Proceedings of the Eastern Asia Society for Transportation Studies, Vol.12,2019

Factors Affecting on Implementation of Bicycle Sharing System in Major City Areas in Sri Lanka

Tharuka KARUNARATHNE[a *], Amila SANDARUWAN[b], Jayalath EDIRISINGHE[c], Vasantha WICKRAMASINGHE[d]

[a,b,c,d] *Faculty of Engineering, University of Peradeniya, Sri Lanka*
[a] *E-mail: tharukaakarunarathna@gmail.com*
[b] *E-mail: amilakanchana65@gmail.com*
[c]*E-mail: jayalath@eng.pdn.ac.lk*
[d]*E-mail: vskw@pdn.ac.lk*

Abstract: Urban cities in developing countries like Sri Lanka face major problems due to rapidly increasing travel demand day by day. Due to the poor quality of public transport systems and the first and last-mile problem people are left with no choice other than using private vehicles. This generates the vital burden of insufficient parking spaces in the cities. Therefore many countries around the world are using alternative travel modes such as cycling. Bike Sharing Systems (BSS) are becoming increasingly popular in cities around the world because they are cheap, efficient, healthy, and green. Since this is a new concept to Sri Lanka, it is a must to determine the public opinion on implementing bicycle sharing in cities. Therefore this paper aims on determining the factors affecting on implementing the BSS and analysis of public opinion on using BSS in major cities in Sri Lanka.

Keywords: Bicycle sharing system (BSS), Sri Lanka, Public opinion

1. INTRODUCTION

Urban cities in developing countries face major problems due to various issues in public transport systems including comfort, safety and inadequate supply upon increasing demand. The population growth, high income, rapid growth of cities and the urbanization has led increase in travel demand (Almselati *et. al*, 2011). Furthermore, people who use public transport systems face the problem of poor first and last mile connection (Shaheen, 2010). Therefore many people are left with no option than using private vehicles. Because of this, private motorized vehicles have taken an important place in the economy and day-to-day life style of people in Sri Lanka. Every household in the society using their private vehicles has now become a major concern due to the heavy traffic congestion in urban area. This problem has become worse due to the lack of parking spaces within the city limits.

It is a well-established fact that Sri Lankan public transport system is the most used method of transportation for many years by the general public. The percentage of users of public transportation marks up to 68% of the population in Sri Lanka (Kanishka *et. al*, 2015). However, due to the poor quality of service in public transport system in Sri Lanka, people have a more tendency to use their own vehicles to travel to the main cities.

The best solution for controlling traffic congestion in urban areas is to reduce the number of vehicles entering in to the cities in an efficient method. Use of bicycles within major city areas is therefore one of the most successful methods that is being used in several

[*] Corresponding author.

countries around the world. This solution addresses the issues in parking limitation hence the need to find parking spaces can also be eliminated.

2. LITERATURE REVIEW

Bicycle Sharing Systems (BSS) also called as “Public-Use Bicycles” (PUBs), “Bicycle Transit” or “Smart Bikes” are ideal for short distance point-to-point trips providing users the ability to pick up a bicycle at any self-serve sharing point and return it to any other point located within the system service area (Zhang et. al, 2015). Bicycle Sharing Systems are convenient in short distance travelling within highly congested areas or in traffic restricted areas such as universities, parks etc. Also cycles are cheap and it is a green form of transportation. Furthermore flexible mobility, emission reductions, increased physical activity, reduced congestion and fuel use, minimum requirement for parking, individual financial savings and support for multi-modal transport connections are some more benefits that can be achieved by implementing a cycle sharing system (Shaheen *et. al*, 2010). Therefore bike-sharing has gained global attention in recent years with the aims of increasing cycle usage, improving the first or last mile connection and alleviating the environmental impact.

