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Investigating informal transport travelers' heterogeneity: A case study of Silor in Bangkok, Thailand

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Abstract

The development of Silor as an informal transport mode in Bangkok responds to the urbanization and rising mobility demand in the city. It functions as the main mode and feeder service, particularly in areas with insufficient or lacking public transport services, making Silor a primary choice for travelers in various regions. This study identifies significant predictors for Silor usage and cross-analyze demographic, trip profiles, and attitudes among the user and non-user segments. Questionnaire interviews on travel behavior and service quality perceptions were conducted on current users and non-users of five Silor routes covering ten districts in Bangkok. Discriminant analysis and the two-step clustering method portrayed heterogeneity in travel behavior and attitudes. Attitudinal variables were factor analyzed and revealed the latent constructs of Silor usage. Results illustrated four distinct user subgroups showing heterogeneous profiles and expectations. Silor users tend to be female, traveling alone, and need a transfer. In contrast, the above-average per capita income, with car availability and long-distance travelers, are more likely to be the non-users. Transfer, route coverage, and crowdedness rank among the top non-use reasons. Study findings and practical implications on Silor usages and preferences contribute to social perception knowledge and better guide informal transportation activities towards sustainable development in the society.

Introduction

With the increase in population growth, urbanization in Bangkok has generated a rising transport demand. The transportation system plays an integral part in people's daily life, fulfills mobility needs, and facilitates access to employment, education, health care, and social services. High quality and sufficient transport services are provided to serve mobility to ensure the quality of life and public well-being. The existing services, particularly informal transport, may face challenges securing current users and attracting potential markets.

Among various transportation services found in Bangkok is Silor (SL), given the local meaning as "four-wheeler." Illustrated in Figure 1, the vehicle is a small-converted

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Figure 1 Silor in Bangkok

pickup truck with 6 to 11 passenger seats, of which the structure was locally modified. The Department of Land Transport (DLT) reported up to 1,964 registered SL vehicles along 143 operating routes in Bangkok in 2018. The SL is known as an informal public transport mode due to incompliance registrations of some vehicles and operators. The services are commonly found in high-density residential spots, where public transportation services are inadequate. It functions as a primary mode and feeder to public buses and mass transit lines. The service system lacks formal regulations on operational features concerning vehicle capacity, fare rates, station, and stop locations. Many routes are not operating as regulated by the DLT, for instance, route extension and unauthorized routes (Choocharukul & Sriroongvikrai, 2011). The recent extension of mass transit lines in Bangkok and its vicinity has made SL service more vital. Such services are thus considered a feeder system, serving the first and last-mile travel that could fill the travel gap for urban commuters, particularly transit dependents. Therefore, it becomes essential for transport authorities and SL operators to determine the demand sides to understand potential users and provide the utmost service quality.

Literature on SL services in Bangkok is relatively scarce. Previous studies investigated SL demand, supply and analysis in safety, route alignment, laws and regulations aspects (Department of Land Transport & Transport Institute, 2009) and SL passengers' perceptions (Amrapala & Choocharukul, 2019a, 2019b; Choocharukul & Sriroongvikrai, 2011). In the context of informal transport in Asian developing countries, similar functioning modes as SL are available, for example, Angkot, Motodup, Remork, Songtaew, and Jeepney (Eung & Choocharukul, 2018; Joewono et al., 2015; Okamura et al., 2013; Tangphaisankun et al., 2009).

An integrated public transportation system must address trip connectors to improve mobility in the city. The SL as one of the connectors has significant potential to improve access to public transportation. Issues to be considered include the need for quality improvement for user subgroups and the development of strategies to attract potential users. Even though past informal transport literature attempted to understand current transport users (Amrapala & Choocharukul, 2019a, 2019b; Choocharukul & Sriroongvikrai, 2011; Eung & Choocharukul, 2018; Joewono et al., 2015; Okamura et al., 2013; Tangphaisankun et al., 2009), more research is needed to identify the barriers to using these modes. As a result, this study includes potential markets in the analysis to identify discriminant variables among users and non-users, as well as the quality preferences of current and potential needs.

