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Understanding the Transit Market: A Persona-Based Approach for Preferences Quantification

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Abstract: The study aims at utilizing a persona-based approach in understanding, and further quantifying, the preferences of the key transit market groups and estimating their willingness to pay (WTP) for service improvements. The study adopted an Error Component (EC) interaction choice model to investigate personas' preferences in a bus service desired quality choice experiment. Seven personas were developed based on four primary characteristics: travel behaviour, employment status, geographical distribution, and Perceived Behavioural Control (PBC). The study utilized a dataset of 5238 participants elicited from the Hamilton Street Railway Public Engagement Survey, Ontario, Canada. The results show that all personas, albeit significantly different in magnitude, are negatively affected by longer journey times, higher trip fares, longer service headways, while positively affected by reducing the number of transfers per trip and real-time information provision. The WTP estimates show that, in general, potential users are more likely to have higher WTP values compared to current users except for at-stop real-time information provision. Also, there is no consensus within current users nor potential users on the WTP estimates for service improvements. Finally, shared and unique preferences for service attributes among personas were identified to help transit agencies tailor their marketing/improvement plans based on the targeted segments.

Keywords: persona-based approach; error component model; service desired quality; willingness to pay; shared and unique preferences

1. Introduction and Background

Luring people out of their cars into public transit is vital for making cities liveable, sustainable, and equitable. Less car-dependent travel behaviour is essential in mitigating congestion and pollution problems in our cities. Transit agencies and decision-makers are striving to understand customers' needs, and hence increasing ridership. As such, there is a continued emphasis in the literature on investigating the desired quality from transit services, such as the work of [1–3]. However, understanding transit service desired quality for a wide spectrum of nontransit users is equally vital to increase transit market share and reduce car dependency.

In this regard, the transit market is often classified, among other classifications, into current and potential transit users [4–7], and/or captive and choice users [8–11]. Choice users have access to multiple modes of travel, while captive users have access to only one mode of travel. A spatial segmentation approach is also adopted to understand the preferences of different groups of transit users from a geographical perspective [12–14]. Additionally, other studies adopted a cluster analysis approach to extract homogenous customer groups with respect to preferences towards transit service quality [12,15,16]. All these prior classification approaches are often utilized to provide additional layers of information to better understand the preferences of different customer groups within the transit market.

Other studies incorporated socioeconomic attributes and travel behaviour characteristics to understand the preferences of different user groups within the transit market, such as the work of [17], who utilized Multinomial Logit (MNL) Interaction Models, [18], who adopted an Ordered Probit Model (OPM), and [3], who employed Multiple Indicators Multiple Cause (MIMIC) Structure Equation Modelling (SEM) approaches. Their central goal, however, is rooted in understanding the heterogeneity in the preferences of transit customers.

In addition, discrete choice models, such as Mixed Logit (ML) Models and Latent Class Choice Models (LCM), are utilized in the literature to understand the broad span of preferences that exist in the transit market. Ventor [10] utilized an ML model to examine the stated preferences of captive and choice transit customers; the study proved the existence of preference heterogeneity within each user group. Also, the ML model was utilized in [19] to investigate observed and unobserved preference heterogeneity within transit users. ML and Latent Class (LC) choice models were utilized in [20] to investigate preference heterogeneity within current and potential transit users' groups, while Eldeeb and Mohamed [21] adopted ML and LC choice models to unveil preference heterogeneity within the whole transit market and classify the transit market into groups with homogenous preferences.

This mosaic of methodological techniques and user classification approaches share the same objective to better understanding the preferences towards transit service quality in a way that represents the entire population.

Nevertheless, recently, transit agencies opt to understand the transit market preferences based on a user-profile approach contrary to investigating the transit market based on independent socioeconomic attributes and/or travel behaviour characteristics. A user-profile approach allows transit agencies to target specific customer groups (i.e., key customer segments) and to consider specific real-life, easy-to-target customers. More specifically, transit agencies such as, among others, Metrolinx [22], TransLink [23], and EMT Madrid [24] are considering a persona-based approach to better understand their customers, as well as their travel behaviours and preferences. According to [25], a customer persona (detailed in Section 2) represents a group of targeted customers that share the same goals, needs, and behaviour.

For example, Metrolinx [22] developed six regional personas to better understand the travel behaviour and preferences of residents of the Greater Toronto and Hamilton Area (GTHA). Those personas are: (1) Time and Balance Seekers, (2) Traditional Suburban Travellers, (3) Frustrated Solution Seekers, (4) Connected Optimizing Urbanites, (5) Satisfied Mature Urbanites, and (6) Aspiring Young Travellers. A detailed description of each persona is available in the Metrolinx 2041 Regional Transportation Plan, Appendix 2D [22].

