Published in final edited form as:

Int J Sustain Transp. 2020 ; 14(12): 944–955. doi:10.1080/15568318.2019.1663962.

Intention to use light-rail transit in Houston, Texas, United States: Findings from the Travel-Related Activity in Neighborhoods study

Ipek N. Sener^{a,*}, Kyuhyun Lee^b, Casey P. Durand^c, Abiodun O. Oluyomi^d, Harold W. Kohl III^e

^aTexas A&M Transportation Institute, The Texas A&M University System, Austin, Texas, USA

^bTexas A&M Transportation Institute, The Texas A&M University System, College Station, Texas, USA

^cUniversity of Texas Health Science Center—Houston, School of Public Health, Dept. of Health Promotion and Behavioral Sciences, Michael and Susan Dell Center for Healthy Living, Houston, Texas, USA

^dDepartment of Medicine, Environmental Health Service, Section of General Internal Medicine, Baylor College of Medicine, Houston, Texas, USA

^eUniversity of Texas Health Science Center—Houston, Michael and Susan Dell Center for Healthy Living, University of Texas at Austin, Dept. of Kinesiology and Health Education, Austin, Texas, USA

Abstract

Using data from the Houston Travel-Related Activity in Neighborhoods (TRAIN) study, this study examined how various factors affect whether individuals intend to use newly opened light-rail transit (LRT) lines in Houston. The Houston TRAIN study is a natural experiment on the effect of new LRT lines on both transit use and physical activity. A mixed binary logit model was developed based on a dichotomous dependent variable and rich set of variables, including sociodemographic factors, health status, travel behavior and technology, and attitudes and perceptions. The mixed model also allowed accounting for the unobserved heterogeneity across individuals in their sensitivity to observed variables. The results indicated the important role of various factors influencing the decision on intent to use the new LRT lines. In general, demographics mattered but to a lower extent than psychological or personality-related variables. For example, attitudes and perceptions toward the public transit system and consciousness of physical activities derived by using public transit were important factors. Personal health constraints negatively influenced intention to use, while experience with the public transport system was among the positive indicators. The findings show the potential of future interventions in this community to promote use of the new system, such as educational campaigns that improve perceptions of public transit use and clarify the benefits of being active. While providing growing evidence that cognitive variables are important in measuring intention to use public transit, the

*Texas A&M Transportation Institute, 505 East Huntland Drive, Suite 455, Austin, Texas, USA; i-sener@tti.tamu.edu.

Disclosure statement

No potential conflict of interest was reported by the authors.

results emphasize the positive role of efforts integrating transportation and health to develop effective and sustainable solutions.

Keywords

Intention to use public transit; light-rail transit; public health; Houston TRAIN study

Introduction

In terms of decision-making related to transportation system changes, information on corresponding actual demand is not available for several years, and not until plans have already been implemented and studied. Because of the practical difficulties in measuring behavior prospectively, planners and policy makers rely on the best available data. In some cases, plans are developed by projecting current values to a future date. In other cases, plans are made by asking respondents about the choices they believe they would make in a hypothetical, futuristic situation (i.e., alternatives that do not currently exist). The stated preferences for a given scenario give planners the best-informed projections of how the planned changes will likely impact people's corresponding decisions. Thus, intention toward transit services is an important concept that underpins modeling future use of public transit and strategies to enhance market share. According to the theory of planned behavior (TPB), a person's intention to perform behaviors is a strong predictor of actual behavior (Ajzen, 1991). The stronger the intention to exert the behavior, the higher the probability of performing the behavior (Ajzen, 1991). It can thus be assumed that if intention to use transit is captured, actual future ridership can be projected, or at least an educated guess about the associated demand can help guide decision-making.

In this respect, this study examined the factors influencing individuals' intention to use newly opened light-rail transit (LRT) lines in Houston, Texas, using the Houston Travel-Related Activity in Neighborhoods (TRAIN) study data. The remainder of this paper begins with a literature review on the influential variables in regard to intention to use public transportation, followed by a discussion on the conceptual hypotheses of the study. Next, materials and methods, including study area, data used, and analysis performed, are presented. The results of the analyses are then discussed in detail, and the paper concludes with a summary of key points.

Literature review

Identifying what determines favorable intention toward using public transportation has been of increasing interest to transportation professionals. This subsection provides a review of the literature on variables related to the intention to use public transportation within four categories of interest: sociodemographics, health status, travel behavior and technology, and attitudes and perceptions.

First, sociodemographic characteristics are important to explain intended use of public transportation, just as they do actual travel decisions. For instance, a study by Spears, Houston, and Boarnet (2013) found that a range of sociodemographic variables (age,

employment status, household income, household vehicle, children under 16, and race/ethnicity) had significant effects on the probability that survey respondents would use public transit during the study period in Los Angeles, California. Inversely, Perk, Flynn, and Volinski's (2008) study indicated that individuals stopped using public transport due to changes in income, occupation, and lifestyles (such as need to pick up children). These sociodemographic–travel mode decision relationships have also been found when predicting future preference for a certain mode choice. In a survey-based study of departure passengers at an airport in Iran (Yazdanpanah & Hosseinlou, 2017), several individual features (age, gender, education, and income) were significant factors underlying participants' future public transport use to access the airport. Among the four identifiers, gender was an indicator of intention to use public modes. A study by Tao, Corcoran, and Mateo-Babiano (2017) revealed that respondents in higher-income brackets had weak intention to use bus services. Another study found that for rural residents in China, personal income and household car ownership had obvious negative effects on intention to use transit (Zhou, Du, Liu, Huang, & Ran, 2017). Similarly, university students who owned a car and were female were more likely to choose a car as a future commuting mode in a study by Van, Choocharukul, and Fujii (2014).

The second category of interest, health status, can be viewed based on connections of willingness to use public transit with public health aspects. Earlier research has found significant relationships between public transit use and healthy body weight. A study by Wen and Rissel (2008), for instance, found that men who commuted to work by public transport were less likely to be overweight and obese compared to those driving to work. Flint, Cummins, and Sacker's (2014) study noted that individuals who had lower body mass index (BMI) levels tended to commute using public transit more often than their counterparts who commuted via private transport including car, taxi, and motorcycle. Yazdanpanah and Hosseinlou (2017) also found that low BMI scores exhibited links to a greater amount of intended public transport use. Another study reported that using the subway to commute was related to a reduced probability of obesity and diabetes compared to using personal vehicles (Tajalli & Hajbabaie, 2017).

The third category, travel behavior and technology, is of interest because past behavioral habits tend to reflect how people will likely behave in the future. In the transportation domain, travel mode choice is considered a habitual behavior that governs intention. Studies have found that car use habits directly and negatively affect intention to use public transit (Imeko-lu, Nordfjærn, & Rundmo, 2015; Yazdanpanah & Hosseinlou, 2017). Similarly, frequent private vehicle use has had a direct and negative impact on car users' intention to switch to public transit (Chen & Chao, 2011). Past transit use habits have also been a determinant factor on willingness to use public transit (Fu & Juan, 2017). Further, extending travel behavior to public health aspects, transit-based travels typically entail interim trips to/from transit stops or stations. When these interim trips are made using an active mode (e.g., walking and biking), transit use may substantially contribute to a person's amount of daily physical activity. Many studies reinforce this idea, showing that traveling by transit is positively related to increased engagement in physical activity. For instance, a study by Miller et al. (2015) that tracked physical activity before and after construction of a light rail suggested that transit use directly generates new physical activity. Likewise, Saelens,

Moudon, Kang, Hurvitz, and Zhou's (2014) study reported that public transit users had more overall physical activity, specifically walking, than did non-transit users. In terms of technology, a study conducted across 18 commuters in Boston and San Francisco found that commuters were more willing to ride public transit when they could effectively manage their commutes through apps providing real-time information about transit schedules, delays, and shops and services along the routes (Latitude and Next American City, 2010).

