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# Young people's perceived service quality and environmental performance of hybrid electric bus service

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ABSTRACT

While cities are moving towards environmentally friendly public transport such as electrification of public buses, the attractiveness of such innovative solutions among the bus users is yet to be explored. We study young people's perception of hybrid electric buses (HEBs) incorporating environmental performance in the bus service quality assessment framework. We collect data using a structured survey questionnaire from young people aged between 18 and 34 years, living in Southern Norway. Methodology-wise, we use the covariance-based structural equation model (SEM). As of contribution, we examine service quality of HEBs, using contextually modified measurement scales adopted from the SERVQUAL framework. We introduce a four-item perceived environmental performance construct in the context of HEBs. We find that tangible features of HEBs, bus service provider's empathy and perceived environmental performance of HEBs have a significant positive association with customer satisfaction, and customer satisfaction is positively associated with life satisfaction of young people. Finally, a post hoc analysis using multi-group confirmatory factor analysis reveals that the levels of young people's perceived service with bus drivers' quality, empathy of the bus service provider and customer satisfaction with HEBs are higher in colder temperature.

## 1. Introduction

Transportation is often referred to as the blood system of society (Banister et al., 2011). Subjective wellbeing of a society depends on multiple interdependent factors, and transportation as a part of daily lives influence these factors (Zhang, 2017). People decide on important life decisions depending upon the transportation facilities available. For example, the location of a residence, job, schooling, leisure activity and quality of a neighbourhood depends on the availability of transportation in that selected area (Zhang, 2017). As a consequence, improved and efficient transportation facility leads to improved quality of life.

Meanwhile, scientists speculated that the world's temperature would rise above 2 °C than pre-industrial time if emissions reduction below 70% and 90% cannot be achieved within 2050 (Johansson, 2009). In general, 20–25% of the world's yearly energy consumption accounts for transportation (Zhou et al., 2017). Among the four major modes of transport (air, sea, road and rail), road transport accounts for the highest share of $CO_2$ emissions (European Commission, n.d.). Hence, it is essential to reduce emissions from the road transport sector to achieve the EU low-emission mobility strategy (European Commission, n.d.). In the European context, among the existing environmentally friendly alternatives, "a solid trend toward electricity emerges" (p. 62), particularly the hybrid electric buses (HEBs) (Corazza et al., 2016).

HEBs are one of the outcomes of the recent development in the transport industry that functions with a propulsion system of both the internal combustion engine and an electric motor as its power source (Tzeng et al., 2005). The development of hybrid vehicles started as early as in the 1800s when Italian Alessandro Volta stated that electric energy could be stored (Høyer, 2008). Later, *Ferdinand Porsche* developed the first hybrid (gasoline-electric car) car in 1900. Since then, many technological and infrastructural innovations took place, resulting in the modern-day hybrid electric vehicles with improved efficiency.

When it comes to electric vehicles (EVs), Norway certainly is one of the fast movers in the world. The Norwegian government offers several incentives for the adaptation of EVs including tax exemptions, toll exemptions, free public parking etc. (Mersky et al., 2016). Other European countries also took such initiatives. As a consequence, on the EU level, EVs, on average, save 50–60% of GHG emissions (Moro and Lonza, 2018). Despite rapid adaptation of EVs across Europe, a modal shift from car to electric buses can contribute further in reducing

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emissions from the transport industry. “Even with a modest level of occupancy”, buses are highly energy-efficient passenger transport mode “contributing to the reduction of $CO_2$ and other GHG emissions” (Corazza et al., 2016, p. 49). However, the environmentally friendly feature is not enough to attract bus users, but the quality of service in terms of design, comfort, punctuality etc. needs to be maintained (Corazza et al., 2016).

Different age groups of society are identified as generations. Strauss and Howe (1991) propose a generational cycle theory, where the generation’s peer personality is recognized by their “common age, location, common beliefs and behaviour and membership in a common generation” (p 64). Researchers have divided the young population as a generation in several ways. For example, 18–34 years old as generation Y (Hopkins, 2016), 15–34 years old as young adults (Zhang, 2017), rising adulthood from 22 to 43 years old (Coomes and DeBard, 2004). The fact that people from the same generation are exposed to similar context of the societal, economic and political situation, studying a topic (e.g. the attractiveness of HEBs) in the context of a generation is essential (Hopkins, 2016). For instance, a larger percentage of millennials in Canada use public transport more frequently in comparison to other age groups (Newbold and Scott, 2018). Furthermore, young population, when moving from their parents’ house and stepping forward to make further life choices, are on a verge of certain challenges regarding decision of new residence and job which ultimately affects their health, social and family life, finance, leisure and overall quality of life (Xiong and Zhang, 2016). In this context, Barton (2009) suggest that better public transportation can influence their quality of life by (1) reducing inequalities in pursuing residence, jobs and other public facilities, (2) reducing lifestyle diseases, (3) improving the environment and living condition by reducing GHG emissions, and (4) making life more enjoyable and safer.

Young population in many countries has been shifting more towards public transport, cycling and walking as a mode of mobility. Between the 1980s and 1990s, acquiring driving license among young people dropped significantly, particularly in Norway and Sweden (Berg, 2001). Similarly, in the USA, young people have travelled 23% less in 2009 compared to 2001 (Davis et al., 2012). The rising environmental awareness among young people could be a driver of this changing travel behaviour. In the same vein, in a survey of 18–34 years old, 16% *strongly agree* with the statement “I want to protect the environment, so I drive less” (Davis et al., 2012). Hence, young people’s perceived service quality and environmental performance of HEBs can play a significant role in HEB adoption. In Norway, currently, about 25% of the total population is young adults (Statistics Norway, n.d.), aged between 16 and 34 years old, which indicates the importance of the perception of this age group for promoting environmentally friendly public transport.

Meanwhile, to the best of authors’ knowledge, in the context of HEBs, a study on young people’s perception towards HEBs is not existent. Hence, we extend the bus service quality assessment framework by incorporating the environmental performance dimension. We find that young people’s perceived bus tangible features, empathy and environmental performance of HEBs are positively associated with their customer satisfaction. In addition, customer satisfaction is positively associated with life satisfaction.

In the next section of this study, we present the literature review and formulate hypotheses. In Section 3, we present data and methodology. Results of the structural equation model (SEM) and summary of hypothesis testing is presented in Section 4. Section 5 presents a post hoc analysis on the impact of the season (outside temperature) on the results. The findings are discussed in Section 6, and finally, Section 7 presents the conclusions.