2.1 History of Bicycle Sharing Systems

The earliest well-known community bicycle program was started in the summer of 1965 in, Amsterdam with fifty white painted bicycles and the bicycles were placed unlocked in Amsterdam for everyone to use freely. However the free service was not successful due to the anonymous customers and within few weeks most of the bikes had been stolen (Shaheen *et. al*, 2011). As a remedy to this concern next attempt was providing the service for registered users using smart technology. For a small fee, users were issued 'smart cards' with magnetic stripes to be swiped through an electronic card reader at a bike deck, unlocking the bike from its storage rack. This system allows the user to take a bike from one rack and return it in any other bicycle rack. Figure 1 shows a bike rack in Melbourne city.

Figure 1: Bike sharing system in Melbourne Australia

Other than this system there are dockless bikes also known as free floating bikes. The dockless bike hire systems consist of a bicycle with a lock that is usually integrated onto the frame and does not require a docking station.

Midgley (2011) states that over the past two decades, bicycle-sharing schemes have developed from being interesting experiments in urban mobility to mainstream public transport options in cities as large and complex as Paris and London. Today there are an estimated 375 bicycle sharing schemes operating in 33 countries in almost every region of the world using around 236,000 bicycles. Figure 2 illustrates the rate of growth in bicycle sharing schemes and fleets and the increase has been very rapid since 2008. As can be seen in Figure 3, bicycle sharing schemes were expanding in Italy and Spain (more rapidly than in France) and this growth has been principally in medium- to small-sized towns with systems of 50 bicycles or so. Therefore, not only are bicycle sharing schemes attractive, it would appear that they are also highly adaptable to different types of cities and city sizes.