This study investigates significant determinants that distinguish between SL users and non-users using discriminant analysis, followed by presenting SL user subgroups characterized by particular behavior and perceptions through cluster analysis. In addition, exploratory factor analysis was used to compare users in other competing modes by extracting key dimensions underlying the reasons for not using SL. Thus, in this study, we seek to address three research questions: (1) What prioritizing socioeconomic and trip variables assist in discriminating between SL users and non-users?; (2) What are the key different travel behavior and perception among distinct user subgroups?; and (3) What are the distinguishing behavioral and attitudinal characteristics of non-users traveling by different modes?

This paper begins with a literature review that presents an overview of informal transport services and perceptions of service quality. Then study area, data collection, and analysis are described, followed by discriminant analysis, cluster analysis, and exploratory factor analysis results. Findings from the comprehensive analysis are provided in detail and discussed. Finally, the core research findings and discussion conclude this paper.

Literature Review

Informal Transport: Roles and Service Quality

Informal transport systems emerge and evolve to meet local mobility needs (Kumar et al., 2016). Talamini and Ferreira (2019) stated that informal transport exists and survives in a tight relationship with the urban village, reducing social-spatial exclusion and enlarging transit system catchment areas. Specifically in Bangkok, the informal transport sector has helped compensate for the

lack of systematic road hierarchy and substandard bus services, providing supplemental capacity while diversifying the service-price options available to the public (Cervero & Golub, 2007).

In Asian developing countries, informal transport markets are known as LAMAT, Locally Adapted, Modified and Advanced Transport, which is the common definition for all paratransit services (Phun & Yai, 2016). Extensive literature can be found on attitudes towards service quality relating to formal public transport modes; however, research on LAMAT service quality, particularly the SL service, is minimal. Previous studies demonstrated that SL's strengths are reliability aspects with the benefits in short travel time and no transfer needed. Shopping appeared to be the most common need driving its utilization (Amrapala & Choocharukul, 2019b).

Previous literature has compared informal transport services and formal ones. It was found that the perceived safety and comfort of the informal ones are lower than bus users (Eung & Choocharukul, 2018). Comparative analysis revealed that minibus users were more comfortable with the service system when compared to bus users. However, bus trips were safer than minibus trips (Murat & Cakici, 2017).

Perception Analysis in Transport Research

Service quality perceptions of public transport users are significant dimensions in evaluating public transport performance. In previous transport studies, perceptions are heterogeneous due to the qualitative nature of public transport service attributes, the difference in demographic profiles, and diverse tastes and attitudes toward public transport (De Ona & De Ona, 2014). Considerable researchers confirmed differences in perceptions among commuters of different socioeconomic profiles (e.g., Alm & Lindberg, 2000; Chocholac et al., 2020; Govender, 2014; Tyrinopoulos & Antoniou, 2014).

Transport researchers employ both existing public transport users and incorporate non-user groups in perception analysis to conduct empirical investigations for potential markets (Nasrudin et al., 2014; Shaaban & Kim, 2016; Tetteh et al., 2018). Factor analysis and market segmentation have been commonly applied in service quality research of informal transportation in Asian developing countries (Bakti & Sumaedi, 2015; Joewono & Kubota, 2006; Tarigan, 2014) as well as public transportation in other countries (Fellesson & Friman, 2008; Yahya, 2013; Vicente & Reis, 2016). Tangphaisankun et al. (2009) employed factor analysis to evaluate attitudinal variables from informal transport users in Thailand. Moreover, Amrapala and Choocharukul (2019a) applied factor analysis and logistic regression to SL service quality and overall satisfaction.

Existing evidence suggests that SL services are potential connectors in an urban transportation network. The significant challenges of SL service are perceived service quality, inclusive service, and accessibility for all. The service needs to become more competitive to retain existing users and attract new ones from other modes. Heterogeneity in service perceptions exists among users of different profiles. Understanding these expectations is necessary to transport operators to formulate strategies to meet their needs.

This paper aims to explore perceived SL service quality and barriers to SL service for each target group, user profiles and attitudes of competitive modes. Such an approach allows issues related to trip profiles to be identified and SL service quality to be prioritized. The findings would help transport authorities and SL operators understand service quality guidelines for efficient SL operation and support policy decisions targeted at each specific group, contributing to a more sustainable mobility option in the society.