Finally, attitudes and perceptions comprise an important category of interest related to intention to use public transportation. From a psychosocial perspective, studies employing the TPB as their theoretical framework have confirmed that the three TPB variables are important determinants of intention to use public transit: attitude (evaluation of public transit use); subjective norm (feelings about the perceptions that other people hold regarding public transit use); and perceived behavioral control (feelings of control over using transit; Chen & Chao, 2011; Donald, Cooper, & Conchie, 2014; Fu & Juan, 2017; Zailani, Iranmanesh, Masron, & Chan, 2016). Extension of psychological variables to safety, moral norms (perceptions of moral obligations regarding public transit use), and overall image (total perception of using public transportation) could provide a fuller explanation of motivational factors on transit mode choice (Donald et al., 2014; im eko lu et al., 2015; Spears et al., 2013; Zailani et al., 2016), with the exception of environmental concerns (Borhan et al., 2014; Donald et al., 2014). When service quality and customer satisfaction variables are integrated, individuals who perceive service quality to be good or exhibit higher satisfaction (or both) are more likely to have stronger intention to use public transportation. For instance, Sumaedi, Bakti, and Yarmen (2012) performed a study in Jakarta, Indonesia, that determined the significant impact of service quality and perceived value on the behavioral intention to use paratransit. Lai and Chen (2011) found service quality, satisfaction, perceived values, and involvement (the level of interest in the importance of public transit to a passenger) had significant impacts on intention to use public transit in Kaohsiung, Taiwan. Another study conducted in Taiwan also found that service quality and satisfaction were important to improve intention for bus passengers in 35 jurisdictions (Chen, 2016). For Malaysians in the Putrajaya area, service quality and attitude positively impacted behavioral intention to use public transport, whereas environmental impact was not influential (Borhan et al., 2014). While these studies offer valuable evidence on various psychosocial factors underlying travel-related intention, they concurrently raise the question of how perception about benefit of daily physical activity expected from transit-based trips will affect people's goodwill to travel by public transport.

In line with the reviewed literature, this study aimed to predict the factors that affect intended LRT use in the Houston region. Findings contribute to the growing literature on the intention to use public transit based on a rich set of variables and provide additional insights on the relationship between health and transportation as a main interest of the study.

Conceptual hypotheses

Based on the perspectives gained from previous studies, this study developed a proposed conceptual model hypothesizing that individuals' intention to use a new LRT line is influenced by a variety of variables (see Figure 1).

First, it was postulated that the sociodemographics of survey respondents in Houston would effectively indicate whether they would be willing to use the new LRT services. Second, this study hypothesized the significant role of health status in measuring the intended likelihood to be a transit rider—primarily in terms of a positive association between better health status and higher intent to use public transit. Third, individuals' travel- and technology-related habits were expected to have an impact on their intention to use public transportation. For instance, it was anticipated that already-active people (in walking, biking, or using transit) would be more likely to intend to take public transportation. In addition, this study expected that the availability of smartphone technology would predict behavioral intention given that smartphone use can potentially enhance transit utility by providing information on such things as scheduling and expected travel time. Finally, encompassing the fitness benefit perception of transit use, it was expected that various cognitive variables would explain variations in individual intention toward using public transit. In particular, positive attitudes and perceptions related to transit use were expected to explain greater intention to use the new LRT services.

In addition to postulating the effects of the observed variables, the current study also hypothesized the presence of unobserved factors—that is, factors that cannot be observed by the analyst but that moderate the effect of some observed variables.

Materials and methods

Study area

Houston, Texas, is the fourth most populous and one of the most demographically diverse cities in the United States (Greater Houston Partnership, 2018). The greater Houston region is currently home to about 6.9 million residents (Greater Houston Partnership, 2018). Population growth in the greater Houston region is high due to both natural increase and immigration to the region. The rate of growth over the last 10 years is expected to continue for the next several decades and will outpace expansion of highways and transportation infrastructure capacity as currently planned. According to the Houston-Galveston Area Council's (2017) regional growth forecast, a steady growth pattern over the next 30 years means that the region's population is expected to reach 10 million people by 2040.

The Metropolitan Transit Authority of Harris County (Houston METRO) is the primary public transit provider in Houston. Houston METRO operates a variety of transit services, including local bus, paratransit bus, park-and-ride bus, vanpool, high-occupancy vehicle lanes, and light rail. Houston's first LRT line (i.e., the Red Line) was the initial modern light-rail line in Houston and began operation in 2004. The original Red Line ran from the current southern terminus at Fannin Park-and-Ride south of IH 610 South Loop to downtown Houston. Houston METRO opened a Red Line extension in December 2013 to connect to additional stations north of downtown, followed by two new lines added in May 2015 (the Green and Purple Lines), providing additional stations to east and southeast Houston from downtown (see Figure 2). The study area surrounding the LRT lines is shown in Figure 2 (also see Lee and Sener [2017] for a detailed evaluation of the LRT area focusing on transportation and land use characteristics).

Data used

The data used in this study were derived from the TRAIN study conducted between 2013 and 2018. The TRAIN study was designed as a natural experiment that aimed to determine whether and how the development of LRT lines in Houston impacted transit use and physical activity behavior over a 4-year period.

TRAIN participants were age 18 years or older and resided within a 3-mile buffer around the new LRT lines. This target buffer for sampling “was chosen to maximize the pool of eligible participants and to provide a diversity of distances from home to the LRT lines, our primary predictor of LRT use” (Durand et al., 2016, p. 3). Only one participant per household was eligible to enroll in the study, and each participant was recruited and surveyed four times (baseline, 1-year, 2-year, and 3-year follow-ups). Several materials were used for data collection, including self-reported surveys, travel diaries, self-reported physical activity questionnaires, and accelerometers. Instruments were administered in both English and Spanish languages. Built environment audits were also completed around the LRT stations (Oluyomi et al., 2019). Using Monte Carlo simulations, the sample size was computed as around 750 participants at baseline. This computation was based on the following assumptions: a desired power of 90%, a significance level of 0.05, 9% participant attrition per year, four waves of data collection, and an effect size of 0.3. A rolling recruitment and enrollment strategy, involving telephone/email and targeted community outreach efforts, was employed until the desired sample size was achieved. These efforts led to an enrollment of 864 persons at baseline, and this baseline data set of the TRAIN study (and its variables) was used for the current analysis. Durand et al. (2016) provided a complete description of the TRAIN study design and methods.

