The pursuit of satisfaction: Variation in satisfaction with bus transit service among riders with encumbrances and riders with disabilities using a large-scale survey from London, UK

David Verbich
School of Urban Planning
Faculty of Engineering
McGill University
Room 401, Macdonald-Harrington Bldg.
815, rue Sherbrooke Ouest
Montreal QC Canada
H3A 0C2

david.verbich@mail.mcgill.ca

Ahmed El-Geneidy (corresponding author)
School of Urban Planning
Faculty of Engineering
McGill University
Room 401, Macdonald-Harrington Bldg.
815, rue Sherbrooke Ouest
Montreal QC Canada
H3A 0C2

Tel: 514-398-8742
Fax: 514-398-8376
ahmed.elgeneidy@mcgill.ca

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ABSTRACT

To retain and grow ridership, transit agencies continuously survey riders to learn how to improve services and understand what leads to rider satisfaction. Nevertheless, transit riders are not a homogeneous entity and understanding the distinctions between transit riders can help transit agencies in their efforts to provide satisfactory service to retain existing riders and attract new ones. To uncover how diverse aspects of bus services can differentially impact satisfaction of different riders, we use data from a large-scale, multiyear bus satisfaction survey from London, UK. Specifically, we model satisfaction using logistic regressions to learn how encumbered riders and riders with physical disabilities value different features of bus services compared to other types of riders. For riders traveling with large items, shopping bags, or children, we find that satisfaction depends on the presence and condition of a bus shelter and the availability of a seat. Satisfaction of riders with disabilities depends on information availability at the bus stop, as well as trip speed and reliability. Our findings indicate that improving waiting area conditions and providing information at the stop can increase the satisfaction of riders with encumbrances and disabilities, respectively. Findings from this paper can be of benefit to transit planners and policy makers as it offers new insights about the determinants of satisfaction of two groups of bus riders not often considered in the public transport literature.

KEYWORDS: Bus satisfaction, Logistic modeling, Encumbered, Disabled, London

INTRODUCTION

Not only must transit agencies operate effective and viable transit networks, but agencies must also understand the needs and satisfaction of riders with the transit system (Koushki, Al-Saleh, & Al-Lumaia, 2003). Satisfying existing riders and attracting new ones is central to a healthy transit system, as is it helps build loyalty to retain riders (Imaz, Nurul Habib, Shalaby, & Idris, 2015).

What will satisfy a transit rider? The answer to this seemingly straightforward question is complex; satisfaction with transit depends on many different components, from safety to courteous staff to punctual and reliable services (Board, 1999; Eboli & Mazzulla, 2007, 2011; Weinstein, 2000). Nonetheless, not all riders value the same features of transit services, so agencies need to clarify distinctions, such as the expectations of different groups of riders. A substantial amount of research is aimed at uncovering different segments of riders, such as captive and choice riders (Krizek & El-Geneidy, 2007; Shiftan, Outwater, & Zhou, 2008; Zhao, Webb, & Shah, 2014), and newer work has parsed riders into even more diverse groups, such as captive-by-choice, riders with access to a car, but choose to use transit (van Lierop & El-Geneidy, 2014).

Apart from more obvious demographic differences based on age and income of riders, or frequency of use, other population segments have received less attention. Often overlooked are riders with physical disabilities who use regular services instead of adapted dial-a-ride services, or riders encumbered by shopping bags or small children. The satisfaction of different groups of riders can be based on different features and if a transit agency understands how riders with disabilities or encumbrances value features of bus services, then policies can be targeted to increase their satisfaction (Delbosc & Currie, 2011). In the present paper, we studied a large-scale, multiyear bus customer satisfaction survey from London, UK, to uncover how these groups of riders value different components of a bus service and compare them to other riders. This in turn will help to generate policies that will be effective in increasing satisfaction among all users.

The paper starts with a literature review on transit customer satisfaction and vulnerable populations' satisfaction with transit. Second, we detail the survey and methods used in the analyses. Third, we describe the results of the logistic model regressions based on three subgroups of defined bus riders. Lastly, we discuss our findings and potential policy implications.

