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To Bus or Not to Bus: Structural Equation Modelling of Ridership Perceptions among University Students as a Planning Tool to Increase Use of Public Transit in Phnom Penh, Cambodia

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Abstract

Reintroduction of Phnom Penh's City Bus in 2014 has encountered challenges related to active ridership and costs, which have raised concerns over future viability of the system. A successful public transportation system is an essential component of a liveable, smart, and sustainable city, but what are the barriers to improved performance of Phnom Penh's City Bus programme? The purpose of this paper is to elucidate factors influencing bus-riding behaviour and suggest policy and planning actions that could increase ridership. Using the Theory of Planned Behaviour (TPB) as an overarching guide and structural equation modelling (SEM) as the primary method of analysis, we explored ridership perceptions of 324 university students in Phnom Penh. We focused on this segment of the city's population as they are highly mobile, tend to be sustainability-conscious, and are predisposed to non-physical, digital, planning strategies. The SEM results indicated that the factors of *timeliness* and *general safety and comfort onboard* are significant predictors of attitudes towards bus ridership. Beyond service attributes, a broader SEM analysis of behavioural intentions suggested that subjective norms (perceived social pressure from important referents), personal norms (self-based moral obligation), and positive anticipated emotion (prospects of affective response to performance of behaviour) are significant factors in predicting bus-riding behaviour among university students. Using the results of the SEM analysis, both physical (e.g., bus priority lanes, enhanced walkways and bus stops) and non-physical, information technology alternatives are suggested to enhance bus ridership.

Keywords

Theory of Planned Behaviour
Structural equation modelling
Public bus ridership
Public transit planning
Phnom Penh

1. Introduction

Transport infrastructure is central to a country's socio-economic development and accessible public transit frequently is used as an indicator in "smart city" assessment frameworks (Jiang et al., 2017; Purnomo & Prabowo, 2016; Irvine et al., 2022). Environmental co-benefits, such as reduced greenhouse gas emissions, also may accrue from an efficient public transportation system (Kwan & Hashim, 2016; Nanaki et al., 2017). In an effort to optimize public transportation service delivery and usage, research has been conducted worldwide to improve understanding of the leading service factors that impact user satisfaction (Eboli & Mazzulla, 2007; Fujii & Van, 2009; Hensher, 2014). Van Lierop et al. (2018) identified seven overarching categories that characterized satisfaction with public transit service: onboard experience, customer service, service delivery, waiting conditions, cost, quality of transfers, and image.

Phnom Penh, Cambodia, recently re-established a public bus service, but there are concerns that current low ridership may render the system unsustainable. This study focused on analysing the bus-riding behaviour among university students, as motorcycles are currently their primary mode of transportation (Figure 1).

The high proportion of motorcycle use is recognised as a main contributor to the transport sector's carbon emission and heavy traffic congestion in Phnom Penh (Choocharukul & Ung, 2011; Ministry of Public Works and Transport, 2013). As a young generation of educated Cambodians who must travel daily for classes, we felt that there may be considerable scope for mobility behaviour modification.

Using the Theory of Planned Behaviour (TPB) as an overarching guide and structural equation modelling (SEM) as the primary method of analysis, the objectives of this study were to: i) elucidate factors that influence bus-riding behaviour of both users and non-users of the City Bus among university students; and ii) suggest policy and planning actions that could be considered in order to increase ridership. In this paper, the term "ridership" connotes two meanings: bus travel experience and the number of passengers; used interchangeably based on the context.

source: photo by authors

Figure 1 Student motorcycle parking at a Phnom Penh university.

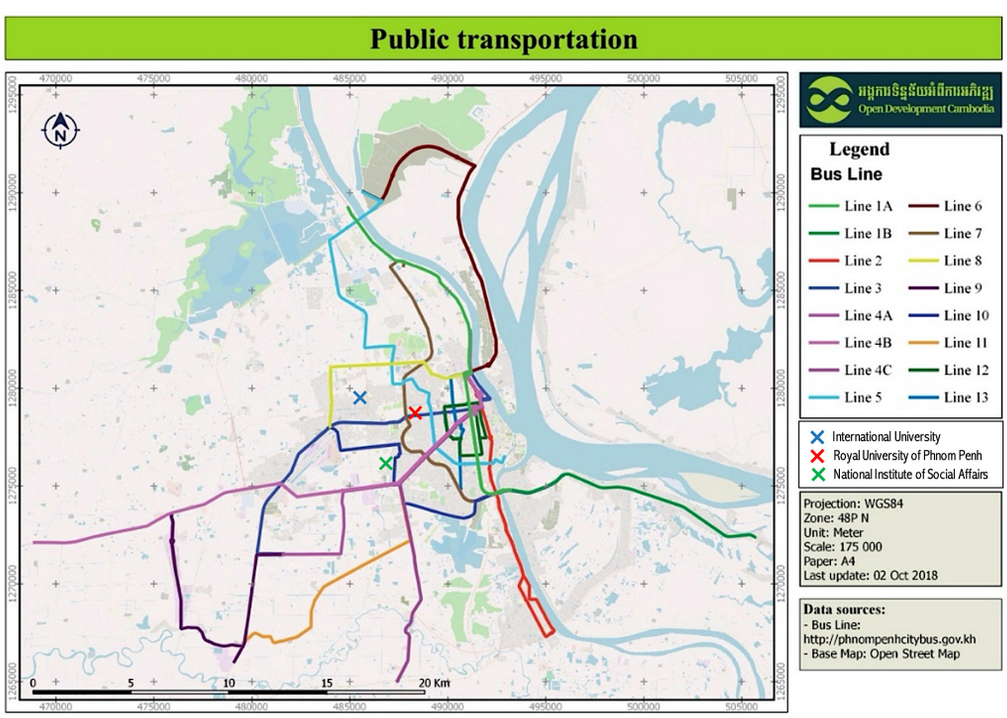
2. Background to the Study – Transportation in Phnom Penh

Infrastructure within Phnom Penh and other Cambodian cities was severely damaged during the civil war (1970-1975), Khmer Rouge period (1975-1979), and subsequent occupation by Vietnam (1979-1989) (Vickery, 1984; Kiernan, 2002). After the first modern free elections in 1993, the country reopened to the world and especially in the past 15 years has seen remarkable re-development; but public transportation planning has been slow to keep pace. About 82% of all registered vehicles in Cambodia are found in Phnom Penh, with motorcycles outnumbering

cars by a factor of 5 (Yoeung, 2015). Traffic congestion and road safety remain significant problems, despite improvements to roadways since the early 2000's (Phun et al., 2015a).