Among the 864 people (comprising the original data set at baseline), 68 did not respond to a key variable of interest (i.e., intended LRT use) and were thus removed from the sample used in the current study. In addition, due to missing values for at least one of the variables used in the analysis, an additional 112 participants were excluded from the sample. After the data screening and cleaning process, the analytical sample size was set at 684 (about 79% of the original sample). In the overall sample, a considerable share of respondents (almost 80%) indicated an intent to use the newly opened LRT lines. Characteristics of participants in the analytical data used as well as the full sample of respondents are shown in Table 1. Overall, there were no significant differences between the original data and the analytical sample. The sample covered neighborhoods in which the average annual income was lower than that reported in Houston and in Texas. Additionally, the neighborhoods represented by the analytical sample had relatively higher racial/ethnic minority populations than the overall region. Both low-income and higher racial/ethnic minority populations are established risk factors for physical inactivity, obesity, and chronic diseases, and eliminating disparities among these population groups requires “innovative, comprehensive, and multifaceted strategies,” as discussed by Taylor (2015, para. 5).

Analysis

As briefly discussed above, in the TRAIN questionnaires, study participants were asked about their intention to use the new LRT lines, and this information was used as the main

variable of interest in this study. Existing transportation literature has not clearly agreed on the definition of *intention* (van Lierop, Badami, & El-Geneidy, 2018). While some researchers are inclined to use a two-part definition—*intended future usage* and *willingness to recommend* (Lai & Chen, 2011)—others add *overall satisfaction with the service* (Figler, Sriraj, Welch, & Yavuz, 2011). In this study, intention referred to the intended future use of newly opened LRT lines in Houston, Texas, defined from the following survey question: “When the new light rail lines open do you intend to use them?” This was used as the dependent variable, which was a binary indicator of whether or not the individual reported an intent to use the new LRT lines in Houston.

In terms of analytic methods, existing intention studies reviewed in this study usually adopted the structural equation model (SEM). The SEM “comprises several equations linking observed and latent variables and parameterizes the endogenous relations,” and it is suitable for modeling the relationships between latent variables and their observed indicators (Zhou et al., 2017, p. 3). While covariance-based SEM (CB-SEM) has been the most commonly used and widely accepted approach to SEM in various fields, researchers have been struggling with its challenging requirements such as distribution assumptions or sample size (Astrachan, Patel, & Wanzanried, 2014). Recently, partial least square SEM (PLS-SEM) has started to gain more popularity as an alternative approach due to its distinctive methodological features (Hair, Sarstedt, Ringle, & Mena, 2012). On the other hand, as noted by Ali, Rasoolimanesh, Sarstedt, and Ringle (2018), “Methodological research in PLS-SEM is very dynamic in terms of evaluating the method’s characteristics” (p. 516). In their extensive evaluation of PLS-SEM research, Hair et al. (2012) pointed to several misunderstandings and misapplications of the technique in the field and indicated the potential of seriously compromising the analysis’ interpretation and value if not applied properly. One such area is the application of PLS-SEM when the outcome variable is a binary indicator. A cautious consideration of using PLS-SEM was recommended by Hair et al. (2012): “Researchers may decide to use a binary single indicator to measure an endogenous construct to indicate a choice situation ... which proves problematic for approximations in the PLS-SEM algorithm since path coefficients are estimated by ordinary least squares regression” (p. 421). Bodoiff and Ho (2016) also noted that “the literature is less explicit and less clear about PLS-SEM’s ability to handle binary outcomes” (p. 401), and “almost no literature directly addresses whether or how to use PLS-SEM for binary endogenous variables” (p. 404). Recognizing the need to do so, some recent methodological studies have overcome such limitations (e.g., Bodoiff & Ho 2016; Hair et al., 2018), but the field demands rigorous future research to empirically determine PLS-SEM’s stability and value in the field (which was not a focus of this study).

In light of the above, and given the discrete binary nature of the dependent variable and the fact that the interest of this study was in conducting an in-depth analysis of multiple factors, discrete choice modeling was chosen as the primary approach. In their study, de Oña, de Oña, Eboli, Forciniti, and Gabriella (2018) indicated the less complex nature of such approaches (compared to SEM) and proposed relatively easy and convenient adaptations to SEM to estimate LRT passengers’ intention to use the service again, which is measured as an ordinal ranking. For a dichotomous outcome (also the case of the current study), for instance, Kwan, Sutan, and Hashim (2018) employed a binary logistic regression to examine

how trip characteristics affected the intention to shift to rail transport (from private motor vehicles). While providing valuable insights on observed variables, the traditional logit models do not allow sensitivity (or taste) variations due to unobserved characteristics, but ignoring such unobserved attributes (if they exist) can lead to biased and inconsistent parameter estimates (Bhat, Eluru, & Copperman, 2008). For example, some individuals may be more time or health conscious than others, thus affecting their sensitivities in transit use decisions. Therefore, this study adopted a multivariate binary mixed logit model as the final modeling approach to test and account for unobserved heterogeneity across individuals in their sensitivity to observed variables in addition to testing the direct effect of an extensive set of explanatory or observed variables.

As mentioned, four primary categories were explored in the model specification: sociodemographic factors, health status, travel behavior and technology, and attitudes and perceptions. Sociodemographic factors included both individual characteristics (e.g., age, gender, race/ethnicity, immigration status, relationship status, education level, driver's license, employment, and flexible work location and schedule) and household characteristics (e.g., household size, number of children in the household, household income, vehicle ownership, bicycle ownership, and residence type). Health status variables included physical disability; self-reported health level; World Health Organization (WHO) classification of self-reported BMI; any disease such as diabetes, asthma, or chronic obstructive pulmonary disease; and level of healthy living such as eating healthy (i.e., number of daily portions of unhealthy or healthy food items) or level of sitting (i.e., the time spent sitting per day while working, reading, studying, watching TV or movies, traveling, etc.). Travel behavior and technology characteristics included current transportation mode habits such as using existing bus or light rail in Houston, or walking or biking for transportation, as well as using smartphones. Finally, several attitude and perception factors were considered including variables specifically related to the system- and service-related characteristics of the current transit system in Houston; perceptions toward using different modes of transportation (i.e., convenience, comfort, safety, reliability, and availability of modes); neighborhood-related attitudes (e.g., protection from traffic and crime, ease of access, sense of community, etc.); and various other motivational factors such as social support or acceptance, environmental concerns, self-efficacy (i.e., respondents' confidence in their ability to undertake a behavior), or perceived benefits (assessed using one item, as reported in Table 2). Table 2 shows descriptive statistics of variables included in the final estimated model.

The final model's specification was based on statistical fit and significance as well as intuitive considerations and insights from the relevant literature. The final variable specification was obtained following a systematic process of eliminating variables found to be statistically insignificant and parsimony in representing variable effects. Different variable specifications and functional forms of variables were examined during model development. Various variables were also examined to account for the potential unobserved heterogeneity in preferences among respondents. The final specification included variables that were statistically significant at around the standard 0.05 level of significance. In addition, a few variables that were significant at the 0.1 level of significance were included for their potential in providing guidance in future studies.

While providing a flexible model structure to accommodate unobserved heterogeneity, the choice probabilities in mixed logit models take the form of a multidimensional integral over a mixing distribution; thus, the integral does not have a closed form in general, so it must be evaluated numerically (Train, 2000). In this study, the mixed logit model was estimated through the maximum simulated likelihood estimation approach using 200 Halton draws (see Bhat [2001, 2003] for detailed information on the Halton sequence and its generation).