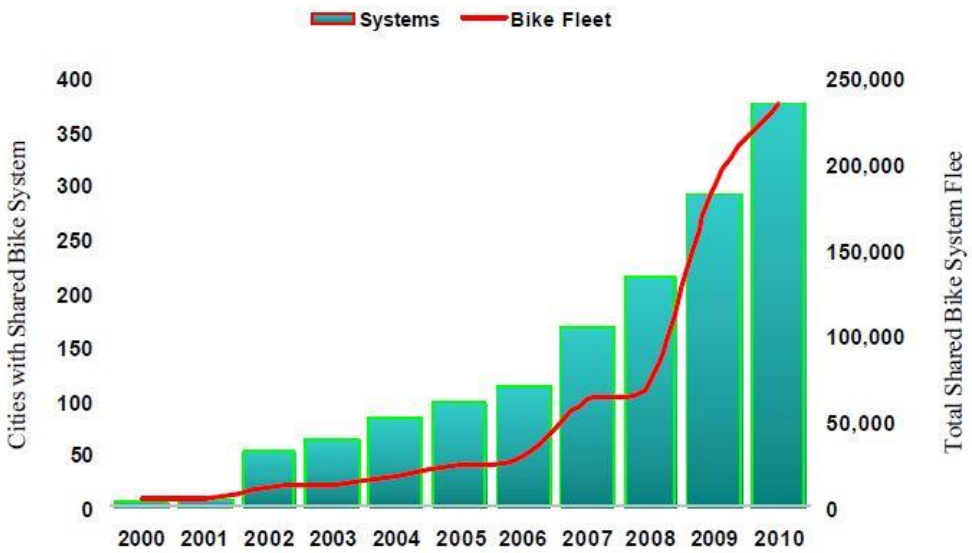

Figure 2: Growth in bicycle sharing schemes and fleet 2000-2010

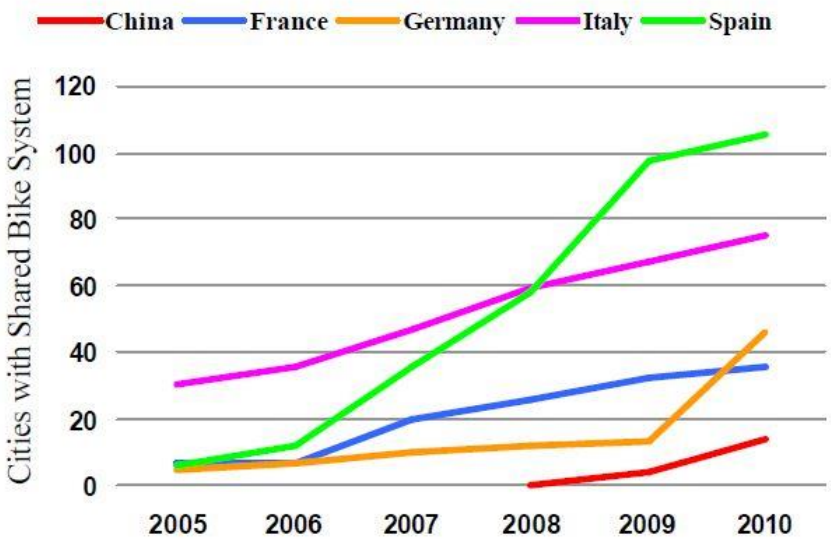

Figure 3: Growth in bicycle sharing schemes in selected countries 2005 -2010

Since 2008 and within Europe, bicycle-sharing has expanded to the Czech Republic, Ireland, Latvia, Monaco, Poland, Romania and Switzerland (with a new system about to open in Hungary). There has been a remarkable growth in Spain where the number of systems has

almost doubled from 58 to 97 between 2008 and 2009, enabling Spain to claim to be the country with the most systems in the world (with currently 105 systems or 28 per cent of global systems). Outside Europe, systems are now operating in Australia, Canada, Japan, New Zealand and Republic of Korea, and for the first time in developing countries - Brazil, Chile, China, India, Islamic Republic of Iran and Mexico (Midgley 2011).

2.2 Factors Affecting on New Implementation of BSS in Sri Lanka

Since this is a new project to be implemented in Sri Lanka, there may be several considerations such as cost, safety of the users, topography and climate. So the first step is to determine those factors affecting the system and evaluating the public opinion on implementing of BSS in major cities in Sri Lanka. The major factors that should be considered are discussed below.

2.2.1 Aim of implementing the BSS

The main aim is to expand and integrate cycling into transportation systems, so that it can more readily become a daily transportation mode (Shaheen, 2010). Other than this it is also seen as a method to promote the viability of public transport by providing an "extension service" for the "first/ last mile" - the distance which many consider to be too far to walk between home and public transport and/or public transport and the workplace (Shaheen, 2010). Figure 4 shows that the cycling distances generally fall within the 1km to 5km range.

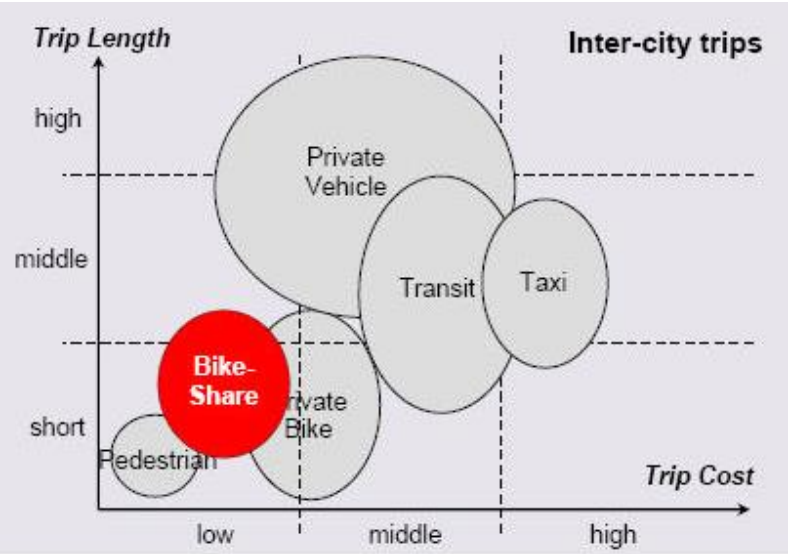

Figure 4: Variation of cycling distance with distance and cost

2.2.2 Topography and climate

Midgley, (2011) stated that cyclists generally dislike going up inclines of more than 4 per cent and avoid inclines greater than 8 per cent. In cities with slopes under 4 per cent, topography is not a limiting factor.