Methodology

Study Area

A total of 143 registered SL routes have been operating in Bangkok area. This study aims to explore a representative of five SL routes in both the West and East sides of Bangkok that demonstrates the feeder functions in connecting with other modes. These service routes represent the spatial and operational context of the existing SL services in Bangkok, including locations on the West and the East of the city, with fixed and non-fixed routes under fixed and distance-based trip fares. Ten districts are covered, comprising Bang Bon, Chom Thong, Bangkoknoi, Bangkokyai, Thonburi, Klong San, Chatuchak, Din Daeng, Klong Toei, and Wattana, as depicted in Figure 2.

The five routes and their service details are shown in Table 1. The first three routes are in West Bangkok, operating on main roads with 10 to 13 km service length. The other two routes are in East Bangkok operating on a narrow road with the service length within 4 km. Most routes connect to the BTS Skytrain and MRT subway stations, while some connect to ferry services. The fare rates are typically charged separately for individual passengers, and drivers usually collect passengers along the way. On the other hand, the fares are negotiated for the for-hired service.

Table 1 Locations and operational characteristics of SL routes

Route	District	Connection to other transport modes	Service pattern	Service length (km)	Fare pattern	Fare (Baht/trip)
#1 Bangbon-Taladplu	Bang Bon Chom Thong Thonburi	- BTS Skytrain (Wuttakart Station)	Fixed route/ collective	13	Fixed	7
#2 Siriraj-Taladplu	Bangkoknoi Bangkokyai Thonburi	- Ferry (Siriraj Pier)	Fixed route/ collective	13	Fixed	7
#3 Charansanitwong soi 13-Klong San	Bangkokyai Thonburi Klong San	- Ferry (Klong San Pier) - BTS Skytrain (Wuttakart Station and Krungthonburi Station)	Fixed route/ collective	10	Fixed	7
#4 Vibhavadi Rangsit soi 16-Ratchadapisek soi 19	Chatuchak Din Daeng	- MRT subway (Ratchadapisek Station)	Fixed route/ collective	1.7	Fixed	8
#5 Sukhumvit soi 39	Klong Toei Wattana	- BTS Skytrain (Phrom Phong Station)	Non-fixed/ for hire	0.3–4.4	Distance-based upon negotiation	10–120

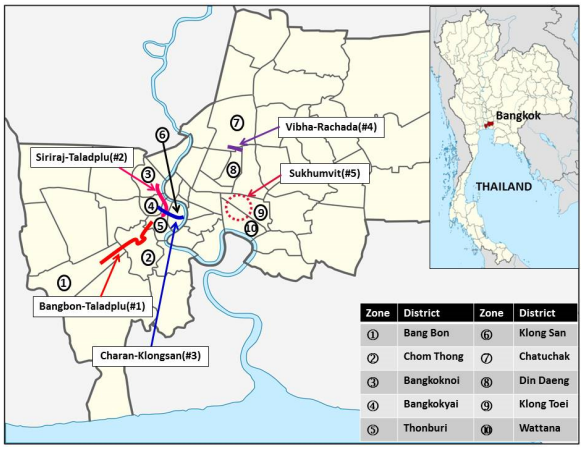

Figure 2 Map of Bangkok districts: Route service area

Data Collection

Data were collected utilizing questionnaire interviews conducted on both SL users and non-users. Non-users are essential components in the comparative analysis of profiles and perceptions and would offer a better understanding of the prospective markets and the current ones. Convenience sampling was employed in the present study since it was considered time and cost-effective to reach the targeted group. Along the five routes, a survey team of four to six members approached respondents on-board and off-board at various locations, such as SL stations, bus stops, restaurants, convenience, and department stores. Respondents were initially screened whether they had used the services. If the answer were yes, the user survey questionnaires would be utilized. On the other hand, another set of questionnaires would be applied to those who never used SL services. A pilot study was conducted, and ambiguous statements were revised according to respondent feedback.

