

Research Paper

Evaluating user's satisfaction of bus service in Mauritius: Decision tree approach

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ABSTRACT

In Mauritius, travelling by bus service widely plays an important role in people's transportation. In 2011, there were 220 bus routes for bus transportation, and 900 bus stops. This research aimed to study the satisfaction of bus users with a variety of service kinds divided into four main aspects including Vehicle, Driver behavior, Bus stop facility, and Service. The data used for analysis were obtained from 531 completely screened questionnaires inquiring bus users' satisfaction in Mauritius. The data were analyzed using Decision tree to classify the importance of criteria for bus users' satisfaction and the Importance performance analysis was used to identify items in each quadrant of which the meaning was different. The result obtained for the most important question item will be used to improve bus service in order to serve bus users' needs. From data analysis, it was found that the strength of bus service in Mauritius was Driver and crew's customs, and the weaknesses were the frequency of bus service and the locations of bus stop facility. In terms of IPA analysis, the frequency of bus services should increase and the locations of bus stops should be safer.

1. Introduction

1.1 Background and Rationale

The Republic of Mauritius in the Indian Ocean lies 800 km east of Madagascar and is constituted of the main island of Mauritius and several outlying islands. The total land area of the country is 2,040 km² of which the main island is 1,864.8 km² which is 58 km north to south by 47 km east to west. Mauritius has a population of 1.2

million whereby the relatively high population density of the main island is of 654 people per square kilometer.

Road is the dominant mode of transport in Mauritius. The non-existence of railway transport makes the country exclusively dependent on road transport. Currently, the Government of Mauritius is strengthening its road infrastructure through rehabilitation and maintenance of roads, bridges, foot-bridges and road safety audits. The country possesses about 2,000 km of roads (with a density of 102 km per 100 km² of land area), of which 3.6% are motorways, 48.5% are main roads, 28.7% are

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secondary roads, and the remaining 19.2% are made up of other types of roads.

As in most developing countries, the demand for transport in Mauritius has risen dramatically in recent years. This is due to a number of factors, including the fast increasing population, an increase in household income, urban sprawl, edge-of-town and out-of-town development, and greater participation of women in the labor force. As a result of the economic growth, the number of registered vehicles in Mauritius (including motorcycles, cars, dual-purpose vehicles, vans, Lorries and buses) is currently growing at 4.8% per annum reaching 486,144 vehicles at the end of 2015. This equates to approximately 198 vehicles per kilometer of road.

Since 1988, the number of cars and dual-purpose vehicles has grown steadily at approximately 7 percent per year. At the end of December 2014, the fleet of vehicles in Mauritius consisted of 48.5% (225,522) cars, double cab pickup and dual purpose vehicles and 40.4% (187,851) auto/motor cycles. The remaining 11.1% comprised vans (26,890), Lorries and trucks (14,243), buses (3,006) and other vehicles (7,540). Mauritian motorization has already reached 180 vehicles per 1,000 people, similar to or above more advanced countries, such as Singapore, Hong Kong SAR and China. Traffic management has become an important and prominent issue due to prevalence of serious congestion in the country's road network. Studies indicates that without proper measures, travel time in the most congested areas will worsen significantly by 2020. At present, road congestion already has a significant economic cost estimated to be MUR 2 billion annually (0.5% of the GDP).

Mauritius is becoming increasingly over-dependent on private vehicles. The National Transport Authority (NTA) figures record that 4,618 thousand passenger bus journeys were made by bus in 2007, rising to 4,900 thousand in 2010, this figure remained same till 2012, in 2013 it was 4,808 thousand and in 2014 it decreased further to 4,805 thousand. So, after a period of high growth, bus use is falling while private car use continues to rise. Also, the Tourism industry is the second pillar of the Mauritian economy, with nearly one million tourists annually (Khadaroo and Seetanah, 2007). There are many research studying about group tours groups visiting Mauritius (Gooroochurn and Thea Sinclair, 2005; Naidoo and Sharpley, 2016; Nunkoo and Gursoy, 2012; Nunkoo and Ramkissoon, 2011) where most tourists use public transportation as the main transportation. Thus, public bus service plays an important role in the economic development of the country. The increase in economic activity is leading to an increase in demand for mobility and thus an increase in car use accompanied by a

worsening in the quality of the environment through worse congestion and poorer air quality (dell'Olio et al., 2010; Sookun et al., 2014). Resource-poor and space-constrained, Mauritius will need to follow an efficient and greener development path in the transport sector. One important measure will be to reduce car use and promote bus travel as a preferred choice for people inland transit. In this context, in order to provide the right incentives, proper collection and analysis of data related to bus travel was needed to be done. This research focuses on the study and the evaluation of public bus service in Mauritius.

