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Rides for Rewards (R4R): A Mobile Application to Sustain an Incentive Scheme for Public Bus Transport

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Abstract. Bus transit is not popular in Brunei partly due to high ownership of private cars and this will lead to severe traffic congestion in the future. This paper discusses the design of a mobile application to sustain an incentive scheme for public bus transportation in Brunei. It supports a case study on whether an incentive scheme has impact to increase bus transit ridership under the prevailing transport conditions. The application has a front-end mobile app to collect dates and time stamps of each ride and a back-end infrastructure to manage stakeholder details, incentive schemes, bus routes and a repository for travel time stamps.

Keywords: Public transportation, incentive scheme, bus system, bus ridership, BaaS, rides for rewards.

1 Introduction

Transportation is among the more vital economic activities to move goods and people on demand from source to destination. As population increases, the cost of transportation manifests itself in many forms such as higher costs of sustaining land use for transportation, and health, safety and environmental effects from pollution and traffic congestions. There is urgent need to strive for optimal use of land for roads and highways, to address traffic congestion and air pollution contributed mostly by petroleum powered vehicles. Hence, an efficient transportation system is critical to balance the needs of essential road users and the environmental impacts from transport.

The two main forms of transportation, private and public differ largely on their usage. Public transportation such as buses and trains generally convey a larger number of people and goods, and available for public use. Normally, it runs on fixed routes and charges set fares. Private transportation is on-demand and not available for public use. Public transportation such as buses and rapid transits are effective for their high capacity modes to move people and goods. Findings argue that effective mobility management resulting in high quality public transportation and transit oriented development reduces vehicle miles travel, thereby reduces pollution emissions and traffic congestion, resulting in better consumer savings and economic development [1]. Such

findings place emphasis for countries to develop effective public transportation strategies to encourage its citizens to peruse of public transportation. In Brunei, this emphasis has yet to be realised nor experienced by the populace due to the ease of owning private vehicles, generous fuel subsidies and relative small population, contributing to low ridership in public transportation. Such issues are highlighted in a white paper on the need to formulate a masterplan to sustain a land transportation system for the country [2]. The current low ridership is a concern. To alleviate this issue, a case study is conducted on whether an incentive scheme has impact to increase ridership under the prevailing bus transit conditions. This paper discusses the design of a mobile application to support the incentive scheme. The application has a front-end mobile app focusing on building the interfaces for the respective stakeholder roles and collects the dates and time stamps of rides, while the back-end supports the administration and database infrastructure.

The rest of the paper is organized into the following sections: Section 2 discusses the prevailing bus ridership problem; Section 3 discusses the background of incentive programs on public transit; Section 4 discusses our approach in designing and developing the R4R incentive application; Section 5 provides a critical discussion of the results of the pilot study; and the conclusion and further research are presented in Section 6.

2 Problem Statement

The current low ridership of the public bus transport is a concern and a reflection of the high ownership of private vehicles in Brunei. Results of the Transport Attitude Survey conducted by the Centre for Strategic and Policy Studies (CSPS) confirm high car dependency across the surveyed population and a large proportion of those who use the bus transport regularly have no access to cars [2]. It is evident that public transportation, particularly buses, is not effectively utilized by the local populace. Despite efforts by the Land Transport Department to improve the bus transport system such as enhancements in route maps, schedules and interior comfort [3], the number of bus riders remain low. Meanwhile ownership of private vehicles increased by 19% over two years (2011-2013) and the car ownership rate at 2.65 people per vehicle is high [4]. Clearly the enhancement efforts have not motivated more local populace to use the public bus transport. This may be due to the common attractions of private car, such as diverse activity locations, abundant parking lots and relative lower levels of traffic jams [5].

3 Related Literature

Incentive schemes have been applied on public transport to reduce commuter congestions at peak times or to encourage more commuters to switch from private to public travel mode. One such scheme is the Travel Smart Rewards (TSR) in Singapore. The TSR is introduced to optimize public transport capacity by reducing morning peak period congestion on the Mass Rapid Transit (MRT) or Light Rail Transit

(LRT) [6]. TSR uses the accumulation of points for cash rebates. Points are earned per trip on the MRT or LRT with the perk of extra points in the morning off-peak hours. Further motivation to induce off-peak riders is the use of "gamification" where riders login to play "Spin to Win" for more point accumulation or gain cash rebate. In 2014, the TSR extended to corporate-tier rewards to encourage companies to create supportive environments for flexi-travel for their employees, i.e. to be able to travel on public transport during off-peak periods [7]. TSR was launched in January 2012 and within two years of implementation, the results are encouraging. On average about 12% employees (pilot study of 12 companies) shifted out of the morning peak periods [8] and an estimated 7-8% decrease in commuters number in the morning peak periods since 2013 [9].

