the customer. This reveals that identifying customer perspectives on mode choice and satisfaction is very useful for decision making on public transport planning and operation. A person's behavioural intention may also affect transport mode choice [12]-[15].

Customer satisfaction, closely related to perceived service quality and value [16–18], is widely regarded as the main driver of consumer loyalty to public transport and behaviour [19]. Improving service quality could lead to higher passenger satisfaction, which could increase the ridership of public transport [8]. He further mentioned that from the view of service supply, the choice of transfer mode for a passenger at a high-speed railway station is influenced by the service quality of both the transfer process and the target traffic mode. Nor et al [20] forecasted that improvements in bus service quality increase ridership depending on trip purpose.

Factors such as connectivity or reach, accessibility to a specific mode of transportation, information, time satisfaction, user attendance, comfort, security and safety, and environmental impact have been identified to be influential in the choice of a commuter [21]. According to Popuri et al [22], reliability, privacy, comfort, availability, safety, and attitudes towards public transportation were key factors in transportation preference of commuters in the Chicago area in the United States. This reveals passenger preference on transit modes is influenced by service quality and operational performance.

According to the existing studies, from the passengers' perspective, comfort, facilities, reliability, waiting time, journey time, convenience, travel cost, punctuality, and accessibility have been considered as the main factors that affect the quality of service. Shaaban and Khalil [23] stated that individual socioeconomic attributes could affect passenger satisfaction, such as gender, age, occupation, income, and marital status. This shows the personal attributes of passengers are crucial factors affecting travel mode choice behavior. Abdel-Aty and Jovanis [24] found that departure time had a significant impact on the travel behaviour of the elderly. Redman et al [25] pointed out that numerous attributes have been proposed to define public travel quality, which can roughly be classified as physical (reliability, frequency, speed, accessibility, price, etc.) or perception (comfort, safety, convenience, aesthetics, etc.). According to [26] passengers always tend to choose the travel modes meeting their expectations of the service performance to the maximum extent.

Kostakis [27] researched on measuring customer satisfaction in urban buses in Greece and found that route waiting time and frequency are the major determinants directly influencing customer satisfaction. Munzilah et al [28] stated that the choice of public

transport as a preferred mode of travel is mainly influenced by the quality of bus operation services. They further mentioned transit users today are more demanding from the bus providers including fast and reliable service, shorter walking distance to stops, low floor buses, cheaper service, and friendly safe drivers. The performance of the bus transferability at stations depends on service quality and efficiency expected by passengers. Madhuwanthi et al [29] conducted research on factors influencing travel behaviour on transport mode choice and identified that vehicle ownership, safety and comfort become the most crucial factors.

Research studies of Mazzulla and Eboli [30] analysed public transport non-use reasons why passengers did not use public transport. According to the analysis, the main reasons for not using public transport are low service frequency followed by vehicle overcrowding, slowness of the vehicles, and long waits at the stop. The Land Transport Authority of Singapore [31] conducted a survey on transport customer satisfaction to determine passenger expectations and identified service attributes for improvement. The survey determined the three most important service attributes: waiting time, travel time, and reliability which provide guidance to enhance the public transport service level for commuter benefit. According to Taylor and Fink [32] service reliability, particularly service coverage and service frequency are the most crucial factors influencing public transport ridership.

The literature review clearly shows that people tend to choose transfer mode with concerning the comfort, security, vehicle in time, trip distance, time reliability, cost of the travel mode, availability, and frequency of services, etc. since people have various opportunities to choose the mode in the present context. Mode choice analysis is vital to organise transportation and adjust operation plan effectively [33]. Hence, determining the factors of transport passenger mode choice and passenger satisfaction, travellers' behaviour and ridership patterns are important aspects of improving transfer bus services.

3. METHODOLOGY

Bambalapitiya Railway Station is located on the Coastline between Kollupitiya and Wellawatte Railway Stations in the Colombo district of Sri Lanka. It is the fourth Railway station located 5.22 km away from Colombo Fort. Bambalapitiya Station is a major transfer point to many suburban areas and main cities in the Colombo District. The station is accessed by many commuters with a high loading level during morning and evening peaks. At present, three bus services: Bambalapitiya-Dematagoda (154), Bambalapitiya-Kadawatha (177), and Bambalapitiya- Sethsiripaya (154) are operated from Bambalapitiya railway station. The services operate during morning peak hours (From 6.00 am to 10.00 am) to target the working population arriving at Bambalapitiya Railway Station.