The final questionnaires consist of three main sections. The first section involves travel characteristics, including travel pattern, transfer, distance, travel time, trip purpose, and the availability of alternative modes and non-user modes. Then in the second section for SL users, questions focus on the importance ratings of service quality to capture attitudes towards the convenience and comfort of SL services. A five-point Likert scale was applied, ranging from 1 (Unimportant) to 5 (Very important). For non-SL users, the second section asks about the level of agreement on reasons for not using the services. Likewise, the Likert scale was utilized for eight attitudinal statements ranging from 1 (Strongly disagree) to 5 (Strongly agree). The last section solicits information associated with the socioeconomic characteristics of the respondents, covering gender, age, marital status, education, monthly income, and household car availability.

Data Analysis

This study applies discriminant analysis to build a model predicting the usage of SL services, distinguishing individuals into either SL users or non-users according to individual characteristics and travel behavior. This approach is widely applied in various areas such as medical science, tourism, finance, industry, and marketing business (e.g., Fiagborlo & Kyeremeh, 2015; Kannaiah et al., 2017; Leles et al., 2009; Murphy, 1983; Nigam, 2012). In transportation literature, the discriminant function has been demonstrated for identifying predictor variables (Bonn et al., 1999; Eboli & Mazzulla, 2011; Sezhian et al., 2014; Wang et al., 2014).

A two-step cluster analysis is further employed for user segments of SL services. This market segmentation approach groups the total demand into homogeneous segments identified by common characteristics, such as geographic, demographic, psychological, psychographic, or behavioral variables (Tynan & Drayton, 1987). Recent transport studies have utilized this method (Yahya, 2013; Chia et al., 2016). Several past studies involved factor analysis in investigating underlying service quality constructs and evaluating perceptions (Bakti & Sumaedi, 2015; Tangphaisankun et al., 2009; Yahya, 2013; Vicente & Reis, 2016). This study also identified the key barriers of SL service by using Principal Component Analysis (PCA). The adequacy of PCA to the initial set of data was assessed by the Kaiser Meyer-Olkin (KMO) statistic and the Bartlett's test (Hair et al., 2010). The reliability test of the resulting service dimensions was computed by Cronbach's Alpha coefficient.

Results

Demographic and Trip Characteristics

The data collection through questionnaire surveys was conducted in August-September 2018 with 545 users and 548 non-users after excluding samples with missing data. The preliminary profiles in Table 2 indicate that SL users are more likely female (69.8%) with no cars (58.5%) and travel with transfer (41.4%). The SL users, on the average, have a shorter trip distance [$t(1049) = 12.033$, $p < .001$] and travel time [$t(1055) = 12.709$, $p < .001$] when compared to the non-user counterparts. User characteristics of SL services in different locations were discussed in detail in the previous studies (Amrapala & Choocharukul, 2019a, 2019b).

Table 2 Socioeconomic characteristics and trip profiles

Variables	Users %		Non-users %		Total %	
Gender						
Female	69.8		51.5		60.6	
Male	30.2		48.5		39.4	
Age						
14–29	28.2		29.4		28.8	
30–39	23.0		24.1		23.6	
40–49	21.2		20.5		20.8	
50–59	16.0		13.4		14.7	
60+	11.6		12.6		12.1	
Marital status						
Single	54.2		52.0		53.1	
Married	45.8		48.0		46.9	
Education						
Primary or below	17.3		17.6		17.4	
Secondary	22.4		23.2		22.8	
Vocational	8.3		8.8		8.5	
Higher vocational	8.8		10.2		9.5	
Studying bachelor	5.7		5.3		5.5	
Bachelor	32.2		28.7		30.5	
Postgraduate	5.3		6.2		5.8	
Income (Baht/month)						
9,999 or less	22.9		14.1		18.4	
10,000–19,999	36.8		44.1		40.4	
20,000–29,999	19.3		19.1		19.2	
30,000–39,999	12.2		10.9		11.6	
40,000–49,999	4.3		4.6		4.5	
50,000 or above	4.5		7.2		5.9	
Have car(s) available to use						
Yes	41.5		49.8		45.7	
No	58.5		50.2		54.3	
Travel pattern						
Travel alone	77.1		72.3		74.7	
More than one person	22.9		27.7		25.3	
Transfer						
Yes	41.4		21.0		31.2	
No	58.6		79.0		68.8	
	M	*SD*	*M*	*SD*	*M*	*SD*
Travel distance (km/trip)	3.56	2.60	8.32	8.76	5.98	6.93
Travel time (min/trip)	14.71	10.55	29.25	24.15	22.03	20.04

Prediction of SL Use

This study applies discriminant analysis to differentiate SL users and non-users based on their corresponding socioeconomic and travel profiles. User and non-user variables were taken as grouping variables or dependent variables, and the socioeconomic and trip profiles as independent variables. Totally 1,055 valid respondents (514 users and 541 non-users) were analyzed. Respondents with at least one missing discriminant variable were excluded from the analysis.