LITERATURE REVIEW

Satisfaction and Public Transit

A large body of research has developed to uncover the service attributes that lead to public transit riders' satisfaction. An early study of rapid transit in the San Francisco Bay Area analyzed customer satisfaction and found that information and service timeliness were most important to customers (Weinstein, 2000). Studying satisfaction with the New York City subway with structural equation modeling (SEM) determined that station cleanliness, predictability or reliability, and personal safety had large direct and indirect impacts on satisfaction (Stuart, Mednick, & Bockman, 2000). SEM is a complex method aimed at elucidating how different factors can impact satisfaction in explicit ways, as well as how factors may work together to indirectly influence satisfaction. A SEM study of satisfaction of a bus route frequented by university students in Italy found that service reliability, comfort, and network design impacted overall satisfaction (Eboli & Mazzulla, 2007). Similarly, a study of transit satisfaction in Calgary, Canada discovered that reliability and convenience were valued more than ride comfort, suggesting that transit providers should focus on reducing multimodal transfers and improving network connectivity (Habib, Kattan, & Islam, 2011). A recent SEM study of perceived service quality discovered that service, comfort, and safety are important service attributes. Moreover, these three attributes were affected by other factors as well. For example, satisfaction with speed and frequency impacted service satisfaction to a greater degree than satisfaction with stop proximity and transit fares (de Oña, de Oña, Eboli, & Mazzulla, 2013).

Nevertheless, other studies have found that safety and ease of transit access were more important for satisfaction compared to information and reliability (Iseki & Smart, 2012). Interestingly, Iseki and Smart (2012) found that subtleties arise when analyzing men and women separately, or frequent riders, for example. This finding suggests that individuals have different requirements for satisfaction with transit. Regardless, components such as waiting time, reliability, journey time, comfort, safety, and driver behavior all influence rider satisfaction, although the degree to which each component contributes to overall satisfaction seems to vary, not only between cities, but between groups of riders as well. Circumstances beyond the control of transit agencies can also influence customer satisfaction with transit, as new work suggests that life satisfaction and personal disposition can significantly explain satisfaction with transit

service (Carrel, Mishalani, Sengupta, & Walker, 2015; Lai & Chen, 2011; St-Louis, Manaugh, van Lierop, & El-Geneidy, 2014).

Rider Segmentation in Transit and Vulnerable Populations

A recent of stream of investigation into transit satisfaction aims at discovering whether personal characteristics modify an individual's use and evaluation of transit services. Two types of riders are commonly identified as captive and choice riders. Captive riders have no other option but to use transit for travel, while choice riders typically have access to a car but choose to use transit for specific trips (Jin, Beimborn, & Greenwald, 2005). Krizek and El-Geneidy (2007) found that these definitions can be extended to regular and irregular users depending on frequency of use, and these four types of users value different aspects of transit service. Recent work based on two Canadian cities uncovered a previously uncategorized type of rider—captive-by-choice (van Lierop & El-Geneidy, 2014). These transit users have car access, but yet choose to use transit for many reasons, including environmental awareness.

Another approach is to analyze pre-defined subgroups and their preferences and satisfaction with transit service. In a study of satisfaction in the San Francisco Bay Area, occasional riders and those with low-incomes were less concerned with daytime safety than higher-income earners (Iseki & Smart, 2012). Gender differences are less clear, such as the importance of on-time reliability or other factors (Carrel, Mishalani, et al., 2015; Iseki & Smart, 2012). More recent work in the Bay Area using vehicle tracking and multiday travel satisfaction surveys found that age was an important determinant of satisfaction with in-vehicle transit time, while income had no effect on satisfaction with in-vehicle transit time, waiting time, transferring, or reliability (Carrel, Mishalani, et al., 2015). However, less work has focused on vulnerable populations and their satisfaction with transit.

Using a household travel survey in Melbourne, Australia, Delbosc and Currie (2011) characterized different groups of transport and transit disadvantaged residents, as well as residents with impairments or social vulnerabilities that hindered their ability to use transit. In particular, impaired residents make fewer trips and describe feelings of social exclusion because they have difficulty reaching transit stations and boarding/alighting vehicles (Delbosc & Currie, 2011). People with sensory disabilities, including hearing and visual impairments, who use public transit require particular attention (Hunter-Zaworski & Hron, 1999), especially in terms of

bus design and accessibility (Bareria, D'Souza, Lenker, Paquet, & Steinfeld, 2012). In addition, people with mobility impairments who use public transit face physical difficulties (Delbosc & Currie, 2011; Hunter-Zaworski & Zaworski, 1999; Lubin & Deka, 2012). Instead, they may opt to use dial-a-ride services, although overall satisfaction depends on numerous criteria (Paquette, Cordeau, & Laporte, 2009) and has been demonstrated to be low (Denson, 2000). Furthermore, dial-a-ride services are typically costly for transit agencies (Marković, Milinković, Schonfeld, & Drobnjak, 2013). Access to dial-a-ride services may not be feasible for all individuals with disabilities given rather stringent qualification criteria (London, n.d.-b), and may be inconvenient for some riders in terms of the need to schedule journeys in advance (MTA, n.d.). As such, the service characteristics of regular transit that may satisfy disabled riders have not been studied. In addition, riders carrying small children or babies, as well as riders using transit for shopping and carrying bags may require special attention to be satisfied and to keep using transit. This is particularly relevant for captive riders using transit for errands.

