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RESEARCH ARTICLE

PASSENGER PERCEPTIONS TOWARDS INLAND WATER TRANSPORTATION: A SRI LANKAN PERSPECTIVE

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ABSTRACT

Traffic congestion has become a significant issue in many cities in Sri Lanka. Colombo, being the commercial capital and largest city of the country, is gravely in need of suggestions to mitigate the loss of efficiency and money due to the idle time on roads. Thus, this paper intends to explore the perception of passengers on an Inland Water Transit (IWT) system which is underexplored or rather unexplored in the context of Sri Lanka. The study seeks to bridge the gap in knowledge between the factors to be considered when planning IWT as a public transit mode by transport planners/providers and the factors passengers would consider when opting for IWT as a public transport mode. Furthermore, the study also attempts to analyze the potential of IWT to be utilized for recreational purposes. Therefore, a conceptual framework was developed based on the literature written in the context of other countries and other modes incorporated with statistics from several authorities as well as data gathered through personal communications with industry experts. This was followed by a survey conducted via printed questionnaires and Google forms among a randomly selected sample of Colombo residents. The sample consisted of passengers bound to take the land routes crossing the canal system proposed for IWT. Details on demographics, trip characteristics and perception towards IWT as a novel public transport mode was collected to proceed with the analysis. After the Exploratory Factor Analysis, a Binary Logistics Regression model was developed to accomplish the primary objective of the research. Apart from the model, Chi-square test, KMO test and correlation analysis are some other analysis techniques employed in the study to derive conclusions on the overall perception of passengers towards IWT. The results suggest that the latent factor 'Amenities', including indicators such as availability of service information, customer service, online facilities, multiple counters, etc. are more significant when considering IWT as a public transport mode, than service issues such as cost, connectivity and punctuality. The findings of this study aim to provide a better understanding of the determinants of modal choice of IWT in Colombo, thus, to encourage the incorporation of such non-traditional service attributes in policy developing, transport planning and service providing. Subsequently, it will address the urgent need to discourage the escalated trend in the use of private vehicles due to the limited inhabitable space in this small island—Sri Lanka.

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INTRODUCTION

Background: Transportation industry as a service industry is now at a boom in facilitating the demands derived through the ever-growing needs and wants of human beings. In Sri Lanka, more than 90% of vehicles on roads fall under private transport, while a mere 1% of vehicles belong to public transport, encompassing mainly buses (Transport.gov, 2019).

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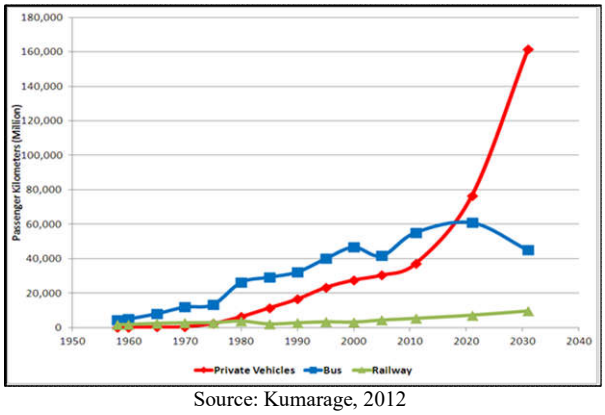
Thus, it is evident that private transportation is dominating over public transportation in Sri Lanka. In rival to the above statistics, it has been found that nearly 60% of the population use public transport, while 37% percent make use of private transport. Out of the population who make use of public transportation, 55% use buses depicting how public transport has reached its capacity (Kumarage, 2012). Colombo being the commercial capital in Sri Lanka, attracts more than one million daily commuters by 160,000 vehicles per day (Kalahe, 2016). In 2014, the modal share of public transport modes was 58% which was at 67% in 2013. During peak hours, the average speed of a vehicle in Colombo has fallen below 10 km/h (Perera, 2014). The vehicle fleet would grow by 190% and

300% increase of vehicle km over the next 20 years and the modal share of private travel would increase from 26% to 57%. As a result, the traffic congestion would rise from 27 to 111 billion vehicles km in 2031 (Kumarage, 2012). As illustrated in Figure 1, is a gradual increase in trend in private transportation modes leading to decrease in modal share of public transportation which is expected to get worse in the future.