The INSTANT project is another example of a pilot program to use an incentive mechanism to decongest roads in Bangalore, India, by encouraging commuters to travel at less congested periods. The focus group is the employees of Infosys Technologies, Bangalore. Qualified commuters are awarded credits daily based on arrival times, and weekly, an algorithm is applied to qualify winning commuters for cash rewards. Winners are randomly selected based on different levels, and non-winners at higher levels qualify for lower levels. After the weekly draw, credit deduction is applied to all winners and non-winners. The credit deduction feature influences the behavior of commuters to arrive early to maintain credit balances for the weekly draws and previous winners would need a longer period to build up credit balances [10]. The project ran for a period of six months and recorded results over three time segments (before 8AM, 8-8.30AM, 8.30-9 AM). The results show that number of commuters in each segment has roughly doubled over the study period [10].

By contrast, our R4R incentive scheme approach focusses on increasing bus ridership overall rather than shifting commuter travel to off peak times. TSR and INSTANT incorporated "gamification" and employers participation to entice travel at less congested periods while R4R is based on specific routes of a bus company and a group of vendors to provide rewards points accumulated per ride, mainly due to the reasons that the Brunei bus transport system has not matured to an extent with convenient routes (bus on-off boarding is within walking distance) and ticketing is manual. Hence the R4R design would need to account for these issues. In addition, for the same public transport patronage scheme, outcomes are different in different countries [11]. This adds up to the novelty of the R4R scheme, introduced in this paper, since no similar schemes have ever been implemented in Brunei.

4 Methodology of the Rides for Rewards (R4R) Application

Fig. 1 shows the methodology applied to develop the R4R mobile application. It has five stages, namely pre-initiation survey, collect requirements, assess requirements, develop prototype and conduct a pilot study. The pre-initiation survey is a

pre-development stage conducted early to gauge the viability to develop the application.

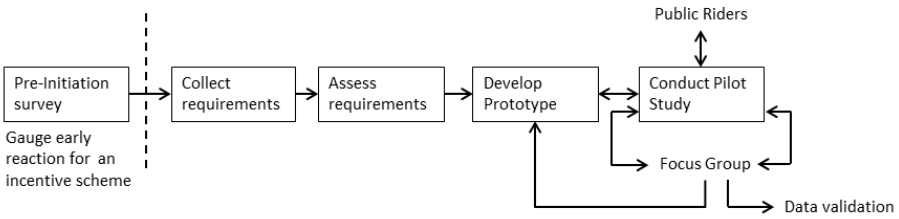

Fig.1. Methodology applied to develop the R4R application.

4.1 Pre-Initiation Survey

Prior to the development of the application, an initial survey is conducted to gauge early opinions on whether the surveyed group would switch to bus transport mode if a mobile based incentive scheme is in place and to get some insights on their preferences on type of rewards. The target group is students from the same university, the rationale being that university students are perceived to be low income earners, dependent on others for transportation and of an age where they are independent travelers. A total of 102 responses are received and 84% are students. While 59% has indicated that they would switch to bus transport if the incentive scheme is introduced, however, only about 21% rate that the scheme would be successful to increase bus ridership. In terms of preferences for rewards, the top three choices are free movie tickets (59%), food vouchers (51%) and entertainment discounts (48%). However, when the respondents are asked to list local businesses by name for rewards redemption, the top business choices are food and beverages related at about 33%. These results show some evidence that an incentive scheme would be supported and preferred rewards are geared towards food and beverages.

4.2 Collect Requirements

Collect requirements is in the form of a survey conducted over a period. A landing page (http://ride4rewards.tumblr.com/) is created to provide information on the R4R scheme and direct respondents to one of two surveys, based on age category: 15-29 years and over 30 years. Link to the survey is propagated on buses and social media. The objectives are to gain insights on the demographic details of bus commuters, frequencies of bus rides, further insights on inducements to convert non-commuters to commuters and the choice of mobile technology in common use. Table 1 is a summary of the responses.