DATA AND METHODOLOGY

Context and Survey Overview

Transport for London (TfL) provides transit services in the Greater London, UK area, a densely populated urban area with a population of nearly 9 million people. TfL services include the London Underground, London Overground, and London Buses. Although TfL sets bus routes and schedules, the operation of individual bus routes is the responsibility of private bus operators, and contracts are awarded through a competitive tender process. Over 90% of Londoners live within 400 meters of a bus stop, and nearly 9,000 vehicles serve 675 routes (London, n.d.-a).

The dataset analyzed in this article comes from a five-year customer satisfaction survey administered by trained interviewers as intercept interviews to passengers alighting at bus stops across the Greater London area. After screening the interviewee based on potential employment or relation to a TfL employee, and whether the respondent is over 16 years of age, the interviewer proceeds with questions pertaining to the bus route from which the respondent just alighted. The respondent is initially asked how much time they spent on the bus, and then specifically their overall satisfaction with the entire trip starting at the boarding bus stop. In this

study, we use overall trip satisfaction, which was rated from 0 to 10, ranging from extremely dissatisfied to extremely satisfied, as the dependent variable in our models.

After asking overall satisfaction, a number of questions delve into different characteristics of the trip, including satisfaction with the bus stop/shelter (if any), the bus condition (exterior and interior), the ride quality, as well as information availability (outside and inside the bus). Other questions pertain to service characteristics, like reliability, satisfaction with time waited and total journey time, journey purpose, as well as personal characteristics such as gender, age, race, and regularity of use. Because this survey took place over five years, questions were modified, and new questions were added throughout the years. For consistency in our models, we mostly used questions that were asked throughout the five-year period to have as large a sample as possible. For instance, household income was queried beginning only in 2014, and therefore reduced the sample size considerably to about 5,000 respondents. We ran pilot models including household income and found that it was not an explanatory variable in our models of overall satisfaction (data not shown).

Data Preparation

The initial dataset included 65,506 respondents from 2010 to 2015. We included only respondents living in London and respondents that were not visitors to limit our dataset to Londoners. Since we wished to study satisfaction with a typical bus journey, to avoid short connecting trips or excessively long trips, we excluded respondents with travel times below 10 minutes and above 70 minutes, reducing the dataset to 43,552 entries. Moreover, because of the 2012 Summer Olympic games and the influx of tourists and athletes, as well as the added traffic in London (Sumner, 2012), we removed respondents from 25 July until 14 August 2012 inclusive. Finally, we removed entries with incomplete, partial, or ‘do not know’ answers leaving 28,375 respondents. We removed riders that had used next-arrival information (except for electronic signage/countdown at the bus stop/shelter) as these riders may have different satisfaction criteria (Carrel, Mishalani, et al., 2015; Tang & Thakuriah, 2011). Moreover, the questions pertaining to next-arrival information became more detailed in 2014, so we included only respondents that were asked simply whether there was an electronic countdown clock at the stop/shelter (and if used or not), as well as respondents that answered as not using any next-arrival information. In addition, this subgroup will be addressed in future studies. The dataset

used before differentiating different subgroups included 22,569 respondents, with 3,603 from 2010, 15,944 from 2011, 13,326 from 2012, 14,659 from 2013, 14,436 from 2014, and 3,538 from 2015. Next, we divided riders into three subgroups of interest: regular, encumbered, and disabled riders.

'Regular riders' are respondents with no encumbrances (i.e., no shopping bags, baby prams or small children, or large items or suitcase) or disabilities, for a total of 16,830 respondents. Note, regular riders in this paper are not defined by regularity of usage, as in previous research (Krizek & El-Geneidy, 2007). 'Encumbered riders' excludes riders with any disabilities, and includes respondents that were carrying the following: suitcase/heavy luggage and/or large or awkward item; shopping bags and/or shopping trolley; or small child/baby in arms and/or baby buggy/pushchair/pram. We excluded respondents that were carrying multiple encumbrances (to ease the interpretation of model results resulting from excessive dummy interaction variables) for a total of 4,136 respondents. For riders with disabilities ('disabled riders'), we included only riders with mobility disabilities (including age-related mobility disabilities), and/or with hearing disabilities, and/or with visual disabilities; respondents may have had more than one of these disabilities. This subgroup excluded respondents with encumbrances for a total of 555 respondents.