## 2. Literature review

Customer satisfaction is a central concept in this study. Customer satisfaction can be defined as a judgement, that a product or service provides an enjoyable level of consumption-related fulfilment, including levels of under or over fulfilment (Oliver, 2014). In the context of public transport, customer satisfaction for a given trip relies on multiple service quality attributes, such as cleanliness and outlook of the travel mode, availability, travel route, presence of required emergency services etc. (Eboli and Mazzulla, 2007). Customer satisfaction with travel can be influenced by several factors and can vary among individuals depending upon their adaptation, geographical location and climate (Abenoza et al., 2017; Liu et al., 2014). Incidents and experiences of a traveller while receiving a commutation service shapes the travellers’ satisfaction (Friman et al., 1998). Also, people of different age groups can have different perceptions of the same transport service (Zhang, 2017). Thus, travel satisfaction of young people of the recently launched HEBs in Southern Norway could impact their willingness to continue using public transport.

The SERVQUAL measurement scale developed by Parasuraman et al. (1988) has been used by previous studies to assess service quality in different contexts. For example, to assess service quality in the transport industry (Morton et al., 2016), travel and tourism (Fick and Brent Ritchie, 1991), airlines (Tsaur et al., 2002) and many more. Morton et al. (2016) adopt the SERVQUAL approach to measure convenience, cabin environment and ease of use of public bus service. Using the SERVQUAL model, Susnienė (2012) study service quality of public transport-related factors including tangibility, reliability, assurance, empathy and responsiveness. Thus, this study adopts a contextually modified SERVQUAL model to measure the service quality of HEBs.

In the next sub-sections, we argue for associations between the three adopted service quality dimensions and customer satisfaction, followed by arguments for the association between environmental performance and customer satisfaction, and the association between customer satisfaction and life satisfaction of young people.

### 2.1. Bus tangible and customer satisfaction

Tangibles are related to the viewpoint of physical layouts, surroundings and facilities provided by the service, such as equipment and appliances, appearance of crews, communication options etc. (Parasuraman et al., 1988). Intangibility, heterogeneity and inseparability of production and consumption make service quality an illusory construct (Parasuraman et al., 1985). As a result, customer measures the quality of service depending upon the tangible features such as the interior of an organization, outlook, atmosphere etc. (Yu and Tung, 2013). Bus service-related tangible features includes the physical condition of the vehicle, cleanliness, air cooling and heating system, audio control for the stoppage and any message or instruction from the driver etc. (Jomnonkwao and Ratanavaraha, 2016). The accessibility of the emergency safety toolkit with necessary signs can also be crucial. The ability to serve special care needs such as children stroller and wheelchair user-friendly boarding system, space for heavy luggage etc. are inevitable features. Eboli and Mazzulla (2007) find that tangible features such as bus stop furniture, cleanliness and maintenance influences students' travel satisfaction. Similarly, Morton et al. (2016) find that cabin environment in buses measured by cleanliness, comfort, safety and security has a positive association with perceived customer satisfaction. Thus, we hypothesize that:

**H1:.** Tangible feature of HEBs is positively associated with young people’s customer satisfaction.

### 2.2. Bus driver quality and customer satisfaction

Bus drivers play an essential role in making the travel comfortable and smooth for the passengers. A skilful and friendly driver can make a difference in customer satisfaction, although a too friendly driver does not have any effect on customer satisfaction (Hensher et al., 2003). Edvardsson (1998) scrutinize written complaints and interviews from public transport passengers of Sweden and find that customer dissatisfaction is linked with treatment and attitude of the bus personnel. Wen et al. (2005) assess bus service quality using four factors, and one of them was the bus crew's attitude. They find a positive association between service quality and customer satisfaction. Wen et al. (2005) use six indicators to measure bus drivers' quality including clean and neat appearance, politeness and friendliness, handling an emergency, not ignoring passengers while busy and providing service actively. In a study on the service quality of a sightseeing school bus, Jomnonkwao and Ratanavaraha (2016) argue that bus crews' attitude as a service quality could affect customer satisfaction. In an earlier study, Ratanavaraha and Jomnonkwao (2014) find that bus drivers' skill, smoking and drinking habit, age, driving license and experience are indicators of users' expectation in a sightseeing bus service. Thus, we hypothesize that:

**H2:.** HEB driver's quality is positively associated with young people's customer satisfaction.

### 2.3. Empathy and customer satisfaction

Empathy drives customer satisfaction in every service industry. In terms of providing service, empathy can be defined as a service element to provide customised and special treatment, and care to make the customer feel valued (Bloemer et al., 1999; Parasuraman et al., 1988). While studying low-cost carriers in South Korean domestic airports, Kim and Lee (2011) find that empathy of perceived service quality has a positive effect on customer satisfaction. Another study on the gas station, airline, trains and bus transportation, using data from Norwegian Customer Satisfaction Barometer, suggests that empathy (measured by employee's treatment, understanding customer need and paying attention) positively associates with customer satisfaction (Johnson et al., 2001). As numbers of educated customers have increased nowadays than before (Mouawad and Kleiner, 1996), they require highly trained and empathetic employees to be satisfied with the service (Donthu and Yoo, 1998). Studies dedicated solely to bus service quality also find a positive association between empathy and customer satisfaction (Sam et al., 2018). Thus, we hypothesize that:

**H3:.** HEB service provider's empathy is positively associated with young people's customer satisfaction.

### 2.4. Perceived environmental performance and customer satisfaction

GHG emissions and reduced urban air quality are strongly correlated with the rise of conventional transportation modes, that is, fossil fuel-driven vehicles (Nesheli et al., 2017). China has been facing a real-time detrimental effect of emissions from an increased number of motor vehicles, leading to a severe level of $NO_2$ and CO in the air (Fu et al., 2001). Meanwhile, HEBs as an environmentally friendly alternative is one of the most suitable public transportation modes that can contribute to reducing GHG and $CO_2$ emissions from the transportation industry (Corazza et al., 2016; Tzeng et al., 2005).

As public awareness regarding environmental sustainability has been gaining attention, from a bus service provider's perspective, it is viable to switch to environmentally friendly buses such as HEBs. While there exist studies concerning consumers' perception toward environmental performance of a product or service in different contexts such as green product consumption (Paul et al., 2016) and hospitality service (Smith et al., 2015), such studies are rare in the context of public transport. Paul et al. (2016) find a significant association between the environmental concern of consumers with their purchase intentions. Smith et al. (2015) find a positive association between environmental programs of resorts and customer satisfaction. Gregory Owen Thomas and Walker (2015) find no significant difference in environmental attitudes of people using different travel modes but in their satisfaction level. Thus, we can argue that a higher level of the perceived environmental performance of HEBs among young people would improve their customer satisfaction. Thus, we hypothesize that:

**H4:.** Young people's perceived environmental performance with HEBs is positively associated with customer satisfaction.

