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Sustainability of Public Transportation: An Examination of User Behavior to Real-Time GPS Tracking Application

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Abstract: Public transportation is an effective method of mobility that promotes cost-saving and is environmentally friendly. Poor public transport ridership in Malaysia is due to the unsatisfactory attitude of public transport users and inaccurate information on departure and arrivals. Sarawak, a state of Malaysia, is especially poor in ridership of public transport. A real-time Global Positioning System (GPS) tracking application (app) was found to be an effective tool to increase the ridership of public transport. Hence, a mobile app named UniBus was developed to enhance the ridership of public transport in Sarawak. The determinants that affect satisfaction and customer loyalty such as accessibility, reliability, comfort, safety, and security were all examined before and after the use of real-time GPS tracking app. The data was collected in Kuching, and targeted public transport users who used the UniBus app. The result indicated that all the mentioned variables were improved after using a real-time GPS tracking app. It is suggested that future studies can consider other factors such as service quality, availability, and perceived value as well as cover other states of Malaysia.

Keywords: accessibility; reliability; comfort; safety and security; satisfaction; loyalty; comparison; before and after; real-time GPS; mobile application

1. Introduction

Public transportation integration has been receiving extensive attention from many cities. The government is enhancing the connectivity among various modes of transport, to ultimately improve the overall public transportation system so that it can be a viable alternative versus private vehicles [1]. Public transportation is recognized as one of the effective external cost-saving and motorize travel negative effect solutions for the government while facing the problem of congestions, over populations, high motorization, and other environmental impacts [2]. The mode of transportation includes bus, train, taxi, ferry, etc., that allows the public to share a vehicle and move around in a specific area [3].

Public transportation plays a significant role in improving productivity and work opportunities, thus, promoting public transport has been an imperative focus in many countries [2,4]. One of the important factors to be considered when promoting public transport is travel time. Travel time links to economic value as it can be translated into transportation cost due to few parameters such as staff's wage, travel condition, the practicality of the trip, etc. [5]. However, organizing a user-friendly

transport system that provides services and facilities to the public to shorten the travel time and wait time is always a major challenge, as this system should take into consideration many aspects, including accessibility and connectivity of the whole public transport network [2].

Many pieces of research have been conducted aiming to increase the ridership of public transport [6–9]. Nevertheless, to date, Malaysia is still facing low ridership. One of the reasons that could deter from using the public transport is unsatisfaction due to lack of information on arrival and departure times [10–12]. In Sarawak, the ridership of public transportation also remains low, which leads to heavy traffic congestions due to the increasing number of private vehicles [13,14]. A vehicle tracking system that facilitates the journey planning of the public could be a solution to this problem [10–12].

To boost and promote the interest of the public for using public transport, retaining the current customers, and at the same time gaining new users is one of the most practical methods [15]. Customer loyalty has become a key to measure the success of the businesses [16,17]. Besides that, customer satisfaction often makes its appearance in the context of customer loyalty as it is widely recognized that positive experiences lead to future behavior [18,19]. This is also applicable in the field of the public transport industry [20].

Smartphone-power technology allows the mobility to be more dynamic, especially in terms of public transportation [21]. The mobile application (app) is recognized as a tool that can enhance customer experience [22–24]. Other than that, as mentioned in the paragraph above, a vehicle tracking system may be a solution to poor ridership of public transport. Hence, a real-time Global Positioning System (GPS) tracking app—UniBus, was developed to improve public transportation ridership. For this, there is a necessity in identifying the perception of the public transport users on before and after the use of the mobile app, including the perception of various key factors that affect customer loyalty, to achieve a sustainable public transportation. Therefore, this study was designed to compare the difference in the perception of the variables such as accessibility, reliability, comfort, safety and security, customer satisfaction, and customer loyalty before and after the use of the real-time GPS tracking app. Besides that, this research will provide empirical evidence on the difference between before and after the use of the real-time GPS tracking app in the public transport sector, as there is no clear evidence indicating the perception changes in this field in Sarawak, Malaysia. Several past studies have found that the real-time GPS tracking of public transport enhanced user satisfaction [25–28]. Despite the importance of user behaviors, the existing literature mostly focused on examining the single factor or measures on certain variables only, such as waiting time, travel time, etc. The current study is differing from the previous studies by including multiple key factors affecting satisfaction and loyalty. Moreover, this study also investigates the effects of the real-time GPS tracking app on these factors. Furthermore, there is limited study conducted to study the real-time GPS tracking app and its impacts on the user behaviors, especially in the context of Malaysia. Hence, the current research could contribute to the body of literature by providing empirical evidence on the user behavior before and after the use of the real-time GPS tracking app. This study is expected to be able to provide more insight into the changes of each determinant for the policymakers, industry players, and researchers in decision making. For theoretical implication, this study will contribute to the number of the research efforts in the field of customer satisfaction and loyalty. In the practical aspect, the public transport operators can identify the most significant factors via this paper which can assist in creating new innovations and making managerial decisions.

The organization of the rest of the paper will start with a literature review and hypothesis development in Section 2, followed by the methodology of the research in Section 3, including research design, measurements, data collection processes, and data analysis. Section 4 will show the findings, and these findings will be discussed in Section 5. Lastly, the paper will conclude with a conclusion, limitation, and recommendation for future studies in Section 6.