Table 3 presents the coefficients of discriminating variables and the summary of the discriminant model. The significant Wilk's Lambda values indicated that the set of independent variables could differentiate between SL users and non-users. From the result, the predictor variables consist of three socioeconomic variables, i.e., gender, monthly income, and car availability. Likewise, three trip variables, including travel distance, transfer, and travel pattern, are statistically significant. A Household Survey of Thailand (National Statistical Office [NSO], 2019) reported an average per capita income of Bangkok of 14,855 Baht/month. Thus, the income variable of 15,000 Baht/month was taken as the cut-off value for above-average per capita income. The 4-km average SL travel distance is used as a cut-off value for the travel distance variable in the model.

The analysis result reveals that the strongest predictors for using SL were transfer, travel distance, and gender, respectively. The negative and positive coefficient values indicate that the likelihood of using SL would decrease and increase, respectively. Female respondents and passengers who need to transfer to other modes have a greater likelihood of using the services. At the same time, trips with longer travel distances were less likely for SL users. Other relevant variables include income, car availability and travel pattern. The decrease in travel distance, monthly income, and car availability would increase the tendency of the respondents to be SL users. The increase in transfer, female, and travel alone would also increase the likelihood of being SL users. The classification results indicated that out of 514 original SL users, 313 (60.9%) were classified correctly. Out of 541 original non-users, 379 (70.1%) were assigned to the correct group. Overall, the discriminant model successfully classified 65.6 percent of actual group cases.

SL User Segmentation

Two-step cluster analysis is performed to divide SL users into heterogeneous groups with homogenous features within each subgroup. As SL users have different characteristics and diverse perceptions, this clustering method would provide a meaningful illustration and understanding of their behavior and expectations. We selected five clustering variables that are useful for interpretation, including demographic, trip profiles, and service quality perceptions. The variables consist of age, transfer, travel time, perceived importance of the convenience of connections and transfer (M = 3.77, SD = 1.16, n = 542), and perceived importance of the availability of shelter and benches at stops (M = 4.23, SD = 0.88, n = 543). The clustering quality is based on silhouette measures of cohesion and separation, determining whether the clusters are internally coherent and well-separated externally (Kaufman & Rousseeuw, 2005). The silhouette coefficient of .25 and above implies acceptable results, whereas the coefficient of less than .25 indicates that the data exhibit no substantial structure.

Based on user respondents, the four-cluster solution appeared to be the most appropriate as it had the silhouette coefficient of .40 and was interpretable. The four segments differ in socioeconomic, trip profiles, and attitudinal variables. They are arbitrarily labeled as Comfort desirer, Easy rider,

Table 3 Overall results of the discriminant model for using SL

Discriminant variables	Standardized coefficients	Wilk's Lambda	p value
Transfer (Yes = 1)	.604	.955	.000
Travel distance (4 km and above = 1)	-.603	.952	.000
Female (Yes = 1)	.485	.966	.000
Have car available to use (Yes = 1)	-.202	.992	.004
Travel pattern (Alone = 1)	.083	.995	.021
Income higher than 15,000 Baht (Yes = 1)	-.045	.997	.085
Function at group centroids			
Group means for users	.393		
Group means for non-users	-.374		
Original grouped cases correctly classified	65.6%		
Users	60.9%		
Non-users	70.1%		

Note: Wilk's Lambda = .872 (p < .001), the eigenvalue = .147 and canonical correlation = .358.

Convenience admirer, and Comfort and convenience seeker, respectively. Table 4 summarizes the characteristics of each user subgroup. The proportion of work trips and captive users is reported to provide more meaningful results.