Results

The final model specification results (including the estimated value of each parameter and its corresponding significance) are shown in Table 3. The first part of the table presents the fixed-effect estimates for explanatory variables of the model (i.e., the regression coefficients, significance levels, and odds ratios). Next, estimates of random parameters are presented (i.e., standard deviations of the observed variables whose random effects were captured through mixing). As noted earlier, random parameters allow heterogeneity across individuals in their sensitivity to observed explanatory variables.

The final model results indicated a good model fit and a statistically significant chi-square statistic. The log-likelihood value at convergence of the final mixed logit model was -209.31 , while the log-likelihood value at convergence without any explanatory variables or unobserved heterogeneity was -346.67 . The likelihood ratio test value for comparing the final mixed logit model with the intercept-only model was 274.72 , which was much higher than the critical chi-squared value with 18 degrees of freedom at any reasonable level of significance. In addition, the log-likelihood value at convergence of the traditional binary logit model without the unobserved heterogeneity was -212.94 . The likelihood ratio test value for comparing the mixed binary logit model with the traditional binary logit model was 7.26 , which was higher than the critical chi-squared value with 2 degrees of freedom at the standard 0.05 level of significance. Also note that while the traditional binary logit model exhibited similar directions of variables as those obtained from the mixed logit model, the magnitudes (and significance levels) of coefficients of variables differed. Overall, the results underscored a significant improvement obtained with the final mixed binary logit model, supporting the hypothesis of the effect of both observed and unobserved factors on individuals' decision-making process on intention to use LRT.

The results indicated significant associations of multiple variables with future LRT use, and generally support the importance of values, attitudes, perceptions, and lifestyle or personal constraints on individuals' behavioral responses to alternative modes of transportation. Overall, this study found that demographics matter but to a lesser extent than psychological or health-related variables, which is in line with previous research that demonstrated that psychological factors had stronger influences on travel mode choice than did sociodemographic characteristics (Hunecke, Haustein, Bochum, & Böhler, 2010; Zhao et al., 2016). Detailed discussions on the mixed logit model results are presented in the following sections within each variable category of interest.

Sociodemographics

The first set of variables indicated differences in terms of racial/ethnic characteristics, revealing a higher odds ratio (OR) of intention to use the new LRT lines for Blacks/African Americans (OR = 3.14; $p = 0.008$) and Hispanics/Latinos (OR = 3.95; $p = 0.003$) than for other racial/ethnic groups. Employment was also an important factor, suggesting a decreased likelihood of intention to use new LRT lines among fully employed individuals (OR = 0.42; $p = 0.046$), which might be indicative of the increased car dependence or time consciousness of this group compared to their peers. Individuals whose work status was permanently and temporarily disabled showed a higher reliance on the new Houston METRO lines (OR = 5.85; $p = 0.052$). This finding might be an outcome of being a captive transit user (e.g., not having access to a car, being in a low-income bracket) due to unemployment caused by disability. Future studies would benefit from research dedicated to better understanding the underlying reasons behind transit use among individuals with disabilities.

Unlike prior studies in which some other sociodemographic features (e.g., age, gender, and income) appeared to be significant (Kwan et al., 2018; Tao et al., 2017; Yazdanpanah & Hosseinlou, 2017; Zhou et al., 2017), those features were not significant in this analysis. This result is likely a reflection of the stronger exertion of attitudes, perceptions, and behavioral and health-related factors in understanding intended use of light rail in the case of Houston. It also contributes to the emerging discussion on the more influential role of psychological factors in travel behavior research compared to demographic factors.

Health status

The health condition results provide important insights into the potential impact of physical health status of individuals on their intention to use transit in two aspects. First, people with chronic diseases were less likely to report an intent to use the new LRT lines (OR = 0.19; $p = 0.094$) compared to individuals without any chronic disease. This negative correlation was also the case for individuals with diabetes (OR = 0.44; $p = 0.1$) and a BMI of 30 or more (i.e., obese according to the WHO classification; OR = 0.39; $p = 0.013$). These findings extend the phenomenon of the observed relationship between poor health status and lower levels of public transit use (Gordon-Larsen, Nelson, & Beam, 2005; Saelens et al., 2014; Wen & Rissel, 2008) to the intention discourse.

While the ability to draw a causal effect from personal health status on whether people intend to use public transit is limited, it is suggested that tailored policy interventions are needed to support population groups who have different health constraints. For instance, it might be riskier for individuals with respiratory diseases to take public transportation because access/egress trips and transit stops are more likely to have higher levels of exposure to vehicle traffic emissions (Moore, Figliozzi, & Monsere, 2012). By contrast, as the second aspect, increased levels of physical activity through public transit use might benefit those who have health threats such as being overweight by reducing the possibility of becoming obese (MacDonald, Stokes, Cohen, Kofner, & Ridgeway, 2010). This notion was also supported by Quist et al. (2018), who highlighted the role of active commuting in reducing fat mass in overweight and obese people. Given that even transit use can be considered an active mode since walking portions derived from transit trips have been

equated to independent walking excursions for commute trips in terms of distance and duration (e.g., see Voss, Winters, Frazer, & McKay, 2015), promotion of transit trips should be given attention from a public health perspective as well as a sustainable transportation system viewpoint.

Travel behavior and technology

The results make a connection between physical activity and transportation, as anticipated. Specifically, individuals who were already active in their mode to/from public transportation showed a slightly higher odds ratio of answering that they would use the new transit lines ($OR = 1.01$; $p = 0.019$), likely being loyal to their current active lifestyles. However, the results indicated statistically significant unobserved heterogeneity across individuals in their sensitivity to this variable, which means the mean effect of the transit-induced physical activity time on LRT use intention varied across respondents because of unobserved factors. For example, individuals who are more health conscious are likely to walk or bike to transit (and for a longer time) as an opportunity to exercise more, while individuals who are more time conscious may prefer to reduce the amount of additional physical activity or active travel for access/egress trips (Eluru, Khakour, & El-Geneidy, 2012; Sener & Reeder, 2014). Such differences between respondents might work heterogeneously.

The association of leisure physical activity on willingness to use the new LRT system was also examined to further identify public health implications. Although the effect was positive (similar to the transit-induced physical activity effect), it was not statistically significant. A potential reason for this finding may be the substitution effect. That is, some individuals may consider their active travel to public transit as part of their exercise routine and may not be interested in additional exercise during the day, as also discussed by Norwood, Eberth, Farrar, Anable, and Ludbrook (2014) and Hirsch, DeVries, Brauer, Frank, and Winters (2018). Future research would benefit from carefully designed experimental studies focused on providing a deeper understanding of such effects. This was also suggested by the unobserved heterogeneity captured through the variable of transit-induced physical activity, as discussed previously.

Another variable indicated a greater likelihood of using the new rail lines among individuals who had used the current public transportation system at least once ($OR = 3.39$; $p = 0.003$). This finding is congruent with previous studies that found that travel-related habits were significantly associated with intended public transit use (Fu & Juan, 2017; im eko lu et al., 2015; Yazdanpanah & Hosseinlou, 2017). For increasing ridership in the future, targeting campaigns and marketing to those who have used the METRO service would be a potentially effective approach.