2. Literature Review

2.1. Accessibility

By its means, accessibility refers to the facilitation of reaching a destination by the passenger from a ride and get off from vehicle [29,30]. It is also one of the measurements for the transport system's performance in transport planning [31]. Accessibility can be measured by two elements, which are the benefit (the location and its attractive urban opportunity) and the cost of travelling from a residential area. An accessible area can be defined as the place which is reachable with lower travel impedance. Public transport holds a critical role in the level of accessibility [32]. Hence, public transport accessibility can be defined similarly, but restricted to only public transport as the mode of transportation [33]. Enhancing the accessibility of public transport is often seen as an efficient and workable method to carry a larger volume of public transport user back and forth between big cities and rural area [34]. Accessibility of public transport also plays an important role in the sustainable development of cities, especially on car traffic congestions and air pollution as effective and efficient public transportation system encourages the use of public transport, which indirectly reduces the number of cars [35]. Furthermore, accessibility, connectivity, and mobility of public transport should provide a user-friendly system for public transport users, while transport and land use policies should focus on enabling the users to reach the destination at reasonable cost and time [36].

Satisfaction is believed to be significantly positively impacted by accessibility to a destination [37]. It is proven in the research of a past study in regards to the factors affecting traveller's satisfaction [38]. Furthermore, in a more recent study, the positive impact of accessibility toward travellers' satisfaction was also found [39]. Due to the strong relationship between accessibility and satisfaction, this study assessed the difference between before and after the use of real-time on accessibility.

2.2. Reliability

In the public transportation system, reliability is considered as one of the most important service factors [40,41]. Reliability refers to the consistency of punctuality and travel time of the public transport according to the scheduled time table [15]. Service reliability of public transportation is more important than service frequency. This may be due to the fact that most of the public transport attributes are inaccurate, causing extra waiting and travel time [42]. The inaccurate waiting and travel time may lead to various negative impacts including the risk of being late, discouragement for the non-risk takers to use public transport, and the uneven load of passengers, which result in more irregular arriving times and frequency of public transport [43]. Moreover, reliability can affect the transport mode of choice for commuting and non-commuting purposes [44,45]. Furthermore, public transport users' time of departure and route choice will be affected by the reliability of public transport due to the traffic condition, unforeseen incidents, traffic control, and environmental factors [46]. At times, reliability of the public transport service can be more imperative than frequency and information of public transport to the public transport users [47].

The satisfaction of public transport users is heavily influenced by onboard experience where it can only be beneficial if the service provided is reliable [48,49]. This is proven in the past study indicating that the commuters travelling with unreliable public transport have lower satisfaction than those who travelled with reliable public transport [50]. Aside from this, it is backed by another research on the effect of public transport reliability toward passengers' satisfaction [51]. There is a need to examine reliability in consideration of its positive relationship with customer satisfaction.

2.3. Comfort

Comfort may refer to one's pleasant or relaxing feeling to the environment [52]. It is one of the important variables in measuring the quality and preference of public transport users [49,53]. Both physical comforts of the vehicle and ambience comfort on board or at the waiting point have to be taken into consideration to measure public transport comfortability. Few aspects to measure

comfort while riding public transport, such as the functionality of passenger facilities, passenger seats, and space, comfortability while riding (when the vehicle starts, stops, or moves), the atmosphere of the ride (cleanliness, noise, traffic condition, etc), complimentary facilities (toilets, commercial, communication, etc.), and ergonomic aspects [54]. Besides that, technological innovations such as smartphones, laptop, and so on, can enhance the level of comfortability as well [55]. Comfort is the most important attribute to interurban public transport users [56]. To achieve the highest level of comfort and optimize the usage of rolling stock, it is compulsory to allocate the maximum number of public transport lines [57].

Dissatisfaction may occur if the physical comfort of the consumers' experience does not meet their expectation [58]. Comfort is also one of the dimension in public transport users' satisfaction [59]. Improvement of comfort can be a strategy for public transport operators to attract more customers, since it can impact on the overall satisfaction [60]. Thus, the public transport sector must ensure the comfortability of the passengers. The past study figured out the positive relationship between comfort and satisfaction in a certain user group of public transport [61]. A recent study also proved that the concept of comfort is critical to ensure the satisfaction of public transport users [62]. Comfort as one of the main dimension in public transport users' satisfaction, needs to test on its effect on before and after the use of a real-time GPS tracking app.

2.4. Safety and Security

In public transportation, safety can be relating to the perception or feeling of the staff and passengers that allows them to travel risk- or harm-free, whereas security means public transport's risk and vulnerability to experience an accident or crime. When safety and security come together in the field of transit environment, they are very much dependent on a multi-scale condition which can be determined by their micro-environment [63]. Safety and security in public transport are serious concerns among various parties especially from the public transport users [64,65]. Physical offence, risk of crime, harassment, and other inhuman behaviors have become a fear to the public transport users which turn out to be a factor that impacts on the confidence of public transport users [66]. Safety and security are often associated with the choice of travel mode and the security problems of frequent public transport users are more likely to happen than for the people who own a private vehicle [67].

Safety and security are believed to be one of the most significant factors of customer satisfaction [68]. Numerous researches are confirming the positive impact of safety and security toward satisfaction. For instance, past research found a significant positive relation of safety and security toward satisfaction [69]. Another study has discovered the same result on the satisfaction and loyalty of public transport as well [70]. In regard to the positive relationship of safety and security toward satisfaction, it is crucial to evaluate its effect after the use of a real-time GPS tracking app.

2.5. Customer Satisfaction

In general, customer satisfaction can be defined as the consumers' experience in terms of pleasure or disappointment during the comparison from the received products or services and their expectations [19,71]. If the received product or services meet the expectations, the customer is satisfied, otherwise, the customer is dissatisfied [71]. It can be allied with the salesperson, product quality, and consumption experiences. Usually, customer satisfaction has been view as an immediate objective and indicator of the performance of organizations [72].