The first cluster includes 159 respondents and is the largest (30.6%). All users are aged 40 and above and make direct trips without transfer. This group revealed a long travel time with a median of 15 minutes. Accordingly, they evaluated high scores on the importance of shelter and benches, leading them to Comfort desirers. The second cluster is made up of 152 individuals (29.2%), who are younger riders, aged under 40, traveling with no transfer. This cluster makes their travel for a short time with no particular focus on service attributes, showing average convenience and comfort scores. Users in this cluster have a high proportion of work trips and captive users, implying that they have no other choices; therefore, this group is then labeled Easy rider. In the third cluster, all are aged 40 and above. They travel in a shorter time but need to transfer to other modes. They express a high score on the convenience of connections and transfers and are called Convenience admirers. The last cluster is characterized by the highest score on the importance of convenience of connections and transfers, and comfort in the availability of shelters and benches. All users are aged 40 and above and need to transfer. These individuals are then named Comfort and convenience seekers.

Overall, the analysis result depicts several interlinkages among demographic, trip, and perception variables. It is noted that users who need a transfer revealed a higher importance score on the convenience of connections and transfer, as characterized in Convenience admirer and Comfort and convenience seeker. Users of age 40 and above showed longer travel time with a higher score on comfort, including the availability of shelters and benches at stops, as shown in Comfort desirer and Comfort and convenience seeker. On the contrary, in the Easy rider and Convenience admirer segments, younger users travel with a lower comfort score for a shorter time. Nevertheless, compared to those aged 40 and above, younger travelers presented a higher proportion of work trips. Also, it is interesting to note that the two clusters with a high percentage of captive users, i.e., Comfort desirer and Easy rider, make a direct trip with no transfer. Comfort desirers are 40 and above with a high proportion of captive riders, while Easy riders are younger SL users with a high share of captive users.

Heterogeneity among Non-users

The attitudinal survey collected from non-users was factor analyzed to capture the key barriers to SL services. Non-users were asked to rate the level of agreement towards statements on reasons for not using SL services. A five-point Likert scale was applied to eight attitudinal statements, ranging from 1 (strongly disagree) to 5 (strongly agree). The top three reasons for not using SL services shown in Table 5 are transfer (M = 3.82, SD = 1.16), route coverage (M = 3.78, SD = 1.20), and discomfort with the crowd (M = 3.66, SD = 1.17).

Exploratory factor analysis is conducted on eight attitudinal variables, and the constructs are labeled according to the content of component variables. Table 6 illustrates the attitudinal scores and factor analysis results showing latent constructs, statement groupings, and factor loadings. The KMO measure of sampling adequacy of .631 exceeds the recommended minimum value of .5 (Field, 2000; Kaiser, 1974), indicating that the data were suitable for the factor analysis. Bartlett's Test of Sphericity is significant ($p < .05$), confirming the patterned relationships among the variables (Yong & Pearce, 2013). Factor analysis results identified three underlying components, which explain 62.9 percent of the total variance. Inconvenience explained the highest total variance (29.0%), followed by Time-related and car dependency (19.6%), and Safety and comfort (14.3%), respectively.

Table 4 Segmentation of SL users

Variables		Comfort desirer	Easy rider	Convenience admirer	Comfort and convenience seeker
Age 40+ (%)		100	0	0	100
Transfer (%)		0	0	100	100
Median travel time (min)		15	10	10	15
Importance of convenience of connections and transfers[a]		3.96	4.19	4.31	4.56
Importance of availability of shelter and benches at stops[a]		3.86	3.76	3.52	3.90
Proportion of work trips (%)		21.4	31.6	37.4	21.3
Proportion of captive users[b] (%)		36.5	38.2	24.3	23.4
Cluster size	*n*	159	152	115	94
	%	30.6	29.2	22.1	18.1

Note: [a] = Mean scores calculated based on five-point Likert scale, [b] = Respondents who indicated that they have no other mode choice.

Table 5 Exploratory factor analysis of reasons for not using SL

Attitudinal variables	*M*	*SD*	Factor 1 Inconvenience	Factor 2 Time-related and car dependency	Factor 3 Safety and comfort
There is no good connection to where I want to go	3.78	1.20	.852		
I do not want to transfer	3.82	1.16	.773		
Stations and stops are not conveniently located	3.35	1.27	.735		
SL is too slow	2.84	1.13		.824	
Long waiting time	3.16	1.17		.811	
I travel by car	3.38	1.44		.526	
I think it is not safe to travel on SL	3.41	1.21			.858
I do not feel comfortable with the crowd	3.66	1.17			.822
Total variance explained (%)			29.0	19.6	14.3

Note: Cronbach's Alpha: .625; KMO: .631; Bartlett's: 777.495, *p* value .000; Loadings < .50 have been omitted.