Moreover, the results showed an interesting technology association: individuals who did not use a smartphone indicated a lower likelihood of intention to use newly opened LRT lines ($OR = 0.26$; $p = 0.002$). This finding may be a reflection of the growing level of transit information (e.g., scheduling and updates on delays) provided through smartphone apps, as other studies have highlighted the importance of information in increasing customer satisfaction and, in turn, framing positive intention (Fu & Juan, 2017). Several cities are working to use technology to help improve transit ridership and make transit more

convenient for users (Brown, 2015). Houston METRO is one of them, improving its transit rates through various innovations such as “a mobile fare card system that lets riders board Houston METRO buses and light rail with tickets purchased right from their phones” (Spector, 2016, para. 2). This program is expected to make it more convenient for tech-savvy persons to use the Houston METRO system. However, Houston METRO will also need to consider providing such convenience to population groups who do not use smartphones.

Attitudes and perceptions

Attitudes and perceptions play an important role in intention-to-use behavior. The first three variables of this category identified the impact of the system- and service-related characteristics of the current transit system in Houston. The positive perception about current light-rail service—that LRT is reliable (OR = 2.14; $p = 0.088$), easy to use (OR = 2.27; $p = 0.070$), and clean (OR = 2.48; $p = 0.031$)—was an important motivator for reporting an intention to use the new LRT lines. Favorable attitudes toward public transportation and its service quality have been a frequently reported finding (Borhan et al., 2014; Chen, 2016; de Oña et al., 2016, 2018; Donald et al., 2014; im eko lu et al., 2015; Zailani et al., 2016). Understanding how passengers feel about service quality, how satisfied passengers are with the service, and how passengers perceive the utility of the service helps develop empirically grounded model estimation.

The positive tendency toward increased intention to use was also associated with subjective norms, revealing the constructive influence of social support or acceptance in using transit (OR = 1.89; $p = 0.005$), consistent with previous studies (Chen & Chao, 2011; Donald et al., 2014; Fu & Juan, 2017). Policy strategies aimed at increasing public transit use and public health (through public transit use) may benefit from focusing on the role of social influence because it can serve as a powerful tool in altering individuals' behavioral intention toward sustainable modes of transportation and provide healthier options for individuals and societies. Another result highlighted the positive role of self-efficacy (defined as feeling confident in the ability to travel by Houston METRO to new places) on intent to use (OR = 3.05; $p = 0.020$). Although this finding is potentially expected, the results also indicated highly statistically significant variation in this variable's effect across individuals, possibly because some individuals may be more sensitive to travel to an unknown location compared to others. On the other hand, the results did not show a significant association of environmental concerns with intention to use, which is consistent with some prior studies. For example, Donald et al. (2014) noted that environmental concerns affected public transit use habits instead of intention, which might support the outcome of the current study given the auto-oriented travel culture in Houston.

The perceived benefit of accruing physical activity by walking to a Houston METRO stop had similar levels of association to other attitude- and perception-related factors (OR = 1.89; $p = 0.0001$). This result implies that the growing health consciousness and interest in well-being may be an important factor in encouraging individuals to choose sustainable modes of transportation. Educational campaigns clarifying the benefit of and need for being active (either in activity or travel) may be an effective tactic to make this community healthier and more active in travel. The fact that people can get some physical activity by walking or

biking to/from transit stops has been positively associated with their intention to use transit and supports this suggestion. Borhan et al. (2014) stressed the importance of focusing on messages that emphasize advantages of using transit in efforts to improve public transport ridership percentages. The health advantages of walkable/bikeable neighborhoods as well as transit-oriented developments should be focal points of interest for transportation and public health researchers, practitioners, and policy makers. Designing cities to minimize the negative impact of motorized vehicle use will be an invaluable asset to society at the intersection of health and transportation.

Discussion

Intention toward new transit services can provide important insights on projected transit use when actual ridership information is not available. Identifying factors that govern the intention to use public transit has generated interest in the literature. Predictors vary by study design, methodology, applied theory, and study region, but efforts to capture the factors of intention are global phenomena. Motivated by the importance of understanding intention to use public transit, this study examined the various factors associated with intention to use newly opened LRT lines in Houston, Texas. The data were drawn from the survey conducted as part of the TRAIN study, which is unique due to its focus on a diverse, high-priority study population that is at a significantly higher health risk. A mixed binary logit model was estimated to examine the impacts of a rich set of factors, including personal health constraints, psychological factors, sociodemographic characteristics, travel patterns, and use of technology, while accounting for unobserved taste preferences across individuals. Findings of the study contribute to not only understating which factors frame individuals' intention to use light-rail services but also predicting who will be more likely to be a customer.

Overall, the results of the current study support the existing literature, in which attitudes and perceptions toward public transit were found to be important predictors of intention to use public transport systems. Survey participants who positively perceived the public transit system in Houston were more likely to report intention to use the new LRT lines. Higher probability of intent was found among respondents who believed that other people would support their transit travel and who felt confident getting to a new place by taking the Houston METRO system. The findings of the current study also show that health-related factors significantly influenced willingness to use the new LRT lines in the study area. First, health constraints (respiratory diseases, obesity, and high BMI scores) were a possible hindrance to using public transit. Second, in the most unique finding of this study, individuals who were conscious of physical activity derived from transit travel and who were already active in getting to/leaving from the LRT system were more likely to respond that they intended to use the new transit lines. Having experience with the public transit system was another indicator of future use of the new LRT lines. Having no smartphone as well as certain sociodemographic features also affected intention to use.

The findings highlight the potential for developing educational or behavioral interventions in this community to promote using the new LRT system. Education that improves perceptions of public transit use and campaigns that advertise the health advantages of being active may

be an effective way to increase transit market share, making the community healthier, more active, and transit oriented through increased use of Houston METRO. The interventions will benefit from tailoring to different population groups (e.g., those who have chronic diseases and do not use smartphones). Providing adequate and safe access to the LRT system for vulnerable groups with impaired mobility, such as the elderly and wheelchair users, should be considered in order to secure access to urban resources and services for all. A study by Sze and Christensen (2017) that reviewed current practices and guidelines of accessible transport design for individuals with disabilities noted that accessible design is effective in enhancing quality of life and perceived level of service, accessibility, and safety. These enhanced perceptions may therefore increase active participation and public transport trips of the elderly and individuals with disabilities.

A primary distinction between this study and previous studies on intention to use public transit is the inclusion of health-related variables in the predictive modeling. Much of the relevant research to date has contributed to the psychological foundations underlying behavioral intention. The current study contributes to the growing evidence that supports the necessity of such cognitive variables in measuring intention. These valuable findings from previous literature do not, however, say whether intention to use public transit is affected by people's attitudes about the benefits of transit-induced physical activity and, if it is, the degree to which health consciousness affects the formation of intention. Active travel or public transit use has significant correlation with personal health conditions (e.g., obesity; Falconer, Leary, Page, & Cooper, 2015; Gordon-Larsen et al., 2005; Saelens et al., 2014), but whether intention to use public transit differs according to health status is another question within the cross section with public health. In addition, whether individuals who already lead active lifestyles have stronger intention to use public transit is little understood. All these questions highlight the need for further research to consider the connections between intention and health-related factors (physical and psychological).