The satisfaction of public transport users is a kind of psychological feeling occurred when passenger expectation meets the perception of public transport service. When public transport users take public transport, they are accepting the service provided by public transport operator, becoming the customer and hence, measuring customer satisfaction in public transportation is measuring the satisfaction of public transport users [73]. Besides that, customer satisfaction in public transportation is increasingly important and widely consider in the process of planning as well as designing a public

transport system [74]. To attract people using private vehicles to public transportations, the service provider should ensure the satisfaction of the customer [75]. The aspects such as reliability, punctuality, connectivity, trip time, and so on, as well as the quality of the information offered to the public transport users, are found to be very closely related to customer satisfaction [76]. In the public transport sector, it is found that overall satisfaction is the noteworthy precursor of loyalty [77]. Past studies suggested that customer satisfaction is bringing a positive effect to the public transportation sector [74,78]. The unsatisfied public transport riders would like to track real-time information on public transport to feel better [79].

2.6. Customer Loyalty

Customer loyalty can be defined as repeat purchases or patronization on particular product brand or services in the future which is driven by a strong sense of commitment [77]. This impact on the repeat purchases of the product's brand, market situation, and marketing of competitors. Generally, loyalty is measured by three approaches which are attitude (prioritize specific brand over other brands), behaviur (constantly repurchase), and the composite of both attitude and behavior [80]. Often, customer loyalty has been identified by four dimensions which are word-of-mouth communication, repurchase intention, complaining behaviour, and price sensitivity. In the service industry, loyalty tends to be more important than the consumer goods industry [53]. The loyal customer tends to purchase a product or service from a supplier and often recommends the people around them. It can lower the cost, increase, and further enhance profitability [72].

Public transportation is considered as a kind of service/product due to its competition with the private vehicle during the decision making on the selection on the mode of transportation; hence, it is reasonable to classify the passenger or traveller as customer [77]. As mentioned, to boost the ridership of public transportation, customer loyalty is one of the critical factors to study. Several studies have identified the importance of customer loyalty in public transportation. Previously, researchers have studied customer loyalty toward GrabBike [81]. Another past study also confirmed that public transport users demonstrated loyalty and act as an ambassador for public transport agencies [15].

2.7. Hypothesis Development

From the literature studies above, accessibility, reliability, comfort, as well as safety and security can directly impact customer satisfaction which will influence customer loyalty. Customer loyalty is viewed as one of the most important criteria to boost the ridership of public transport. Past studies found that a GPS tracking system can improve accessibility [82], reliability [83], comfort [84], safety and security [85], and satisfaction [86]. Moreover, the public transport experience of the users can be improved when the movement of transportation is predictable and traceable [87,88]. The improvement of customer experience in public transport will lead to an increase in customer loyalty [89]. Therefore, all of the mentioned factors are crucial to be investigated on the perception of before and after the use of a real-time GPS tracking app from public transport users. Hence, the following hypotheses were formulated:

Hypothesis 1 (H1): *After the use of UniBus app, accessibility is higher than before the intervention due to the sufficient information provided by the real-time GPS tracking features and the unique function provided by UniBus app to its users.*

Hypothesis 2 (H2): *After the use of UniBus app, reliability is higher than before the intervention due to the sufficient information provided by the real-time GPS tracking features and the unique function provided by UniBus app to its users.*

Hypothesis 3 (H3): *After the use of UniBus app, comfort is higher than before the intervention due to the sufficient information provided by the real-time GPS tracking features and the unique function provided by UniBus app to its users.*

Hypothesis 4 (H4): *After the use of UniBus app, safety and security are higher than before the intervention due to the sufficient information provided by the real-time GPS tracking features and the unique function provided by UniBus app to its users.*

Hypothesis 5 (H5): *After the use of UniBus app, customer satisfaction is higher than before the intervention due to the sufficient information provided by the real-time GPS tracking features and the unique function provided by UniBus app to its users.*

Hypothesis 6 (H6): *After the use of UniBus app, customer loyalty is higher than before the interventio due to the sufficient information provided by the real-time GPS tracking features and the unique function provided by UniBus app to its users.*

3. Methodology

The UniBus app consists of 2 interfaces which are for bus operators and bus users. These two interfaces are linked and will run concurrently on a 24/7 basis. The icon (square dot) will change to the green triangular icon once the public transport is moving. On top of the triangular icon, car plate number, speed, date, and time will be shown. Figure 1 illustrates the screenshots of the UniBus app (user interface) that was developed to increase the ridership and sustain public transportation in Sarawak.
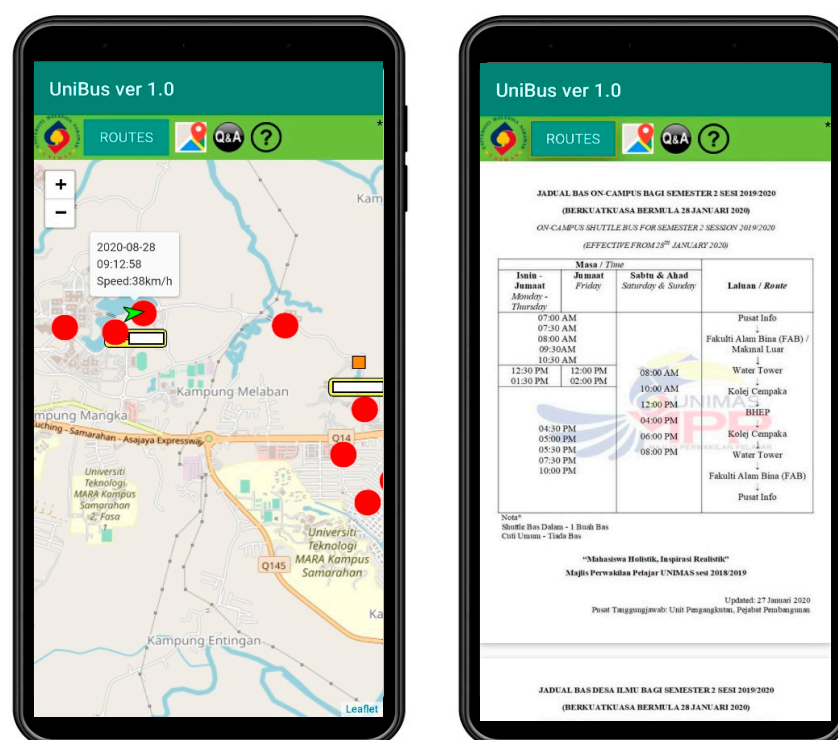

Figure 1. Screenshots of UniBus App (user interface): Real-time GPS tracking App for Public Transport.