Presently, the City Bus is the only formal municipal public transportation system serving Phnom Penh. A public bus system was first trialled in 2001, through funding provided by the Japan International Cooperation Agency (JICA). A fleet of about 20 buses operated on two routes, but due to funding constraints and dissatisfaction over limited service area, the programme was discontinued after one month (Sokunthea, 2015).

In 2014, the Phnom Penh City Bus system (City Bus) was re-launched through a cooperative effort with Japan and China, starting with 3 bus lines. The programme has now expanded to 13 major routes with about 230 buses in service (Figure 2). Operating hours are from 0530hrs to 2030hrs and regular fare has been set at 1500 riels (~$0.38 USD) per trip, irrespective of distance. Students, elderly, monks, and disabled people ride for free. Service quality also has improved. For example, the Chinese government donated 98 smart buses (equipped with real-time monitoring systems and air-conditioning), providing for a safer and more comfortable ride along 5 bus routes (Sovan & Mao, 2018). In October 2018, Phnom Penh received 80 Japanese-made super-luxury buses to service 5 recently added routes (Buh, 2018). Furthermore, provision of onboard Wi-Fi service is in a pilot phase, to increase passengers' convenience and comfort (Suy, 2018). A free mobile application, "Stops Near Me", enables users to locate near-by bus stops and provides suggested routes, allowing for more efficient journey planning (Chanraksa, 2017). However, concern remains about the viability of the fledgling City Bus system due to low ridership and high operational cost (particularly when donor-country support is phased out). Although the City Bus has seen ridership increase from 5,000 passengers per day since its launch to about 10,000 passengers per day currently, buses are still running at low capacity, with monthly economic loses being about 150,000 USD (Sophon, 2018).



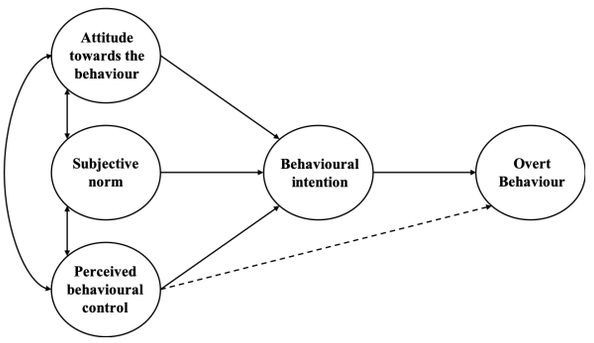
source: Open Development Cambodia, 2018

Figure 2 Bus Lines for Phnom Penh City Bus Adapted from "Public transportation".

Apart from personal private modes of transportation and City Bus, there are alternative forms of transportation in Phnom Penh, namely, taxi and paratransit (motodop, remork, tuk tuk, and cyclo) (Phun et al., 2015b). Motodop is a motorcycle taxi while remork consists of a two-wheeled carriage pulled by a motorcycle. Presently, no official statistics exist for paratransit modes, although Choocharukul and Ung (2011) have attributed the popularity of informal transit to the lack of adequate public transportation in Phnom Penh. In recent years, ride-hailing applications for remork and taxis, such as Passapp, also have emerged (Phun et al., 2018).

3. Theoretical Framework – Theory of Planned Behaviour

We administered a questionnaire, which was framed using the Theory of Planned Behaviour (TPB) as the theoretical anchor, to assess factors influencing bus ridership. The survey data were analysed using a structural equation modelling (SEM) approach to identify significant factors associated with respondents' decision to take the City Bus. The TPB suggests that behavioural intentions, which have three conceptually independent constructs, are the precursors and closest antecedents of overt behaviour (Figure 3). Ajzen (1991) theorized that attitude towards overt behaviour is determined by the degree to which an individual has a favourable or unfavourable appraisal of behaviour outcomes. Individuals with a favourable attitude towards a certain behaviour perceive that engaging in the behaviour will lead to positive outcomes and therefore are more likely to execute the behaviour. Serving as external motives influencing an individual's behavioural intentions, subjective norms, are social pressures or perceived expectations from important referents, such as family members or close friends (Ajzen, 1991). Perceived behavioural control represents an individual's perception about factors that promote or impede a behaviour's enactment.



source: Ajzan, 1991

Figure 3 The Theory of Planned Behaviour Adapted from "The Theory of Planned Behaviour".

The TPB and extended TPB (with additional latent variables) have been applied in various domains, including transport-related behaviour (e.g., Bamberg et al., 2003; Donald et al., 2014; Heath & Gifford, 2002; Huang et al., 2015). Our study seeks to extend the original TPB by including the latent factors of: i) descriptive norms, or perceptions of the typical behaviours performed by others that are related to one's perception of what behaviour is occurring (rather than what behaviour *ought to be*)(Cialdini, 1991); ii) personal norms, the intrinsic motivation of an individual's personal feelings and obligation about the performance of a behaviour (Harland et al., 1999); and iii) anticipated emotion, the prospects of a positive or negative feeling after performing or not performing a behaviour (Rivis et al., 2009). These additional factors may provide a deeper understanding of motivations to take the City Bus.

4. Methodology

4.1 Questionnaire

Questionnaires were administered at three universities, Royal University of Phnom Penh (RUPP), International University (IU), and National Institute of Social Affairs (NISA) (Figure 2). The questionnaires were done face-to-face in a classroom setting where a research assistant (RA) first provided information about the study and obtained informed consent (in Khmer). As the university students had basic English

proficiency, the questionnaire was delivered in English but the RA (fluent in Khmer and English) provided clarification, as needed, to ensure accuracy of responses. Samples were collected from 5 to 13 December 2018. The survey method was approved through the NIE/NTU IRB process before study commenced. With respect to sample size, Weston and Gore (2006) recommend a minimum sample size of 200 for any SEM study; the total number of participants in our study was 324 students.