Since heavy road traffic congestion occurs during this time period and passengers are facing inconveniences to reach their destinations, improving the transferability of prevailing bus services and introducing new transfer bus services are a paramount solution to enhance passenger mobility and accessibility. The passengers who transfer from the Bambalapitiya Railway Station mainly use state and private buses, para transits, or office transport services as their egress modes. The study is based on the quantitative research method and collected primary data from passengers who are currently not using public bus transport as their transfer mode at the Bambalapitiya Station. Further, the study focused on passengers who make mode choice as their egress mode. A structured questionnaire with five-point Likert scale was used to ascertain passenger experience and opinions of different mode choices. The study was conducted during the morning peak which could be identified many transfers. Among the total population of the survey which consists of total transfer passengers from the Bambalapitiya station from 6.00 am to 10.00 am, 150 passengers were randomly selected as the sample. The survey is based on the identified factors of service quality attributes and the factors were tested on passengers' perspectives. Sixteen key quality attributes (accessibility, waiting time, cleanliness of the bus stop, facilities of the bus stop, occupancy level, safety of driving, traffic conflict, harassments, curtsey of bus crew, bus route coverage, bus frequency, availability, bus quality, privacy, cleanliness and travel time) that influence passengers' transfer mode choice were used in this study and the selection of the quality attributes was based on the literature survey and brainstorming.

Data analysis is based on the evaluation of passengers' level of agreeability on service quality. A five-point Likert scale with "Highly Agree (HA)" equalling 5, "Agree (A)" equalling 4, "Neutral (N)" equalling 3, "Disagree (D)" equalling 2, and "Highly Disagree (HD)" equalling 1, was used in the rating of the questions for the assessment of passengers' mode choice. A descriptive analysis and factor analysis were used to examine the underlying constructs. First, correlation analysis was undertaken to measure the linear correlation between quality attributes, and factor analysis was performed to cluster them using SPSS software.

4.   RESULTS AND DISCUSSION

4.1   Analysis of Descriptive Statistics

According to the analysis of socio-economic data, the sample consisted of 57% female and 43% male passengers in different age groups. The highest age group categories who are not using bus transport as their transfer mode are 20-30 years (32%) and 30-40 years (23%) which represent almost half of the total sample. As per the analysis of employment status, the majority of people who are not using bus transfer service are employed as office workers and businesspeople (51%). As per the

frequency of usage, 55% of passengers used transfer services 'mostly' and 18% of passengers used 'on average' to reach their destination. This shows the majority of rail transport users regularly choose different services as their egress mode. Further, the majority of the sample has a wide experience of existing transfer modes and their quality as regular passengers.

Table 1 depicts descriptive statistics for quality attributes under investigation. The descriptive analysis shows passengers agreed that considerations related to accessibility, waiting time, occupancy level, harassments, courtesy of bus crew, bus frequency, privacy, and travel time (Mean >3.0) for not using bus transfer service. The quality attributes passengers are most concerned with are high occupancy level (Mean= 4.3) and travel time taken to complete their journey (Mean = 4.6) that reflects the most crucial factors on transfer mode choice.