This research was conducted by collecting data from public bus' passengers and asking about the satisfaction levels of various quadrant including Vehicle, Driver behavior, Bus stop facility, and Service (Jomnonkwao and Ratanavaraha, 2016; Ratanavaraha et al., 2016; Tyrinopoulos and Antoniou, 2008; Verbich and El-Geneidy, 2016). Each quadrant had Items in details to analyze and identify which Item should be improved or developed, which item should be ignored. The objective is the identification of strengths and weaknesses of the bus service in Mauritius. There are many statistical methods to analyze them. However, most of them use Classification and Regression Tree (CART) method to identify the levels of importance of each item and Importance performance analysis (IPA) to identify the item into quadrant. The advantage of IPA is that it not only potentially identifies the strengths and the weaknesses but it also enables simultaneously to apprehend the Quality of service and Importance level of the particular public bus service clearly, and also provides illustrations for more comprehensibility.

The objective of this research is to identify the strengths and the weaknesses thus indicating which item in the questionnaire should be managed/improved for public bus service in Mauritius. It must be noted that there has never been such research before. In order to make public bus entrepreneurs and organizations involving government improve and increase the levels of services in bus travel, this will turn more people to use public transportation leading to be sustainable transportation system.

1.2 Literature review

1.2.1 Satisfaction

Satisfaction is people's comparison between expected service level and real service level. The appreciation may be through eyesight or verbal. If the received service is better than expected, the level of satisfaction is at "very" level making people continue using the service for many times until the satisfaction is

over (Kotler, 1997; Van Looy et al., 2003). Thus, the levels of satisfaction can indicate the strengths, the weaknesses and/or the efficiency of that service.

1.2.2 Factors for measurement of bus quality service

A lot of previous researches have studied about the quality of service of Road public transportation. One remarkable research has investigated Greek passengers' perceived service for public mass land-transportation system consisting of the following mode of travel, namely; Underground railway, Bus, Electric bus and Electric railway. The comparison between the operation method, the efficiency and policies involved were studied by investigation of users' levels of satisfaction. The factors comprising of 23 items were grouped into the four parts: i) General characteristics of the public transit system such as Service frequency, In-time performance, Service provision hours, Network coverage, General information provision, Types of tickets and passes, Prices of tickets and passes, Tickets selling network, Personnel behavior, Existence of bus lanes, Measures for environmentally friendly public transit. ii) Terminals and stops including Walking distance to terminals and stops, Information provision at terminals and stops, Conditions at terminals and stops, Safety at terminals and stops. iii) Vehicles such as onboard conditions, Vehicles cleanliness, Driving behavior, onboard information provision, Accessibility to disabled and mobility impaired people. iv) Transfers points including Distance between transfer points, Waiting time at transfer points, Information provision at transfer points (Tyrinopoulos and Antoniou, 2008).

The evaluation of passengers' perceived service in Spain was evaluated by a method called ordered probity. The factors used for the evaluation of parameters of the Focus Groups were waiting time, journey time, access time walking to the initial bus stop, safety within the vehicle, comfort during starting and stopping, comfort during the journey, deviation from the optimal route, cleanliness of the vehicle, price of the bus ticket, quality of the vehicle, reliability of the vehicle and the kindness of the bus driver. (dell'Olio et al., 2010).

Consequently, in 2011, the comparative study between background information and perceived service in each aspect of bus service was analyzed by Multinomial logit. The factors considered in the analysis were; waiting time, Vehicle Occupancy, Cleanliness, Journey time, Driver Kindness, and Comfort. (dell'Olio et al., 2011).

The Transit service quality in Cosenza and Rend in the south of Italy was analyzed by bus service users and the evaluation of the Transit agency. The factors used for the analysis were Route and service characteristics,

Service reliability, Comfort and cleanliness, Fare, Information to passengers, Safety and security, Personnel and customer services and Environmental protection (Eboli and Mazzulla, 2011).

Public transit in Taiwan has been studied using SEM with Latent variables including Service quality, Perceived value, and Satisfaction, Involvement and Behavioral intention. The variables of perceived service considered were General information provision, Network coverage, Service provision hours, Prices of tickets, Service frequency, Complaint dealing, Ticket selling network, Train information provision, Personnel behavior, Facility cleanliness, Vehicle cleanliness, Vehicle safety, Safety at terminals and stops, Vehicle stability, Conditions at terminals and stops, Onboard information provision (Lai and Chen, 2011). The difference of perceived service of Inter-urban bus service between males and females was evaluated by the method Ordered probity. The different perceived services included Ease of ticket purchase, Punctuality, Information on bus schedule, Frequency of service, State of bus, Cleanliness of vehicle (overall), Temperature inside bus, Seat comfort, Noise level, Journey time, Safety, Number of stops and Price-Quality Ratio. (Rojo et al., 2011).