Climate also can affect the mode choice due to hot climate conditions in countries like Sri Lanka. Therefore cyclists tend not to choose riding bicycles for larger distances. So the user opinion on this should be determined.

2.2.3 Bicycle priority and safety

For bicycle-sharing to function effectively, cyclists must be able to move around the city easily and safely. A network of bicycle lanes and dedicated bicycle paths, although not absolutely essential, is clearly an asset (Midgley, 2011). Also, most of the BSSs in the world provide safety helmets.

Other than these given major considerations, ability to ride a bike, age and health condition, social status of a person, public opinion and several other factors should be considered. Therefore a questionnaire survey was carried out to find the effect of those factors on new implementation of BSS.

3. METHODOLOGY

A questionnaire survey was carried out via Google forms and printed questionnaire papers to determine the public opinion and the suggestions to implement and improve the Bicycle Sharing System in major cities in Sri Lanka. Google form was sent to more than 1000 people and 220 responses were received and were used to data analysis. The questionnaire basically aimed to obtain the public opinion on using cycles to replace private vehicles to reduce the traffic congestion in major cities.

The questionnaire contained a brief introduction of BSS since it is a new concept to Sri Lanka. Also the questions were categorized into four sections, personal information, daily travel requirements, opinion on using BSS, and suggestions. The Google forms were sent to local as well as foreign people who have been lived in Sri Lanka and have experienced the service provided by BSSs in other countries.

Personal information section collected data of age, gender, educational background and the profession of the respondent.

The second section collected data on daily travel requirements of the respondents' such as travel frequency, travel distance and the distance they have to walk daily, current travelling mode, parking availability, and preference on riding bicycles.

The third section collected the data on preferences of the respondents' of riding bicycle in city area and the reasons, ability of riding bicycles, opinion on the new system, and preference and ability of using smart technology for BSS.

Final section collected the suggestions of respondents' to improve the system.

The data were collected from 220 responses received for data analyses. Data was analyzed using statistical analysis methods and pivot tables in MS excel software.

4. DATA ANALYSIS AND DISCUSSION

4.1 Personal Information of Respondents

Table 1 shows the personal information of respondents. Data shows that the percentage of male respondents was 62% and percentage of female respondents was 38%. Results show that the average age for the respondents is 27 years for the sample having a minimum of 21 and a maximum of 61 years. It can be observed that the most interested age range for this project is 25 – 27 years. Figure 5 shows the variation of age with the gender of the respondents. The results show that 75% of the respondents were graduated or tertiary educated and 56% of the respondents are employed in private sector companies and 23% are government employed.

Table 1: Personal information of respondents

Parameters	**Frequency (%)**
Gender	
Female	37.9
Male	62.1
Age (years)	
21	0.9
22	0.5
23	2.3
24	3.7
25	28.5
26	24.3
27	20.1
28	8.4
29	3.7
30	2.3
31-40	1.4
40-50	2.3
>50	1.4
Education background	
Graduated / tertiary	75.5
Postgraduate	15.1
Undergraduate	3.8
Up to A/L	5.7
Profession	
Government employed	23.3
Private sector	56.2
Retired	0.5
Self employed	1.4
Unemployed	18.6