Although SEM is common in the transit satisfaction literature, structural equation models are nevertheless difficult to interpret because of how different variables work together to influence unobserved variables. In addition, whether transit agencies derive added benefit from complicated models is questionable. In the present paper, we used logistic modeling to determine how different criteria impact the odds that a bus rider will be satisfied or not. The dependent variable of interest was derived from the question on overall satisfaction, rated from 0 to 10. To convert these ratings into discrete binary variables, we converted ratings of 6 and below to 0 (dissatisfied) and 7 and above as 1 (satisfied). We chose this cut-off because the survey interviewers were instructed to follow-up satisfaction questions rated 6 or below on topics such as satisfaction with ride smoothness, interior cleanliness, etc., to determine the reasons for respondent dissatisfaction ("Why were you not particularly satisfied with…?"). We kept satisfaction ratings on the various components as continuous variables, and combined similar questions based on a factor analysis (discussed below), confirmed by how the questions were

grouped in the questionnaire. Other variables, such as the presence of a bus shelter or familiarity with the bus route, were converted to dummy variables for inclusion in the models.

Principal Component Analysis

Given the large set of questions that could be included in the models based on theory and the high levels of correlations between some of the variables, it was difficult to select which questions to include in the model. Applying a principle component analysis (factor analysis) to a set of survey questions and including the factor loadings as independent variables is one way to bypass these issues and has been used in past literature (Damant-Sirois & El-Geneidy, 2015; Hong & Chen, 2014). The analysis included questions related to satisfaction with the bus stop/shelter, the different components of the ride, and the different components of the bus itself. Table 1 presents the grouping results, the weights of different components, and the name of each factor component.

TABLE 1 Results from the Principle Component Analysis

Component	Question	Loading
1. Satisfaction with **ride quality**	Satisfaction with driver's behavior and attitude to you	0.725
	Satisfaction with your personal safety during the bus journey	0.717
	Satisfaction with the ease of getting on and off this bus	0.683
	Satisfaction with the smoothness and freedom from jolting during your journey	0.575
2. Satisfaction with the **bus exterior**	Satisfaction with the state of repair of the outside of the bus	0.781
	Satisfaction with the cleanliness and freedom from graffiti of the outside of the bus	0.773
	Satisfaction with the information provided on the outside of the bus	0.693
3. Satisfaction with the **waiting area**	Satisfaction with the freedom from litter	0.798
	Satisfaction with the cleanliness and freedom from graffiti	0.764
	Satisfaction with the state of repair	0.688
	Satisfaction with your personal safety	0.628
4. Satisfaction with **interior comfort**	Satisfaction with the cleanliness and freedom from litter inside the bus	0.729
	Satisfaction with your comfort inside the bus	0.669
	Satisfaction with the state of repair inside the bus	0.607
	Satisfaction with the level of crowding inside the bus	0.514
	Satisfaction with the notices and other information provided inside the bus	0.450

Four distinct components appear. The first deals with the quality of the on-board ride or experience, including driver's behavior and driving, and personal safety, and explains 18.49% of the variance. The second component pertains to satisfaction with appearance of the bus exterior and explains 17.96% of the variance, while the third component focuses on the appearance and experience at the waiting area (bus stop and/or shelter) and explains 16.65% of the variance. The fourth component focuses on satisfaction of the interior comfort of the bus, including cleanliness and crowding and explains the 15.19% of the variance. The factor loadings were used in the logistic regression models, and their averages are presented in Table 1.

RESULTS

The average values for the variables shown in Table 2 demonstrate that all subgroups had similar percentages of satisfied respondents, and slightly more disabled riders were satisfied with overall service (regular, 87%, encumbered, 87%, and disabled, 90%). Average travel times were also similar, about 18 to19 minutes for each subgroup. In general, encumbered riders gave slightly higher satisfaction scores on waiting time, length of journey time, reliability and information at the bus stop than regular riders, and these scores were again slightly higher for disabled riders (Table 2). Table 1 also shows the average values of the factor loadings for each groups of riders derived from the principle component analysis.