In 2012, there was a study of the relationship between service quality and demand for inter-urban buses. The variables used to analyze bus service were Accumulated delay of bus, Number of intermediate stops on route, Provision of air-conditioning in the bus, Toilet/WC and television facilities in the bus, Availability of local public transport for travel to and from the bus station, Accessibility with regard to location of bus station, Availability of information on time-tables at the bus station, Opening hours for ticket office, Possibility of buying tickets at home (internet, phone, etc.), Level of customer service, Journey distance, Age of bus, and High standard bus (Rojo et al., 2012). In 2013, the service quality of inter-urban bus from the users' viewpoint was studied. The factors used for the analysis were Ticket price, Duration of journey, Delay, Number of stops, State of the bus, Bus facilities (air conditioned, Wash room/WC, television), Features of the bus station, Ticket office features (Rojo et al., 2013). The bus service was evaluated by Decision tree (DT). The input variables used were Information provision, Punctuality, Safety on-board, Driver courtesy, Bus interior cleanliness, Bus space, Bus temperature, Accessibility to/from the bus, Fare, Speed, Frequency of service, Stops proximity to/from origin/destination (J. de Oña et al., 2012). The following year, SEM was used to analyze for Perceived service quality in bus transit service. Observer variables or attributes included Frequency, Punctuality, Speed, Proximity, Fare, Cleanliness, Space, Temperature,

Information, Safety, Courtesy, Accessibility (J. de Oña et al., 2013). The investigation about quality of bus service in Brazil employed Importance satisfaction analysis (ISA) by considering Quality parameters including Attendance, Vehicle, Route, Passengers security, Differential service, Ticket fare (Freitas, 2013). The satisfaction of Bus service in Qatar was studied by using SEM. The variables included were the i) Station; Dimensions, Accessibility, Shade, Safety, Cleanliness, Crowd level and Noise Level. ii) Bus; which included Safety, Punctuality, Cleanliness, Travel time, Frequency, Fairness of fare and Noise level iii) Driver; including Knowledge of route, Abiding to traffic laws, Appearance, Welcoming and Privacy invasion (Shaaban and Khalil, 2013). Research for understanding experience and its impact on attitudes, emotion and loyalty of bus in Portugal was conducted by using SEM. The 28 variables grouped into seven dimensions or experience factors were: Individual space, Information provision, Staff's skills, Social environment, Vehicle maintenance, Off-board facilities, and Ticket line service (Carreira et al., 2014). The bus service users' comprehension was analyzed by their satisfaction. The variables used to study were On-time performance, Travel speed, Service frequency, Prices of the tickets, Personnel behavior, Driver's behavior, Display of information on delays, Ticket-selling network, Information provision at stops, Safety at stops, Vehicle tidiness, Ease of boarding and alighting, Seating capacity, On-board noise and Safety on board (Mouwen, 2015). The standard of urban bus services in Indonesia has been analyzed in view of improvement of the policy with regard to bus travel by using SEM. The variables used in the analysis were; On-time performance, Vehicle cleanliness, Bus station cleanliness, Vehicle safety, Vehicle security, Consistency of fare and Driving skills (Joewono et al., 2016). The satisfaction of Bus transit in London has been studied by using Logistic modeling. The variables used in the analysis were i) Out-of-vehicle; Time waited, Bus stop/shelter information ii) In-vehicle; Journey time, iii) Level of Service; Reliability (Verbich and El-Geneidy, 2016). The suitability of Driver's characteristics of sightseeing buses has been studied by using CFA to analyze the variables including Age, Experience, Education, Driver license, Route expert, Training, Smoking and Drinking habit (Ratanavaraha and Jomnonkwao, 2014). The study of factors grouping of Sightseeing bus service by using Cluster analysis included; convenience (i.e. comfortable bus seat, air

condition etc.), service (i.e. first aid service etc.), driver (i.e. age, route skill etc.) and safety dimension (i.e. safety belt, emergency exit etc.) (Jomnonkwao et al., 2015). A model was built to measure perceived service quality of sightseeing buses with regards to different aspects including i) vehicle; noise, neatness and cleanliness, bus audio, vehicle body, convenient toilet, safety equipment, air-conditioning, entertainment facilities, space between two seats in a row ii) Drivers and crews; personality and appearance, friendliness, helpful and polite, emergency management, service provision, Professional, driving skills, driving safely, knowing how to fix engine, tour routes and on-time performance iii) Management; customer contact system, Pleasurably allowing customers for a pre-trip inspection, GPS, safety equipment usage via video, two drivers, accident insurance and Appropriate driver recruitment (Jomnonkwao and Ratanavaraha, 2016). A recent research has been carried-out using Multi-level SEM to analyze perceived service of Sightseeing buses by using three service factors including Vehicle characteristics, Driver behavior and Management level (Ratanavaraha et al., 2016). According to Literature review, all quality measurement can be divided into four main aspects including Vehicle characteristics, Driver behavior, Level of Service and bus stop facility as in **Table 1**.