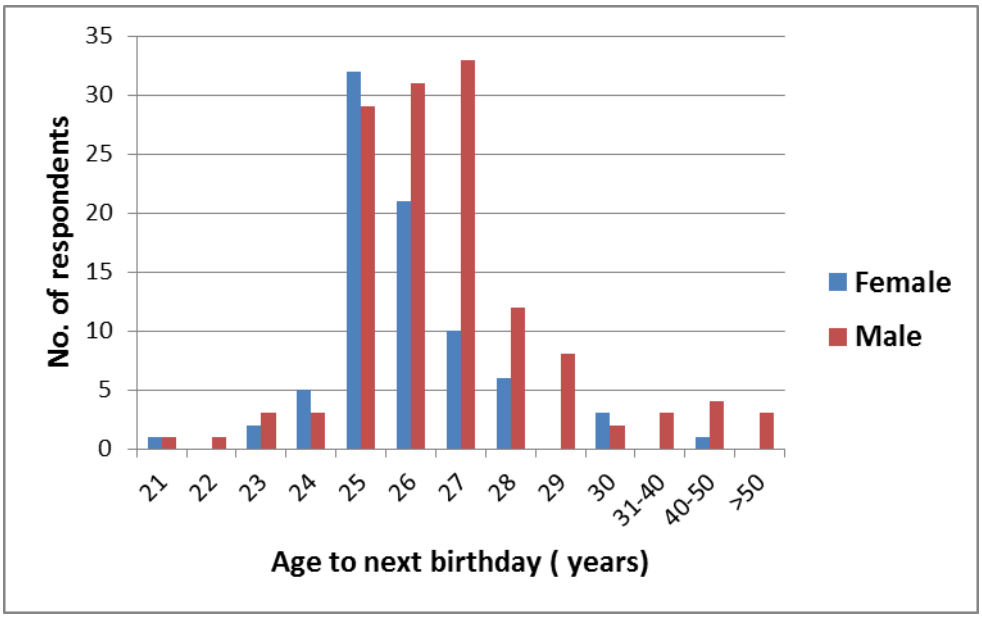

Figure 5: Age and gender distribution of respondents

4.2 Travel Requirements

Table 5 shows the travel frequency for each travel mode use by the respondents to their daily travel.

Table 2: Travel frequency in each travel modes

Travel mode	Daily	Frequently	Rarely	Total
Bus	60	35	8	103
Company vehicle	9	3	1	13
Government vehicle	2	2	1	5
My own Motor bike	18	11	2	31
My own vehicle - Car/van/jeep	19	12		31
three wheeler	1	1		2
Train	17	0		17
Walking	8	3	1	12
Total	134	67	13	214

It shows that more than 60% of the respondents travel to the main city area daily. The majority of the respondents' daily travel mode was obtained to be bus. Therefore the "first/ last mile" travel can be identified as a major concern for them.

Table 3 shows the average travel distance in each travel mode. It shows that when the travel distance is less than 15 km people tend to use bus and private vehicles or company vehicles. For distance more than 30 km, they tend to choose train as their daily travel mode.

Table 3: Variation of travel mode with the average travel distance

Travel Mode	Average travel distance (km)
Walking	0.04
Bus	4.4
Company vehicle	10.0
Government vehicle	11.0
My own Motor bike	15.0
My own vehicle - Car/van/jeep	20.8
three wheeler	25.0
Train	30.1

Table 4 shows the parking availability at the destination for the respondents who use private vehicles.

Table 4: Parking availability of respondents at their destination

Parking Availability	No. of respondents
Yes	68
No	104

Sixty percent of the responses show that unavailability of parking spaces near their destination. So they also face the problem of “first/ last mile” travel.

4.3 Respondents’ Preferences

As a remedy to “first/ last mile” travel issue, providing safe parking places away from the city center and providing cycle sharing was suggested. Also for people who commute by bus or train, providing cycle sharing from bus/train station was suggested.

Figure 6 and the table 5 illustrate the preference of respondents on parking private vehicles away from the city area if secured parking area is given. Sixty five percent of the respondents prefer parking in a separate parking area and use BSS to travel to the city area.