Source: Kumarage, 2012

Figure 1: Modal share projections in Sri Lanka

Problem Statement: Instead of relying and investing on capital-intensive hinterland-based transport modes, the focus should now be shifted to exploiting existing resources with lower capital investments. As suggested by the previous studies, Colombo has the capability to utilize the existing canal systems in order to combat the aforementioned issues (See Senanayake et al., 2013). Inland Water Transportation (IWT) can be defined as the transportation by means of inland waterways using a rolling stock which has the potential to move on water. IWT is known to be a low cost, fuel efficient and a less capital-intensive mode of transportation which facilitates large capacity and minimal pollution. It can also be promoted as a mode for recreational purposes (Ishiwatari, 2011). IWT would be a feasible solution to reduce the reduce the burden on land transportation and to provide a pleasant, economical and time-saving journey to passengers.

Scope: Sri Lanka Land Reclamation and Development Corporation incorporated with Megapolis has initiated a project to develop an inland water transport system. Hence, scope of the research has been confined to the route from Wellawatthe to Battharamulle which is the first phase of Megapolis and SLLRDC's IWT plan (Pre-Feasibility Study Inland Water Based Transport Project (Phase I), 2017).

Objectives: The primary objective of this study is to analyze the passenger perception towards IWT as an alternative mode of public transport from Wellawatthe to Battharamulle. Several secondary objectives were also set to analyze the perceived viability of IWT for the use of mode for recreational purposes as well during off-peak/ night-time.

Significance: Since user satisfaction is critical to generate demand for a mode, it is important to identify what passengers would expect from a novel transport mode as IWT and thereby to provide several feasible options for the general public as public transport modes. Thus, a shift could be expected from private to public transport modes and ultimately reducing the burden on hinterland-based transport modes. Hence, the prospective users of IWT would be mainly benefitted by this study. Although the government, policy makers, investors and infrastructure providers have now started to eye on IWT, there exists limited contemporary research on water transit systems, especially in Sri Lankan context. Considering the current literature, they are rather focused on the technical feasibility, land use and planning implications. There exists some literature on factors considered when opting for a mode and barely few on the user perception on IWT in foreign contexts, but none yet in Sri Lankan context. This study intends to bridge the gap in knowledge regarding the service factors that prospective users consider to be significant and to aid in planning the future water transit network, thus providing the basis for why this research is significant. Considering the transport-related projections on future modal shares, this research can also be considered as a timely study. The study is also significant when considering the unique context in urban water transit in Sri Lanka due to its culture, lifestyles and the weather. Since IWT can also be promoted for recreational purposes, thus, promoting tourism, tourism sector could also be considered as a prospective benefiter by this study.

LITERATURE REVIEW

Overview on IWT: Waterborne transport can be considered as the oldest and cheapest mode of transportation compared to other modes of transportation existing in the world (Kalahe, 2016). IWT is an environmental-friendly mode of transportation with a high potential to function as an alternative and a supplementary method of transportation. It also functions as an inter-modal mix of public transportation (Senanayake et al., 2013). As suggested by Ishiwatari (2011), in the case of a developing country with congested roads, IWT can serve as a convenient mode. As cited by Kalahe (2016), European Commission has identified that the investment needed for IWT is lower when compared to other modes of transport, figuratively it only accounts for 5%-10% of the investment for an equivalent road or rail line. Its maintenance cost accounts for only 20% of road maintenance cost. Ishiwatari (2011) states that the consumption of energy per kilometer/ton of transported goods in IWT is 17% of that of road transport and 50% of rail transport. IWT can actively contribute to promoting a low-carbon society as the carbon emissions from IWT are much lower than those of road transport. In contrast to the pros of IWT, there could be some pollution taking place on the water body itself due to fuel leaking from the boats with the operation of boats. As the movement of boats generate waves, another concern on environment is the erosion of the canal banks (Inland water transport system: Detailed project proposal, 2016).