The questionnaire was divided into three main sections: demographic; respondents' travel information; and extended TPB components. The scenario given of "If I take the City bus next week..." allowed for both bus riders and non-riders to participate in the questionnaire, enabling perceptions of both groups to be captured. Specific questions were developed through the team's prior understanding of transportation issues in Cambodia and in consultation with previous transportation studies using the TPB framework (Bamberg et al., 2003; Choocharukul & Ung, 2011; Fu & Juan, 2017; Heath & Gifford, 2002; and Huang et al., 2015; and Phun et al., 2015a). A sample of the full questionnaire is available from the corresponding author.

4.2 Data Analysis

Data were reviewed and rectified for missing data and outliers following the approaches described by Osborne (2013), with the data subsequently being tested for statistical assumptions of additivity, linearity, normality, homogeneity and homoscedasticity following Berry and Feldman (1985). Two separate SEM analyses were performed – one to understand the relationship of factors influencing perceived service quality of the City Bus (that considered 28 indicators) and the other to understand the relationship of factors influencing respondents' behavioural intentions to use the City Bus per the extended TPB framework (that considered 19 indicators). The software R in Rstudio was used for the SEM analysis.

SEM consists of a measurement model and a structural model. For the measurement model, an a priori path analysis diagram is constructed to illustrate the set of relationships between exogenous and endogenous variables, with the assumption of unidimensionality (Weston & Gore, 2006). The measurement model validity is assessed through confirmatory factor analysis (CFA). A structural model is then specified and assessed for model validity. The model depicts the hypothesized relationships among latent factors. Multiple-fit indices, including chi-square, root mean square error of approximation (RMSEA), standardized root mean square residual (SRMR), goodness-of-fit statistic (GFI), adjusted goodness-of-fit statistic (AGFI), comparative fit index (CFI), Tucker Lewis Index (TLI), and Parsimonious Normed Fit Index, were used to assess the structural model's goodness-of-fit.

5. Results

5.1 Demographic characteristics

Of the 324 respondents who participated in the questionnaire survey, 133 respondents (41.0%) were male and 191 (59.0%) were female. The average age for respondents was 20.0 years old. Respondents represented 17 different university courses, with the largest proportion of students (30.4%) being year 4 Bachelor's degree students (Figure 4).

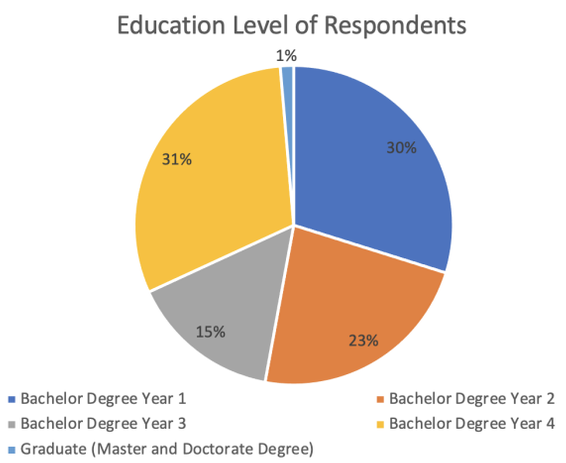


Figure 4 University education level of respondents (note that there was 1 additional respondent in year 6 Bachelor's degree under the medical degree programme.

The majority of respondents (86.7%) were not born in Phnom Penh, originating from 20 different provinces (and 1 respondent from Laos). The average residential time for respondents who were not born in Phnom Penh, but have lived in the city for more than a year, was 3.0 years, but 18.5% of the students had lived in Phnom Penh for less than a year.

Respondents born outside of Phnom Penh were asked who they lived with and responses were categorized into: i) family; ii) friend(s); iii) family and friend(s); and iv) alone. Under the family category, respondents indicated parents, aunts and uncles, and siblings; none of the respondents indicated family members from two generations before (i.e. grandparents). Most respondents lived with family and/or friend(s) (265 respondents, 89.1%), and only a minority live alone (29 respondents, 10.9%) (Figure 5).

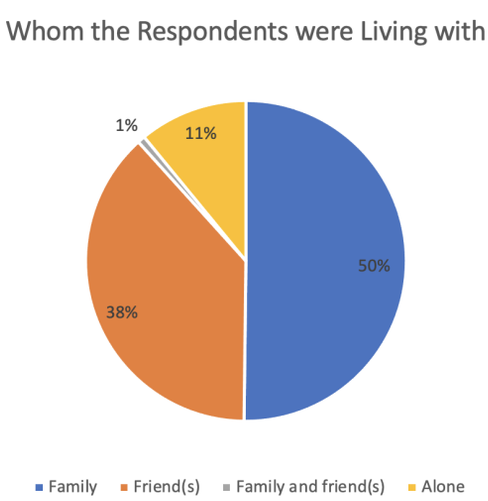


Figure 5 Whom the respondents from other provinces lived with while in Phnom Penh.

The median annual household income reported by the respondents was 3,000 USD, which is lower than the median household income of 10,900 USD in 2015 for Phnom Penh as a whole (Gaudemar, 2016). Furthermore, the mean annual household income of respondents was 4,440 USD which is lower than the national mean annual income of 5,750 USD (in 2017) (National Institute of Statistics, 2018). These results imply that respondents surveyed, in general, came from households that were relatively less affluent.

5.2 Travel mode choices

General questions about respondents' travel choices provided an understanding of the most frequent mode of transportation, City Bus ridership experience, and reasons for transport mode choices. The mean number of motorcycles per household was 2.07, while the mean number of cars per household was 0.24, implying that most households would have a motorcycle available for use, although automobile availability was considerably less, consistent with the household income results.

Motorcycle was the most frequently used mode of transportation (215 respondents, 69.8%), followed by bicycle (40 respondents, 13.0%) and walking (28 respondents, 9.1%). Only 7 respondents (2.3%) indicated that they used the City Bus as their most frequently used mode of transportation. Respondents who had not previously taken the City Bus were asked why and results are summarized in Figure 6. Long distances to bus stops (190 responses, 23.9%), long waiting time (137 responses, 17.2%) and the bus being a slow mode of transport (115 responses, 14.5%) were the top three reasons for not taking the City Bus and collectively may be attributed to the factor of time.