Table 5: Preference in parking private vehicles away from work places

	Yes	Maybe	No	Total
My own Motor bike	18	6	7	31
My own vehicle - Car/van/jeep	22	5	4	31
Total	40	11	11	62

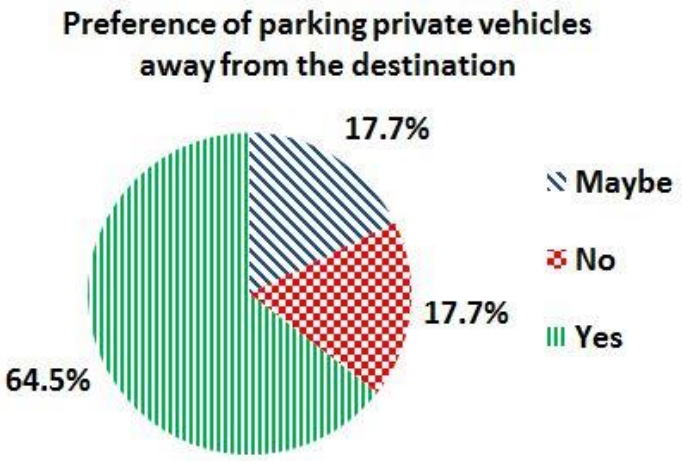

Figure 6: Preference in parking private vehicles away from work places

Figure 7 illustrates the preference on riding cycles from bus/train stations to work places. Fifty three percent of the respondents prefer using BSS to travel to the city area from bus/train station without using three wheelers.

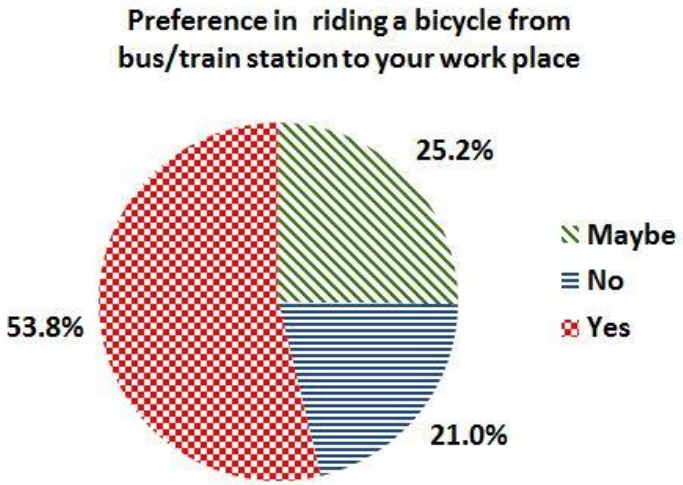

Figure 7: Preference on riding cycles from bus/train stations to work places

Table 6 shows the preference in riding cycles within city area. It shows that 58% of the respondents prefer riding cycles. Table 7 shows the variation of preference of riding bicycles with gender, educational background and the profession.

Table 6: Preference in riding cycles within city area than other modes

Preference in riding cycles in town area	No. of respondents
Maybe	48
No	42
Yes	125

Table 7: Variation of preference in riding bicycles

Parameter	Frequencies (%)		
	Yes	May be	No
Gender			
Female	50.6	22.8	26.6
Male	48.9	26.7	24.4
Educational Background			
Graduated / tertiary	51.9	25.6	22.4
Postgraduate	50	21.9	28.1
Undergraduate	50	25	25
Up to A/L	8.3	33.3	58.3
Profession			
Government employed	52.1	20.8	27.1
Private sector	50	24.1	25.9

It can be observed that the preference of riding bicycles does not vary with the gender. 50% of females and 49% of males responded that they prefer cycling. When consider the educational background, it can be identified that more than 50% of responded who have been graduated or tertiary educated, postgraduates and undergraduates are willing to ride bicycles. However 58% of respondents having educational qualifications up-to A/L examinations responded that they do no prefer cycling. Furthermore, more than 50% of both government employed and private sector employed respondents responded that they prefer riding cycles within the city.