TABLE 2 Means of Variables in Overall Satisfaction Models

"Thinking about this **particular bus journey you have just made**, starting at the bus stop, how satisfied are you on a scale of 0 to 10 (where 10 is extremely satisfied and 0 is extremely dissatisfied) with the overall service you experienced today?" **0–10 scale converted 0–6 to 0, dissatisfied, and 7–10 to 1, satisfied**

		Regular 16,830	**Encumbered** 4,136	**Disabled** 555
	Variable description			
Dependent variable				
Satisfaction with overall service	Dummy variable equal to 1 if satisfied (score >6)	0.87	0.87	0.90
Independent variable				
Out-of-vehicle				
Shelter	Dummy variable equal to 1 if stop had a shelter	0.86	0.86	0.82
Waiting area condition	Factor loading for satisfaction with waiting area condition	-0.0051	0.011	0.063
Bus exterior	Factor loading for satisfaction with the bus exterior	-0.022	0.074	0.11
Time waited	Satisfaction with length of time waited	76.91	78.27	80.13
Bus stop/shelter information	Satisfaction with information available at bus stop/shelter	79.64	79.95	81.26
In-vehicle				
Journey time	Total journey time in minutes	19.74	19.31	18.08
Journey time satisfaction	Satisfaction with the length of time for the journey	81.03	82.14	83.46
Ride quality	Factor loading for satisfaction with the ride quality	0.011	-0.025	-0.16
Interior comfort	Factor loading for satisfaction with interior comfort	-0.018	0.043	0.21
Seat	Dummy variable equal to 1 if rider had a seat	0.96	0.94	0.98
Security agent	Dummy variable equal to 1 if a police officer, ticket inspector, and/or traffic warden was on the bus	0.038	0.040	0.031
Service attributes				
Reliability satisfaction	Satisfaction with reliability of present and recent trips on current bus route	76.52	77.67	78.65
Trip purpose				
Commuter	Dummy variable equal to 1 if main trip purpose is	0.43	0.28	0.18

	commuting (including employer's business)			
Education	Dummy variable equal to 1 if main trip purpose is for education	0.12	0.061	0.023
Shopping	Dummy variable equal to 1 if main trip purpose is shopping	0.15	0.38	0.34
Leisure	Dummy variable equal to 1 if main trip purpose is visiting friends/relatives, leisure, personal business or holiday/sightseeing	0.29	0.26	0.46
Child-related	Dummy variable equal to 1 if main trip purpose is taking or collecting a child	0.0092	0.025	–
Personal attributes				
White	Dummy variable equal to 1 if respondent is White (British, Irish, other)	0.54	0.62	0.78
Mixed race	Dummy variable equal to 1 if respondent is Mixed race (White and Black Caribbean, White and Black African, White and Asian, any other mixed background)	0.031	0.022	0.011
Asian	Dummy variable equal to 1 if respondent is Asian/Asian British (Indian, Pakistani, Bangladeshi, Chinese, other)	0.25	0.17	0.083
Black	Dummy variable equal to 1 if respondent is Black/Black British (Caribbean, African, other)	0.17	0.18	0.12
Male	Dummy variable equal to 1 if respondent is male	0.53	0.33	0.50
Familiar	Dummy variable equal to 1 if respondent is very or quite familiar with the journey	0.98	0.98	–
Encumbered				
Large item	Dummy variable equal to 1 if the respondent is carrying a suitcase/heavy luggage and/or large or awkward item	n.a.	0.16	n.a.
Shopping	Dummy variable equal to 1 if the respondent is carrying shopping bags and/or shopping trolley	n.a.	0.72	n.a.
Child	Dummy variable equal to 1 if the respondent is carrying a small child/baby in arms and/or baby buggy/pushchair/pram	n.a.	0.12	n.a.
Disability				
Mobility	Dummy variable equal to 1 if the respondent has a mobility impairment (including age-related)	n.a.	n.a.	0.83
Visual	Dummy variable equal to 1 if the respondent has a visual impairment	n.a.	n.a.	0.11
Hearing	Dummy variable equal to 1 if the respondent has a hearing impairment	n.a.	n.a.	0.09

n.a. indicates variables not included in a specific subgroup; – indicates variables with too few entries to be included in the model

Using logistic modeling of overall satisfaction, we uncovered potential and important divergent qualities that impact overall satisfaction of the three subgroups (Table 3).