Contemporary examples of IWT: Inland water transportation is widely used in Europe, Asia, Africa and America for both passenger and freight transportation. IWT represents 32% of the transport sector in Bangladesh and 20% in Germany (Kalahe, 2016). IWT represents a significant share in transporting goods in Europe. The percentage of goods transportation in Netherland is 42%, 14% in Germany and 12% in Belgium (Ishiwatari, 2011). IWT accounts for roughly 15% of the total intercity commerce by volume in the US as it transports the principal commodities such as coal, petroleum, farm products, chemicals and crude materials (Kalahe, 2016). Bangladesh being abundant with inland waterways, IWT is used as a major mode of goods and passengers. It provides mobility to 68 million passengers annually through its 1,400

landing stations and 11 principal river ports along the inland waterways. It is projected that 1/3 of the country's total traffic is projected to be transported via IWT in the near future (De Silva, 2003). Out of the 3000km of waterways available in Thailand, only 30% is capable of navigating commercially. 20 million tons of cargo is transported annually via IWT which represents 4.5% of inland cargo volume. Bangkok is much popular for passenger movement via IWT and it caters to the mobility requirements of around 1.5 million passengers. IWT in Bangkok is a good example to demonstrate how IWT can be used for recreational purposes (Senanayake et al., 2013).

IWT in Sri Lanka: Senanayake et al. (2013) in their study reveal about the advanced inland transport system which prevailed in Sri Lanka. There is evidence on the existence of a canal system in Sri Lanka during the 18th century, which has been developed by the Dutch to transport spices and coconut to Colombo. De Silva (2003) in his studies states that the navigable channel from Diyawanna Oya up to the sea outfall at Wellawatthe which is the study area of this research is 8.1 km in length. The canal passes through 4 major A-class highways and 3 B-class which makes it of the most potential waterways for public transportation as it acts as a transverse link for all the radial links available.

Overview on factors influencing modal choice: According to Hu, Zhao, & Wang (2015), perception of a person depends on the attitude of that person, which has a psychological influence and it also acts as a major criterion in determining the behavior of people. Srinivasan et al. (2007) and De Witte et al. (2013) suggests that a passenger's decision on mode choice is influenced by socio-psychological indicators which includes socio-demographic factors, journey characteristic indicators and spatial indicators. De Witte et al. (2013) states that that there is no strong consensus about the role of gender in mode choice. Satiennam et al. (2011) as well as Thamizh et al., (2011) have found a that females have a higher probability to shift to public transport. Abuhamoud, Rahmat and Ismail (2011) has established a positive relationship between age and the willingness to use public transport. Employment influence on income and car ownership. The modal choice of commuters depends on the type of occupation and job characteristics. Especially for commuting trips, the mobility policy of the company also has an impact on the modal choice of its staff (De Witte et al., 2006; Bastin and Dobruszkes, 2006). Based on a stated preference survey of mode choice in Burma, Fujiwara et al., 2008 states that passengers' income groups influence on their sensitivity to fare price and travel time. According to Limtanakool et al. (2006), people with higher education qualifications tend to rely on private vehicles than on public transport modes. Williams (1978) states that vehicle ownership influence on an individual's decision to use the vehicle for commuting and shopping activities. Factors such as cost, flexibility, etc. are more important than relaxing factors, restful for commuting, while they are equally important for leisure trips (Ye and Titheridge, 2019).