A total of 226 responses were recorded, 191 responses from the 15-29 years category and 35 responses from the over 30 years. In the 15-19 years category, respondents are mostly predominantly students (87%) with 85% in low income level. The over 30 years category are mostly working in the public sector (66%) and 57% are in the considerable high income level. In frequency of using public bus, both categories

show similar results i.e. 63% have never taken the bus. This is reflected in their daily mode of travel of very high usage of private vehicles at 90-100%. There is some evidence that a bus ridership incentive scheme would encourage more riders in both categories; 51% from the 15-24 years and 29% in the over 30 indicated that they would take the bus with an incentive scheme in place. The surveyed results also show Android device is predominantly high for both categories at over 60%, though there is a relatively high percentage for IOS device at 30-37%.

Table 1. Summary of responses from the Collect Requirements stage

	Category: 15-29 years	Category: over 30 years
Number of responses	191	35
Demographics		
Age group	43% in the 20-24 age group	40% in the 30-34 age group
Nationality.	87% citizens; 8% permanent residents	91% citizens; 6% permanent residents
Occupation	4% government sector; 87% students	66% government sector; 2% students
Average monthly income	85% in the $0-$499 range	57% in the above $3000 range
Bus ridership		
Permission to ride bus	61% have parents who allow them to use the bus on their own	63% would allow their young children, 15 years and above, to ride the bus on their own
Frequency of rides	63% have never used the bus; 3% use the bus daily	63% have never used the bus; 3% use bus at least monthly
Incentives		
R4R incentive scheme (claim travel behavior)	51% stated R4R will encourage them to ride the bus	29% stated R4R will encourage them to ride the bus
Rewards	15% towards free bus rides; 26% towards gadgets, clothes and food/beverage vouchers	26% towards free bus rides; 20% towards gadgets, clothes and food/beverage vouchers
Others		
Mobile technology	66% used Android phones; 30% used iPhone	63% used Android phones;37% used iPhone
Daily transport mode	90% private vehicle; others 10%	100% private vehicle

4.3 Assess Requirements

The findings of the Collect Requirements stage are used to identify which stakeholders to connect with, in terms of relevant bus routes and businesses providing the rewards. The findings will also influence the development technology for the mobile application. From the responses, the mobile application can expect better support from students and youths in the age group 15-29 years, with low income level. Hence bus routes selected for the study are more relevant to this group. Brunei has only six

private bus companies and each company is allowed to operate specific routes. Amongst the six companies, only one company (PHLS Sdn. Bhd.) agreed to participate on six of their routes. These routes cover some of the areas highlighted in the survey as relevant to this group, such as places of worship, shopping malls and youth centers. Similarly, the vendors supplying the rewards are selected based on the preferred choices of rewards identified from the survey. Hence, the six businesses participating in the scheme include apparel, restaurant franchises and companies promoting activities which appeal to youths such as a fitness center. Finally, the predominant mobile technology is identified as Android based (66%) though the IOS based devices are relatively high at 30%. Therefore the mobile application was developed on Android. IOS based devices will access the scheme via Web app.

Though the assessment is focused on the youths, comments from the over 30-years category should be noted, that an incentive scheme would have minimal success without taking into account factors such as high ownership of private vehicles, generous fuel subsidies and sufficient number of bus stops within walking distance for commuters.

4.4 Develop Prototype: R4R Mobile Application

Developing the prototype takes into consideration the needs of the main stakeholders and the potential that the R4R incentive scheme can evolve into a business platform to sustain the public transportation industry in Brunei.

Description of the R4R Ecosystem

R4R is designed to support an incentives-based ecosystem comprising several stakeholders: bus riders, bus companies, vendors providing the rewards and administrator. Fig.2 shows a high level use case diagram of the main actors i.e. stakeholders. The main role of the bus rider is to earn points and redeem points for rewards. Points are earned per bus ride, by referral and a once-off for registration. During the study period, riders are issued special R4R tickets with unique codes which can be scanned to earn points using the mobile application. After accumulation of sufficient points, riders select respective rewards to redeem. Once they claimed a reward, a unique code is issued. This code will enable the rider to use the reward at the respective vendor's business place by simply showing the code. The role of the vendors is to supply details of the rewards and to verify the rewards claim upon presentation of the code by the rider. For the bus companies, their role is to supply details of the bus routes and to issue the special R4R tickets to the riders. The administrator's role is to manage the platform for the R4R ecosystem. This includes managing all components relating to riders, vendors, bus companies, the rewards system, the code system and in addition, the R4R platform itself.