TABLE 3 Results of Logistic Regression Models

Satisfied with overall service experience on the particular bus journey just made

	Regular			Encumbered			Disabled		
	Odds ratio	90% Conf. intervals		Odds ratio	90% Conf. intervals		Odds ratio	90% Conf. intervals	
Out-of-vehicle									
Shelter (dummy)	**1.19****	1.05	1.34	**1.47*****	1.16	1.88	1.07	0.52	2.17
Waiting area condition	**1.52*****	1.45	1.58	**1.40*****	1.28	1.53	1.27	0.97	1.67
Bus exterior	**1.10*****	1.05	1.15	**1.21*****	1.11	1.32	0.80	0.59	1.09
Time waited	**1.02*****	1.01	1.02	**1.02*****	1.01	1.02	1.00	0.99	1.02
Bus stop/shelter information	**1.00*****	1.00	1.01	1.00	0.99	1.01	**1.02****	1.00	1.04
In-vehicle									
Journey time	**0.99*****	0.98	0.99	**0.98*****	0.98	0.99	0.99	0.97	1.02
Journey time satisfaction	**1.02*****	1.02	1.03	**1.02*****	1.02	1.03	**1.03*****	1.01	1.05
Ride quality	**1.40*****	1.27	1.38	**1.46*****	1.33	1.60	1.24	0.94	1.63
Interior comfort	**1.32*****	1.27	1.38	**1.46*****	1.33	1.59	1.26	0.93	1.70
Seat	**1.44*****	1.19	1.75	**1.70*****	1.22	2.36	0.28	0.02	4.66
Security agent	**0.66*****	0.54	0.80	1.32	0.82	2.12	0.45	0.13	1.59
Service attributes									
Reliability satisfaction	**1.02*****	1.01	1.02	**1.02*****	1.01	1.02	**1.03*****	1.02	1.05
Trip purpose (compared to commuting)									
Education	0.95	0.83	1.08	1.10	0.76	1.59	0.84	0.19	3.82
Shopping	1.06	0.93	1.22	1.04	0.83	1.31	1.88	0.84	4.20
Leisure	**1.25*****	1.12	1.40	1.28	0.99	1.64	1.71	0.83	3.49
Child-related	1.66	0.97	2.84	**0.58***	0.34	0.98	n.a.	n.a.	n.a.
Personal attributes									
Mixed race[#]	0.96	0.75	1.23	0.82	0.47	1.43	0.18	0.022	1.48
Asian[#]	0.95	0.85	1.05	1.15	0.91	1.47	0.60	0.24	1.47
Black[#]	**0.72*****	0.64	0.81	0.86	0.69	1.08	**0.34*****	0.17	0.68
Male	**1.13****	1.03	1.24	1.01	0.83	1.24	0.85	0.48	1.52
Familiar	**1.47****	1.10	1.96	0.72	0.32	1.60	–	–	–
Encumbered (compared to large item-carrying)									
Shopping	–	–	–	0.97	0.75	1.25	–	–	–
Child	–	–	–	1.09	0.75	1.60	–	–	–
Disability									
Mobility	–	–	–	–	–	–	0.75	0.17	3.43
Visual	–	–	–	–	–	–	0.59	0.14	2.47
Hearing	–	–	–	–	–	–	0.92	0.22	3.90

	Regular	Encumbered	Disabled
N	16,830	4,136	555
Pseudo R^2	0.25	0.25	0.30
Log-likelihood	-4793.41	-1195.44	-126.43
AIC	9630.82	2438.87	298.85
BIC	9800.90	2590.73	398.19

– indicates variables not included in a specific subgroup; n.a. indicates variables with too few entries to be included in the model; [#]compared to White riders; **bold** indicates statistically significant variables at *$P < 0.10$, **$P < 0.05$, ***$P < 0.01$.

Table 3 presents the odds ratios and 90% confidence intervals for the three models. For out-of-vehicle variables, having a bus shelter increases the likelihood of being satisfied overall by 1.19 times for regular users, but by 1.47 times for encumbered users, while disabled riders are not affected by the presence of shelters. Having a bus shelter to sit in and rest encumbrances is clearly a priority for encumbered riders. Relatedly, increasing satisfaction of regular users with the waiting area (stop and/or shelter) will increase overall satisfaction by 1.52 times, while encumbered users are 1.40 times more likely to be satisfied overall; this variable is non-significant for disabled riders. This finding shows that in addition to having a shelter, a strong predictor of satisfaction is a clean, safe, and well-maintained waiting area that will benefit encumbered riders and also regular riders. The exterior condition of the bus has less of an impact, as increasing satisfaction with the bus exterior will increase the likelihood of overall satisfaction for regular riders by 1.10 times and 1.21 times for encumbered riders, while the bus exterior has no impact on satisfaction of riders with disabilities. This finding is similar to previous research stating that a bus exterior that is well-maintained is appreciated but not a priority compared to a comfortable waiting area (Yoh, Iseki, Smart, & Taylor, 2011).