Respondents were asked how they first got to know about the City Bus. Friends of university students were a key information provider (56 responses, 53.3%), as depicted in Figure 7.

5.3 SEM Modelling - Perceived service quality

Descriptive statistics for variables pertaining to perceived service quality of the City Bus system are shown in Table 1. In the data screening process, variables CF2 and SA2 were removed from further analysis as they had >5% missing data points, while 37 respondents had >5% missing data points and an additional 7 respondents were identified as outliers. Hence, the original sample size of 324 was reduced to 280. Correlations between measured variables were <0.8 and VIF ranged from 1.41 to 2.13, indicating the assumptions regarding multicollinearity and additivity

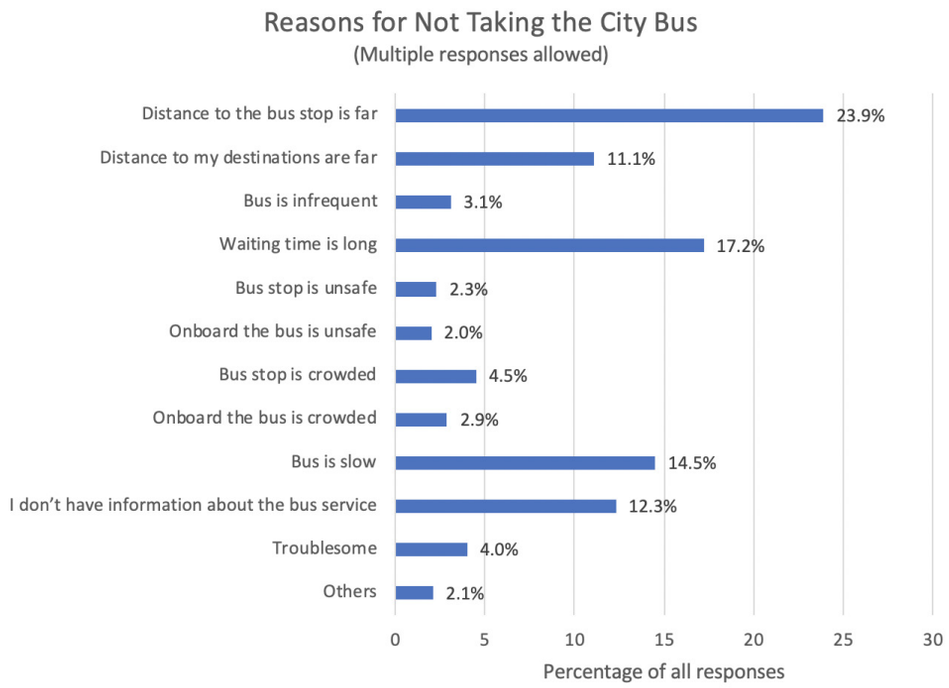


Figure 6 Reasons for not taking the City Bus (responses from those who have never taken the bus).

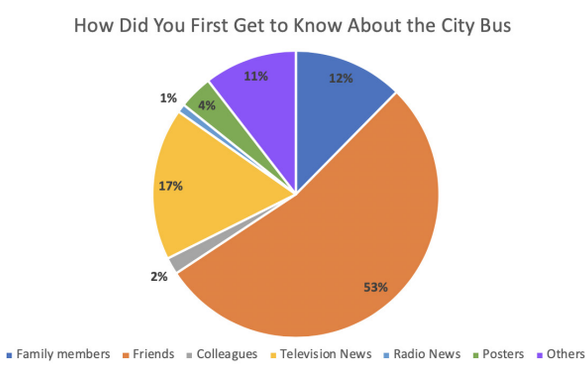


Figure 7 Initial sources of information about the City Bus service.

were met. Assumptions of linearity, normality, homogeneity and homoscedasticity also were fulfilled. Bartlett's test of sphericity was significant and the KMO sampling adequacy test was 0.91 (>0.7). Both results indicated suitability of proceeding with Exploratory Factor Analysis (EFA).

Factor extraction or dimensionality assessment conducted using parallel analysis suggested 4 factors be retained, while analysis with the visual scree plot and Kaiser criterion indicated 2 factors be retained. As such, the structures of two-factor, three-factor and four-factor models were tested. The three-factor solution, with an RMSR of 0.03, RMSEA index of 0.040, TLI of 0.967, CFI of 0.979, cumulative variance of 0.48 and factor with lowest Cronbach's alpha value of 0.77, was selected as the most suitable model. Therefore, by means of EFA, three latent factors were retained. The first factor included the variables COS1, CF1, CF3, SA1, CF6, CL1, DR2, and EN1; the second factor included variables CV3, T1, T2, T3, and T4; and the third factor consisted of variables SA3, SA4, CL2, and INF1. SEM subsequently was conducted using the three-factor solution.

In consideration of space, we do not include the intermediate CFA and measurement model steps here, but only the final structural model results. Details of the intermediate steps can be provided by the corresponding author upon request. Following the verification of the measurement model, a structural model was constructed (Figure 8), with the results of the fit indices being $\chi 2$ =1.478, RMSEA=0.043, SRMR=0.046, GFI=0.957, AGFI=0.932, CFI=0.980, TLI=0.973, and PNFI=0.698. All threshold values for the fit indices were met and the explained variance (R^2) was 0.482. Table 2 summarizes the measured variables, corresponding questionnaire questions, and the appropriate names for each factor.

Table 1. Summary statistics of questions pertaining to perceived service quality.