However, recognizing the scarcity of implementing the persona method in the transit quality literature, the authors argue on the pressing need of public transit agencies to better understand the preferences of the key market segments and advance the use of the persona-based approach beyond its current qualitative nature.

In this respect, the aim of this paper is twofold: (1) Understanding the preferences of the dominant transit market segments considering a persona-based (user-profile) approach, and (2) Advancing the use of the persona-based approach through quantifying personas' preferences and estimating their willingness to pay for service improvements. Accordingly, transit agencies should reconcile their marketing/improvement plans with a better understanding of their key customers' needs and based on quantified measures.

Towards that end, the study adopted an Error Component (EC) interaction choice model along with a persona-based approach in order to investigate shared preferences versus unique preferences associated with different transit market groups and quantify their willingness to pay (WTP) for service improvements. The study utilized a primary dataset of 5238 respondents elicited from an online survey that was part of Hamilton Street Railway (HSR) Public Engagement efforts in the city of Hamilton, Ontario, Canada.

The remainder of this paper is arranged as follows: Section 2 provides a review of previous persona-based studies; Section 3 describes the modelling approach as well as the data collection process; Section 4 presents the results of the Error Component (EC) interaction model, which is followed by a discussion and concluding remarks in Sections 5 and 6, respectively.

2. Persona-Based Approach

A persona, first introduced by Cooper [26], is a user-centric design approach. The persona is defined as a fictitious character that portrays a targeted group of customers [26]. A customer persona represents a group of individuals who share common goals, needs, and behaviour [25]. From a practical approach, the customer persona method is used by designers, planners, and developers to identify, and later target, key customer segments. The persona method, as stated in [27], facilitates two major questions: *first*, who are we planning for? and *second*, who are we not planning for?

The method has been successfully implemented in understanding the actual goals of the targeted customers, prevention of self-referential design, and structuring research data in a more vivid form compared to raw data [27]. A step-by-step methodology of developing personas as a user-centred design method is provided by Nielson [28].

The persona-based approach has been adopted in many disciplines such as, among others, software development and webpage design to allow software/web developers to better understand prospective customers as well as their needs and requirements [29,30]. It was also implemented in automotive manufacturing to ensure that the design team has a common understanding of the customers' needs [31], and to examine different scenarios of vehicle design conception [32]. Further, in health sciences, the persona method was used to develop tailored health education messages to address patients' preferences [33] and to inform the design of a user-centred information resource regarding natural-products and conventional-drugs interaction [34]. In education, the persona approach is utilized as a pedagogical tool [35,36].

In the transportation research literature, Lindgren et al. [37] used personas to identify the requirements of a dynamic graphical interface for Advanced Driver Assistance Systems (ADAS). Schäfer et al. [38] adopted the persona method in describing escape routes' users in subway stations to better picture their expectations and requirements. De Clerk et al. [39] employed a persona-based approach to assessing the balance between ownership and external costs associated with electric and conventional vehicle technologies. Kong et al. [40] employed personas to aid the design of human–robot interactions to build acceptance among various user types regarding the use of autonomous buses in mass transit.

However, to the best of the authors' knowledge, the use of the persona method in the transit quality literature remains rare.

Despite the aforementioned advantages, there are some limitations associated with the persona-based approach. The main limitation is the validity of the developed personas. It is argued that personas are hard to validate as they are developed based on the qualitative understanding of the important aspects of the final product/service [41]. Additionally, as argued in [42], the process of persona development might lead to base personas on stereotypes instead of genuine user types. However, the validity of the developed personas could be enhanced by using real data to inform the process of developing personas [43]. Another point to consider is that the prevalence rate (i.e., the proportion in the population) of a persona decreases with the addition of more attributes to describe each persona [44]. Nevertheless, the prevalence issue might be resolved through tuning down the number of attributes used in the persona development.

In this respect, the paper aims at utilizing the persona-based approach as a transit market taxonomy tool and advancing this approach by introducing quantified preferences and willingness-to-pay estimates for each persona. It is worth noting that the focus of this paper is not the development process of the personas; it is, rather, understanding and quantifying the preferences of the salient transit personas.

3. Methodology

3.1. Methods

This study utilized an Error Component (EC) interaction model to investigate personas' preferences in a bus service desired quality choice experiment, and to estimate the influence of each attribute on the overall transit utility with respect to each persona.