Greater satisfaction with waiting time increases the likelihood of overall satisfaction by 1.02 times for both regular and encumbered riders, but not for disabled riders. Satisfaction with information about the bus route and schedule at the stop/shelter (including electronic next-arrival board) increases the likelihood of overall satisfaction for disabled riders by 1.02 times, while it has a marginal impact on regular users and was non-significant for encumbered riders. This heterogeneous affect on the different subgroups is likely due to next-arrival information access; perhaps disabled riders have less access to next-arrival information on devices like smartphones and thus rely most on information at the bus stop. Taken together, for out-of-vehicle characteristics, overall satisfaction of disabled riders is only influenced by information at the stop/shelter, while encumbered and regular riders' satisfaction overall depends largely on the presence of a shelter and the condition of the waiting area.

Total journey time significantly impacts satisfaction for regular and encumbered riders, as every minute of travel time decreases the odds of regular riders being satisfied by 1.01 and by 1.02 times for encumbered riders. Journey time is not significant for disabled riders. Nevertheless, subjective satisfaction with journey time is a significant variable for overall

satisfaction for all three subgroups. Increasing satisfaction with journey time increases the likelihood of overall satisfaction by 1.02 times for regular and encumbered riders, and 1.03 times for disabled riders. Our finding is consistent with a large amount of literature demonstrating the importance of journey time in transit satisfaction (Carrel, Mishalani, et al., 2015; Schmitt, Currie, & Delbosc, 2013; Zhao et al., 2014), and shows that all subgroups studied here value rapid trips.

More importantly, increasing satisfaction with ride quality—which relates to driver behavior, smoothness of the ride, and personal safety—for regular riders will increase their likelihood of overall satisfaction by 1.40 times and 1.46 times for encumbered riders. Greater satisfaction with comfort during the ride, including satisfaction with cleanliness of the bus interior, level of crowding, and information on the bus, increases the likelihood of overall satisfaction by 1.32 times for regular riders and 1.46 times for encumbered riders. None of the previously discussed variables were statistically significant for disabled riders. These findings recapitulate previous work showing that the level of crowding is a key determinant of satisfaction and route usage (Imaz et al., 2015; McMullan & Majumdar, 2012). Associated with crowding is the ability to find a seat, and having a seat will increase the likelihood of overall satisfaction for regular riders by 1.44 times and 1.70 times for encumbered riders. Interestingly, having a seat does not influence the satisfaction of riders with disabilities, and since most riders with disabilities had a seat, our models demonstrate the effectiveness of priority seating as a policy. Curiously, for regular riders, the on-board presence of a security agent will decrease the odds of overall satisfaction by 1.52 times. While safety was included in the 'ride quality' and 'waiting area' variables, safety with transit use seems to depend mainly on an individual's trust of others and their neighborhood (Delbosc & Currie, 2012b). A conspicuous security agent, on the other hand, may cause antagonism.

Reliability is a key indicator important to both bus operators and riders (Carrel, Lau, Mishalani, Sengupta, & Walker, 2015; Eboli & Mazzulla, 2011; Hensher & Stanley, 2003; Tyrinopoulos & Antoniou, 2008; Yoh et al., 2011), and we confirm that all subgroups in our study place importance on reliability. Increasing satisfaction with reliability of the bus route will increase the overall likelihood of satisfaction by 1.02 times for regular and encumbered riders, and 1.03 times for disabled riders. Therefore, all riders value reliability, and for in-vehicle features, having a seat is most important for regular and encumbered riders, but satisfaction with journey time is most important for disabled riders.

Regarding trip purpose, compared to commuting, regular riders traveling for personal reasons like visiting friends and family will be 1.25 times more likely to be satisfied with their trip. Interestingly, encumbered riders on child-related trips will be 1.72 times less likely to be satisfied with their trip compared to encumbered commuters. This finding highlights that traveling with children may be a stressful experience, and transit agencies should make journeys as convenient as possible to encourage riders with children to use transit, like providing priority seating for parents with small children as well as bus shelters.

We also analyzed some personal rider attributes and found that regular and disabled riders who are Black are 1.39 times and 2.94 times, respectively, less likely to be satisfied with their trip. Our finding lends credence to the potential differences in preferences for transit qualities by race (Iseki & Smart, 2012). Regular riders who are men are 1.13 times more likely to be overall satisfied, demonstrating gender differences which have been more tenuous in past literature (Carrel, Mishalani, et al., 2015; Iseki & Smart, 2012). Regular riders who are familiar with their journey are 1.47 times more likely to be satisfied overall, corroborating a recent study that showed how unfamiliar riders develop negative views toward transit upon first usage (Schmitt et al., 2013). Therefore, transit agencies could employ advertisement campaigns to promote the benefits of transit to a large population, in an effort to capture infrequent users (Krizek & El-Geneidy, 2007).