The main features of this mobile app include tracking the real-time information of the bus, view the current location of users, the latest routes, associated stops, and stations of the bus. The schedule of the bus and feedback function to the operator are available too. In addition, the app can provide a

real-time alert to the users and operators if there are breakdowns, delay, traffic jams, and re-routing. This allows the rider to be aware and estimate the arrival of public transport.

Figure 2 illustrates the operator interface which can be accessed by any devices with all types of internet browsers. This interface allows management to edit the routes, stops, and schedules. Monitoring on the bus status (breakdowns, delay, traffic jams, and re-routing), speed tracking as well as historical data of the bus are made possible by the Unibus app. One notable innovation of this app is that users can request the bus. This feature provides information to the operator on the number of riders in a particular stop, which can facilitate route planning of the bus to capture all the passengers. If a particular stop is frequently overcrowded at a certain period, the operator can plan more buses to pass by the bus stop, in order to take all the passengers, while avoiding the huge crowd. Through these functions, the operator can improve the route and time planning effectively and efficiently from time to time.
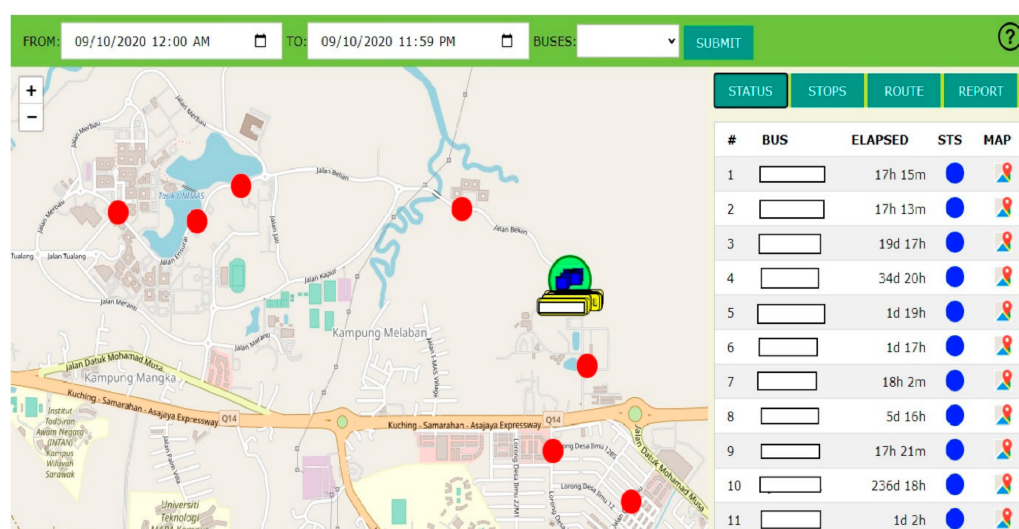
Figure 2. Screenshot of UniBus App (management interface): Real-time GPS Tracking App for Public Transport.

To investigate the perception related to the determinants that affect the customer experience, a quantitative study by using a structured questionnaire of before and after the use of the real-time GPS tracking app was conducted in the city of Kuching in Malaysia. The structure of the questionnaire consisted of 2 sections which comprised 37 questions. Section 1 comprised 8 profiling questions and Section 2 contained 29 items related to the determinants that are: accessibility, reliability, comfort, safety and security, customer satisfaction, and customer loyalty. All items in the questionnaire were adapted from previous studies and were slightly adjusted after pre-testing [41,90–96]. The 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree) were used to measure the items.

A before–after control group research design was used for data collection. The "before" survey was conducted in June 2019. The public transport users were asked to rate their perceptions of each factor towards their public transport riding experience. The respondents were assured of the confidentiality of their responses to help increase the response rate. Out of the 600 distributed questionnaires, a total of 215 questionnaires were returned (response rate of 35.8%). The "after" survey was conducted in January 2020. The 190 persons who indicated their contact details in the "before" questionnaire received a new questionnaire to rate their perceptions of each factor towards their public transport riding experience after using the app. A total of 179 responses were used for further analysis after preliminary data analysis. Among the 179 sets of data collected, 56.1% were female and 43.9% were male; 59.6% of the respondents had a degree or professional qualification and 83.3% of the respondents had a driving license. Among the respondents, 84.2% were using public transportation about one to four times in a week and 53.5% of them were using it for commuting purposes. To ensure the sample

size was sufficient, G*power analysis was used for the calculations, with a priori analysis at 5% level of significance, power of 80%, 0.15 effect size, and 6 predictors. The results indicated that a minimum of 98 samples was needed. Hence, the data collected from the sample size of this study was considered sufficient to test the significance of the hypotheses.

To compare the perception changes of the respondents, the mean was taken for each item in every variable. Statistical Package for the Social Sciences (SPSS) version 23.0 was used to analyze the data. The mean was then derived from the analysis of SPSS and a table was created in Microsoft Excel to perform the comparison. The same technique was performed twice to analyze the differences in user perceptions before and after the use of the real-time GPS tracking app. Next, bar charts were created to present the differences by using Microsoft Excel. Finally, paired-samples t test was performed to calculate the significance of the result.