1.2.3 CART and IPA

Decision tree modeling (DT) is a method indicating the relation between the different variables (Chou, 1991). The strength of DT can be used to analyze both continuous and discrete data but more specifically regression tree constructed by using continuous data (S. Lee et al., 2007). Classification tree is used to predict problems (Berry and Linoff, 2000). CART model is the combination of the two strengths to analyze the relation between non-parametric and non-predefined variables (Hernandez et al., 2016). CART is a part of Data-mining method developed by Breiman et al. (1984). In previous research, CART model has been used to analyze many aspects Barlin et al. (2013); Hwang et al. (2013) in medical field or energetic field (Mikučionienė et al., 2014). Moreover, it was employed in transportation field such as decision-making in transportation (Koo et al., 2014), the analysis of injury levels from road accidents (Chang and Wang, 2006; Pakgohar et al., 2011), the analysis of main factors of transportation services (J. de Oña et al., 2012).

Table 1. Summary Factor for measurement public transit quality service

Author (Year)	Type of road public transportation (Country)	Method	Quality			
			Vehicle	Driver behavior	Service	Bus stop facility
(Tyrinopoulos and Antoniou, 2008)	Public transit (Greece)	Logit model	✓		✓	✓
(dell'Olio et al., 2010)	Bus (Spain)	Odered probit	✓	✓	✓	✓
(dell'Olio et al., 2011)	Bus (Spain)	Multinomial discrete choice	✓	✓	✓	✓
(Eboli and Mazzulla, 2011)	Bus (Italy)	Logical and Mathematical	✓	✓	✓	✓
(Lai and Chen, 2011)	Rapit transit (Taiwan)	SEM	✓	✓	✓	✓
(Rojo et al., 2011)	Bus (Spain)	Odered probit	✓		✓	✓
(Rojo et al., 2012)	Bus (Spain)	Discrete choice Model	✓		✓	✓
(Rojo et al., 2013)	Bus (Spain)	SEM	✓		✓	✓
(R. de Oña, 2013)	Bus (Spain)	CART	✓	✓	✓	✓
(J. de Oña et al., 2013)	Bus (Spain)	SEM	✓	✓	✓	✓
(Freitas, 2013)	Bus intercity (Brazil)	Importance-Analysis	✓	✓	✓	✓
(Shaaban and Khalil, 2013)	Bus (Qatar)	SEM	✓	✓	✓	✓
(Carreira et al., 2014)	Bus (Portuguese)	SEM	✓	✓	✓	✓
(Mouwen, 2015)	Bus (Netherland)	Multiple regression	✓	✓	✓	✓
(Joewono et al., 2016)	Bus (Indonesia)	SEM	✓	✓	✓	✓
(Verbich and El-Geneidy, 2016)	Bus (United Kingdom)	Logistic modeling	✓	✓	✓	✓
(Ratanavaraha and Jomnonkwao, 2014)	Sightseeing bus (Thailand)	CFA		✓		
(Jomnonkwao et al., 2015)	Sightseeing bus (Thailand)	Cluster analysis	✓	✓	✓	
(Jomnonkwao and Ratanavaraha, 2016)	Sightseeing bus (Thailand)	CFA	✓	✓	✓	
(Ratanavaraha et al., 2016)	Sightseeing bus (Thailand)	MSEM	✓	✓	✓	

Note: SEM = Structural Equation Modeling, CFA = Confirmatory Factor Analysis, MSEM = Multi-level Structural Equation Modeling

Importance-performance analysis (IPA) was developed by Martilla and James (1977). It was the method used to evaluate quality of service. It has been often applied to question items about satisfaction by collecting data from its service users. The principle of IPA application is the division of data into two dimensions namely, Customer Satisfaction or Performance (X-axis) and Importance (Y-axis) by levels of ratings (rating scales etc.) or derived importance (multiple regression weight) (Matzler et al., 2004).

It can be grouped into be 4 Quadrants including i) "Possible Overkill" (Low Importance/ High satisfaction). For this quadrant, there is a need to decrease the development in that aspect ii) "Keep going up the good work" (High Importance/ High satisfaction) for this quadrant the aspects considered should continuously be

provided and the activities maintained iii) "Low Priority" (Low importance/Low satisfaction) quadrant of which the criteria of interest were low so that it will be unnecessary to improve these criteria iv) "Concentrate here" (High Importance/Low satisfaction). The entrepreneurs should urgently improve criteria which are in this quadrant (Freitas, 2013). As seen in **Fig.1**, in the past, IPA was taken to indicate the relation between Importance and Satisfaction, for example; the evaluation of Marine-Park hinterland of western of Australian (Wall and McDonald, 2007) the evaluation of Tourism (Azzopardi and Nash, 2013; F. C. Pan, 2015; Sörensson and von Friedrichs, 2013), the evaluation of visitors at the zoo in Korea (H.-S. Lee, 2015), the evaluation of patients' perceived service (Cohen et al., 2016; Mohebifar et al., 2016), and the

evaluation of perceived service of public transportation in

Brazil (Freitas, 2013; Hernandez et al., 2016).