Measured variable	Questionnaire question	Mean	Median	Standard deviation
Attitude 1 (AT1)	Overall, I will find using the City Bus to be good	3.57	4	0.85
Attitude 2 (AT2)	Overall, I will find using the City Bus to be important	3.42	4	1.04
Attitude 3 (AT2)	Overall, I will find using the City Bus to be sensible	3.35	3	0.96
Cost 1 (COS1)	I will find using the City Bus to be cheap	3.97	4	0.97
Convenience 1 (CV1)	In general, I will find using the City Bus to be convenient	3.39	4	0.94
Convenience 2 (CV2)	It will be easy to get to the bus stops (from (1) origin to bus stop and (2) Bus stop to destination)	3.04	3	1.09
Convenience 3 (CV3)	The distances to the bus stops are near (Distance includes (1) origin to bus stop and (2) Bus stop to destination)	2.99	3	1.08
Timeliness 1 (T1)	In general, the City Bus will be a fast mode of transport	2.65	2	1.11
Timeliness 2 (T2)	The waiting time for a bus will be short	2.98	3	1.21
Timeliness 3 (T3)	The travel duration on the bus will be short	2.89	3	1.10
Timeliness 4 (T4)	The bus will be on time (i.e. punctual)	3.02	3	1.20
Comfort 1 (CF1)	In general, I will find using the City Bus to be comfortable	3.68	4	1.01
Comfort 2 (CF2)	The bus stop will be pleasant	3.30	3	0.98
Comfort 3 (CF3)	I will be able to relax on the City Bus (e.g., nap, read, chat, etc)	3.64	4	1.01
Comfort 4 (CF4)	The City Bus will not be crowded	3.18	3	1.08
Comfort 5 (CF5)	There will be enough seats on the bus	3.34	4	1.09
Comfort 6 (CF6)	I will find that using the City Bus protects me from the weather (e.g., rain and sun)	3.84	4	0.98
Safety 1 (SA1)	In general, I will find using the City Bus to be safe	3.74	4	1.06
Safety 2 (SA2)	On board the City Bus will be safe	3.57	4	1.00
Safety 3 (SA3)	Waiting at the bus stop will be safe	3.28	3	1.10
Safety 4 (SA4)	En route to the bus stop will be safe (e.g., walking to the bus stop)	3.09	3	1.09
Cleanliness 1 (CL1)	The bus will be clean	3.72	4	0.91
Cleanliness 2 (CL2)	The bus stop will be clean	3.26	4	1.09
Driver's quality (DR1)	The bus driver and conductor's service will be good	3.56	4	0.98
Driver's quality (DR2)	The bus driver will drive safely (e.g., obey speed limit and other traffic rules)	3.86	4	0.91
Other commuters (OC1)	Other commuters on the bus will be good (i.e. considerate, friendly, polite, etc)	3.33	4	0.97
Environmental-friendliness (EN1)	I will find using the City Bus to be environmentally-friendly	3.76	4	0.96
Information (INF1)	I will have sufficient reliable information about the bus service (e.g., information about the bus schedule)	3.37	4	1.02

* The three highest values for the mean and standard deviation are highlighted in yellow and the three lowest values in blue.

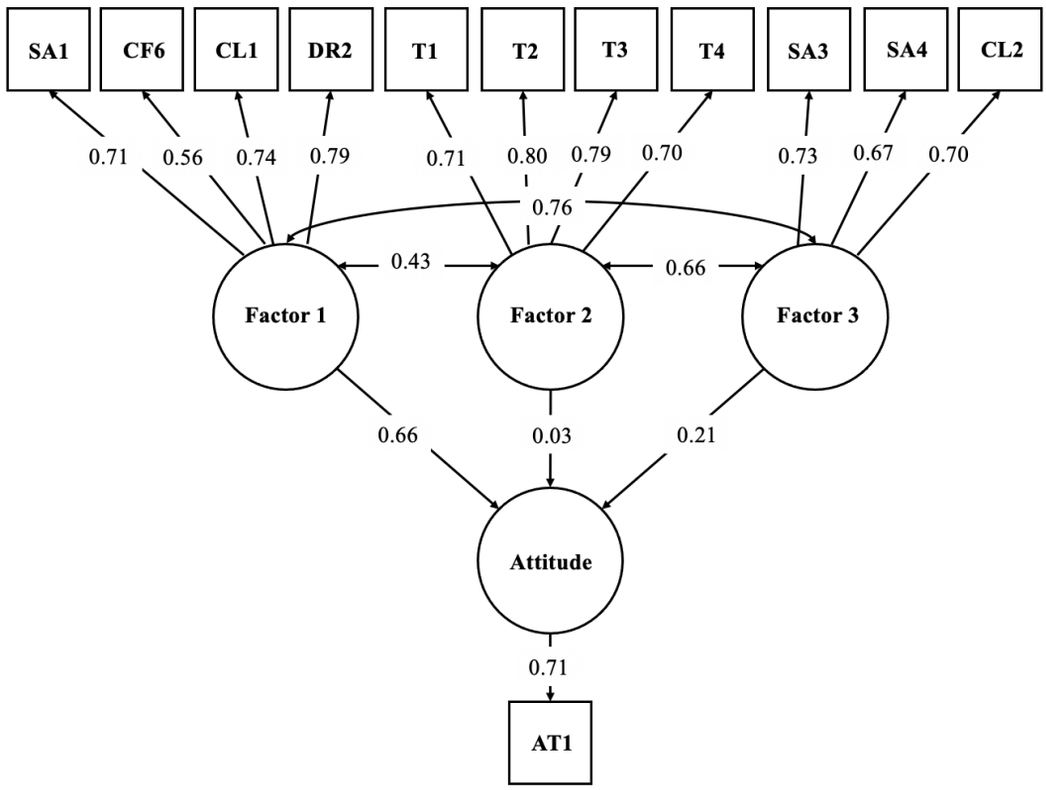


Figure 8 Structural model for City Bus perceived service quality, where the values indicate factor loading.

Table 2. Questionnaire questions and factor names for measured variable in structural model.