4. Findings

Generally, the results indicated an overall improvement in the perception of all determinant related items comparing before and after the use of the real-time GPS tracking app. Figure 3 shows the overall chart for the 29 items. The subsequent section indicates the mean value followed by the mean standard error of every item. For the items of each variable, refer to Appendix A.
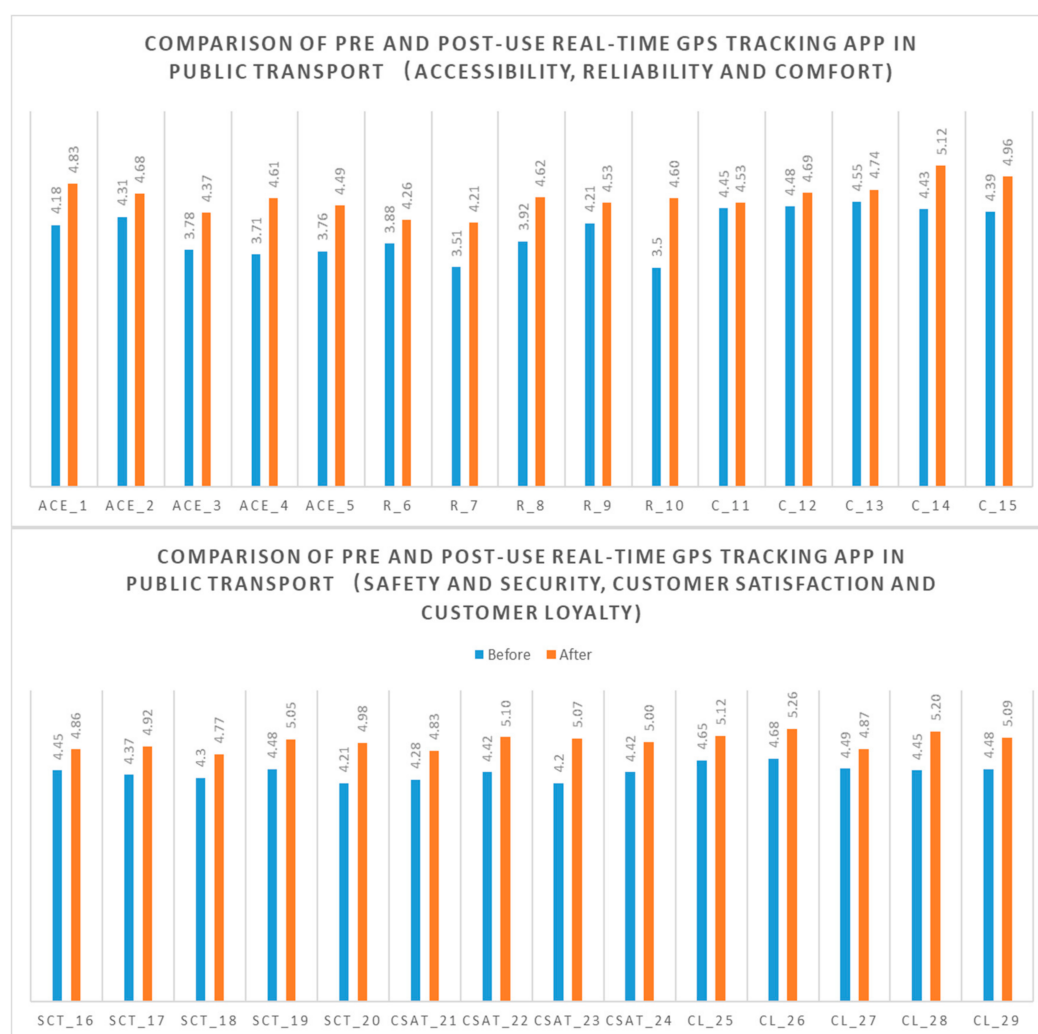
Figure 3. Overall Result Comparison (mean) of Perception Changes on Before and After the Use of Real-time GPS Tracking App.

4.1. Effect on Accessibility

Figure 4 displays the mean value on the perception of accessibility. Item ACE_1 to ACE_5 showed an upsurge of the average perception after the implementation of the real-time GPS tracking app. For ACE_1, the average value increased from 4.18 (standard error 0.11) to 4.83 (standard error 0.16). ACE_2 increased from 4.31 (standard error 0.12) to 4.68 (standard error 0.15), ACE_3 increased from 3.78 (standard error 0.13) to 4.37 (standard error 0.17), ACE_4 improved from 3.71 (standard error 0.12) to 4.61 (standard error 0.16), and ACE_5 increased from 3.76 (standard error 0.13) to 4.49 (standard error 0.18). Among the 5 items, ACE_4 had the biggest difference in mean value (0.90). The overall upsurge of all the items in accessibility after the use of the real-time GPS tracking app proved that H1 is supported.
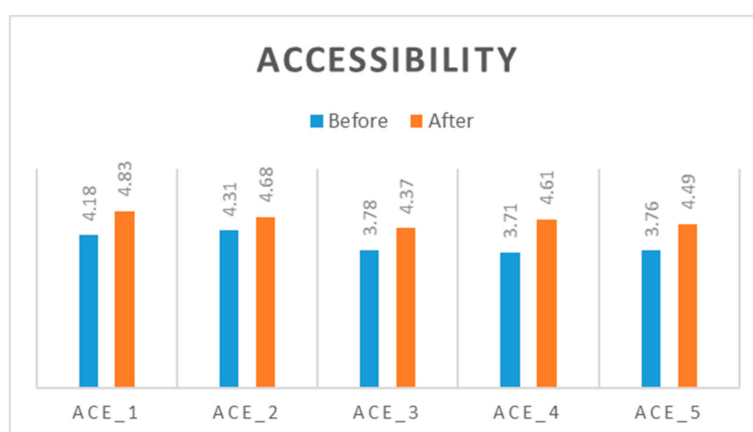
Figure 4. Average of the Perception Changes of Accessibility Before and After the Use of Real-time GPS Tracking App.