### 2.5. Customer satisfaction and life satisfaction

The cognitive evaluation of how good a person's life is, through a certain period of time, can be defined as life satisfaction (De Vos and Witlox, 2017). As multiple studies suggest, a well-developed commutation service goes a long way to build a better and active social life leading to life satisfaction. One part of customer satisfaction with HEB service can be referred to as travel satisfaction through the trip. Gregory O Thomas, Walker, and Musselwhite (2014) find that satisfaction with travel mode is closely linked to feelings of control. De Vos (2019) show how travel satisfaction, directly and indirectly, influences life satisfaction. Association between travel satisfaction and life satisfaction can also be explained by outdoor activities that people participate through a good travel and the sense of wellbeing they receive (Abou-Zeid et al., 2012; Diener, 2000). A stressful trip might lead to dissatisfaction for the upcoming activity following the trip and reduce the satisfying quality of the activity (De Vos and Witlox, 2017), leading to an overall dissatisfaction, if repeatedly observed. As such, there exists a spillover effect of the subjective experiences during a trip on the perception of life satisfaction (Bergstad et al., 2011; Ettema et al., 2010). Thus, we hypothesize that:

**H5:.** Young people's customer satisfaction with HEBs is positively associated with life satisfaction of young people.

Based on the arguments and hypotheses presented in Section 2, the conceptual framework of this study is depicted in Fig. 1.

## 3. Data and methodology

### 3.1. Context of the study

Young people's travel behaviour has been changing recently with a noticeable decline in acquiring of driving licence, particularly in Norway and Sweden (Sivak and Schoettle, 2012). Southern Norway – the context of this study is interesting for two reasons. Firstly, on June 2018, all the public transport buses in major cities in the Agder county of Southern Norway (Kristiansand, Søgne, Songdalen, Vennesla,

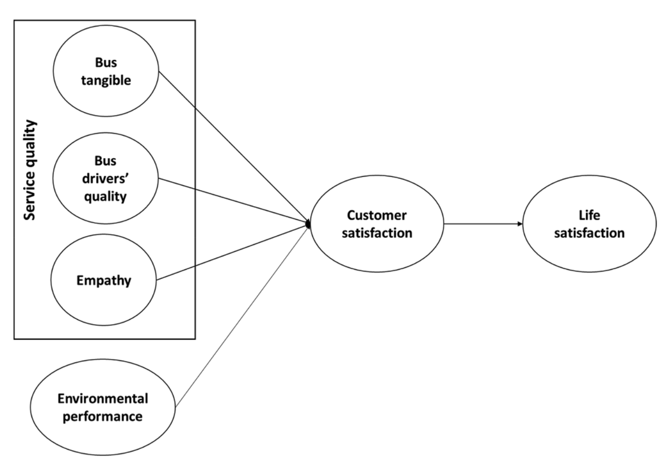


**Fig. 1.** Conceptual model.

Birkenes and Lillesand)[1] were replaced with HEBs. Norway generates 98% of its electricity from renewable sources such as hydropower and wind.[2] This means HEBs in Norway are even more environmentally friendly compared to countries generating electricity from non-renewable sources. The second reason is that Norway is a high-income country, and previous studies suggest that car ownership and usage among young people in developed countries have to be reduced to achieve better environmental performance from the transport sector (Muromachi, 2017).

We collect data in two waves. First, in November 2018, and second, in January 2019, from young people, mainly students of the University of Agder. The University of Agder has two campuses, one in Kristiansand (West-Agder) and another in Grimstad (East-Agder). The Kristiansand campus accommodates approximately 76% of the university's total students. The population of Kristiansand (the fifth largest city in Norway) is about 85,000. The total number of students at the Kristiansand campus (approx. 10,000) is almost 12% of the population of the city. We distributed a structured web-survey among the students of four classes in the Kristiansand campus. The survey did not collect personal data in any form, and therefore, ethical or data protection approval was not mandatory.[3] The students were given about 20 min in the class to complete the survey. The survey administrator informed the students that it is not mandatory to participate in the survey, and they could opt-out at any time. In total, 322 students participated in the online survey, among which 272 are valid (101 valid responses from November 2018 and 171 from January 2019). We exclude observations with the respondent's age outside the range between 16 and 34 years, if the respondent has not experienced HEBs in real life and straight-lining. About 91% of the respondents in the sample reside in the city of Kristiansand, and rests are spread over surrounding cities, mainly Arendal, Mandal, Lillesand and Vennesla.

Kline (2015) suggest at least 100 observations to estimate SEM and 200 observations for reliable estimates, which is certainly met by our sample size of 272. Table 1 briefly presents the demographic profile of the respondents and their monthly use of the HEBs. The sample represents rather an equal gender balance with 51% female and 49% male respondents. Mean age of respondents is 21.71 years, with a minimum age of 18 years and a maximum of 34 years, indicating the representativeness of young people. In terms of education level, 79% of the respondents are enrolled in a bachelor's degree program and 21% in a master's degree program. Majority of the respondents, that is, 51% use HEBs frequently. One reason for 38% using HEBs occasionally could be that many students live on/near campus who use the bus only when travelling to the city centre.

Moreover, in the survey, respondents self-reported their degree of mobility using car, bike and walking on a scale of 1 (light user) to 5 (heavy user). To check for non-response bias, we divide the sample of 272 into two equal sub-samples, and compare the degree of mobility using car, bike and walking between the first respondents (1–136 observations) and last respondents (137–272 observations). We find no significant difference between the first and last respondents in terms of their degree of mobility using car (T-test, p-value: 0.597), bike (T-test, p-value: 0.516) and walking (T-test, p-value: 0.695). Thus, the results of this study are not affected by any severe non-response bias issue.

### 3.2. Measurement model

The measurement model is a prerequisite for SEM, which relates measurement items to their respective latent variables. In this section, we present the theoretical background and statistical analysis to confirm the validity and reliability of the measurement model. For analysis purpose, we use the mathematical programming software *R*, particularly the *lavaan* package for SEM (Rosseel, 2012).

**Table 1**
Demographics of the respondents.

| Variable | Categories | Frequency/ Statistics | Percentage |
|---|---|---|---|
| Gender | Male | 133 | 49 |
| | Female | 139 | 51 |
| Age | Mean | 21.71 | - |
| | Standard deviation | 2.90 | - |
| | Maximum | 34 | - |
| | Minimum | 18 | - |
| Education level | Bachelor's degree | 214 | 79 |
| | Master's degree | 58 | 21 |
| Monthly use of hybrid electric bus | Less than 5 times | 105 | 38 |
| | About 6–10 times | 29 | 11 |
| | About 11–15 times | 16 | 6 |
| | More than 15 times | 122 | 45 |

#### 3.2.1. Operationalization of latent variables

As shown in Fig. 1, the conceptual model consists of six latent variables, which are multifaceted and cannot be measured through a single observed variable. Thus, we use multiple observed items to measure each of the latent variables of the conceptual model.