The EC interaction model was used to independently investigate the preferences of the seven personas (explained in the next section), while accounting for the "*panel effect*" that emerged from the Stated Preference (SP) experiment. As one form of the Mixed Logit (ML) modelling family, the EC model was developed based on the works of [45,46] and considered the Random Utility Maximization (RUM) theory [47,48]. For the EC model, the RUM adopts a rational decision-making approach, which assumes that individual i picks the choice j that maximizes their utility U_{ijt}, in the choice situation, t:

$$U_{ijt} = \beta\, X_{ijt} + \eta_{ijt} Y_{ijt} + \varepsilon_{ijt}., \quad (1)$$

where X_{ijt} is the observable component of the utility function, which is a vector of explanatory variables, and β is a vector of estimated fixed parameters, while η_{ijt} is a vector of random elements with a distribution (assumed as normally distributed with zero mean), assigned by the modeller, and Y_{ijt} is a vector of unknown attributes. ε_{ijt} is the error term, which is assumed to be identically and independently distributed (IID).

The explanatory variables might include choice attributes as well as interaction variables reflecting the characteristics of each persona, which adopts the systematic taste variations specification suggested by [49,50]. The unconditional choice probability, as mentioned in [51], for individual i, selecting a choice j, based on the EC formulation, is expressed as follows:

$$P_{ij} = \int \prod_{t=1}^{T_q} \left[\frac{e^{\beta\, X_{ijt} + \eta_{ijt} Y_{ijt}}}{\sum_{j=1}^{J} e^{\beta\, X_{ijt} + \eta_{ijt} Y_{ijt}}} \right] f(\eta)\, d(\eta). \quad (2)$$

The EC interaction model is estimated using a range of Modified Latin Hypercube Sampling (MLHS) draws (e.g., 50, 100, 500, 1000) through the Pandas Biogeme package [52]. According to Hess et al. [53], the MLHS outperforms other types of Quasi-random number sequences such as Halton draws. Since the choice experiment being dealt with is unlabelled, all alternative specific constants were excluded, and no respondents' specific attributes were introduced [54].

3.2. Data and Survey Instrument

The paper utilized a primary dataset from an online survey that was part of Hamilton Street Railway (HSR) Public Engagement efforts in the city of Hamilton, Ontario, Canada. HSR is the municipal public transit provider for the city of Hamilton and provides a service coverage area of 243 square kilometres through 35 regular bus routes [55]. The general purpose of the survey is to benchmark the service quality provided by HSR based on Hamiltonians' preferences and expectations. As mentioned in [56], the survey is designed for all Hamiltonians (i.e., both current and potential transit users) and structured in four independent sections: (1) Socioeconomic demographic characteristics and travel behaviour, (2) Stated Preference (SP) experiments, (3) Service quality aspects, and (4) Attitudinal and behavioural characteristics.

This paper utilized the unlabelled SP experiment, socioeconomic attributes, and travel behaviour characteristics components of the survey. The total number of respondents who answered the online survey by April 2019 was 5781 Hamiltonians. A total of 543 invalid, unengaged, and incomplete responses were removed based on a thorough validation process. Hence, a validated dataset of 5238 participants was utilized in the study.

The design of the SP experiment employed, as advised by Bliemer and Rose [57], a three-stage sequential process (i.e., model specification, experimental design, and questionnaire) for the selection of the attributes and their associated levels. The final list of attributes and the associated levels are presented in Table 1.

Table 1. Unlabelled SP experiment attributes and their associated levels [56].

Service Attributes	Attribute Levels
One-way trip cost	\$3, \$4.50, and \$6
One-way trip travel time	20, 30, and 40 min
Walking time to and from the bus stop	0, 5, 10, and 15 min
Service headway	5, 10, 15, and 30 min
Number of transfers	0, 1, and 2 transfers
Real-time information	At-stop, onboard and none

The experimental design of the SP experiment adopted the efficient design approach, to improve the statistical efficiency and maximize the amount of information extracted from the SP experiment [58]. For the interested reader, a detailed description of the design process of the unlabelled SP experiment is introduced in [21,56]. Overall, the experimental design produced twelve scenarios grouped into three blocks. Each respondent faced four scenarios, and their choices were made from three unlabelled bus transit alternatives, as shown in Figure 1.

Trip & Service Attributes	Option - A	Option - B	Option - C
Bus Fare (one-way trip)	\$ 3.00	\$ 4.50	\$ 3.00
Time Spent Travelling on Bus (one-way trip)	40 min	30 min	40 min
A Bus Departs from My Stop (at the start/end and transfer stops)	every 5 min	every 10 min	every 10 min
Walking Time to/from Bus Stop (includes walking time between transfer stops)	15 min	5 min	5 min
Number of Transfers Between Buses (during one-way trip)	2 Transfer	0 Transfer	1 Transfer
Real-time Trip Information (e.g. about delays)	None	At stop	On board
To Complete My Regular One-Way Trip, I would Choose	○	○	○

Figure 1. Example of a stated preference scenario in the survey [56].