Factor	Measured variable	Questionnaire question	Factor name
Factor 1	SA1	In general, I will find using the City Bus to be safe	General safety and comfort onboard
	CF6	I will find that using the City Bus protects me from the weather	
	CL1	The bus will be clean	
	DR2	The bus driver will drive safely	
Factor 2	T1	In general, the City Bus will be a fast mode of transport	Timeliness of service
	T2	The waiting time for a bus will be short	
	T3	The travel duration on the bus will be short	
	T4	The bus will be on time (i.e. punctual)	
Factor 3	SA3	Waiting at the bus stop will be safe	Safety and cleanliness before boarding
	SA4	En route to the bus stop will be safe	
	CL2	The bus stop will be clean	

The compound effect size of factor 1, 2 and 3 is calculated to be 0.514, 0.175 and 0.313 respectively. Other than having the largest effect size, factor 1 was also the only factor with a p-value < 0.05. Therefore, general safety and comfort onboard was the most significant factor of consideration for predicting university students' attitude towards the City Bus.

5.4 SEM Modelling - Behavioural intentions

The summary statistics for the questionnaire questions (measured variables) pertaining to the behavioural intentions of taking the City Bus are shown in Table 3. None of the measured variables had >5% missing data. However, 37 respondents had >5% missing data and there were 10 outliers which were excluded from the analysis. The data fulfilled the assumptions of additivity, linearity, normality, homogeneity and homoscedasticity required for SEM. VIF ranged between 1.285 and 2.133, which is less than the cutoff of 5 and therefore no variables were removed. EFA was performed on an initial measurement model. Measured variables were then checked for significant loading factors of >0.6 and the indicators AT1, AT3, SN3, PBC2, PBC3, NAE1, and BI2 which had loading factors of <0.6 were removed.

In consideration of space, we do not include the intermediate CFA and measurement model steps here, but only the final structural model results. Details of the intermediate steps can be provided by the corresponding author upon request. Following the verification of the measurement model, a structural model was constructed and results are shown in Figure 9. The goodness-of-fit indices were: $\chi 2$=1.56, RMSEA=0.045, SRMR=0.026, GFI=0.975, AGFI=0.934, CFI=0.980, TLI=0.956, and PNFI=0.431. All threshold values for the fit indices were met and the explained variance (R^2) was 0.369.

In summary, of the 8 latent factors tested, the effect of 3 latent factors (subjective norms, personal norms, and positive anticipated emotion) were significant with respect to university students' behavioural intentions of riding the City Bus. This analysis suggests that factors predicting behavioural intentions may be important, as behavioural intention is the precursor to behavioural enactment. The significant variables of the three latent factors are summarized in Table 4.

6. Discussion

Based on the questionnaire results and SEM analysis, we identified four important factors that impact bus ridership, specifically in relation to university students: i) Timeliness; ii) Safety; iii) Referents; and iv) Personal norms and positive anticipated emotion. We discuss each in turn:

6.1 Timeliness as a Factor

The factor of timeliness (which includes en route timeliness, waiting time, and journey time) emerged as an overarching factor that significantly impacts an individual's choice to take the City Bus. Multiple dimensions were related to the timeliness factor, including reliability of service and service coverage. Table 1 shows that the variables with the three lowest mean responses were associated with the timeliness of service factor - T1 (general speed of service), T2 (waiting time) and T3 (travel duration). With mean values below the neutral value of 3 on the 5-point Likert scale, this implied a perception that timeliness of the bus service was less satisfactory. Furthermore, Figure 6 shows "distance to the bus stop is far" was the most frequently cited reason for not taking the City Bus, followed by "waiting time is long" and "bus is slow". Collectively, this is compelling evidence that time was a crucially important factor that should be improved in the City Bus service.

Phun et al. (2015b) investigated factors that could affect ridership using an ordered probit model during the introductory phase of the current City Bus

Table 3. Summary statistics of questions pertaining to behavioural intentions.

Measured variable	Questionnaire question	Mean	Median	Standard deviation
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Attitude 2 (AT2)	Overall, I will find using the City Bus to be important	3.42	4	1.04
Attitude 3 (AT3)	Overall, I will find using the City Bus to be sensible	3.35	3	0.96
Subjective norm 1 (SN1)	My family members think that I should take the City Bus	3.09	3	1.04
Subjective norm 2 (SN2)	My close friends think that I should take the City Bus	3.08	3	0.99
Subjective norm 3 (SN3)	The authorities (e.g. government officials) think that I should take the City Bus	3.57	4	1.04
Descriptive norm 1 (DN1)	My family members themselves use the City Bus frequently (at least 4 times in a week)	2.30	2	1.06
Descriptive norm 2 (DN2)	My close friends themselves use the City Bus frequently (at least 4 times in a week)	2.66	2	1.07
Personal norm 1 (PN1)	I feel a personal obligation to use the City Bus	3.13	3	1.01
Personal norm 2 (PN2)	I am willing to use the City Bus on a regular basis (at least 4 times in a week)	2.85	3	1.05
Perceived behavioural control 1 (PBC1)	I can easily use the City Bus	3.22	3	1.06
Perceived behavioural control 2 (PBC2)	I know enough information about the City Bus (e.g. information about the bus schedule, location of bus stop, etc)	2.88	3	1.08
Perceived behavioural control 3 (PBC3)	The decision whether to use the City Bus is entirely up to me	3.41	4	1.01
Positive anticipated emotion 1 (PAE1)	If I use the City Bus, I will feel happy	3.36	4	0.99
Positive anticipated emotion 2 (PAE2)	If I use the City Bus, I will feel proud	3.31	3	1.00
Negative anticipated emotion 1 (NAE1)	If do not use the City Bus, I will feel discontented	2.75	3	0.94
Negative anticipated emotion 2 (NAE2)	If do not use the City Bus, I will feel guilty	2.62	2	0.94
Behavioural intention 1 (BI1)	I intend to use the City Bus as my main mode of travel	3.11	3	1.02
Behavioural intention 2 (BI2)	I will use the City Bus in the future	3.80	4	1.05

**The three highest values for the mean and standard deviation are highlighted in yellow and the three lowest values in blue.*