Table 6 Comparative analysis among non-SL users

Variables	Bus users (n = 211)	Motorcycle users (n = 130)	Private car users (n = 109)
Reasons for non-use			
Factor 1 Inconvenience	3.75	3.59	3.60
Factor 2 Time-related and car dependency	2.81	3.48	3.54
Factor 3 Safety and comfort	3.61	3.41	3.75
Demographic and trip profile			
Transfer (%)	29.9	10.8	11.0
Female (%)	58.8	41.5	40.4
Age 40+ (%)	51.2	30.2	55.0
Median monthly income (Thousand Baht)	15.0	15.0	27.0
Mean numbers of cars available to use	0.46	0.55	1.61

Note: Factor scores are mean scores calculated for each group based on a five-point Likert scale.

The top three non-user modes, accounting for the majority (82.9%) of all non-user respondents, were selected for comparative analysis, including buses, motorcycles, and private cars. Table 6 shows attitudinal factor scores with socioeconomic and trip profiles and denotes the differences in characteristics and perception of barriers to SL usage from three different viewpoints. This approach made the comparative analysis more accessible and understandable.

This study captures from the three non-SL group analysis that bus users demonstrate the highest proportion of female (58.8%) and transfer trips (29.9%), and therefore evaluated the highest score on the derived inconvenience factor. They show the lowest car availability and score on time-related and car dependency factors. Motorcycle users stand out with the lowest proportion of users aged 40 and above and the lowest score on safety and comfort considerations. As expected, private car users are distinct in their monthly income and car availability.

Discussion

Heterogeneity of SL and Non-SL Users

Findings from the discriminant analysis illustrate positive coefficients in females, travel alone, and transfer trip variables, indicating a greater likelihood of SL users. On the other hand, negative coefficients are found in income, car availability, and distance variables. Respondents having above-average per capita income, with car availability, and long-distance trip are more likely to travel by other modes rather than SL. In previous studies, women make more use of informal modes than men (Buckner, 2009; Munira et al., 2013; Wongwiriya et al., 2017). Accordingly, this study reports a consistent trend that SL users are primarily women. Bhat (1997) pointed out that traveling by solo-auto mode over shared-riding or transit was more likely among upper income. Our results revealed a similar pattern, with a significant association between the below-average per capita income and SL usage.

From the global perspective, the previous informal transport study (Cervero & Golub, 2007) supports SL user characteristics in our findings. First, informal services in many areas are the only means of mobility available to the poor. The evidence in our study shows a negative relationship between income and SL use as well as negative relations between car availability and SL use. Moreover, on their function basis, a feeder service may require transfers and connections with other transport modes. Consequently, our study reveals that the SL trips are more likely to involve transfer than the non-SL trips. As the role of transfer connectors, SL trips are more likely to be shorter in the distance than non-SL counterparts.

The four resulting clusters from the segmentation approach confirm the inter-linkage between socioeconomic, travel profiles, and perceptions towards SL services. The long travel time for Comfort desirer and Comfort and convenience seeker clusters is associated with a desire for comfort, such as shelter and benches. Commuters may experience more negative emotions, such as weariness and tension, as their trip time lengthens (Jamal et al., 2019), and thereby trip comfort is highly expected. Additionally, Comfort desirer and Easy rider are the two groups that showed the higher share of SL-captive, signifying no other mode choices. Their ratings on comfort and convenience aspects were average. The possible reason could be their high reliance on the mode, and they appear to use SL daily, hence it is understandable that they do not place much emphasis on these attributes.