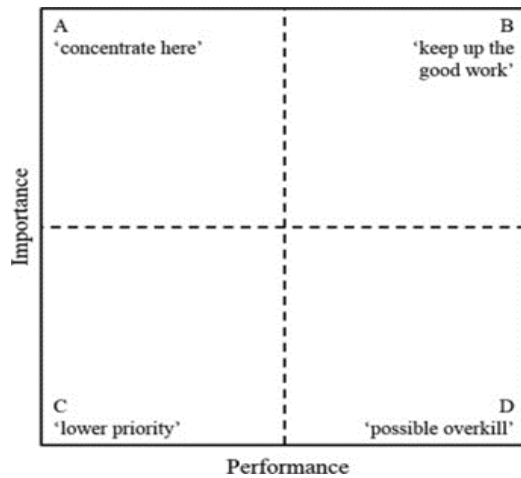


Fig.1. Importance-performance analysis

2. Methodology

The research procedure consisted of two main steps comprising i) designing the questionnaire and collecting data ii) conducting two steps of analysis; the first step of analysis being to find out Derived Importance by analysis using CART model and the second step being to construct an IPA diagram with 4 Quadrants in order to identify the level of importance of specific Items and simultaneously the level of satisfaction obtained. This would enable the decision of what type of remedial actions need to be taken regarding those Criteria or Items.

2.1 Surveys design and collection of data

Data was collected using questionnaires with easily comprehensible, relevant and practical questions. (Hernandez et al., 2016). The questionnaire was divided into of two parts including i) Demographic items comprising Gender, Age, High education level, Average income, Citizen end the last experience in travelling ii) Quality items chosen from the literature review about the factors used to study the level of service concerning Public transit. The different factors for the evaluation of quality were divided into 4 aspects namely; Vehicle (Vehicle body, Bus cleanliness, temperature in bus, crowded etc.), Driver's behavior (Personality of driver and crew, friendly and helpful, driving safety), Bus stop facility (distance between bus stops, roofs, seats, crowded, suitable, location located safe etc.) and Service (enough

service on rush hour, routing, ticket, service time etc.).

Thus, 30 items were included in the questionnaire to enquire about the levels of satisfaction as seen in **Table. 2**. For Value measurement of satisfaction of each Item in the list, Five-point Likert-type scale was used, including 1-Strongly Disagree, 3-Neither Agree nor Disagree, 5-Strongly agree. This kind of scale is widely employed to ask about the satisfaction in various fields concerning transportation and others (J. de Oña et al., 2013; R. de Oña, 2013; Hernandez and Monzon, 2016; Hernandez et al., 2016; S. Lee et al., 2007; Rasoolimanesh et al., 2016; Tonge and Moore, 2007). The data were collected by conducting face-to-face interview with travelers at bus stops and terminals or during their waiting time for buses by filling the questionnaires on the spot. The data which was collected from bus users nationwide consisted of 531 respondents.

2.2 CART and IPA

The CART model in this research was used to identify the importance of variables or Derived importance of Items. From a total of 30 items in the questionnaires, CART model was used for the classification using Historical data to construct the so-called decision tree. CART is used when we want to know the information in form of number (Timofeev, 2004) which could respond to Item about variable importance ranking (Loh, 2011). Importance-performance analysis (IPA) was used for the evaluation of each Item in the questionnaire. In this research, the 30 Items were classified into each of the four Quadrants which was set by considering two aspects including; i) Importance (Y-axis) calculated from CART model. Each Item will be ranked from 0-1 by using General satisfaction in Locating crosshairs in IPA (Deng, 2007; J.-N. Pan and Nguyen, 2015) ii) Performance measured from the average of General Satisfaction of each Item (Cohen et al., 2016; Hernandez et al., 2016) and employed General satisfaction to classify its level. Likewise, Importance was calculated from Weighted average in Gini impurity measure, Gini index will split variables by maximizing the homogeneity of child node (Hernandez et al., 2016). This study used Satisfaction ranking item in questionnaire (30 items) as independent variables and overall satisfaction or 'general satisfaction' as Dependent variables. Tree optimal was calculated by 10-fold cross-validation (Witten and Frank, 2005).