4.2. Effect on Reliability

Figure 5 demonstrates the mean on the perception of reliability. Item R_6 to R_10 showed an improvement in the average perception after the implication of the real-time GPS tracking app. For R_6, the average value increased from 3.88 (standard error 0.14) to 4.26 (standard error 0.17). R_7 had an upsurge from 3.51 (standard error 0.13) to 4.21 (standard error 0.18), R_8 increased from 3.92 (standard error 0.14) to 4.62 (standard error 0.16), R_9 was raised from 4.21 (standard error 0.13) to 4.53 (standard error 0.16), and R_10 had an upsurge from 3.50 (standard error 0.13) to 4.60 (standard error 0.15). Among these 5 items, R_10 had the major changes of 1.10 on the mean value. The general increase in perception of reliability showed that H2 of this study was supported.
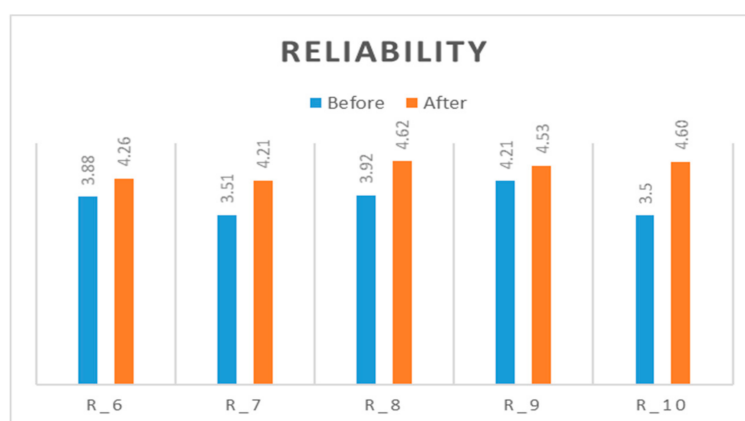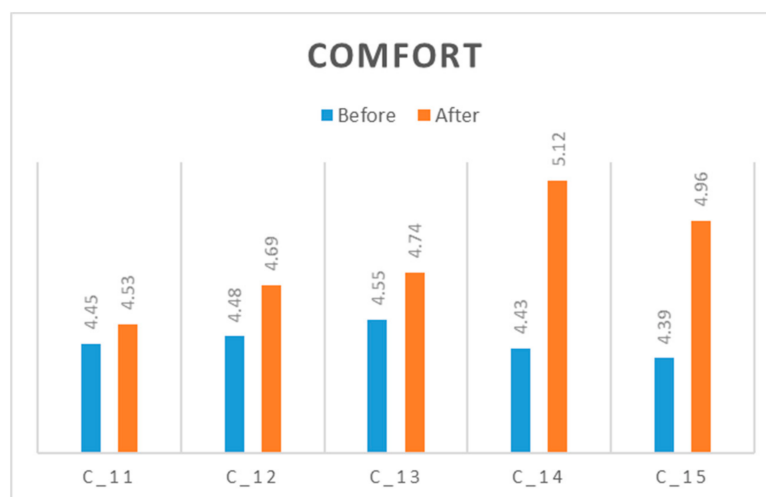

Figure 5. Average of the Perception Changes of Reliability Before and After the Use of Real-time GPS Tracking App.

4.3. Effect on Comfort

Figure 6 presents the mean value of comfort. Item C_11 to C_15 showed an increased in the average perception after the use of real-time GPS tracking app. For C_11, the mean value improved from 4.45 (standard error 0.10) to 4.53 (standard error 0.15). C_12 was raised from 4.48 (standard error 0.10) to 4.69 (standard error 0.13), C_13 increased from 4.55 (standard error 0.11) to 4.74 (standard error 0.14), C_14 improved from 4.43 (standard error 0.11) to 5.12 (standard error 0.13), and C_15 improve from 4.39 (standard error 0.10) to 4.96 (standard error 0.13). Among the mentioned items, C_14 had a significant upsurge of 0.69 on the mean value. The remarkable increase of comfort confirmed that H3 is supported.

Figure 6. Average of the Perception Changes of Comfort Before and After the Use of Real-time GPS Tracking App.

4.4. Effect on Safety and Security

Figure 7 illustrates the mean value of safety and security. The item SCT_16 to SCT_20 was raised on the average of the post-use perception on the real-time GPS tracking app. For SCT_16, the mean value improved from 4.45 (standard error 0.10) to 4.86 (standard error 0.12). SCT_17 increased from 4.37 (standard error 0.10) to 4.92 (standard error 0.12), SCT_18 increased from 4.30 (standard error 0.10) to 4.77 (standard error 0.12), SCT_19 increased from 4.48 (standard error 0.10) to 5.05 (standard error 0.14), and SCT_20 increased from 4.21 (standard error 0.10) to 4.98 (standard error 0.14). Among these items, SCT_20 had a noteworthy upsurge of 0.77 in mean value. Generally, the increase in the perception of safety and security indicated that H4 is supported.
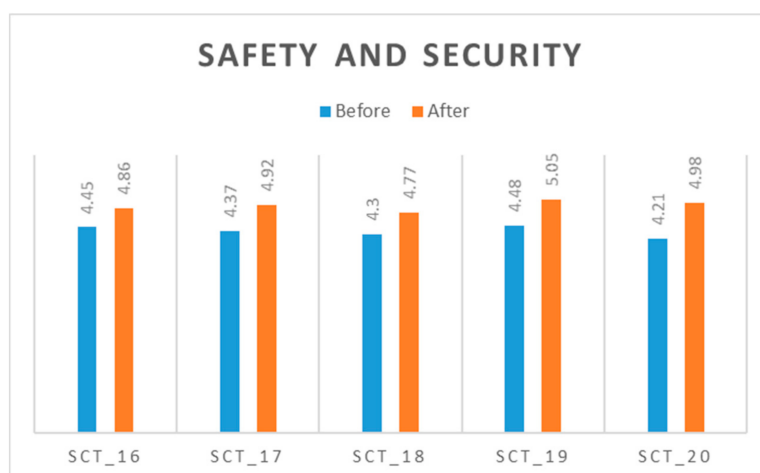
Figure 7. Average of the Perception Changes of Safety and Security Before and After the Use of Real-time GPS Tracking App.