The first three exogenous variables relate to the service quality of hybrid electric buses. The well-known study by Parasuraman et al. (1988) developed measurement scales to measure the service quality of firms. However, the bus service is somewhat different from traditional business service. Thus, relying on Parasuraman et al. (1988), we adopt measurement scales for 'bus tangible' and 'bus drivers' quality' from Jomnonkwao and Ratanavaraha (2016). Initially, bus tangible is constructed as a seven-item latent variable, where items one to six are taken from Jomnonkwao and Ratanavaraha (2016), and item seven is the authors' contribution. Later, we drop item three due to poor factor loading. The four items of bus driver quality construct are taken from Jomnonkwao and Ratanavaraha (2016), too. The five items for 'empathy of bus service provider' are adopted from Parasuraman et al. (1988) but modified for the bus service industry. The three items for customer satisfaction are adapted from Davidow (2000).

For measurement of the perceived environmental performance of HEBs, to the best of authors' knowledge, no previous study has developed scales using multiple observed variables. Meanwhile, relevant scales to measure environmental performance is well documented in the green supply chain management literature, e.g. Zhu, Sarkis, and Lai (2008). Therefore, we construct a four-item perceived environmental performance latent variable for HEBs relying on Mishina and Muromachi (2017), Gopal, Park, Witt, and Phadke (2018) and He, Chen, and Conzelmann (2012). Finally, for life satisfaction measurement, the five items are adopted from the well-known study by Diener, Emmons, Larsen, and Griffin (1985). Table 2 presents the measurement items with their respective latent variables.

#### 3.2.2. Normality check

Before proceeding with the measurement model, that is, confirmatory factor analysis (CFA) model, we check for normality of measurement items using both multivariate and univariate normality tests. Normality of data is important, as the estimation method in CFA (and SEM) is dependent on the normality of data. Mardia test (p-

[1] https://www.boreal.no/agder/category1705.html, accessed on January 15, 2019.
[2] https://www.ssb.no/en/energi-og-industri/statistikker/elektrisitet, accessed on December 20, 2019.
[3] Checked at https://nsd.no/personvernombud/en/notify/notification_test.html

**Table 2**
Measurement items and their reliability.

| Constructs and their respective items | Factor loadings |
|---|---|
| Tangible features of the buses (BT, alpha: 0.85, CR: 0.85) | — |
| 1. Physical facilities of a bus are modern looking | 0.699 |
| 2. Neat and clean inside a bus | 0.696 |
| 3. *No disturbing noise from engine when sitting inside a bus* | *Dropped* |
| 4. Good condition of air cooling and heating system | 0.655 |
| 5. Good working condition of bus audio system | 0.691 |
| 6. Visibility of a complete set of safety equipment (i.e. glass | 0.717 |
| breaking device, emergency door, etc.) with instruction | 0.694 |
| signs | |
| 7. Suitable for special need users (i.e. users with wheel chair, | |
| baby stroller, heavy luggage, etc.) | |
| Bus drivers' quality (BD, alpha: 0.86, CR: 0.86) | — |
| 1. Bus driver with good driving skills | 0.762 |
| 2. Good appearance of bus driver (i.e. neat, clean and meets | 0.762 |
| uniform standards) | 0.801 |
| 3. Friendly, helpful and polite customer service of driver | 0.767 |
| 4. Effective and correct emergency management | |
| Empathy of bus service provider (EMP, alpha: 0.82, CR: 0.83) | — |
| 1. Punctual departure and arrival schedule | 0.705 |
| 2. Availability of bus routes within and outside city | 0.731 |
| 3. Availability of bus routes between city and airport | 0.627 |
| 4. Provision of compensation scheme in cases of loss or hazard | 0.739 |
| 5. Attention paid when passengers are boarding on-and-off a | 0.681 |
| bus | |
| Customer satisfaction (CS, alpha: 0.94, CR: 0.94) | — |
| 1. My satisfaction with this bus service has increased. | 0.910 |
| 2. My impression of this bus service has improved | 0.955 |
| 3. I now have a more positive attitude towards this bus service | 0.889 |
| Perceived environmental performance (EP, alpha: 0.92, CR: | — |
| 0.92) | 0.909 |
| 1. This hybrid electric bus service is more environmentally | 0.982 |
| friendly | 0.774 |
| 2. This hybrid electric bus service reduces CO2 emission from | 0.782 |
| road transport | |
| 3. This hybrid electric bus service reduces noise pollution in | |
| comparison to diesel bus | |
| 4. Using hybrid electric bus service, I contribute to the | |
| betterment of global environment | |
| Life satisfaction (LS, alpha: 0.85 CR: 0.91) | — |
| 1. In most ways my life is close to my ideal. | 0.855 |
| 2. The conditions of my life are excellent. | 0.926 |
| 3. I am satisfied with life. | 0.851 |
| 4. So far, I have gotten the important things I want in life. | 0.799 |
| 5. If I could live my life over again, I would change almost | 0.597 |
| nothing. | |

CFA model-fit: $\chi^2$ (3 0 9) = 483.499, CFI = 0.95, TLI = 0.95, RMSEA = 0.05, SRMR = 0.05; Alpha represents value of Cronbach's alpha, and CR represents composite reliability.

value < 0.05) rejects the null hypothesis of multivariate normality, and similarly Shapiro-Wilk test (all p-values < 0.05) of all measurement items rejects the null hypothesis of univariate normality. Thus, we use the maximum likelihood robust (MLR) estimator, also known as Satorra-Bentler rescaling method, to estimate the measurement model instead of the maximum likelihood (ML) estimator (Rosseel, 2012).

### 3.2.3. Reliability and validity

Data of the measurement items are collected through self-reported questionnaire. All the items are measured in a 7-point Likert scale, where '7' represents strong agreement with the statement, and '1' represents strong disagreement. After dropping item three of the bus tangible construct (see Table 2), the exploratory factor analysis (EFA) of the 27 items indicates a six-factor model (see Appendix A), later confirmed using confirmatory factor analysis (CFA). The right column in Table 2 presents the standardized factor loadings of the CFA model, all of which are statistically significant (p-value < 0.001) indicating that the items reflect their underlying latent construct. This confirms the convergent validity of the measurement model (Anderson and Gerbing, 1988). Cronbach's alpha (Cronbach, 1951) and composite reliability (CR) of each of the factors are also presented in Table 2. Cronbach's Alpha and CR values of all factors exceed the recommended threshold of 0.70, as suggested by Hair, Black, Babin, and Anderson (2010). Thus, the reliability of the measurement model is established. Taken from Hair et al. (2010), we can calculate CR using the following equation:

$$CR = \frac{\left(\sum_{i=1}^{n} FL_i\right)^2}{\left(\sum_{i=1}^{n} FL_i\right)^2 + \left(\sum_{i=1}^{n} ME_i\right)} \tag{1}$$

Here, $FL_i$ is the standardized factor loadings of measurement item $i$, $n$ is the number of items in a factor, and $ME_i$ is the measurement error of the item $i$. $ME_i$ is calculated as: $(\sum 1 - FL_i^2)$.