Table 2. Questionnaire items

Variable	Question	Group
Item1	Decent appearance of vehicle body	Vehicle
Item2	Clean and adjustable bus seats with a space between two seats in a row	
Item3	The bus floor is clean without any dust or garbage.	
Item4	While sitting in the buses, the temperature inside is cool, and it is not stuffy.	
Item5	In rush hours, the buses are crowded. There are no available seats.	
Item6	Outside rush hours, the buses are crowded. There are no available seats.	
Item7	Good personality and appearance of driver and crew that is neat, clean, and meets uniform standards	Driver
Item8	Friendly, helpful and polite customer service of driver and crew	
Item9	Bus driver driving safely, i.e. at a safe speed, politely, with respect for traffic rules	
Item10	The distance between bus stops and the destination of traveling is not very far.	Bus stop facility
Item11	Bus stops have roofs that provide protection from sunlight and rain.	
Item12	Bus stops have enough seats for waiting.	
Item13	Bus stops are large and not crowded.	
Item14	Bus stops are clean without any dust or garbage.	
Item15	Bus stops are durable and strong without any damage.	
Item16	Bus stops are suitable.	
Item17	Bus stops are sufficiently available in the main buildings.	
Item18	The locations of bus stops are appropriate. They are not very far from residences.	
Item19	Bus stops have sufficient lighting at night.	
Item20	Bus stops are located in safe areas that are not lonely and fearful.	
Item21	There are enough bus services in rush hours.	Services
Item22	There are enough bus services outside rush hours such as during daytime and evening	
Item23	During the service time of regular bus, you can do activities in the daily routine conveniently.	
Item24	The buses run punctually according to the bus schedule.	
Item25	There are widespread public relationships of bus schedules on the internet/application.	
Item26	There are available of schedule/maps at bus stops	
Item27	Bus routes cover every area.	
Item28	Bus routes are directly	
Item29	Ease of purchasing tickets	
Item30	Timetable is clear and easy to understand	

3. Results

3.1 Descriptive statistics

From **Table.3** showing the overall picture of all respondents, it was found that most respondents were Male 65.7%, and 34.3% were Female. For the age groups, they were split into ten years interval each. It was found that the majority of age group was 20-29 years 41.3%, followed by <20 years 21.8% Then 30-39 years, 40-49 years, 50-59 years and >60 years were 14.3%,

11.2%, 7.3% and 4.1% respectively. For respondents' education, it was found that most of them were in Upper secondary/Vocational Certificate 65%, followed by Bachelor's degree 22.22%, the rest was in Diploma /High Vocational, Master's degree in the proportion of 11.3%

and 1.5% respectively, and no respondents in Doctor's degree.

The mean value could indicate the overall picture of bus service in Mauritius as seen in **Table 4**. It can be explained as follows; considering bus service, Driver Behavior had the highest Mean satisfaction at 2.77, The Item with its highest satisfaction is Item 7-'Good personal and appearance of driver and crew that is neat, clean and meet uniform standards' at mean value of 2.87, followed by Item 9-'Bus driver driving safe followed by, i.e. at a safe speed, politely, with respect for traffic rule'. For the second highest satisfaction, Service was at mean value of 2.617. Item of which the highest Mean of satisfaction could reach at 3.45 was Item 29 'Ease of purchasing tickets', followed by Item 27 'Bus route cover every area'. The next was Item 24 'The buses run

punctually according to the bus schedule’, Item 28 ‘Bus route are directly’ at Mean 2.73 and 2.71 respectively. The third highest Mean of satisfaction was Bus stop facility at mean 2.496. Item of which the highest mean was Item 17-‘Bus stops are sufficiently available in the main buildings’, Item 10-‘The distance between bus stops and the destination of traveling is not very far’ at Mean 2.85 and 2.73 respectively. For Vehicle, the lowest mean of satisfaction was 2.4. Item of which the highest Mean of satisfaction was Item 5-‘in rush hours, the buses are crowded. There are no available seats’ at mean 3.08, the second was Item 6 ‘outside rush hours, the buses are crowded’.

Table 3. Respondents' characteristics

		Percentage
Gender	Female	34.3
	Male	65.7
Age	<20	21.8
	20-29	41.3
	30-39	14.3
	40-49	11.2
	50-59	7.3
	>60	4.1
Highest education level	Upper Secondary / Vocational Certificate	65
	Diploma/ High Vocational	11.3
	Bachelor's degree	22.2
	Master's degree	1.5
	Doctor's degree	0
Average income	<5,000	16.2
	5,000-10,000	39.7
	10,000-15,000	8.7
	15,000-20,000	8.3
	20,000-25,000	5.3
Citizen	25,000-30,000	15
	>30,000	6.8
	Mauritius	97.4
	Tourists	2.6

There are no available seats’ at mean 2.69. For Item which had the lowest satisfaction in group and the overall picture was Item 2-‘Clean and adjustable bus seats with a space between two seats in a row’ and Item 3-‘The bus floor is clean without any dust or garbage’ at Mean 1.96 and 1.88 respectively.

3.2 Importance analysis by CART

The accuracy rate of the model valued 69.5% which was at the accepted criteria when compared with the

research analyzed by using Decision tree (Hernandez et al., 2016; Wong and Chung, 2007). From the results, it was found that the Node of number was 11, the Node of terminal nodes was 6 and depth of tree was 4. From the **Fig.2** showing which Item in questionnaire was the most important, it was found that Item which had the highest ‘Purity’ was Item 9-‘Bus driver driving safely, i.e. at a safe speed, politely, with respect for traffic rules’. Item which had the largest amount after being separated from Node 0 was Item 7-‘Good personality and appearance of driver and crew that is neat, clean, and meets uniform standards’ (Node 1) and Item 22-‘There are enough bus services outside rush hours such as during daytime and evening’ (Node 2) which had Item score more than 1.5. Regarding Importance variable shown in **Table 5**, it was found that the most important Item was Item23-‘During the service time of regular bus, you can do activities in the daily routine conveniently’ Item9-‘Bus driver driving safely, i.e. at a safe speed, politely, with respect for traffic rules’ and Item 8 ‘Friendly, helpful and polite customer service of driver and crew’ respectively.