4.5. Effect on Customer Satisfaction

Figure 8 explains the mean for customer satisfaction. Items CSAT_21 to CSAT_24 experienced growth on the mean value as well. For CSAT_21, the mean value increased from 4.28 (standard error 0.11) to 4.83 (standard error 0.14). CSAT_22 increased from 4.42 (standard error 0.10) to 5.10 (standard error 0.13), CSAT_23 had an upsurge from 4.20 (standard error 0.11) to 5.07 (standard error 0.14), and CSAT_24 increased from 4.42 (standard error 0.10) to 5.00 (standard error 0.12). Among these items, CSAT_23 had a remarkable increased in the mean value of 0.87. In general, the improvement of customer satisfaction after the use of the real-time GPS tracking app showed that H5 is supported.

Figure 8. Average of the Perception Changes of Customer Satisfaction Before and After the Use of Real-time GPS Tracking App.

4.6. Effect on Customer Loyalty

Figure 9 shows the mean value of customer loyalty. CL_25 to CL29 all had an overall improvement. CL_25 had an upsurge from 4.65 (standard error 0.10) to 5.12 (standard error 0.12). CL_26 increased from 4.68 (standard error 0.10) to 5.26 (standard error 0.13), CL_27 increased from 4.49 (standard error 0.10) to 4.87 (standard error 0.12), CL_28 had a growth from 4.45 (standard error 0.09) to 5.20 (standard error 0.12), and CL_29 increased from 4.48 (standard error 0.10) to 5.09 (standard error 0.12). Between these items, CL_28 had a notable improvement of 0.75. The last variable of the current study,

customer loyalty, also had an outstanding improvement after the use of the real-time GPS tracking app. This again evidenced that H6 is supported.

Figure 9. Average of the Perception Changes of Customer Loyalty Before and After the Use of Real-time GPS Tracking App.

4.7. Significant Analysis (t-Test)

Table 1 indicated the mean, standard deviation, mean difference together with *t*-value and *p*-value after a paired-sample t test of each variable. The result, again, showed that the developed hypotheses (H1 to H6), are statistically significant as the threshold of *p*-values is 0.05, whereby in all the results shown on the table above, the *p*-values are lower than 0.01, which represents very statistically significant results.

Table 1. *t*-test (before and after the use of UniBus).

Before >> After	Before		After		After—Before		
	Mean	Std. Deviation	Mean	Std. Deviation	Difference (Mean)	t-Stat	*p*-Value
Accessibility	3.95	0.92	4.60	1.53	0.65	4.33	$p < 0.01$
Reliability	3.81	1.08	4.44	1.60	0.63	3.67	$p < 0.01$
Comfort	4.46	0.88	4.81	1.25	0.35	2.62	$p < 0.01$
Safety & Security	4.36	0.89	4.92	1.23	0.56	4.17	$p < 0.01$
Satisfaction	4.36	0.89	5.11	1.23	0.75	5.76	$p < 0.01$
Loyalty	4.55	0.84	5.11	1.17	0.56	4.14	$p < 0.01$

5. Discussion

To improve the public transport ridership, it is important to improve customer loyalty, satisfaction as well as the factors that impact on customer satisfaction, as these factors are known to impact on the ridership of the public transport. For this, a real-time GPS tracking app—UniBus, was invented and it is believed that the app can enhance all the factors, as mentioned above, evidenced by the past studies in the literature studied. One of the main objectives of this paper was to determine the difference that occurred on the perception of the variables, before and after the use of the UniBus app.

From the findings above, the perception of accessibility, reliability, comfort, safety and security, customer satisfaction, and customer loyalty were improved after the use of the real-time GPS tracking app. The finding of the current study is supported by the result found in a past study on the increase of the perception of accessibility [97]. This is due to the fact that the app has equipped the public transport users with all the accurate information regarding the public transport, can facilitate for the users the search of the nearby public transport. A recent study found that the most imperative feature

of the public transport app is the function of checking the public transport information such as routes and schedule [98]. While information needed to locate a public transport station and public transport schedule is handy, the accessibility of public transport will be enhanced as it is easy to be allocated by the users. Reliability has been enhanced as well, which is reinforced by past research [99]. The reason is that the real-time GPS tracking app provides real-time information on public transport as well as allows public transport users to estimate the time of arrival to avoid long waiting time and uncertainty on the arrival. Accurate time prediction can reduce the waiting time of the public transport users and they can better plan their trip and time as they can utilize the time that was allocated for waiting to other activities in the same time, while not missing the ride of public transport. Comfort is enhanced after the use of real-time GPS tracking app which is tallied with the suggestion of the previous study [100]. This is because the users can request the public transport, allowing public transport operator to make timely management on the flow of the crowd to avoid overly crowded public transport and ensuring enough seats. This can impact a lot on the comfort of the public transport users, as the space in public transportation and seats are available at any time when they are taking the ride, including peak hours. Safety and security are enhanced, which is supported by the previous researches as well [101,102]. The real-time GPS tracking app provides the real-time alert function to the public transport users as well as the management team. If there is an emergency or if an unexpected incident happens on the road, the bus driver can press on the emergency button to alert the management team for immediate actions which can enhance the safety and security of the public transport users. This function may provide the psychological feeling of security to the public transport users as well as the staffs, because the timely action can be taken whenever there is unexpected occasion by the management team. Satisfaction is found to be increased as well, which is supported by past studies [103]. With the real-time GPS tracking app, the public transport users feel that they are being served well, especially getting handy information regarding the public transportation schedule from the app allowed them to pre-plan their journey, equip a more secured, safer, and comfortable on-ride environment. The feature of the app is adequate in providing a great experience that exceeds the expectations of the users.