Divergent or discriminant validity (DV) confirms whether constructs that should not have any relationship, indeed are not related to each other. One way of confirming this is to position squared-correlations of all latent variables in a matrix and compare with their average variance extracted (AVE), such as in Table 3. Based on Hair et al. (2010), we can calculate AVE using the following equation:

$$AVE = \frac{\sum_{i=1}^{n} FL_i^2}{n} \tag{2}$$

Here, $FL_i$ is the standardized factor loadings of measurement item $i$, $n$ is the number of items in a factor. According to Hair et al. (2010), squared-correlations below diagonal should be lower than AVE of each latent variable to confirm DV. From Table 3, DV of the latent variables is confirmed, although the bus tangible AVE and squared-correlation falls in border-line thresholds. However, the measurement items of *bus tangible* are well-established in the literature (Jomnonkwao and Ratanavaraha, 2016; Wen et al., 2005). Thus, we confirm the DV of the latent variables.

Furthermore, the measurement model has a good fit (see exact values below Table 2) as indicated by the Comparative Fit Index (CFI) and the Tucker-Lewis Index (TLI) above the recommended level of 0.90, and Root Mean Square Error Approximation (RMSEA) and Standardized Root Mean Square Residual (SRMR) below the cut-off value of 0.08 (Hair et al., 2010). As the measurement model is now established, we present the descriptive statistics in Table 4.

**Table 3**
Divergent validity analysis.

| | BT | BD | EMP | CS | EP | LS |
|---|---|---|---|---|---|---|
| BT | 1.00 | | | | | |
| BD | 0.48 | 1.00 | | | | |
| EMP | 0.22 | 0.37 | 1.00 | | | |
| CS | 0.32 | 0.32 | 0.36 | 1.00 | | |
| EP | 0.27 | 0.20 | 0.17 | 0.23 | 1.00 | |
| LS | 0.13 | 0.08 | 0.07 | 0.09 | 0.08 | 1.00 |
| AVE | 0.48 | 0.60 | 0.49 | 0.84 | 0.75 | 0.66 |

Values in the matrix represents squared correlations among latent variables. A higher AVE value than the column-wise squared correlations indicates divergent validity.

**Table 4**
Descriptive statistics and correlations among latent variables.

| Latent Variables | Mean | SD | BT | BD | EMP | CS | EP | LS |
|---|---|---|---|---|---|---|---|---|
| BT | 4.89 | 1.05 | 1.00 | | | | | |
| BD | 4.72 | 1.20 | 0.69 | 1.00 | | | | |
| EMP | 4.25 | 1.16 | 0.47 | 0.61 | 1.00 | | | |
| CS | 4.43 | 1.28 | 0.57 | 0.57 | 0.60 | 1.00 | | |
| EP | 5.09 | 1.25 | 0.52 | 0.44 | 0.41 | 0.48 | 1.00 | |
| LS | 4.92 | 1.15 | 0.37 | 0.28 | 0.26 | 0.30 | 0.28 | 1.00 |

Note that mean and standard deviation (SD) values are based on arithmetic average of items scores measuring respective latent variables. The correlation matrix represent correlation among the latent variables based on extracted factor values through confirmatory factor analysis (CFA).

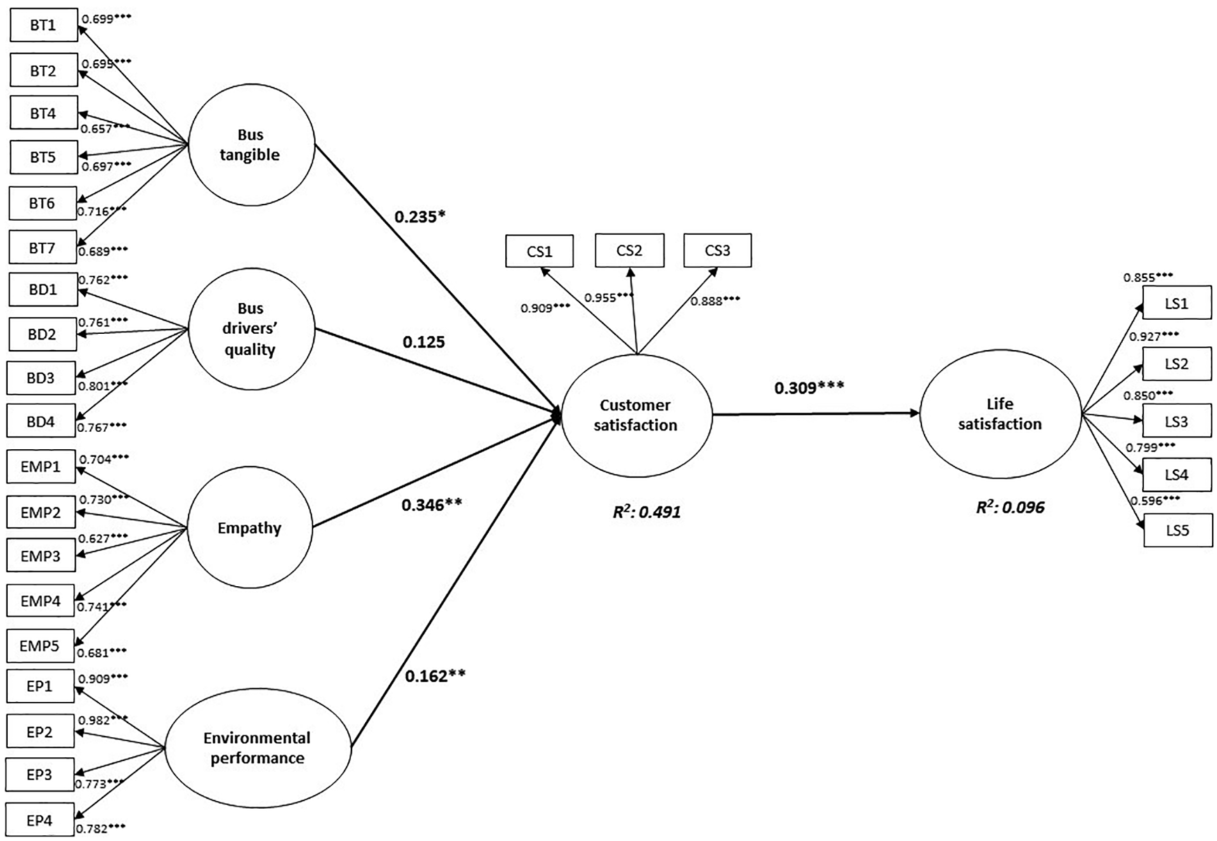


**Fig. 2.** The estimated structural equation model. ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$, $^{+}p < 0.10$. SEM model –fit: $\chi^2$ (3 1 3) = 496.106, CFI = 0.95, TLI = 0.95, RMSEA = 0.05, SRMR = 0.07.