According to Iles (2005), service quality, embracing reliability, punctuality, safety, comfort, security and convenience are of utmost importance when a passenger opts for a public transport mode and they are also the first responsibility of a transport undertaking its customers. Use of public transport is much sensitive to increases in public transport fares (Vega and Reynolds-Feighan, 2009; Vasconcellos, 2005). In rival to this fact, Tyrinopoulos and Antoniou (2012) states that high fare levels do not discourage passengers from using public transport, and this would allow policy makers to increase fares slightly and divert the additional revenue to improve other public transport services. Studies suggests that both transportation planners and the public rank time as one of the most important determinants in the selection of a transportation mode (Srinivasan et al., 2007; Wallin and Wright, 1974). Easy access to information and Up-to-date information are significant factors for public transport use and it is also considered to be an important indicator of public transport quality (Grotenhuis et al., 2007). Ko, Lee and Byun (2019) states that environmentally concerned transport users are more likely to choose environmentally sustainable modes. Tanko et al. (2019) suggests that on-water environment may offer passengers a passive benefit from the view alone. Márquez et al., 2014 suggests that the effect on comfort will be higher for the younger generation (under 38 years) and for those who have a higher level of education (bachelor's degree). He also states that the boat journeys can potentially be more favorable to work on-board due to the presence of less lateral motion (as experienced in buses). Ponnuswamy and Anantharajan (1993) emphasize on the impact of qualitative factors such as comfort, convenience, safety, security during travel are considered influential although they are less easy to measure in practice.

Considering IWT alone, in a survey in New York it has been found that the ferry service is used by passengers due to two main reasons: IWT is a less stressful mode to commute and it is a respite from the overcrowded subway. Similarly, in a survey in London, reasons for commuting by boat were concluded as a less stressful journey (36.5%), the convenience of service (29.5%) and the reliability (14.6%) (Trivector Traffic, 2014). According to Stockholm County Council (2013) and Translink (2016), surveys on regular public transport satisfaction in Brisbane and Stockholm also show that comfort, over-crowding and on-time performance are the aspects boat users are mostly satisfied with.

METHODOLOGY

The study included a survey to analyze the passenger perception on IWT and the factors affecting the choice of IWT as a public transportation mode in Sri Lanka. There has been increasing criticism of the inputs used to develop models, especially when predominantly focusing on travel times and cost as it does not reflect user choices in the real world and the contemporary nature of transport choices. Hensher (1998) states that while focusing on simple inputs produce easily tractable models, overly simplistic models also neglect individual behavioral aspects and hence such models cannot deal with apparently irrational decisions. Therefore, the Theory of Planned Behavior (TPB) (Fishbein and Ajzen, 1975) was applied to conceptualize the decision-making process of people to determine the influencing factors. Behavior of people is dependent on the intention, where the attitude towards the behavior (whether choosing IWT makes sense to the decision-maker), subjective norms (cultural factors, travel behaviors, opinions of others, etc.) and perceived behavioral control (how easy/difficult it is to use a transport mode) factors in. The following conceptual framework was developed accordingly (See Figure 2).

The survey was conducted via distributed questionnaires focusing on passengers who generally take land-based modes crossing Wellawatthe-Battharamulle canal route and google forms to represent the rest of the population of interest based on simple random sampling technique. In total 426 responses were available for analysis. The survey consisted of 3 sections: Firstly, several structured questions to gather the socio-demographic factors and journey characteristics of the respondents. Then, personal attitudes were gathered to identify which factors influence the respondents to choose IWT. To analyze these latent variables, a five-point Likert scale measurement from 'Not important at all' to 'Very important' was used.

Finally, several structured questions were included to gather specific answers to some of the important factors mentioned in the second section. A hypothesis of the survey was that latent factors related to cost and time aspects are significant. The survey was designed to assess which factors passengers would consider when considering IWT as an alternate mode of public transport. Hence, a Logistics Regression model was developed after the Exploratory factor analysis (EFA) to address the above concern.