Surprisingly, there is no known research on customer loyalty enhanced by a real-time GPS tracking app of public transport. However, a past study confirmed that customer loyalty can be enhanced by a mobile app developed by a public transportation company [104]. Additionally, past research on public transportation suggested that the higher the satisfaction level of customer, the higher the loyalty [105]. In the current study, the result shows that customer loyalty was remarkably improved after the use of the real-time GPS tracking app in public transportation. This means that the public transport users are willing to repeat patronization to the same public transport company at the same cost after the use of the real-time GPS tracking app. Moreover, public transport users intend to recommend the company who provides the app to other people. Hence, the ridership of public transport will be improved through a higher level of customer satisfaction and loyalty [106–108]. The reason is that maybe the enhanced satisfaction level which is influenced by the factors of this research, is encouraging public transport users to recommend, and re-patronize the service over and over again.

6. Conclusions

The current study has provided empirical evidence on the concept of the real-time GPS tracking app enhancing on customer satisfaction and loyalty which will lead to the increase of public transportation ridership. The factors affecting customer loyalty have been put to the investigation as well. Hence, the variables including accessibility, reliability, comfort, safety and security, customer satisfaction, and customer loyalty have been compared on the before and after use of the real-time GPS tracking app. The results indicated that accessibility was enhanced after employing the real-time GPS tracking app. Reliability was improved after the use of the real-time GPS tracking app. Furthermore, comfort was enhanced through the use of the real-time GPS tracking app. Moreover, safety and security were boosted by the real-time GPS tracking app. Overall customer satisfaction had significant improvement too. Lastly, customer loyalty was enhanced by the real-time GPS tracking app which is a remarkable

finding of this study. All the studied variables turn out to be statistically significant as all the *p* values are lower than 0.01.

6.1. Theoretical and Practical Implication

The findings are valuable evidence for the scholars to perform further researches in the related field, especially the noteworthy finding on customer loyalty, which was found to be strengthened by the real-time GPS tracking app. Scholars may conduct more related researches concerning this finding.

This finding provides additional insight to the scholars who are conducting related researches, especially in the field of public transport user behavior study. Researchers can use the findings of the current study as a base to conduct more detailed researches. Especially the current study has included the determinants that will affect customer satisfaction and loyalty which can equip scholars with more in-depth information of every factor from this study on the effect of before and after the use of the real-time GPS tracking app. Furthermore, all the variables of this study (accessibility, reliability, comfort, safety and security, customer satisfaction, and customer loyalty) are affecting user behavior, thus, these variables could be the pertinent variables for examining public transportation user behaviors, especially before and after the use of the real-time GPS tracking app.

The finding of this study serves as a recommendation for industry players and policymakers in terms of providing more information for decision making. It is especially valuable for public transport operators in the decision making on the investment on a real-time GPS tracking app. This is because the decision-makers would like to know the user perceptions on the real-time GPS tracking app before investing in the app to ensure the effectiveness and the return of investment. It is important to consider the users' perception and behavior before embarking on the heavy investment of a real-time GPS tracking app.

Last, but not least, information and communication technology (ICT) providers can benefit from this study in terms of software, hardware, and business development. The ICT provider can use this study as a base to develop new softwares and hardwares that can further enhance the user experience. In addition, ICT providers can use this study as evidence to secure more businesses by providing similar services to public transport operators and also creating innovations in the field of public transportations.

6.2. Limitations of the Study and Recommendations for Future Research

Even though the objective of this study was accomplished, there are still limitations throughout the whole study. First of all, the factors examined in this study are limited. It is recommended to extend the study to other factors that affect satisfaction and loyalty, such as service quality, availability, perceived value, and so on, to have a broader prospect in this field. Due to the time constraints, the research site is limited to only Sarawak state. It is suggested to expand the research sites to other states in Malaysia. These may help to furnish more comprehensive data to decisions makers, scholars and policymakers by covering a broader perspective and perception of the public transport users from different places in Malaysia.

Appendix A

Table A1. Construct(s) and Measurement Item(s).

No	Dimension Factors
	Accessibility
ACE_1	It's easy to find bus stop or station.
ACE_2	Walking distance to bus stop or station is reasonable.
ACE_3	The bus densely spreads over the Kuching city.
ACE_4	The adequate bus service means that there are no hard-to reach areas within Kuching city.
ACE_5	The bus allows you to easily reach anywhere you need to go.
	Reliability
R_6	The bus you use is usually on time.
R_7	The waiting time for the arrival of the bus is short.
R_8	The bus you use leaves at the time according to the schedule.
R_9	The bus you use gets you to your destinations on schedule.
R_10	The bus you use is not overly crowded.
	Comfort
C_11	Bus stop or station is well maintained.
C_12	Clean environment on the bus.
C_13	Comfortable temperature on the bus.
C_14	Seats are available when riding.
C_15	The equipment in the bus satisfies passengers' needs.
	Safety/Security
SCT_16	Bus company provides safe and modern buses.
SCT_17	The bus is equipped with safety facilities.
SCT_18	The company handles emergency situation properly.
SCT_19	You feel safe while taking trips via the bus.
SCT_20	You feel safe from crime where you get on and off the bus.
	Customer Satisfaction
CSAT_21	The schedule and routes satisfy customers' needs.
CSAT_22	Customers are served well.
CSAT_23	The service is better than expected.
CSAT_24	I felt enjoyable to travel by this company's bus.
	Customer Loyalty
CL_25	You would probably ride the same bus again.
CL_26	You would probably ride the same bus with the same costs.
CL_27	It would be a hassle for you to get information about other bus companies.
CL_28	You would like to travel by this bus company again.
CL_29	You would like to recommend this bus company to others.

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