**Table 5**
Summary of hypothesis testing.

| Hypothesis | Standardized coefficient | Remark |
|---|---|---|
| H1: Bus tangible → Customer satisfaction | 0.24 (0.13) * | Supported |
| H2: Bus drivers' quality → Customer satisfaction | 0.13 (0.12) | Not supported |
| H3: Empathy → Customer satisfaction | 0.35 (0.11) ** | Supported |
| H4: Environmental performance → Customer satisfaction | 0.16 (0.06) ** | Supported |
| H5: Customer satisfaction → Life satisfaction | 0.31 (0.06) *** | Supported |
| Indirect/mediation effects | | |
| Bus tangible → Customer satisfaction → Life satisfaction | 0.07 (0.04) * | Partial mediation |
| Bus drivers' quality → Customer satisfaction → Life satisfaction | 0.04 (0.03) | No mediation |
| Empathy → Customer satisfaction → Life satisfaction | 0.11 (0.03) ** | Partial mediation |
| Environmental performance → Customer satisfaction → Life satisfaction | 0.05 (0.02) * | Partial mediation |

Standard error in parenthesis. ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$, $^{+}p < 0.10$.

#### 3.2.4. Common method bias

Common method bias refers to measurement errors due to methodological issues. For instance, having a common measurement scale (e.g. 7-point Likert scale) for all survey questions may lead to common method bias. Podsakoff, MacKenzie, Lee, and Podsakoff (2003) outline a few statistical remedies to common method bias, each of which comes with pros and cons. In this study, we use Harman's single factor test, which is the most widely used one. We perform unrotated exploratory factor analysis using the 27 items loading on one latent factor. Average variance explained by the single factor is only 33% (well below the recommended cut-off 50%). Thus, common method bias is not an issue in this study.

## 4. Results

As the measurement model is established in the previous section, we proceed with the structural model to examine associations among the latent variables. Again, we use the MLR estimation for SEM, as suggested by Rosseel (2012) for non-normal data. We depict the estimated SEM in Fig. 2. In complex SEM studies with more than 12 measurement items such as this study, it is challenging to establish identical theoretical and observed structural model at 5% statistical significance (Hair et al., 2010). In such cases, the ratio between chi-square statistic and degrees of freedom (DF) should be below three (Bollen and Long, 1992), which is evident in the estimated SEM model (496.106/313 = 1.585) indicating a good model fit. Furthermore, other model-fit indices requirements are met. The CFI and TLI are above 0.90, and RMSEA and SRMR are below 0.08. Thus, SEM estimations are valid. The variance of the two endogenous variables (as indicated by the r-square of latent endogenous variables), customer satisfaction and life satisfaction, are explained about 50% and 10% by the model, accordingly.

Based on the SEM model in Fig. 2, we present a summary of hypothesis testing in Table 5. The first three hypotheses relate to the association between service quality of HEBs and customer satisfaction. Among those three, H2 is not supported, suggesting that bus drivers' quality is not associated with customer satisfaction in the context of Southern Norway. H1 and H3 are supported, suggesting a positive association between tangible features of bus and customer satisfaction, and between empathy of bus service provider and customer satisfaction. Also, H4 and H5 are supported, suggesting that the higher the perceived environmental performance of HEBs, the higher is customer satisfaction, and the higher the customer satisfaction with HEBs, the higher is the life satisfaction of young people. Furthermore, customer satisfaction plays a mediating role in the relationships of bus tangible, empathy and environmental performance with life satisfaction of young people.

For robustness check, we estimate the conceptual framework using the partial least squares (PLS) SEM (Hair et al., 2011). Appendix B presents a detailed result of PLS-SEM estimation. We find that the covariance-based SEM and PLS-SEM provide identical results for hypothesis testing.

## 5. Post hoc analysis: multi-group CFA

While checking for any difference in the monthly bus use frequency between the November 2018 and January 2019 sub-samples, we find a significant difference (T-test, p-value: 0.025). One reason could be that, in January, young people use public transport more frequently due to weather conditions, that is, colder and windier than other times of the year. Triggered by this observation, we estimated a multi-group CFA model considering the 101 observations of November 2018 as one group and 171 observations of January 2019 as another. Both groups individually meet the data requirements of CFA (Hair et al., 2010; Kline, 2015). This approach is inductive, and the purpose is to find out whether there is a significant difference in the perceived service quality, environmental performance and life satisfaction of young people depending on the time of the year or season of bus use. Earlier studies show that weather can have an impact on public transport ridership (Singhal et al., 2014; Zhou et al., 2017). The average temperatures in Kristiansand on the survey dates in November 2018 were 8.3 °C (06 Nov), 9.3 °C (07 Nov) and 6.4 °C (14 Nov), and on the survey date in January 2019 was 0.9 °C (21 Jan).[4] Generally, January in Southern Norway has a higher number of extremely cold and windy days than November.

To estimate a multi-group CFA for mean comparison of latent variables, invariance of the measurement model (see Section 3.2), particularly scalar invariance, across groups must be confirmed (Byrne et al., 1989; Chen, 2008). Before scalar invariance, metric invariance must be confirmed, which is established if there is no significant difference between the configural model (MG in Table 6) and the equal factor loadings model (MG2). Then, scalar invariance is achieved by fixing factor loadings and intercepts equal across groups (MG3) and then comparing MG3 with a metric invariance model (MG2). At first, we fail to achieve metric invariance due to a significant difference (p-value 0.03) between the MG and MG2. However, partial metric and scalar invariance is confirmed after withdrawing the equal factor loading constraint of the observed variable EP3 (that is, the third measurement item of perceived environmental performance) across groups. As can be seen in Table 6, the p-value of 0.438 for MG and MG2 comparison and p-value of 0.378 for MG2 and MG3 comparison indicates no difference and confirms scalar invariance. Thus, we can compare the means of latent variables of the scalar invariance model across groups.

The multi-group CFA reveals that the January group exhibits significantly higher levels of perceived service with bus drivers' quality (unstandardized beta: 0.335, p-value: 0.028), empathy of the bus service provider (unstandardized beta: 0.294, p-value: 0.073) and customer satisfaction (unstandardized beta: 0.294, p-value: 0.058) compared to the November group. In addition, negative coefficients of the satisfaction with bus tangible (unstandardized beta: −0.068), perceived environmental performance (unstandardized beta: −0.079) and life satisfaction (unstandardized beta: −0.188) indicate lower levels of these factors among the January group compared to the November group, but not statistically significant (p-values > 0.10).