Table 1: Descriptive Statistics

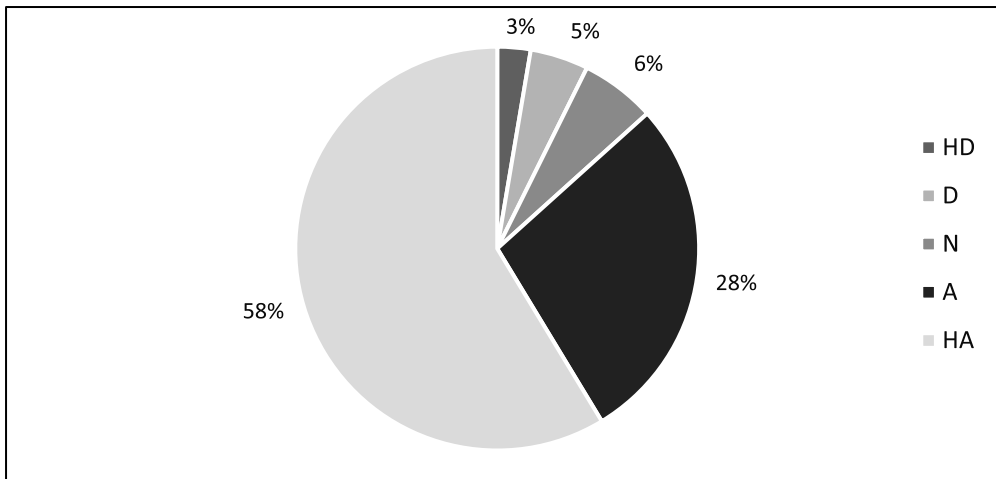| Component (Quality Attribute)	N	Minimum	Maximum	Mean	Std. Deviation
Accessibility	150	1.0	5.0	3.213	1.5910
Waiting Time	150	1.0	5.0	3.033	1.3581
Cleanliness of Bus stop	150	1.0	5.0	2.053	.6833
Facilities of Bus stop	150	1.0	5.0	2.567	1.1138
Occupancy Level	150	1.0	5.0	4.353	.9772
Safety of Driving	150	1.0	5.0	2.767	1.0832
Traffic Conflict	150	1.0	5.0	2.033	.9005
Harassments	150	1.0	5.0	3.033	1.4536
Curtsey of Bus Crew	150	1.0	5.0	3.533	.9530
Bus Route Coverage	150	1.0	5.0	2.933	1.2674
Bus Frequency	150	1.0	5.0	3.167	1.3532
Availability	150	1.0	5.0	2.820	1.7573
Bus Quality	150	1.0	5.0	2.527	.9603
Privacy	150	1.0	5.0	3.900	.9814
Cleanliness	150	1.0	5.0	2.300	.8956
Travel Time	150	2.0	5.0	4.593	.6564
Valid N (listwise)	150				

Source: Author

Figure 1: Passengers Perspective about Occupancy Level of Transfer Bus Service

Statistics shows that 86% of passengers considered the high passenger occupancy level (Figure 1), and 95% passengers considered the high travel time associated with the prevailing transfer bus service as the reasons for not using buses as their egress mode (Figure 2).
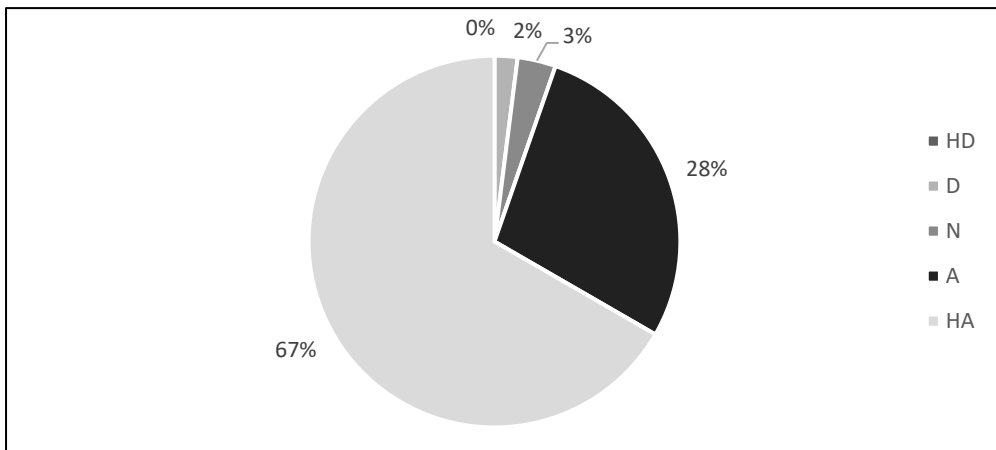

Figure 2: Passenger Perspective about Travel Time of Transfer Bus Service

4.2 Factor Analysis

The factor analysis produces a small number of factors from a large number of variables which is capable of explaining the observed variance in the larger number of variables. The Exploratory Factor Analysis (EFA) was carried out in the study for the selected 16 quality attributes that contribute to the transfer mode choice at Bambalapitiya Station.