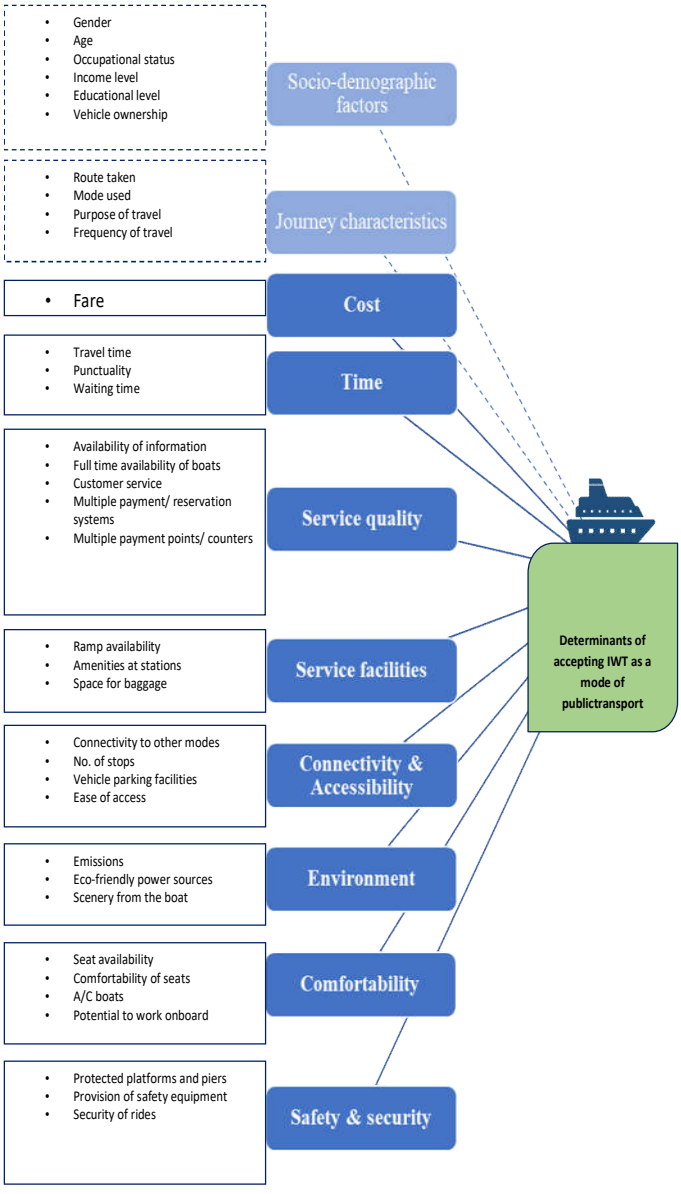


Figure 2: Conceptual framework

RESULTS

Socio-Demographic profile: When considering the demographic distribution of the sample chosen for the study, around 53% of the sample comprises of males and 47% females. Around 38% of the participants comprised of the age category between 26-35 years, followed by 35% of respondents in between 16-25 years. 61.5% of the sample are employed while 57% of the sample work in the private sector. 49.3% of the population has bachelor's as their highest educational qualification. When considering the average monthly income, around 27% of the population are dependents followed by 20% of the population earn between LKR 25000-50000 per month. 62.9% of the sample do not own any vehicle while 33% owns 1 or 2 four-wheelers. Majority, in number 53%, of the sample use the bus as the most common mode of transportation. According to the chi square-p value of the socio-demographic factors, it was determined that average monthly income and the IWT acceptance have an association with each other. In the post-hoc test conducted on average monthly income factor it was identified that there is an association between IWT acceptance decision and the category of respondents earning above LKR 100,000 per month. The rest of the socio-psychological factors analyzed in the study do not seem to have a statistically significant association with IWT acceptance. As per the responses provided by the sample the most utilized road is Galle road / Marine drive and this utilization is 45% of the total sample who are willing to take IWT, followed by Duplication which as a percentage is 24%. Therefore, it is evident that the respondents utilizing these roads are desperately in need of solution for the existing congestion problem.

Passenger Perception on IWT: As per the responses provided for the questionnaire, 97% of the sample have faced transport-related issues with the existing transport service, while 91% think a new transport mode would be a solution to overcome such issues. It can be concluded that 95% of the respondents perceive IWT to be viable mode of public transport to combat the ever-growing traffic congestion, while 94% perceive IWT to be a viable mode for the use of recreational purposes during off-peak or night-time. Given the condition that IWT meets the requirements of the respondents, around 95% of the respondents are willing to take IWT for their travel purposes.