While providing important insights, this study is not without limitations, and the results highlight the need for various future studies. As a natural next step to this study, it is essential to compare the intention to use the LRT lines to measurements of actual use. While such a comparison is in the best interest of transit agencies seeking to retain current passengers and attract new customers, it may also eventually lead to better planning in the future and provide insights into improving survey question design and/or modeling practices. In addition, although this study examined the direct and parallel effects of health-related factors and other variables on intention to use the LRT system, the indirect impacts of the variables on the psychological construct and the interrelation between the variables were not measured. Health-related factors may affect the attitudes, perceptions, and social norms related to the Houston METRO system and thus indirectly influence intention to use. Development of methodologies to increase the explanatory power and disentangle the complex decision-making process of individuals is essential.

In moving forward, it will also be important to extend this study with a detailed focus on different trip characteristics. For instance, predictors of intention to use public transit may vary depending on the trip purpose, such as for work, shopping, or leisure trips, as exemplified by Zailani et al. (2016). Finally, while the study results provide significant

associations between health-related factors and intention to use, they are limited in terms of establishing a direct causal relationship (which was outside the scope of this study). Better understanding the directionality and causation of the associations found in this study would be of utmost importance in future studies of sustainable modes of transportation. Despite the limitations, this study contributes to the growing evidence that cognitive variables are important in capturing intention to use public transit. Furthermore, findings of the study can be used to develop adaptive strategies to integrate the advantages of public transportation and public health.

Acknowledgments

Research reported in this publication was partially supported by the National Institute of Diabetes and Digestive and Kidney Diseases of the National Institutes of Health under Award Number R01DK101593. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health. The authors would also like to acknowledge Dawn Herring for her editorial review, and four anonymous reviewers for their insightful feedback.

References

- Ajzen I (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50, 179–211. doi:10.1016/0749-5978(91)90020-t
- Ali F, Rasoolimanesh SM, Sarstedt M, Ringle CM, & Ryu K (2018). An assessment of the use of partial least squares structural equation modeling (PLS-SEM) in hospitality research. *International Journal of Contemporary Hospitality Management*, 30(1), 514–538. doi:10.1108/ijchm-10-2016-0568
- Astrachan CB, Patel VK, & Wanzenried G (2014). A comparative study of CB-SEM and PLS-SEM for theory development in family firm research. *Journal of Family Business Strategy*, 5(1), 116–128. doi:10.1016/j.jfbs.2013.12.002
- Bhat CR (2001). Quasi-random maximum simulated likelihood estimation of the mixed multinomial logit model. *Transportation Research Part B*, 35, 677–693. doi:10.1016/s0191-2615(00)00014-x
- Bhat CR (2003). Simulation estimation of mixed discrete choice models using randomized and scrambled Halton sequences. *Transportation Research Part B*, 37(9), 837–855. doi:10.1016/s0191-2615(02)00090-5
- Bhat CR, Eluru N, & Copperman RB (2008). Flexible model structures for discrete choice analysis In Hensher DA & Button KJ (Eds.), *Handbook of transport modelling* (2nd ed., pp. 75–104). Dordrecht, Netherlands: Elsevier Science.
- Bodoff D, & Ho SY (2016). Partial least squares structural equation modeling approach for analyzing a model with a binary indicator as an endogenous variable. *CAIS*, 38, 23. doi:10.17705/1cais.038123
- Borhan MN, Syamsunur D, Akhir NM, Yazid MRM, Ismail A, & Rahmat RA (2014). Predicting the use of public transportation: A case study from Putrajaya, Malaysia. *The Scientific World Journal*. doi:10.1155/2014/784145
- Brown J (2015, 5). Can technology help improve mass transit use? Retrieved from Government Technology website: <http://www.govtech.com/transportation/Can-Technology-Help-Improve-Mass-Transit-Use.html>
- Chen CF, & Chao WH (2011). Habitual or reasoned? Using the theory of planned behavior, technology acceptance model, and habit to examine switching intentions toward public transit. *Transportation Research Part F*, 14, 128–137. doi:10.1016/j.trf.2010.11.006
- Chen HK (2016). Structural interrelationships of group service quality, customer satisfaction, and behavioral intention for bus passengers. *International Journal of Sustainable Transportation*, 10, 418–429. doi:10.1080/15568318.2014.965372
- de Oña J, de Oña R, Eboli L, Forciniti C, & Gabriella M (2016). Transit passengers' behavioural intentions: The influence of service quality and customer satisfaction. *Transportmetrica A: Transport Science*, 12, 385–412. doi:10.1080/23249935.2016.1146365

- de Oña J, de Oña R, Ebohi L, Forciniti C, & Gabriella M (2018). An ordered regression model to predict transit passengers' behavioural intentions. *Case Studies on Transport Policy*, 6, 449–455. doi:10.1016/j.cstp.2018.05.004
- Donald JJ, Cooper SR, & Conchie SM (2014). An extended theory of planned behaviour model of the psychological factors affecting commuters' transport mode use. *Journal of Environmental Psychology*, 40, 39–48. doi:10.1016/j.jenvp.2014.03.003
- Durand CP, Oluyomi AO, Gabriel KP, Salvo D, Sener IN, Hoelscher DM, ... Kohl HW III (2016). The effect of light rail transit on physical activity: Design and methods of the Travel-Related Activity in Neighborhoods study. *Frontiers in Public Health*, 4. doi:10.3389/fpubh.2016.00103
- Eluru N, Khakour V, & El-Geneidy A (2012). Travel mode choice and transit route choice behaviour in Montreal: Insights from McGill University members commute patterns. *Public Transport*, 4, 129–149. doi:10.1007/s12469-012-0056-2
- Falconer C, Leary SD, Page AS, & Cooper AR (2015). The tracking of active travel and its relationship with body composition in UK adolescents. *Journal of Transport and Health*, 2, 483–489. doi:10.1016/j.jth.2015.09.005 [PubMed: 26740922]
- Figler S, Sriraj P, Welch E, & Yavuz N (2011). Customer loyalty and Chicago, Illinois, transit authority buses: Results from 2008 customer satisfaction survey. *Transportation Research Record: Journal of the Transportation Research Board*, 2216, 148–156. doi:10.3141/2216-16
- Flint E, Cummins S, & Sacker A (2014). Associations between active commuting, body fat, and body mass index: Population based, cross sectional study in the United Kingdom. *British Medical Journal*, 349, 1–9. doi:10.1136/bmj.g4887
- Fu X, & Juan Z (2017). Understanding public transit use behavior: Integration of the theory of planned behavior and the customer satisfaction theory. *Transportation*, 44, 1021–1042. doi:10.1007/s11116-016-9692-8
- Gordon-Larsen P, Nelson MC, & Beam K (2005). Associations among active transportation, physical activity, and weight status in young adults. *Obesity Research*, 13, 868–875. doi:10.1038/oby.2005.100 [PubMed: 15919840]
- Greater Houston Partnership. (2018). 2018 Houston facts. Retrieved from https://www.houston.org/sites/default/files/2018-12/Houston_Facts_2018.pdf
- Hair JF, Ringle CM, Gudergan SP, Fischer A, Nitzi C, & Menictas C (2018). Partial least squares structural equation modeling-based discrete choice modeling: An illustration in modeling retailer choice. *Business Research*, 1–28. doi:10.1007/s40685-018-0072-4
- Hair JF, Sarstedt M, Ringle CM, & Mena JA (2012). An assessment of the use of partial least squares structural equation modeling in marketing research. *Journal of the Academy of Marketing Science*, 40, 414–433. doi:10.1007/s11747-011-0261-6
- Hirsch JA, DeVries DN, Brauer M, Frank LD, & Winters M (2018). Impact of new rapid transit on physical activity: A meta-analysis. *Preventive Medicine Reports*, 10, 184–190. doi:10.1016/j.pmedr.2018.03.008 [PubMed: 29868365]
- Houston-Galveston Area Council. (2017). 2017 H-GAC regional growth forecast. Retrieved from <http://arcgis02.h-gac.com/RGF2017/>
- Hunecke M, Haustein S, Bochum R, & Böhler S (2010). Attitude-based target groups to reduce the ecological impact of daily mobility behavior. *Environment and Behavior*, 42(1), 3–43. doi:10.1177/0013916508319587
- Kwan SC, Sutan R, & Hashim JH (2018). Trip characteristics as the determinants of intention to shift to rail transport among private motor vehicle users in Kuala Lumpur, Malaysia. *Sustainable Cities and Society*, 36, 319–326. doi:10.1016/j.scs.2017.10.030
- Lai WT, & Chen CF (2011). Behavioral intentions of public transit passengers—The roles of service, quality, perceived value, satisfaction and involvement. *Transport Policy*, 18. doi:10.1016/j.tranpol.2010.09.003
- Latitude and Next American City. (2010). Tech for transit: Designing a future system. Retrieved from <https://www.infrastructureusa.org/wp-content/uploads/2011/03/tech-for-transit-summary.pdf>
- Lee RJ, & Sener IN (2017). The effect of light rail transit on land use in a city without zoning. *The Journal of Transport and Land Use*, 10(1), 541–556. doi:10.5198/jtlu.2017.926