The figure 8 and table 8 illustrate the variation of the ability of riding bicycles with the gender. It shows that 99% percent males are able to ride bicycles while only 74% of females are able to ride cycles.

Table 8: Ability of riding a cycle

	Ability of cycling		
Gender	No	Yes	Total
Female	21	59	80
Male	1	132	133

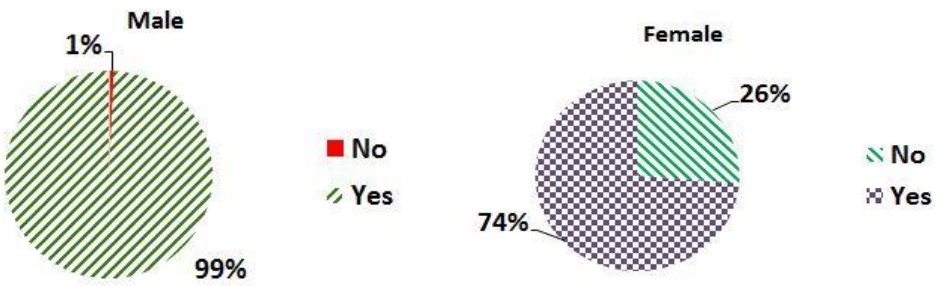

Figure 8: ability of riding a cycle

Implementing a successful new BSS is a challenge when considering safe returning of cycles. Therefore it was suggested to introduce a smart option based on mobile application to the user. Since the majority of the people in the society are now using smart mobile phones,

the respondents were asked whether they are familiar of mobile apps and whether they prefer using an app to unlock cycles from cycle racks and to return them back. The results are given in Figure 9 and in table 9 below.

Table 9: Preference in using a mobile app to use the BSS

Familiarity to mobile apps	Preference in using an mobile app to use the BSS			
	Yes	Maybe	No	Total
No	1			1
Yes	168	30	14	212
Total	169	30	14	213

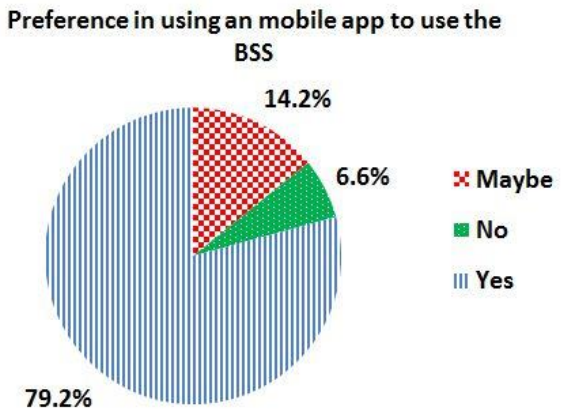

Figure 9: Preference in using a mobile app to use the BSS

4.4 Opinions and Suggestions

Final section of the questionnaire collected the opinion of respondents' on advantages and disadvantages of the system, reasons for their preferences and suggestions of respondents' for successful implementation of the system. The opinions are categorized below. Results show that 58% of the respondents prefer riding cycle within the city area and 19% did not show any preference in cycling. Also 23% of them were not sure of whether they like it or not. Therefore it is important to determine the positive and negative opinions.

4.4.1 User opinion on advantages of the system

According to the respondents' opinions, the advantages of implementing BSS in major cities in Sri Lanka can be identified as the possibility of reaching most of the places rather than driving a motor vehicle, good for health because of the exercise, eco-friendly and less environmental pollution, relaxing and fun, less space will be needed for parking, can save time waiting in heavy traffic congestion, and the low cost.

4.4.2 User opinion on disadvantages of the system

The collected responses show that 42% of the respondents are not ready to accept the implementation of the BSS since, there is not safe and separated cycling lanes, there is not safe parking areas to park private vehicles, climate in Sri Lanka is not favourable for cycling

in daytime, it is not favourable for cities having hilly terrain roads, and it is not safe for cycling at night time.