Influencing factors: According to the results of the Descriptive Statistics the most rated variable influencing people to select IWT system is 'travel time' which has a highest mean of 4.62, followed by 'punctuality' and 'safety', while the least important factors are 'potential to work on board', 'air-conditioned boats' and 'good scenery from the boat' in the descending order of importance. This finding could be of importance to the transport provider when planning the infrastructure and other service features. Considering the results of the chi-square tests conducted on planning factors, it was found that other than 'Amount paid for the trip', 'Scenery from the boat', 'Connectivity to other transportation modes', 'comfort ability of seats' and 'Air-conditioned boats', the rest of the factors have an association with the passenger's decision to accept IWT. In the advanced factor analysis, it was revealed that the passengers place highest importance on the 'punctuality of the service', 'travel time', 'waiting time for the mode arrival', 'connectivity to other transport modes' and 'provision of safety equipment' in the descending order of importance.

When the factors were summarized based on its importance, most important factor has been 'punctuality' (91%), 'transit time' (90%), 'waiting time' (88%), 'connectivity' (88%) and 'safety' (88%), while the least important factor is the 'scenery from the boat' (42%). Further, when further analyzing the latent factors, it was identified that majority of the respondents which accounts for around 40% of the sample are willing to pay LKR 100-150 for the whole journey from Wellawatthe to Battharamulle. 44% of the respondents expect boat departures every 15 minutes. The expected travel time for the full journey is 30-40 minutes which has been preferred by around 43% of the sample. Majority of the respondents have opted for the following facilities to experience at the jetty: ATM, washrooms, communication center and washrooms and a cafeteria. Researcher has also analyzed the purpose the respondents are willing to take IWT, and it was found that 50% of the respondents expect to use IWT for commuting purposes, 35% for leisure travel and 15% for business travel, which also implies that respondents perceive IWT to be more viable as a public transport mode during peak hours.

Factor Analysis: The KMO and Bartlett's test proved the sample adequacy of 95.2% and 0.00 p-value, suggesting that there is a correlation between variables and to proceed with the factor analysis. As per the eigen values in total variance explained table and scree plot graph, it was concluded that almost 62% of the cumulative percentage is explained by just three factors. Using Exploratory Factor Analysis, the 26 variables were classified into three latent factors and these factors were named as "Service features", "Amenities" and "Comfortability". During this process 'Parking facilities', 'Emissions' and 'Eco-friendly power source' factors have been eliminated to formulate the latent factors. The "service features" factor consists of the highest number of variables, which is 10 in number. Pearson chi-square p-values (< 0.05) of hypothesis testing suggested that the latent factors have an influence on the passenger's decision in choosing IWT as an alternative mode of public transport. The Alpha statistic obtained in the Reliability test resulted in values greater than 0.8, which suggested that the internal consistency of the items in the data set is good and hence the latent factors meet the reliability requirement. This was followed by a Correlation analysis for the latent factors, the significant p-values suggested that all latent factors have an association with passenger's decision to accept IWT.

Regression Analysis: Binary Logit model was constructed for the three latent factors using SPSS 23.0 statistical software. The Hosmer - Lemeshow test suggested that the model obtained is statistically significant (0.03) with a Chi Square value of 17.06 representing the goodness of fit and validity of the model. As per the omnibus test, it was proved that adding the 3 latent variables is explaining and contributing in the model apart from intercept as the p-value is 0.046. Binary logistics model explains that amenities has a significant positive effect on accepting IWT as a public transport mode with a P value is 0.029 and an individual beta value is 0.899. It further suggests that probability of accepting IWT as a public transport mode is 99.3% as log odds is 5.015, then odds is 150.65 from antilog of natural logarithm. These results suggest that the "amenities" factor is very important for the respondent's decision on choosing IWT as an alternative mode of public transport. Interestingly, the association with "Service features" and "Comfortability" is negative as the P values are 0.487 and 0.837 respectively. However, even when all three factors are important, logit value is 3.711, then odds is 10.89 and still the probability of accepting IWT remains at 97.6%.