For users of other modes, difficulties associated with the transfer, route coverage, and crowdedness are among the top three reasons SL was not chosen. Such a situation is consistent with a survey finding in Indonesia that ranked over-crowdedness as one of the top three barriers to using public transport (Susilo et al., 2010). In previous research on non-users of Songtaew (Wongwiriya et al., 2017), safety, convenience, and reliability were significant attributes affecting service usage, in line with the three main service reasons in this study. Nevertheless, some attributes differ from other public transport cases (Le-Klahn et al., 2014). This may be the consequence of the formality of different transport modes and diverse location contexts that may affect the level of service quality in several aspects, and therefore influence user perceptions of such a service.

Interestingly, our study portrays heterogeneous demographic profiles among different travel modes. The higher proportion of female bus users in this study supports the previous research that women were less likely to use a car (Duchene, 2011) and coincides with bus users which revealed that the majority were female from the lower-income group (Mohamed et al., 2018). Present findings generally agree that car users possess higher car availability than bus users (Allopi & Sakar, 1997). For motorcyclists, we found a notably lower share of females and those aged over 40 compared to bus and private car users. The lower proportion of female motorcycle users aligns with the previous research (Hongsranagon et al., 2011). Likewise, safety reasons could be a possible barrier to choosing a motorcycle, and therefore, older people are less willing to take such risks (Cantillo et al., 2015; Simons et al., 2013; Sullivan et al., 2011).

From our findings, private car users had the most car availability, which is consistent with previous studies (e.g., Kenworthy & Laube, 1996; Cirillo & Axhausen, 2002; Limtanakool et al., 2006), indicating the probability of choosing a car for travel increases with the increasing number of household cars. Public transport usage was more extended among lower-income groups in developing countries, probably due to their lower affordability (Chee & Fernandez, 2013). Car users felt that public transport was unreliable, overcrowded, and the journey time was too long (Allopi & Sakar, 1997). Our findings supported previous literature in that the upper-income group, the highest number of cars available to use and the highly expected comfort are found in private car users.

Practical Implications

Our findings are useful for SL operators and transport authorities for their practical implications. SL operators should consider the improvement of non-standard vehicle structure to enhance safety and comfort as well as provision of supports on facilities for seamless transfer and convenience in connections. Transport authorities should note three critical issues underlined in this study. First, the demand for SL use is associated with passengers who are female, travel alone, and need transfer. This recommends the appropriate provisions and designs of transfer facilities to enhance the comfortability of riders in this specific group. Second, SL users with heterogeneous socio-economic backgrounds and travel habits differ in their desires for service quality aspects. This implies that, to retain SL ridership, policy considerations should not overlook user profiles in terms of age, transfer, travel time, and service quality in comfort and convenience aspects. Third, the key factors that are influential to the decision not to use SL are (1) inconvenience, (2) time-related and car dependency, and (3) safety and comfort. When developing policies to persuade non-SL users to use SL, such factors should be considered in the development strategies.

Conclusion and Recommendation

This paper highlights several aspects to keep informal transport, like SL in the present study, more sustainable and better serving the transport system in urban areas. Our findings reveal that travel distance, transfer, gender, monthly income, car availability, and travel pattern are significant predictors of SL usage. Implementing users' socioeconomic characteristics, trip patterns, and perception-based segmentation improves explanations of SL individual travel behavior. Confirmed in this study, users of diverse profiles and situations expect and perceive the service differently. Therefore, it is necessary to consider travelers' heterogeneous preferences. Nonetheless, user groups in other transport modes revealed critical SL operation and service issues, mainly due to transfer, crowdedness, and limited route coverage. Improving these service aspects may increase SL use and make the service a feasible alternative.

Some limitations of the study should be noted. There are various forms of informal transport services in other locations in Bangkok and other countries, particularly different contexts related to operational characteristics, connection mode, service patterns, and fare structures. Therefore, findings from the present study are considered empirical and might not be generalized to all services due to diverse geographical context, heterogeneous backgrounds, travel behavior and perceptions.

Although the dataset and findings in this study provide transport authorities and SL operators with an essential foundation for future work, there is still room for research extension. Further studies could investigate psychological and trip determinants to bring new insights on crucial factors to increase informal transport use. Positive and negative experiences in a particular mode could play a decisive role in selecting travel choices. Trip purposes and travel expenditures could be significant determinants in modal choice. Exploring these aspects further to formulate appropriate policies and integrate informal transport modes into the urban transportation network would be worthwhile.

Conflict of Interest

The authors declare that there is no conflict of interest.

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