Table 4. Descriptive statistics of items

	N	Mean	Std. Deviation	Group	Mean of group		
Item1	531	2.47	1.201	Vehicle	2.41		
Item2	531	1.96	1.164				
Item3	531	1.88	1.145	Driver	2.77		
Item4	531	2.38	1.039				
Item5	531	3.08	1.697				
Item6	531	2.69	1.261				
Item7	531	2.87	1.335				
Item8	521	2.68	1.307				
Item9	531	2.76	1.478				
Item10	531	2.73	1.521			Bus stop facility	2.496
Item11	531	2.59	1.285				
Item12	531	2.59	1.628				
Item13	531	2.49	1.408				
Item14	531	2.33	1.331				
Item15	531	2.38	1.155				
Item16	531	2.63	1.162	Services	2.617		
Item17	531	2.85	1.419				
Item18	531	2.55	1.399				
Item19	531	2.03	1.333				
Item20	531	2.29	1.253				
Item21	531	2.33	1.322				
Item22	531	2.42	1.147				
Item23	531	2.19	1.163				
Item24	531	2.73	1.413				
Item25	531	2.27	1.469				
Item26	531	2.49	1.250				

Item27	531	2.95	1.321
Item28	531	2.71	1.298
Item29	531	3.45	1.372
Item30	531	2.63	1.316

3.3 Evaluation performance of quality by IPA

For Importance-Performance analysis which showed the cluster of Item obtained from questionnaires by linking between Importance and Performance or Satisfaction, the results were shown in Fig.3 and summarized as follows;

Table 5. Derived importance of independent variable

Question	Importance	Normalized Importance
Item22	0.162	100.00%
Item9	0.146	89.90%
Item8	0.145	89.30%
Item7	0.14	86.20%
Item24	0.124	76.40%
Item18	0.12	73.90%
Item21	0.112	69.30%
Item20	0.111	68.50%
Item23	0.099	61.00%
Item1	0.094	58.20%
Item2	0.094	57.80%
Item11	0.088	54.50%
Item16	0.088	54.40%
Item15	0.084	52.20%
Item29	0.081	50.00%
Item10	0.076	47.10%
Item12	0.073	45.40%
Item17	0.06	37.30%
Item30	0.054	33.20%
Item27	0.053	32.50%
Item5	0.042	26.00%
Item13	0.039	24.10%
Item14	0.021	12.80%
Item19	0.018	11.00%
Item3	0.018	11.10%
Item26	0.011	6.60%
Item25	0.008	4.70%
Item4	0.006	3.80%
Item28	0.001	0.40%
Item6	4.81E-06	0.00%

“Possible Overkill” Quadrant Focuses on the low Importance but at the high satisfaction. Items in this Quadrant were Item 30, Item 17, Item 27, Item 5, Item 28, and Item 6. Item which was clearly outstanding (Lowest importance in group) was Item 5-‘during rush hours, the buses are crowded. There are no available seats’ and Item 6-‘Outside rush hours, the buses are crowded There are no available seats’.

“Keep going up the good work” this Quadrant had both high Importance and Satisfaction. Items in this Quadrant were Item 8, Item 9, Item 7, Item 24, Item 18, Item 11, Item 16, Item 10, Item 29 and Item 12. For Item which was at the most outstanding position (Most