[4] According to https://www.yr.no/place/Norway/Vest-Agder/Kristiansand/Kristiansand/statistics.html.

**Table 6**
Comparison of multi-group CFA model fit for invariance test.

| Model(s) | $\Delta\chi^2$ | Δdf | ΔCFI | ΔRMSEA | *P* value |
|---|---|---|---|---|---|
| *Initial invariance testing* | | | | | |
| MG (Configural, $\chi^2$ = 975, df = 618) | – | – | – | – | – |
| MG Vs. MG2 (Equal loadings) | 34.44 | 21 | 0.003 | 0.000 | 0.032 |
| MG2 Vs. MG3 (Equal intercepts) | 22.53 | 21 | 0.001 | 0.001 | 0.370 |
| *After removing equal factor loading constraint of EP3* | | | | | |
| MG (Configural, $\chi^2$ = 975, df = 618) | – | – | – | – | – |
| MG Vs. MG2 (Equal loadings) | 20.49 | 20 | 0.000 | 0.001 | 0.438 |
| MG2 Vs. MG3 (Equal intercepts) | 22.37 | 21 | 0.001 | 0.001 | 0.378 |

*MG* multi-group model, *Δdf* change in degrees of freedom, *ΔCFI* change in Comparative Fit Index, *ΔRMSEA* change in Root Mean-Square Error of Approximation.

## 6. Discussion

The introduction of HEBs can result in a step forward to green and sustainable city planning. In this study, we observe that young people consider HEBs as environmentally friendly transport mode when provided with adequate service quality. In our sample of 272, 156 respondents said that the HEBs are better than previous diesel buses in terms of overall service quality, while 104 respondents said no difference and only 12 said worst. Although we find that perceived environmental performance of HEBs influences customer satisfaction, the used methodology does not allow us with the opportunity to conclude on whether young people will switch to environmentally friendly travel mode if satisfied with the service quality. Meanwhile, previous studies suggest unaffiliated intention to safeguard the environment by changing travel behaviour (Line et al., 2010). Thus, there exists room for future research to investigate the influence of the introduction of environmentally friendly bus services on an individual's travel mode choice.

To summarise the key findings, first, we examine young people's perceived service quality of HEBs in Southern Norway based on three factors, bus tangible, bus drivers' quality and empathy of the bus service provider. As shown in Table 4, on the aggregate level, bus tangible receives the second-highest score (mean: 4.89, SD: 1.05), followed by bus drivers' quality (mean: 4.72, SD: 1.20), and empathy received the lowest score (mean: 4.25, SD: 1.16). Thus, the bus service provider should consider improving empathy-related services such as punctuality of schedules, availability of bus routes, provision of compensation scheme in cases of loss or hazard and paying attention when boarding on-and-off passengers. Similarly, Andreassen (1995) survey public transport users in Norway. According to the author, differentiation of service will lead to increased customer satisfaction because of a higher degree of congruence between supply and demand. From a policy perspective, the most important factors to focus on are travel time, fare level and design of public transport (Andreassen, 1995). Moreover, young people of Southern Norway perceive a high level of the environmental performance of HEBs (mean: 5.09, SD: 1.25). This indicates that HEBs are a viable, environmentally friendly, alternative to traditional fossil-fuel buses.

Second, we investigate the effect of HEB service quality factors on young people's customer satisfaction with the bus service. We find that bus drivers' quality is not associated with customer satisfaction. One explanation of this could be that passengers, in general, interact too little with bus drivers, especially in the developed countries as service like ticketing can easily be done online or via mobile phone applications. Meanwhile, bus tangible features are more visible to the users, and empathy-related factors such as punctuality, paying attention when boarding on-and-off passengers etc. are more dependent on the bus service provider and can influence customer satisfaction to a greater extent. This is evident in our findings. Similarly, Wen et al. (2005) find a positive association between bus service quality and customer satisfaction, too.

Third, we find a positive association between the perceived environmental performance of HEBs and customer satisfaction and a positive association between customer satisfaction and life satisfaction. De Vos (2019) also find a positive association between customer satisfaction from transport service and life satisfaction. In addition, this study reveals a positive association between the environmental performance of HEBs and customer satisfaction. However, the service quality-related factors, that is, bus tangible and empathy are still the strongest determinants of customer satisfaction as indicated by the standardized coefficients of SEM. Furthermore, the findings indicate that service quality factors, that is, bus tangible (standardized beta: 0.07, p-value: 0.03), empathy (standardized beta: 0.11, p-value: 0.00) and perceived environmental performance (standardized beta: 0.05, p-value: 0.02) of the HEBs have an indirect positive effect on life satisfaction of young people mediated by customer satisfaction. This provides evidence of the spillover effects of bus transportation service (Bergstad et al., 2011; Ettema et al., 2010). A smooth bus trip can lead to a satisfactory transition to an upcoming event (for example, arrival to the exam hall on time) that in turn can lead to a higher degree of life satisfaction.

Furthermore, the multi-group CFA reveals that the level of perceived service with bus drivers' quality, the empathy of bus service providers and customer satisfaction is higher among the January group. One reason could be that due to extreme cold weather in January compared to November, it is difficult to bike or walk in the city, even for shorter distances, and thus, young people in general use buses more and have a positive perception towards bus service. Hence, for the colder days of the year, the bus service providers should emphasize more on allocating highly skilled drivers and ensuring punctuality of bus schedule.

## 7. Conclusion

In many cities, traditional fossil fuel-driven buses are being replaced by HEBs. Meanwhile, to the best of the authors' knowledge, no studies exist on the assessment of the service quality of HEBs from the users' perspective. Thus, we study young people's perception of HEBs, incorporating environmental performance in the bus service quality assessment framework. We collect data from 272 university students in Southern Norway. A conceptual model is estimated using the covariance-based SEM, and also the PLS-SEM for robustness check of the estimates. Moreover, we conduct multi-group CFA to investigate the mean difference in latent constructs across two sub-samples exposed to varying outside temperatures.

We find significant positive effects of bus tangible features, the empathy of bus service provider and environmental performance of HEBs on young people's customer satisfaction. Also, the higher the customer satisfaction of young people, the higher is their life satisfaction. Besides, the multi-group CFA reveals that the level of young people's perceived service with bus drivers' quality, the empathy of the bus service provider and customer satisfaction with HEBs are higher in colder temperature.