None of the specific encumbrance or disability variables were significant (Table 3), suggesting that encumbered and disabled riders, in our models at least, are comparable regardless of encumbrance or disability. However, this is probably artificial, since a bus rider with a hearing impairment will likely have different struggles compared to a bus rider with a mobility impairment. Future work should analyze a larger cohort of riders with different disabilities using regular transit.

The models for regular and encumbered riders explain approximately 25% of the variance in overall satisfaction, while the model for disabled riders explains approximately 30%. Our models are comparable in explanatory power to other travel satisfaction models (Collantes & Mokhtarian, 2007; Iseki & Smart, 2012; St-Louis et al., 2014). Finally, the log-likelihood tests reveal that the models for encumbered and disabled riders have better data fits than the model for regular riders.

DISCUSSION AND CONCLUSIONS

In this study, we used a large-scale bus satisfaction survey to determine how overall satisfaction of regular riders, encumbered riders, and riders with disabilities is based on different components of the journey. Our work sheds light on how disabled riders view regular bus services, a topic that has received little previous attention. Moreover, we also analyzed encumbered riders to learn about their satisfaction with different attributes. While regular and encumbered riders have similar concerns suggesting that these groups are comparable, few variables were of significance for riders with disabilities. This suggests that disabled riders likely have larger concerns than the appearance of a bus, for example, and prioritize a reliable and speedy journey.

For regular riders, satisfaction with the waiting area is an important quality, echoing previous work in different cities (de Oña et al., 2013; Weinstein, 2000). Our work also uncovers important policy targets that will not only improve overall satisfaction for all riders, but as well for subgroups of riders who have vulnerabilities, be they a physical disability or because they rely on transit for child-related or shopping purposes (Delbosc & Currie, 2011, 2012a). Importantly, the presence of a bus shelter increases the odds of overall satisfaction the most for encumbered riders, suggesting that to satisfy riders with children or shopping bags, an important feature to provide is a well-maintained bus shelter where they can sit or place their bags safely, especially in a city like London that is well-known for its rainy seasons. Therefore, if a transit agency wishes to increase ridership for shopping trips, then supplying bus shelters would be an appropriate strategy. Riders with disabilities are more likely to be satisfied overall if they are satisfied with information at the bus stop, but this variable is non-significant for encumbered riders and has very little impact of the satisfaction of regular riders. Perhaps a lack of access to other forms of next-arrival information increases the reliance of disabled riders on information at a stop, while other riders will check information elsewhere. For visually impaired riders specifically, having access to audible cues or schedules, as well as personalized services or training (Hunter-Zaworski & Hron, 1999) may increase their satisfaction and autonomy. Therefore, agencies should ensure up-to-date information and functional next-arrival boards. Another strategy could be to provide more space for pushchairs or large bags to ease the journeys of encumbered riders.

In-vehicle travel time and reliability are important variables leading to satisfaction in many studies (Carrel, Mishalani, et al., 2015; Habib et al., 2011; Iseki & Smart, 2012), and we

confirm this for all subgroups in our study. Future work should also examine how transfers affect the subgroups we identified here, since the format of the question in the present survey was complex and were difficult to control for. We also have a hint at the psychological impacts on trip satisfaction (St-Louis et al., 2014); regular riders traveling for personal business or leisure are more likely to be satisfied than commuters, while encumbered riders on child-related travel are less likely to be satisfied than commuters with their trip. These observations require more detailed analysis through in-depth interviews to understand the reasons for these discrepancies in the levels of satisfaction. Finally, regular riders who are men are more likely to be satisfied overall, although future work could parse the genders to determine which components may be important to men and women equally, since previous work was inconclusive (Carrel, Mishalani, et al., 2015; Iseki & Smart, 2012).

While our study has addressed how riders with disabilities and encumbrances value different aspects of bus services, future work could split these groups into irregular and regular riders based on usage (Krizek & El-Geneidy, 2007), as well as into captive, choice, and captive-by-choice categories (van Lierop & El-Geneidy, 2014). It would thus be important that future surveys include questions about car availability. For disabled riders using regular transit, follow-up surveys about specific problems they encounter may help improve bus design for these vulnerable users (Bareria et al., 2012). Lastly, people filter their experiences through their personal values, and subjective well-being is an important factor for transit satisfaction (Carrel, Mishalani, et al., 2015; Eboli & Mazzulla, 2011). Bearing this in mind, future transit customer satisfaction surveys should query general well-being and mood.

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