The test for the validity of the dataset was examined according to Kaiser- Meyer-Ohlin (KMO) measure of sample adequacy and Barlett's test of sphericity (Table 2). According to Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy, the study shows KMO value of 0.613, confirming acceptance of the model for factor analysis to proceed. KMO value more than 0.5 score implies the analysis could be continued further for all given factors in the study. The Bartlett's significant score (Sig. = 0.000) indicates that the variables are relevant and suitable for structure detection. The test result shows the strength of the relationship among variables indicating that the correlation matrix is not an identity matrix.

Table 2: Results of Kaiser-Meyer-Ohlin [KMO] Measure and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.613
Bartlett's Test of Sphericity	Approx. Chi-Square	508.518
	df	120
	Sig.	.000

Source: Author

Table 3: Total Variance Explained

Component (Quality Attribute)	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.673	16.708	16.708	2.673	16.708	16.708	2.159	13.494	13.494
2	2.476	15.477	32.185	2.476	15.477	32.185	2.123	13.267	26.762
3	1.836	11.476	43.661	1.836	11.476	43.661	1.789	11.181	37.942
4	1.250	7.812	51.473	1.250	7.812	51.473	1.735	10.844	48.786
5	1.149	7.181	58.654	1.149	7.181	58.654	1.399	8.744	57.531
6	1.028	6.428	65.082	1.028	6.428	65.082	1.208	7.551	65.082
7	.862	5.390	70.472						
8	.770	4.814	75.286						
9	.727	4.544	79.829						
10	.615	3.842	83.671						
11	.568	3.548	87.219						
12	.541	3.382	90.601						
13	.493	3.080	93.681						
14	.446	2.787	96.468						
15	.311	1.942	98.410						
16	.254	1.590	100.000						

Source: Author   Extraction Method: Principal Component Analysis.

Table 3 above shows all the factors extractable from the analysis along with their eigenvalues that met with the cut-off criterion (extraction method). As per the percentage of variance attributable to each factor after extraction (Extraction Sums of Squared Loadings % of variance), six factors were identified which would contribute to improving bus transfer service.

Figure 3 shows the scree plot of eigenvalues against all the factors. The graph clearly shows that the curve begins to flatten after the factors 6 and it is noticeable that factor 7 onwards have an eigenvalue of less than 1, so only six factors have been retained as per the analysis.
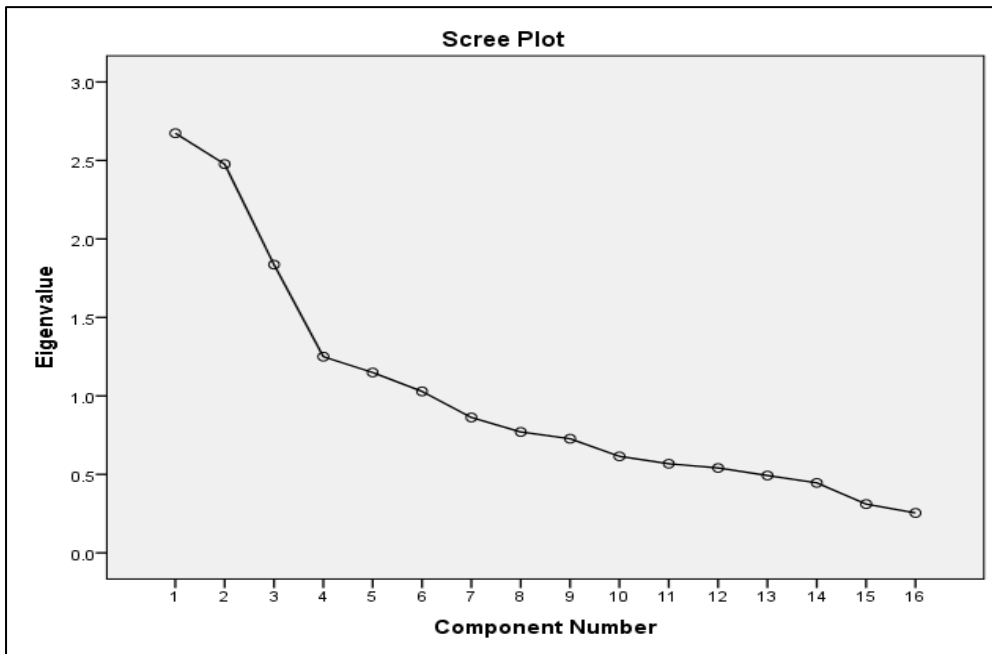