4.4.3 User suggestions

Suggestions for successful implementation was collected from the respondents and they are, providing separate cycling lanes and safety helmets, maintaining cycle docks frequently, carrying out awareness programs for general public, providing the service at early morning and at evening when the public bus services are poor, and introducing a user friendly mobile application.

5. CONCLUSIONS

For a group of respondents of 62% of males and 38% of females, the average age is 27 years, with 75% is graduated or tertiary educated, 56% is employed in private sector and 23% is employed in government sector, 48% use bus and 30% use private vehicles as the daily travel mode, 63% travels daily into the city, it can be obtained that;

When the average travel distance is 0.04km, they chose to walk and when it is in the range of 4 – 20km, they tend to travel by bus, private vehicles or by company vehicles into the city. When the travel distance is more than 30km they choose to travel by train. Therefore people who travel by public transport methods face the “first/last mile” travel issue. Respondents, who use their own vehicles, responded that 60% of them do not have parking places in their destination.

Furthermore, the responses show that 65% of the private vehicle owners are willing to park their vehicle away from the city and use cycle sharing to reach their destinations. Also, 54% of respondents who travel by bus or train prefer using cycle sharing system to travel the “first/last mile”.

Also the preference of riding bicycles does not vary with the gender. 50% of females and 49% of males prefer cycling. More than 50% of responded who have been graduated or tertiary educated are willing to ride bicycles in city areas. Fifty percent of postgraduates and undergraduates also prefer cycling within city areas. However 58% of respondents having educational qualifications up-to A/L examinations responded that they do no prefer cycling. Therefore it can be identified that preference is dependent on the educational level. Furthermore, more than 50% of both government employed and private sector employed respondents responded that they prefer riding cycles within the city.

It also shows that 79% of the respondents are willing to use a smart mobile app to release cycles from docks and to return them safely.

REFERENCES

Chardon C.M., Caruso G., Thomas I., (2016), Bicycle sharing system ‘success’ determinants. Journal of Transportation Research Part A 100, (2017) pages 202–214.

Kanishka D.M.W., Rambukewella K.U.K.. Djoen San Santoso (2015), Customer satisfaction analysis of luxury long distance bus service in Sri Lanka. Journal of Eastern Asia Society for Transportation Studies, Vol. 11, 2015. Pages 1272-1290

Kumarage A. S., Bandara M., Munasinghe D., (2010), *Analysis of the economic and social parameters of the Three-Wheeler Taxi service in Sri Lanka.* Research in Transportation Economics. Journal homepage**:** www.elsevier.com/locate/retrec. Pages

395 - 400
Kumarage A. S., Wirasinghe S. C., (1997), An aggregate demand model for intercity passenger travel in Sri Lanka. Kluwer Academic Publishers. Printed in the Netherlands. Pages 77–98.
Lu-Yi Qiu, Ling Yun He (2018), Bike sharing and the economy, the environment, and health-related externalities. Sustainability, Volume 10, Issue 4 (April 2018).
Midgley P., (2011), Bicycle-sharing schemes: enhancing sustainable mobility in urban areas. Paper presented at Commission on Sustainable Development 19th Session, New York, 2-13 May 2011.
Shaheen, S., Guzman, S., Zhang, H. (2010). Bike sharing in Europe, the Americas, and Asia: past, present, and future. Transportation Research Record: Journal of the Transportation Research Board, No. 2143, Transportation Research Board of the National Academies, Washington, D.C., 2010, pages 159–167
Zhang, L., Zhang, J., Duan, Z., Bryde, D., (2015). Sustainable bike-sharing systems: characteristics and commonalities across cases in urban China. Journal of cleaner production, Volume 97. 15 June 2015, Pages 124-133.