- MacDonald JM, Stokes RJ, Cohen DA, Kofner A, & Ridgeway GK (2010). The effect of light rail transit on body mass index and physical activity. *American Journal of Preventive Medicine*, 39, 105–112. doi:10.1016/j.amepre.2010.03.016 [PubMed: 20621257]
- Miller HJ, Tribby CP, Brown BB, Smith KR, Werner CM, Wolf J, ... Oliveira MGS (2015). Public transit generates new physical activity: Evidence from individual GPS and accelerometer data before and after light rail construction in a neighborhood of Salt Lake City, Utah, USA. *Health & Place*, 36, 8–17. doi:10.1016/j.healthplace.2015.08.005 [PubMed: 26340643]
- Moore A, Figliozzi M, & Monsere CM (2012). Air quality at bus stops: Empirical analysis of exposure to particulate matter at bus stop shelters. *Transportation Research Record: Journal of the Transportation Research Board*, 2270, 76–86. doi:10.3141/2270-10
- Norwood P, Eberth B, Farrar S, Anable J, & Ludbrook A (2014). Active travel intervention and physical activity behaviour: An evaluation. *Social Science & Medicine*. 113, 50–58. doi:10.1016/j.socscimed.2014.05.003 [PubMed: 24836843]
- Oluyomi AO, Knell G, Durand CP, Mercader C, Salvo D, Sener IN, & Kohl HW (2019). Foot-based audit of streets adjacent to new light rail stations in Houston, Texas: Measurement of health-related characteristics of the built environment for physical activity research. *BMC Public Health*, 9(1), 238. doi:10.1186/s12889-019-6560-4
- Perk V, Flynn J, & Volinski J (2008). Transit ridership, reliability, and retention. Tallahassee, FL: Florida Department of Transportation.
- Quist JS, Rosenkilde M, Petersen MB, Gram AS, Sjodin A, & Stallknecht B (2018). Effects of active commuting and leisure-time exercise on fat loss in women and men with overweight and obesity: A randomized controlled trial. *International Journal of Obesity*, 42, 469–478. doi:10.1038/ijo.2017.253 [PubMed: 28993707]
- Saelens BE, Moudon AV, Kang B, Hurvitz PM, & Zhou C (2014). Relation between higher physical activity and public transit use. *American Journal of Public Health*, 104, 854–859. doi:10.2105/ajph.2013.301696 [PubMed: 24625142]
- Sener IN, & Reeder PR (2014). An integrated analysis of worker's physically active activity and active travel choice behavior. *Transportation Research Part A Policy and Practice*, 67, 381–393. doi:10.1016/j.tra.2014.03.007
- im eko lu Ö, Nordfjærn T, & Rundmo T (2015). The role of attitudes, transport priorities, and car use habit for travel mode use and intentions to use public transportation in an urban Norwegian public. *Transport Policy*, 42, 113–120. doi:10.1016/j.tranpol.2015.05.019
- Spears S, Houston D, & Boarnet MG (2013). Illuminating the unseen in transit use: A framework for examining the effect of attitudes and perceptions on travel behavior. *Transportation Research Part A*, 58, 40–53. doi:10.1016/j.tra.2013.10.011
- Spector J (2016, 2). Houston gives transit riders a quicker way to pay. Retrieved from CityLab website: <https://www.citylab.com/transportation/2016/02/houston-metro-fare-mobile-app-payment/471318/>
- Sumaedi S, Bakti IGM, & Yarmen M (2012). The empirical study of public transport passengers' behavioral intentions: The roles of service quality, perceived sacrifice, perceived value, and satisfaction (Case study: Paratransit passengers in Jakarta, Indonesia). *International Journal for Traffic and Transport Engineering*, 2(1), 83–97. doi:10.20858/tp.2016.11.1.10
- Sze NN, & Christensen KM (2017). Access to urban transportation system for individuals with disabilities. *International Association of Traffic and Safety Sciences*, 41(2), 66–73. doi:10.1016/j.iatssr.2017.05.002
- Tajalli M, & Hajbabaie A (2017). On the relationships between commuting mode choice and public health. *Journal of Transport & Health*, 4, 257–277. doi:10.1016/j.jth.2016.12.007
- Tao S, Corcoran J, & Mateo-Babiano I (2017). Modeling loyalty and behavioral change intentions of busway passengers: A case study of Brisbane, Australia. *International Association of Traffic and Safety Sciences*, 41, 113–122. doi:10.1016/j.iatssr.2016.10.001
- Taylor WC (2015). Disparities in physical activity among low-income and racial/ethnic minority communities: What can we do? Retrieved from National Academy of Medicine website: <https://nam.edu/perspectives-2015-disparities-in-physical-activity-among-low-income-and-racial-ethnic-minority-communities-what-can-we-do/>