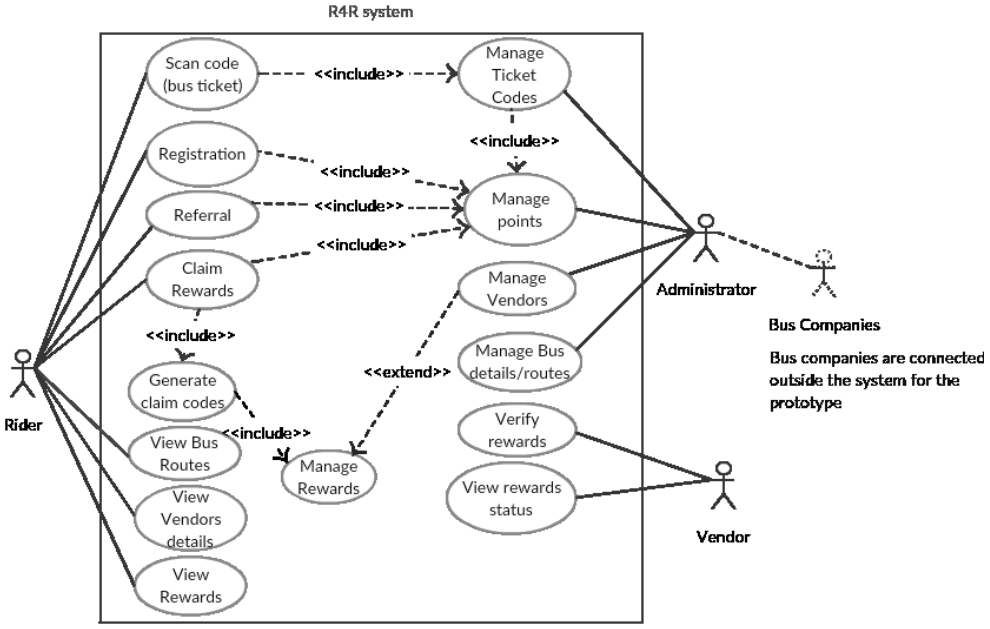

Fig.2. Use case diagram for the main actors of the R4R system.

For the prototype, management of the ecosystem is highly dependent on the administrator. If the R4R ecosystem goes "live" and operates as a business entity, it is to be expected that some of the other actors (stakeholders) will assume better control of their respective functionality. For example, vendors should have autonomous control to initiate their own rewards and bus companies would directly update their route information.

Architecture Overview of R4R

The architecture overview for the R4R application is based on a Backend as a Service (BaaS) approach to connect the front-end mobile app to the backend resources in the cloud using unified application programming interfaces (APIs) and software developer's kits (SDKs).

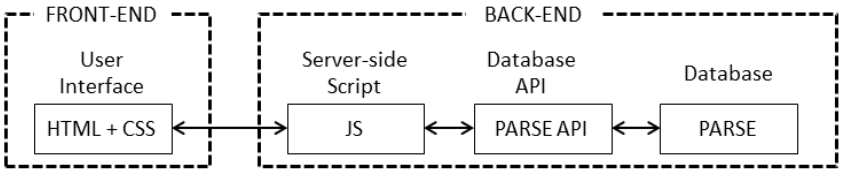

Fig.3. Architecture overview of the R4R system.

The front-end R4R mobile app is designed using Intel XDK software [12]. It is created as a hybrid app of web and native technologies using HTML5 technologies,

integrated with Cordova plugin which enable the app to access the device's native features such as camera and GPS. Pure JavaScript is used to communicate data between the client (app) and the server. Parse is used for the back-end comprising the Parse server and online database [13]. Parse has its own API to communicate with the database using JavaScript, Java or Objective-C. This is an advantage as it provides a unified interface between HTML5 and the back-end technology. Hence developers need not switch between different programming languages during development and can focus more on the front-end app development.

Features of the R4R Mobile App

The R4R mobile app prototype is focused on two actors, Riders and Vendors. Hence the app features two different login modes, Rider login and Vendor login. Riders have access to four main features: Rewards, Scan for points, Feedback, and Profile. Rewards feature lists available rewards that can be redeemed with the required number of points. Scan for Points feature allows riders to earn points by scanning the QR code on the special R4R bus ticket or by manually keying in the code found below the QR code. Fig. 4 shows the process of how Riders earn points and redeem rewards. Feedback feature is a form whereby riders' feedback is captured live on the Parse database. The Profile feature is where Riders edit account details. In addition, Profile comes with additional views: "MyRewards", "MyTasks", "Sponsor Profiles" "Bus Routes" and "About". All these views basically list the information relevant to the Rider and inform various statuses of their points and rewards.