Several extensions of the current research framework (Fig. 1) can be considered in future research. First, bus terminal related tangible factors can be considered as a moderating variable in the relationship between service quality and customer satisfaction. This is interesting because bus terminals are not maintained by the bus service provider company but by the local authority. Meanwhile, the terminal experience can influence bus service experience, particularly in Norway. For example, if there is no waiting-stand in the bus terminal, the overall bus riding experience of a passenger would be adversely affected in the cold Nordic weather. Another research direction could be looking into perceived value (typically measured by price and quality) of the bus service by young people. Compared to other age groups, young people are usually more price and quality conscious. Thus, incorporating perceived value as a determinant of customer satisfaction in the current model would be interesting. Also, the effect of customer satisfaction on word of mouth and customer loyalty should be considered.

## CRediT authorship contribution statement

**Ziaul Haque Munim:** Conceptualization, Data curation, Methodology, Writing - original draft, Writing - review & editing. **Tehjeeb Noor:** Writing - original draft, Writing - review & editing.

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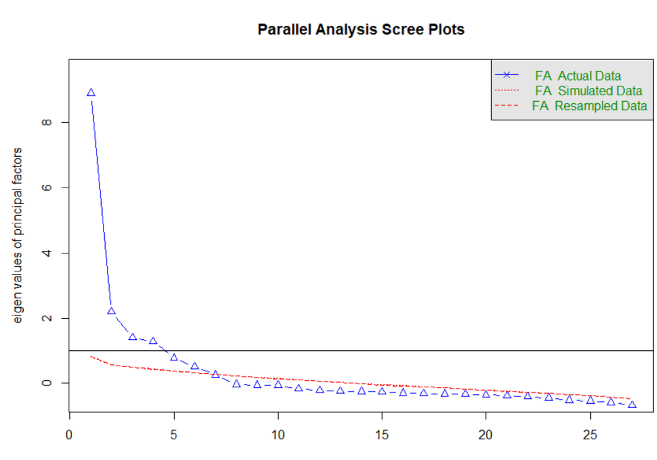
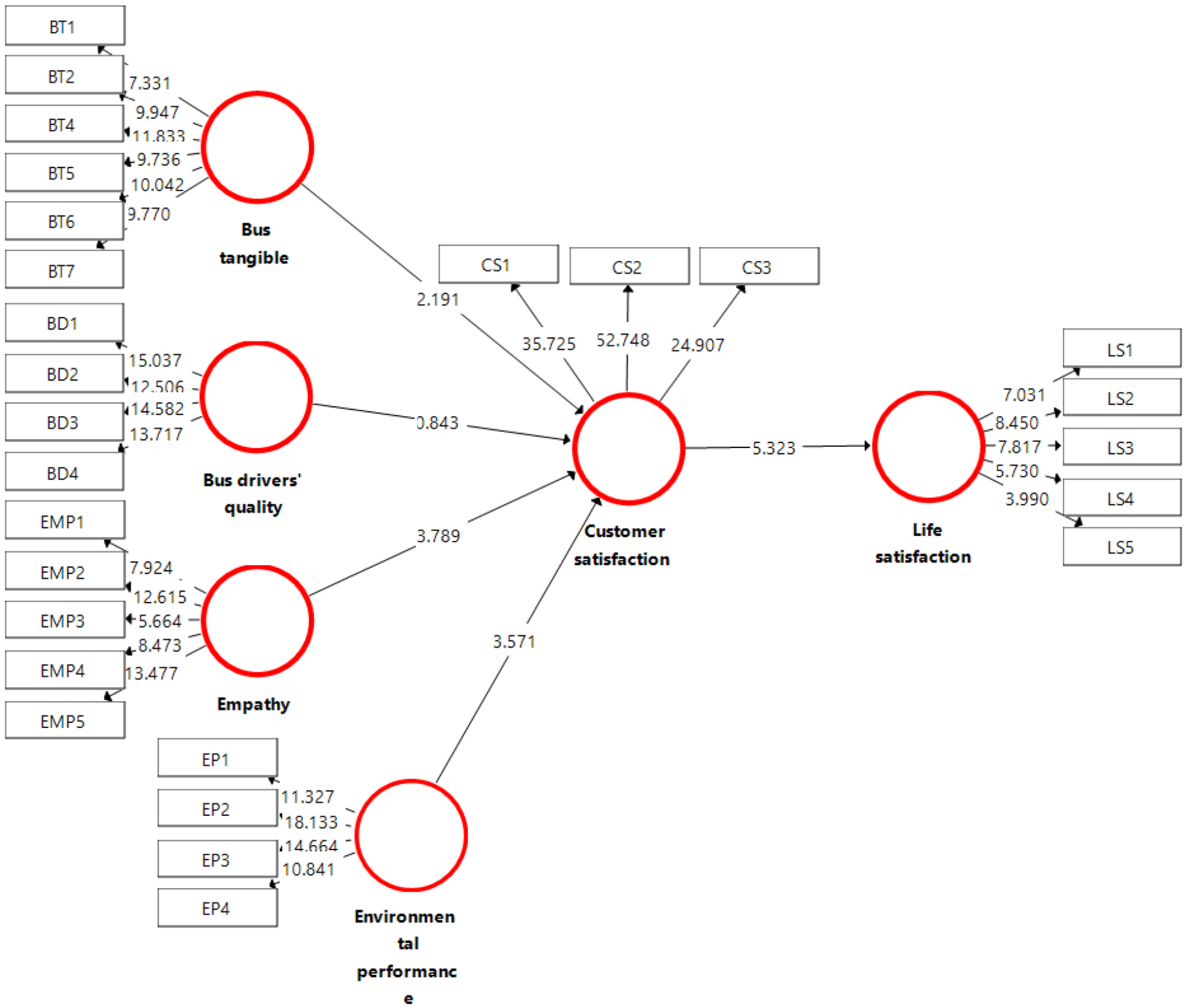
## Appendix A. Exploratory factor analysis of 27 measurement items




Parallel analysis scree plot confirms existence six factors.

## Appendix B. PLS-SEM estimation results for robustness check




We estimate the PLS-SEM model using the Smart-PLS software. The values in the figure represent t-values. Values higher than 1.64 (one-tail test) indicate statistical significance at 5%. The table below summarizes hypothesis testing results, identical to the covariance-based SEM estimation.

| Hypothesis | Standardized coefficient | Remark |
|---|---|---|
| H1: Bus tangible → Customer satisfaction | 0.207 (0.10)* | Supported |
| H2: Bus drivers' quality → Customer satisfaction | 0.097 (0.12) | Not supported |
| H3: Empathy → Customer satisfaction | 0.351 (0.10)*** | Supported |
| H4: Environmental performance → Customer satisfaction | 0.224 (0.06)*** | Supported |
| H5: Customer satisfaction → Life satisfaction | 0.300 (0.06)*** | Supported |

***p < 0.001, **p < 0.01, *p < 0.05, +p < 0.10.

## Appendix C. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.tbs.2020.03.003.

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