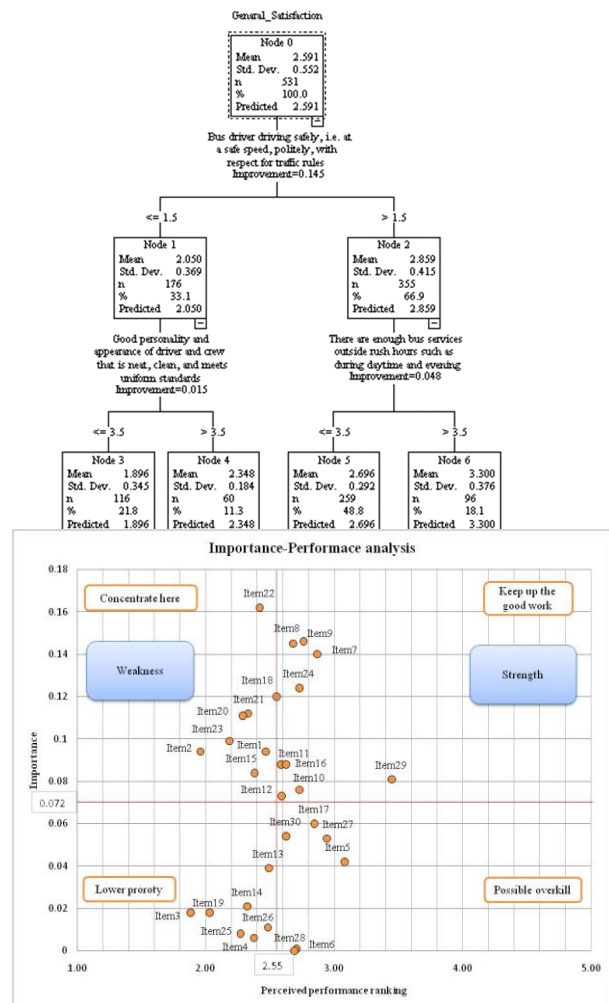


Fig.2. Classification and regression tree

Fig.3. Importance-Performance analysis

personality and appearance of driver and crew that is neat, clean, and meets uniform standards’ and Item 9- ‘Bus driver driving safely, i.e. at a safe speed, politely, with respect for traffic rules’.

“Low Priority” this Quadrant was the group of low Perceive value and Importance included Item 13, Item 14,

Item 19, Item 14, Item 19, Item 3, Item 26, Item 25, and Item 4. The most outstanding position Items were Item 3- 'the bus floor is clean without any dust or garbage', and Item 4- 'While sitting in the buses, the temperature inside is cool, and it is not stuffy'.

'Concentrate' this Quadrant set Item at High importance and Low satisfaction. All Items included Item 22, Item 8, Item 21, Item 20, Item 23, Item 1, Item 2, and Item 15. For the most outstanding Item, in other words, its Importance was higher than other Items. Item 22- 'There are enough bus services outside rush hours such as during daytime and evening' Item 20 - 'Bus stops are located in safe areas that are not lonely and fearful' and Item 21- 'There are enough bus services in rush hours'.

For strengths and weaknesses, they were separated by satisfaction level comprised of; i) Vehicle which included Item 2- 'Clean and adjustable bus seats with a space between two seats in a row' ii) Bus Stop facility including Item 15- 'Bus stops are durable and strong without any damage, Item 20- 'Bus stops are located in safe areas that are not lonely and fearful', and iii) Service including Item 21- 'There are enough bus services in rush hours', and Item 23- 'During the service time of regular bus, you can do activities in the daily routine conveniently'. Strengths were as follows; i) Driver behavior Item 7- 'Good personality and appearance of driver and crew that is neat, clean, and meets uniform standards' and Item 9- 'Bus driver driving safely, i.e. at a safe speed, politely and abiding traffic rules' ii) Service which included Item 29- 'Ease of purchasing tickets'.

4. Discussion and conclusion

The evaluation of public bus service quality in Mauritius was done by analyzing users' questionnaires throughout Mauritius from 531 Respondents. They were evaluated by the method called Importance-performance analysis (IPA) which consisted of two main steps including i) use of Decision tree to find the importance of Independent variables (Items), and ii) use of IPA to relate between mean of satisfaction of items and mean of importance of items which enabled to identify in which Quadrant the specific Item was to be located. After that, it could be identified which Item should be urgently improved, which Item should be kept to its standardized work, or which item should be given low priority. For Items which require urgent improvement, they were located mainly be in the quadrant called "Concentrate" since this quadrant has high importance but still has low satisfaction. If there is some improvement in this quadrant, the level of perceived service or satisfaction will increase better than it is actually. From the results of IPA, it was found that Items in the quadrant which should be

given less priority were in the part concerning crowded buses during or outside rush hours, that is, in every bus trip, there are enough seats available for passengers. For the quadrant which has good operation, the efficient operation should be maintained such as driver behavior; bus drivers and permanent staff with good personality as well as clean dressing with standard uniform. Another Item is Driver's driving which is should be extremely safe either concerning speed or abiding by traffic laws. If Driver behavior's efficiency needs to be increased, the criteria of driver's recruitment may be determined such as age which should be in a range of 25-50 years, experience and education level (Ratanavaraha and Jomnonkwao, 2014). For Quadrant to which bus service users do not give much importance, improvement should not be emphasized on. Item in quadrant vehicle was vehicle's cleanliness both floors and seats, and also temperature within vehicle.

Regarding the quadrant which requires urgent improvement, Item which is rather very important to users and have a rather low satisfaction. The quadrants to be developed were i) Service; the number of buses should be increased by increasing the frequency of buses (Mouwen, 2015; Tyrinopoulos and Antoniou, 2008) ii) Bus stop facility; Bus stops are located in isolated places and thus not safe. The locations of bus stops should be nearer to community areas and sufficient lighting facilities should be provided at night.

Further research should be conducted to study users' viewpoints about which quadrant should be given more attention. Consequently, if for that bus service item remedial action is taken and improvements brought about, then the user's behavior will be understood through a study about loyalty.

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