Vendors have access to two features, view the status of their rewards offered and use the Scan Code feature to scan codes from Riders claiming their rewards. Administrator oversees the R4R platform i.e. manages the technical operations of the platform as well as the business process(es). For example, a business process is capturing sponsor and reward details on the system, after negotiating and agreed upon on the terms with vendors. "Bus Companies" is currently an actor that does not interact direct with the R4R system. They feed details of the bus routes manually to the Administrator for input into the system.

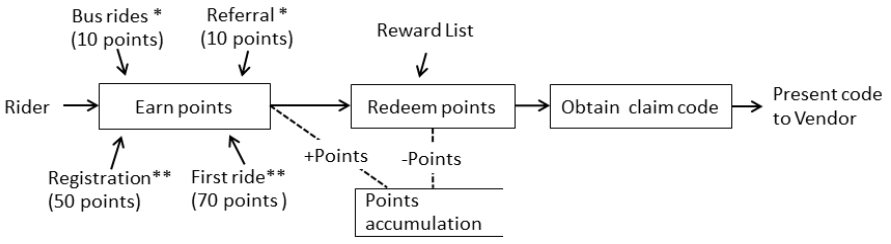

Fig.4. Process to earn and redeem points for reward;
*Points earned each time; **Points earned once-off

R4R Mobile App User Interface (UI) Design

The overall UI is designed for familiarity in user experience. Hence the design is influenced by minimalistic art movement for simplicity and to reduce graphic noise. Button and input boxes are designed with rounded edges to soften the look. Icons are designed for familiarity to engage riders (users). Serif font is chosen as it is web-browser friendly. "Roboto Slab" font is selected for highlights as it gives off a semi-formal look and its thickness is ideal for legibility against the Serif font. Finally the main color scheme is "teal/green" to reflect the sustainability nature of the study and because "Green" colour has a feel of nature, balance and harmony. Fig. 5 shows the UI design for the app and the theme is consistently applied throughout.

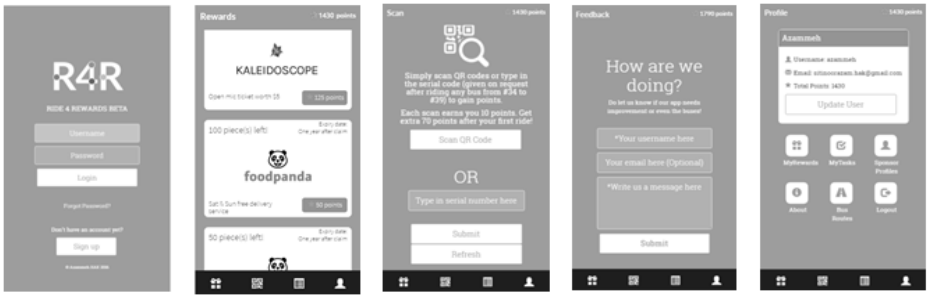

Fig.5.User Interface (UI) for the R4R mobile app. (1) Login page (2) List of available rewards (3) Scan QR code on R4R bus ticket (4) Riders' feedback (5) Riders' profile page. Noted the picture is shown in shades of grey while the actual colour presentation is in shades of "teal/green".

4.5 Conduct Pilot Study

A pilot study is conducted to test the prototype on the field and to observe claimed and actual travel behaviour during the trial period. The trial period is three weeks. The participants are one bus company with six routes (Routes 34-39), six vendors sponsoring the rewards and riders and bus Riders. The Riders also include a focus group of seventeen survey respondents randomly selected. The focus group will test and provide technical feedback of the R4R app and participate in the data validation where the main purpose is to observe the claimed and actual travel behaviour with the R4R incentive scheme during the trial period. Public riders were informed of the study and where to access the app through posters on the buses and ticket conductors. The Android version is downloadable from Google Play [14]. The web app version is downloadable via a URL link [15]. Riders who participate in the R4R pilot study are required to request for QR codes from the conductor. One QR code would be issued per ride. The codes are scanned via the mobile app to earn ten points. The point system was designed in such a way that riders would earn points not only by riding the bus but also by completing other tasks such as referrals of the mobile app. During the trial period, riders are rewarded generously to encourage them to take the first step towards sustainable travel behaviour as shown in Fig 6.

	Register	First ride	Refer a friend	Total
Points	50	70	10	130

Fig.6. R4R pilot study bonus points

Technical bugs with the application as reported by the focus group were resolved with relative ease within the study period, though non-technical issues were not resolved, such as some buses being unable to distribute the codes as they were not adequately briefed about the trial study.