Figure 3: Factor Scree Plot

The idea of factor rotation is to reduce the number of factors on which the variables under investigation have high loadings. As per Table 4, three variables named bus route coverage, bus frequency, and availability are loaded on factor one named 'Network Design.' The next three variables named privacy, curtsey of bus crew, and occupancy level are in the second factor named 'Convenience'. The third factor named 'Safety' contains variables of harassments, safety of driving, and Traffic Conflict. The fourth factor named 'Quality of Buses' contains two variables of bus quality and cleanliness. The fifth factor named 'Background Factors' contains variables facilities of the bus stop, cleanliness of bus stop, and accessibility. The sixth factor named 'Time Consumption' contains variable waiting time and travel time of buses.

Table 4: Rotated Component Matrix

Component (Quality Attribute)	Factor					
	Network design	Convenience	Safety	Quality of Buses	Background Factors	Time Consumption
Bus Route Coverage	.869	.016	.006	.096	.002	-.137
Bus Frequency	.843	.021	-.058	-.031	.107	.155
Availability	.632	-.267	.133	-.146	.163	.242
Privacy	-.029	.769	.017	.173	-.064	-.081
Curtsey of Bus Crew	-.105	.659	.335	.110	.110	-.048
Occupancy Level	-.011	.627	.245	-.243	.005	.246
Harassments	-.153	.136	.769	-.039	-.056	.046
Safety of Driving	.084	.305	.663	.131	.128	-.067
Traffic Conflict	.196	-.098	.658	.347	-.026	.035
Bus Quality	.023	.040	.178	.847	-.050	-.035
Cleanliness of Buses	-.056	.035	.068	.803	.142	.137
Facilities of Bus stop	.082	-.044	-.005	.065	.801	-.200
Accessibility	.222	.407	-.067	-.045	.579	.183
Cleanliness of Bus stop	-.035	-.351	.265	.143	.563	.477
Waiting Time	.370	.014	.034	.234	-.083	.679
Travel Time	-.118	.465	-.136	-.141	-.033	.498

Source: Author

Cronbach's Alpha reliability test is conducted to measure the internal consistency i.e. reliability of the measuring instrument (Questionnaire). According to Table 5, Cronbach's Alpha value, 0.64 which is greater than 0.5 shows the results of the analysis are reliable.

Table 5: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardised Items	N of Items
.637	.647	16

Source: Author

5.   CONCLUSIONS

The study investigates factors of improving bus transferability as the choice mode of passengers at the Bambalapitiya railway station. The contribution of this study is the assessment of the passenger perspective on transfer mode choice and ascertain the service quality attributes for improving bus transferability. The study mainly considered sixteen quality attributes: accessibility, waiting time, cleanliness of the bus stop, facilities of the bus stop, occupancy level, safety of driving, traffic conflict, harassments, courtesy of bus crew, bus route coverage, bus frequency, availability, bus quality, privacy, cleanliness, and travel time that affect transfer mode choice.

The study focused on the perspectives of passengers who are currently not choosing bus transport as their transfer mode and the findings of the study reflect the factors of passenger mode choice which are useful to improve bus transferability at the Bambalapitiya Railway Station. The results of the descriptive analysis clearly show overcrowding and increased travel time are the most crucial factors for not choosing bus services as the transfer mode. The study provides a direction to transport policy decision-makers, regulators, and service providers to improve bus service quality and frequency while introducing new bus services during peak hours to minimise the overcrowding of buses and increase the efficiency of service.

The results of factor analysis show six groups of variables with similar characteristics. The six factors containing the sixteen quality attributes are network design, convenience, safety, quality of buses, background factors, and time consumption that could be used as variables for further analyses. According to the factor extraction, passengers are more concerned about network design. It represents bus route coverage avoiding further transfers, availability of service to their destination, and level of frequency which connects with the arrival time of trains. The study provides a guide to the government to nominate policy priorities for introducing new transfer bus services by both state and private sectors according to passenger demand for destination centres. Imposing and enforcing time schedules for bus dispatching is imperative to reduce waiting time for buses and travel time delays. The study gives a reasonable path ahead to the configuration of policies that will ensure more effective bus transferability to the existing bus users as well as attracting new passengers through an efficient rail-bus integration system.

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