Logit (Willingness to use IWT) = 0.846 - 0.249 (Service) + 0.899 (Amenities) – 0.077 (Comfortability)

DISCUSSION

Despite the other socio-demographic factors, it was observed that the average monthly income has an association with the decision on using IWT. This could be due to trend in use of paratransit/private modes of transportation rather than relying on public transport modes as the income increases. The underlying reasons for this are subjective norms, cultural norms (status) and travel behavior. It was also evident that the people who undertake Galle road, Duplication road or the Marine Drive would have a more tendency to use IWT due to existing overwhelming traffic congestion on those roads during peak hours. As per the results of the analysis, it was evident that the passengers perceive IWT to be viable enough to cater to both the requirements as public transport mode and a recreational mode. It came into light that time related factors and safety are main factors the passengers would place prominence on in the decision of using IWT. Interestingly, it was identified that the ticket fare, air-conditioned state of the boats or the scenery would not be of major consideration for passengers. Hence, the transport planners have the chance to increase the fare slightly to provide more comfortability and amenity factors to the users. Since majority of the respondents are willing to use IWT for commuting purposes, planners could also tailor the boats to fulfill that requirement.

Another interesting finding was the focus on "Amenities" by the respondents, which includes factors such as availability of service information, availability of boats, customer service, online facilities, availability of multiple counters, amenities at the jetty, etc. This finding represents the digital-oriented busy lives of the prospective users who expect to get things done faster and easier, especially when it comes to commuters. This is another important aspect the planners could give place of prominence. In order to generate demand for the IWT system from Wellawatthe to Battharamulle, most important consideration is to educate the general public about the IWT system and its benefits, especially on the environmental and reliability aspects. It can also be recommended to have a PPP in order to develop infrastructure and for the service provision which would lead to good competition and ultimately improvement in the quality of service. Connectivity between the modes would be vital to generate demand for IWT. Air-conditioning could be decided based on the smell of the canals as it was found to be a less concerned factor by the passengers. A good suggestion observed in the comments section is that the availability of trained staff and a lifeguard in a case of emergency as safety has been considered to be significant. Another suggestion in the comments section was to opt for more sustainable power sources for boats such as solar or tidal power. In the meantime, steps should be taken to minimize pollution by the boats and the users. Further, in order to promote IWT for recreational purposes, it is important to find a feasible solution to overcome the bad odor of the existing canals due to pollutants and sewage which was the most common concern in the comments section. Finally, as per the results of the analysis, it is evident that people have a positive perception on IWT which would influence them to choose IWT as a mode of public transport from the available alternatives,

given that their expectations are met in terms of service features and amenities.

Limitations and Recommendations

The preliminary limitation of the study is that the survey was focused only on water transit and not a wider transport network, which refrained any comparison between modes. Further, this study was restricted to only one urban water transit route, thus, there could be variations between each study area, especially in the case of rural areas. Therefore, future researches could expand these results to allow wider generalizations. In addition to that, another limitation encountered was the lack of knowledge regarding the subject matter of the research. Since IWT would be a novel mode of travel to Sri Lanka, prior to conducting the survey, the respondents had to be provided with some knowledge regarding IWT, which was challenging to do for questionnaires filled via google forms. Future research could also incorporate more land-use or spatial characteristics into the questionnaire, to have more traceability to the research. Given that IWT becomes a reality in Sri Lanka, future surveys could develop more advanced models to compare the expectation vs. the reality of the user experiences.

Conclusion

This paper intended to determine the passenger perception on the viability of IWT system during peak time as an alternative mode of public transport and for recreational purposes during off-peak and night-time. Furthermore, this study intended to analyze the factors the passengers consider to be important when choosing IWT as a mode of public transport and also included a comprehensive study on passenger expectations of the service features. Thus, the results of this study have useful policy implications which could be considered as planning factors by the transport planners, providers and infrastructure developers.

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