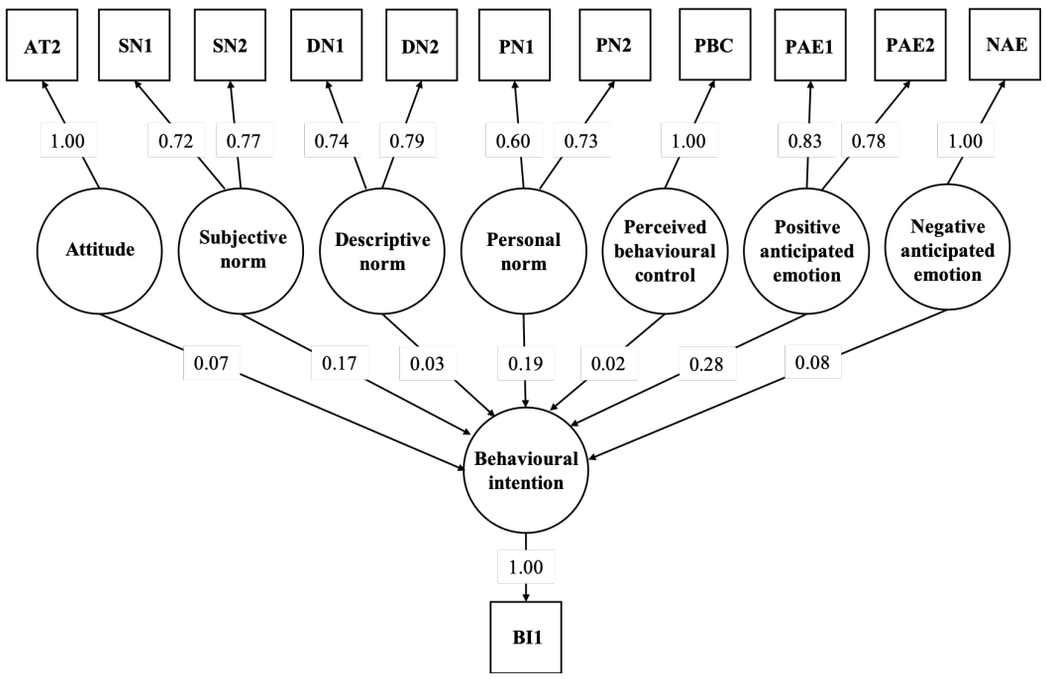

Figure 9 Structural model for behavioural intentions, where the values indicate factor loading.

Table 4. Questions contributing to latent factors with large effect sizes.

Latent factor	Measured Variable	Questionnaire question
Subjective norm	SN1	My family members think that I should take the City Bus
	SN2	My close friends think that I should take the City Bus
Personal norm	PN1	I feel a personal obligation to use the City Bus
	PN2	I am willing to use the City Bus on a regular basis (at least 4 times in a week)
Positive anticipated emotion	PAE1	If I use the City Bus, I will feel happy
	PAE2	If I use the City Bus, I will feel proud

service and reported that of five subjective bus attributes, speed was the factor that obtained the lowest mean score during the initial introductory period. The City Bus service network has expanded from 3 to 13 lines since its inception in 2014, but coverage of service still emerged as a factor of concern, a finding consistent with results reported by Sum et al. (2020) in an analysis of general population ridership. Accessibility issues (distance and ease of access) render the travel less seamless. For example, it may be necessary to employ a motodop to bridge the distance from home to the bus stop and again after alighting from the bus to a final destination. Le and Trinh (2016) investigated factors accounting for low bus adoption despite improvements in public transport service in Ho Chi Minh City and argued that the city remains motorcycle dependent as motorcycles allow shorter travel time and provide commuters greater flexibility in travel schedule. The findings of Phun et al. (2015); Sum et al. (2020); and Le and Trinh (2016) underscore the importance of timeliness as a service quality factor.

6.2 Safety as a Factor

The SEM analysis showed the perceived service quality factor, "general safety and comfort onboard" as being significant for predicting attitude towards bus ridership. The importance of safety as a primary consideration also was highlighted by Lon et al. (2013) in their survey conducted during the planning stage of the current City Bus system, concluding that reliance on motorcycle and car travel may be reduced if public transportation systems are safe. Public transportation generally has better onboard safety as compared to private transportation modes, especially motorcycles (Roehler et al., 2015). In Le and Trinh's (2016) study, inadequacy of safety was statistically significant in relation to student choice in taking the bus. Susilo et al.'s (2010) study of public transport in 3 Indonesian cities highlighted safety and security issues as the most significant aspect of service, with about 90% of respondents willing to pay higher fares for increased safety and security. Interestingly, Sum et al. (2020) did not find safety to be a primary indicator of service quality amongst the current, general bus ridership in Phnom Penh. The difference may have occurred because our survey focused on university students and also because the students were predominantly non-bus users.

While descriptive statistics in Table 1 show that travel by City Bus generally is perceived safe, we do note that safety en route to the bus stop scores relatively lower, with a mean value of 3.09. Walkability in Phnom Penh most certainly can be impacted by informal pavement economy, poor sidewalk maintenance, and community space spillover, amongst other issues (Figure 10; Kolnberger, 2012; Yen et al., 2021).

6.3 Referents as key actors

Under the TPB framework, the importance of significant reference persons (referents) is connected to the factor of subjective norms (Ajzen, 1991). Subjective norms, an outcome of normative belief, may be conceptualized as perceived expectations of "important others" to engage in a certain behaviour. Consequently, the fear of social exclusion motivates people to conform with social norms in performing particular behaviours. Social norms also may directly impact the development of personal moral norms, as individuals internalize group standards. Yadav and Pathak (2016) found, for example, that pro-environmental behaviour was influenced by important referents within an individual's social network.

source: photos by authors

Figure 10 Bus stop with no walkway buffer and surrounded by overgrown grass and rubbish (left); bus stop being obstructed by vehicles (middle); and food vendor in front of a bus stop (right).

The subjective norms factor (with friends and family members as key referents) was one of the latent factors with large effect, while conversely, measured variable SN3, "the authorities (e.g., government officials) think that I should take the City Bus" was an insignificant factor. Notably, most respondents (89.1%) share living accommodation with family and/or friend(s). Reid et al. (2009) concluded that households are important social units, where norms, values and ways of living are shared. Especially in school settings, friends may encourage each other to carry out similar actions (Li & Zeng, 2017). Interestingly, however, we found that while family members and friends were important determinants of university student's decision-making on the behavioural intention to take the City Bus, most of these important referents themselves do not take the City Bus nor do they advocate for respondents to take the City Bus. Potentially, then, family and friends may have a negative influence on university student behaviour with respect ridership uptake. Although students may serve as key drivers of change, outreach programs catering to different demographic groups should be considered and may prove mutually reinforcing.