- Train K (2000). Halton sequences for mixed logit. Retrieved from <https://eml.berkeley.edu/wp/train0899.pdf>
- Van HT, Choocharukul K, & Fujii S (2014). The effect of attitudes toward cars and public transportation on behavioral intention in commuting mode choice—A comparison across six Asian countries. *Transportation Research Part A*, 69, 36–44. doi:10.1016/j.tra.2014.08.008
- van Lierop D, Badami MG, & El-Geneidy AM (2018). What influences satisfaction and loyalty in public transport? A review of the literature. *Transport Reviews*, 38(1), 52–72. doi:10.1080/01441647.2017.1298683
- Voss C, Winters M, Frazer A, & McKay H (2015). School-travel by public transit: Rethinking active transportation. *Preventive Medicine Reports*, 2, 65–70. doi:10.1016/j.pmedr.2015.01.004 [PubMed: 26793430]
- Wen LM, & Rissel C (2008). Inverse associations between cycling to work, public transport, and overweight and obesity: Findings from a population based study in Australia. *Preventive Medicine*, 46(1), 29–32. doi:10.1016/j.ypmed.2007.08.009 [PubMed: 17904210]
- Yazdanpanah M, & Hosseinlou MH (2017). The role of personality traits through habit and intention on determining future preferences of public transport use. *Behavioral Sciences*, 7(8), 1–15. doi:10.3390/bs7010008
- Zhao X, Shi X, Ye Z, Wu L, Wu Y, & Lu J (2016). Investigating the influence factors of public transit rider transfer intentions: A case study in Nanjing. Paper presented at CICTP 2016: Green and Multimodal Transportation and Logistics. doi:10.1061/9780784479896.077
- Zailani S, Iranmanesh M, Masron TA, & Chan T (2016). Is the intention to use public transport for different travel purposes determined by different factors? *Transportation Research Part D*, 49, 18–24. doi:10.1016/j.trd.2016.08.038
- Zhou X, Du H, Liu Y, Huang H, & Ran B (2017). Investigating the intention of rural residents to use transit in Cixi, China. *Journal of Urban Planning and Development*, 143, 1–8. doi:10.1061/(asce)up.1943-5444.0000367

Figure 1.
Conceptual model of factors on intention to use transit.

Figure 2.
Study area in Houston, Texas.

Table 1.

Sample characteristics.

Variables	Percentage	
	Analytical sample (<i>N</i> = 684)	All participants (<i>N</i> = 864)
18–29 years old	11.6%	11.7%
30–44 years old	24.0%	22.3%
45–64 years old	51.1%	50.6%
Female	63.2%	58.2%
Black or African American	39.2%	39.0%
Hispanic or Latino	25.3%	24.0%
Less than high school/GED	12.6%	13.1%
High school/GED	19.6%	19.3%
Full-time employed (40 hours or more a week)	30.0%	25.7%
Part-time employed (less than 40 hours a week)	14.0%	12.2%
Flexible work location	22.8%	21.5%
Flexible work schedule	35.5%	32.6%
WHO classification of BMI: overweight (BMI is between 25 and 29.9)	32.9%	29.5%
WHO classification of BMI: obese (BMI is greater than or equal to 30)	38.3%	36.6%
Single-person household	32.3%	31.9%
Raising children	27.9%	25.9%
Household income less than \$20,000	38.3%	36.9%
Household income between \$20,000 and \$39,999	16.7%	15.4%
Household income between \$40,000 and \$59,999	9.4%	8.6%
No motorized vehicles in the household	31.3%	32.1%
One motorized vehicle in the household	35.1%	31.9%
Homeowner	44.3%	41.2%

Table 2.

Descriptive statistics of final model variables.

Final Model Variables			Mean	Std. Dev.	Min.	Max.
Intention to Use New Light-Rail Lines			0.80	0.404	0	1
Socio-demographics	Race/ethnicity	Black or African American	0.39	0.489	0	1
		Hispanic or Latino	0.25	0.433	0	1
	Work status	Full-time employed (work 40 hours or more a week)	0.30	0.458	0	1
		Not working—Permanently/temporarily disabled	0.15	0.356	0	1
Health Status	Disease	Have chronic obstructive pulmonary disease (such as chronic bronchitis or emphysema)	0.05	0.214	0	1
		Have diabetes	0.15	0.354	0	1
	WHO classification of BMI: obese (≥ 30)		0.38	0.486	0	1
Travel Behavior and Technology	Transit-induced physical activity (i.e., walking and biking to/from transit; in total minutes per week)		107.95	220.848	0	2520
	Have used Houston METRO public transit system (bus or light rail)		0.84	0.369	0	1
	Do not use smartphone		0.31	0.464	0	1
Attitudes and Perceptions	Related to Houston METRO system	Light-rail service is reliable	0.71	0.455	0	1
		Light rail is easy to use	0.73	0.442	0	1
		Light rail is clean	0.69	0.463	0	1
	Subjective norm—Most people who are important to me would support me taking the Houston METRO bus or light rail (4-item scale ranging from <i>strongly disagree</i> to <i>strongly agree</i>)		2.97	0.822	1	4
	Self-efficacy—I feel confident taking Houston METRO when I have to go somewhere I have never been before (5-item scale ranging from <i>not at all confident</i> to <i>extremely confident</i>)		2.39	1.299	1	5
	Perceived benefit—If I walk to the Houston METRO stop, I will be able to get some exercise for the day (5-item scale ranging from <i>not important</i> to <i>extremely important</i>)		3.15	1.287	1	5

Table 3.

Mixed binary logit model results for intention to use Houston METRO new LRT lines.

Explanatory Variables (fixed effects)			Coefficient	t-stat.	p-value	Odds Ratio
Socio-demographics	Race/ethnicity	Black or African American	1.143	2.65	0.008	3.14
		Hispanic or Latino	1.373	2.96	0.003	3.95
	Work status	Full-time employed (work 40 hours or more a week)	−0.859	−2.00	0.046	0.42
		Not working—Permanently/ temporarily disabled	1.766	1.95	0.052	5.85
Health Status	Disease	Have chronic obstructive pulmonary disease (such as chronic bronchitis or emphysema)	−1.653	−1.67	0.094	0.19
		Have diabetes	−0.818	−1.64	0.100	0.44
	WHO classification of BMI: obese (≥ 30)		−0.932	−2.48	0.013	0.39
Travel Behavior and Technology	Transit-induced physical activity (in total minutes per week)		0.012	2.36	0.019	1.01
	Have used Houston METRO public transit system (bus or light rail)		1.221	3.01	0.003	3.39
	Do not use smartphone		−1.362	−3.12	0.002	0.26
Attitudes and Perceptions	Related to Houston METRO system	Light-rail service is reliable	0.763	1.71	0.088	2.14
		Light-rail service is easy to use	0.822	1.81	0.070	2.27
		Light rail is clean	0.910	2.15	0.031	2.48
	Subjective norm—Most people who are important to me would support me taking the Houston METRO bus or light rail		0.636	2.79	0.005	1.89
	Self-efficacy—I feel confident taking Houston METRO when I have to go somewhere I have never been before		1.115	2.32	0.020	3.05
	Perceived benefit—If I walk to the Houston METRO stop, I will be able to get some exercise for the day		0.639	3.89	0.0001	1.89
Constant			−6.173	−4.86	<.0001	0.002
Standard Deviations of Unobserved Heterogeneity		Variables (with random effects)	Estimate	t-stat.	p-value	
		Transit-induced physical activity	0.008	1.94	0.053	
		Self-efficacy	0.792	2.45	0.014	
N(sample size)			684			
McFadden rho-square			0.559			
Log-likelihood at constant			−346.67			
Log-likelihood at convergence for traditional logit model(with no unobserved heterogeneity)			−212.94			
Log-likelihood at convergence for <i>final mixed logit model</i> (with unobserved heterogeneity)			−209.31			