5 Results

Survey results from the pre-initiation stage show some evidence that commuters will switch to taking bus transport with an incentive scheme, as claimed in 59% of the respondents, who are mainly tertiary level students. The basis of this percentage justify developing the R4R mobile application to support the pilot study. The follow-up survey from the Collect Requirements stage is targeted for two age groups 15-29 and over 30. Results show that the highest percentage of feedback comes from the age group 20-24, of which 87% are students (Table 1). This is expected as the incentive scheme would appeal more to those who are low income owners and are dependent on others for transport. This age group is also tech-savvy according to Socialbakers which stated a majority of Facebook users in Brunei are 18-24 (33% population) [16]. Not surprisingly, the survey shows 96% in this age group own a mobile smart device (Table 1). This is crucial as the R4R incentive scheme is developed for mobility.

Findings from both surveys influenced the development of the R4R system as a platform as well as the user interface design of the R4R mobile app. The platform has to support a mobile solution where commuters can do live updates to earn and redeem points and vendors are able to do live validation of claim codes. The mobile app is both Android and web based for broad coverage. The R4R platform and mobile app went live during the pilot study stage. The process flow of earning, redeeming and claiming points (Fig.4) using the R4R system was successfully demonstrated. The results of the study period showed that R4R gained thirty two registered users and eleven riders successfully earn points by scanning or keying codes from bus tickets. The highest point earner from one rider is 140 points. A total of 10 reward vouchers were claimed by the riders.

In the pilot study stage, the focus group of 17 participants are sorted into two groups where 9 of 17 answered ‘Yes’ to taking the public bus with R4R incentive scheme, meanwhile 8 out of 17 answered ‘No’ to taking the bus with R4R incentive scheme. The number of participants in each group is decided in such a way to replicate similar claimed behaviour percentage (Table 1) from the survey conducted at the Collect Requirement stage. In the first week, none of the participants took the public bus. In the final week, only 4 out of 9 participants who claimed that they will take the public bus with R4R incentive scheme actually took the public bus, the other 5 did not. For the 8 participants who claimed that they will not take the public bus with R4R incentive scheme, 6 performed as claimed while 2 shifted their behaviour and

took the bus. Based on this, 35% of the participants took the public bus with R4R incentive scheme and 65% did not. A discrepancy can be observed between the participants' claimed behaviour from the survey responses (51%) and the actual behaviour (35%) from the pilot study. This is as expected it takes time to change habits or behaviours [17].

6 Conclusions and Future Work

There are technical and business aspects to sustaining the R4R incentive scheme for public bus transport. The technical aspects involve the development of the front-end mobile app and the back-end cloud infrastructure. This led to the implementation of the R4R mobile and web apps accessible on Google Play and URL respectively, while the R4R cloud is on a BaaS service provider (Parse). The business aspect of R4R includes integrating all the services of the vendors (rewards sponsors) and the bus companies with the back-end to serve the riders.

The R4R technical platform has demonstrated its workability to capture data especially ride information details and emulated the process of earning, redeeming and claiming rewards. This technical platform has potential to be evolved into a business to support not only bus transport but other forms of public transports. The business aspect of the R4R scheme would have to encompass the main stakeholder, riders, vendors, bus companies and the business itself. To be a viable business, the technical platform has to be further developed to include features to let vendors and transport companies do live updates and provide advertisement space. It would also need to go beyond the current basic gamification features to better engage riders. Furthermore, as data accumulate, there is potential to include analytics clients to explore data.

At the conclusion of the study, it is not possible to determine if the R4R scheme was able to increase bus ridership based on current conditions. This is due to several factors such as: the study period of three weeks being too short to get realistic data, insufficient bus operators are participating and therefore there are insufficient bus routes to simulate normal travel conditions, insufficient propaganda on the scheme hence attracting minimal riders. However, the focus group results (35%) show some evidence that riders will actually take the bus with an incentive program in place. This is a good indication to further the research of the R4R scheme to better understand its viability as an incentive mechanism and a sustainable business to address the low ridership issue.

It should be noted that the CSPS whitepaper has discussed that the main issue which causes low ridership in bus transport is poor quality of the bus transport system in terms of conditions of buses and bus terminals, connectivity to places, overall journey speed and high ownership of private vehicle [2]. Collaborative efforts with several organisations such as the Land Transport Department, policy makers and bus operators are necessary to manage this issue. The R4R platform aspires to be the catalyst to initiate such organisations to start prioritising improvement of the public bus transport system to address the low ridership issue.

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