6.4 Personal norms and positive anticipated emotion

We determined personal norms and positive anticipated emotion to be important in influencing behavioural intentions and therefore behaviour of riding the bus. Consistent with the conclusions of Huang et al. (2015), a sense of personal obligation (personal norm) serves as intrinsic motivation to use public transportation and is therefore significant to increasing the likelihood of taking the bus. In terms of anticipatory emotions, it was important that university students could potentially feel positive after performing the behaviour of taking the bus. In contrast, negative anticipated emotion was not significant. Other studies also have reported that moral obligations and problem awareness positively impacted environmental and public transportation ridership (Fujii & Van, 2009; Le & Trinh, 2016; Nordlund & Garvill, 2003).

Related to behavioural intentions, we note variable BI2 had the highest mean value of 3.80 (Table 2), which is promising as it showed that university students were likely to consider the City Bus as a mode of transport in the future. However, BI1 which measured behavioural intention as well, had a considerably lower mean of 3.11. It seems that while university students will consider using the bus in the future, it was less likely that the bus will be their dominant form of travel. Possibly, the City Bus could become a dominant mode of transport if sustained positive experiences of using the bus are felt.

7. Implications for Planning – Possible Ways Forward

A successful public transportation system requires comprehensive multi-pronged strategies, as evidenced by experience in Tokyo, Singapore, Hong Kong and Seoul (Barter, 2000; Ibrahim, 2003). For example, in Singapore enhancements to the bus system included improved bus designs, improved intermediate and end-point facilities (e.g., shelters, linkways, bus interchange developments, intermodal connections), provision of various bus service types (including express and night bus service), integrated fare systems through contactless smart cards, and data systems to manage bus bunching (Ibrahim, 2003; Liu et al., 2019). Based on the SEM results we make three planning recommendations that might be implemented to increase bus ridership:

7.1 Pedestrian walkways

Improvements to pedestrian walkway networks (including connected sidewalks, bridges, underpasses) could address the key concern of safety. Besides, it provides for weather protection and improved accessibility to bus stops and this contributes to positive anticipated emotions of the bus riding experience. Grass and tree buffers between the road

and pedestrian sidewalks could prevent currently prevalent illegal parking and informal businesses from occupying the sidewalks. While the global ideal of clean and orderly streets may not be a possible (or even desirable) goal, perhaps the model of managed informality as practiced in Bangkok (Batréau & Bonnet, 2016) might be better implemented to facilitate pedestrian access to bus stops.

Increased connectivity to the bus stops would enhance bus ridership through increased convenience and accessibility. However, in addition to increased ridership, a move away from vehicle-oriented city planning to a people-oriented and transit-oriented city planning approach could contribute to building Phnom Penh into a sustainable, liveable city (Cervero, 2013; Shamsuddin et al., 2012); the concepts of connectivity and a seamless, effective, mass transit system have been promoted as components of the smart city movement (e.g., Irvine et al., 2022).

7.2 Bus priority lanes

Implementation of bus priority lanes targets the factor of timeliness as it would help to minimize traffic disruptions which increases the speed and reliability of service. We understand that, in fact, the government has plans to pilot a stretch of bus priority lane, but a key challenge may be infrastructural constraints of existing narrow roadways, since priority lanes could increase traffic congestion along certain roads. One way to combat space limitation is to establish partial bus lanes which operate only within a stipulated time, such as during peak traffic hours. Bus priority lanes also may be implemented on short stretches of road, in key areas where bus timeliness would be improved by the enactment of such lanes (Sakamoto et al., 2007). Bus alighting bays requiring only a cut into the pedestrian sidewalks for the segment around the bus stop, also would allow for minimal disruption to the flow of traffic. However, effectiveness of bus bays in comparison to curb-side stops has yielded mixed results and is context-dependent (Liu et al., 2017). Hence, pilot testing and place-based analysis would prove useful. Effective implementation can only work with the understanding and cooperation of the public.

7.3 Information technology

Information technology can be used to support a more user-centric transportation service (Piro et al., 2014; Liu et al., 2019). Adoption of ride-hailing apps has been on the rise in Phnom Penh (Phun et al., 2018) and an existing mobile app, "Stops Near Me" shows the location of bus stops and real time locations of buses. Increased publicity of the application is suggested, as many students were unaware of its existence. In addition, aspects of personalization could be included, such as individualized accounts that track use of public transportation. The use of public transportation could then be connected to an emissions savings counter that reflects a tangible environmental benefit, such as the number of trees saved. We hope the technology would encourage university students to be active agents of environmental change rather than mere users of transport services.

A gamification platform to help enhance intrinsic motivation for bus ridership and include credit rewards redeemable through participating sponsors also might be implemented (e.g., Morganti et al., 2017; Wee & Choong, 2019; Irvine et al., 2022). Functions that allow for sharing on a social media platform could be employed to leverage on the positive effects of social networks, enhance community connectivity, and resonate with the university student demographic. As such, the adoption of information technology targets university students' key decision-making factors of peer influence from referents and the degree of positive anticipated emotion.

8. Conclusion

An SEM analysis of questionnaires administered to 324 university students in Phnom Penh showed the factors of timeliness and general safety and

comfort onboard were significant in explaining drivers of bus ridership. The SEM analysis also showed behavioural intentions, subjective norms, personal norms, and positive anticipated emotion as significant factors in predicting bus riding behaviour. The influence of key referents on university student bus riding behaviour also is crucial. Hence, consideration of other demographic groups should not be discounted. Perhaps further study on a broader demographic sample population could be conducted in the future; catering strategies to improve bus ridership amongst other age groups would be complementary to strategies targeting university students. In addition, as the level of infrastructure for the bus service tended to be different in different areas (e.g., central and suburb areas), there is scope for future studies on the relationship between the people's place of origin to their perception and ridership of the City Bus.

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