In addition to the stated preferences, Perceived Behavioural Control (PBC) towards public transit was also utilized, which represents how easy/difficult respondents perceive transit use [59]. PBC was measured using three attitudinal statements: (1) Finding routes and schedules for my trip does not require too much effort, (2) It is easy to travel around the city using the HSR transit service, and (3) Transferring between routes is easy. Respondents were asked to assess their agreement on the accuracy of each statement on a 5-point Likert scale. These attitudinal statements have a Cronbach's alpha of 0.770, which indicates internal consistency.

3.3. Adopted Personas

Based on semistructured workshops with HSR personnel, the preliminary seven personas were identified. These personas are deemed to best describe the key groups of the targeted transit market within the city of Hamilton. The personas were developed, independently from the HSR public engagement survey, based on four main characteristics: travel behaviour, employment status, geographical distribution, and Perceived Behavioural Control (PBC).

The seven personas represent around 55.50% of our dataset; and the subsample includes 2907 respondents. Each persona portrays a typical group of Hamiltonians who are current or potential transit users as follows:

1. Persona 01 represents full-time employees who consider public transit as their primary mode of travel and are more likely to have a positive transit PBC and live in urban areas. This persona represents 912 respondents from the sample.
2. Persona 02 portrays students who rely on public transit as their primary mode of travel and are more likely to have a positive transit PBC and live in urban areas. This persona represents 526 respondents from the sample.
3. Persona 03 portrays full-time employees who live in urban areas, consider private vehicles as their primary mode of travel, and have more potential to have a neutral PBC. This persona represents 701 respondents from the sample.
4. Persona 04 depicts retirees who consider private vehicles as their primary mode of travel and are more likely to have a neutral transit PBC and live in urban areas. This persona represents 407 respondents from the sample.
5. Persona 05 represents students who consider private vehicles (driver or passenger) as their primary mode of travel and are more likely to have a neutral PBC and live in urban areas. This persona represents 142 respondents from the sample.
6. Persona 06 portrays full-time personnel who consider private vehicles as passengers their primary mode of travel and are more likely to have a neutral PBC and live in urban areas. This persona represents 83 respondents from the sample.
7. Persona 07 portrays full-time employees who live in the suburbs, identify private vehicles as their primary mode of travel, and are more likely to have a negative transit PBC. This persona represents 136 respondents from the sample.

Table 2 depicts the distribution of the personas' subsample, 2907 respondents, associated with different socioeconomic and demographic characteristics. The utilized sample represents more females (57.93%) than males (39.32%) and also includes 2.75% gender self-identity (e.g., prefer not to answer, non-binary, neutral, agender, transgender, etc.). Middle-aged respondents are the most represented in the sample (50.33%), while old respondents are the least represented (16.58%). Vehicle ownership ratio is relatively high, where about 83.21% of respondents have a vehicle in their household. Most respondents have a driver's licence (78.57%) and live in urban areas (83.56%).

Figure 2 summarizes the distribution of different socioeconomic and demographic characteristics for each persona. The highest percentages of males are in Persona 03 and Persona 04, while females are the highest in Personas 02, 05, and 06 categories. Among full-time personnel personas (i.e., Personas 01, 03, 06, and 07), the highest proportion of young respondents is in Persona 01, while the highest proportion of middle-aged respondents is in Persona 07. This corroborates that transit use is more prevalent among young full-time personnel compared to other age categories. The highest ratios of two or more vehicles in the household are in Persona 07 and Persona 05, while the highest ratio of one vehicle in the household is in Persona 06. Aside from Persona 07, the highest percentage of respondents who live in the suburbs are in Persona 04 (31.45%) and Persona 05 (32.39%). Regarding transit PBC, the highest percentage of respondents with a positive transit PBC is in Persona 01 (60.16%), while the highest with a negative transit PBC is in Persona 07 (59.80%).

Table 2. Sample distribution.

Category	Subcategory	Users (%)	Population (%)
Total	Total	2907	747,645 (100%)
Gender	Male	39.32%	48.90%
	Female	57.93%	51.10%
	Self-identity	2.75%	
Age	Less than 30 years old	33.09%	35.72%
	30 to 59 years old	50.33%	40.64%
	Over 60 years old	16.58%	23.64%
Vehicle ownership	Zero Vehicle	16.79%	13.00%
	One Vehicle	41.04%	87.00%
	Two or more	42.17%	
Driver's licence	Holding	78.57%	—
	Not holding	21.43%	—
Geographic distribution	Suburban areas	16.44%	36.69%
	Urban areas	83.56%	63.31%

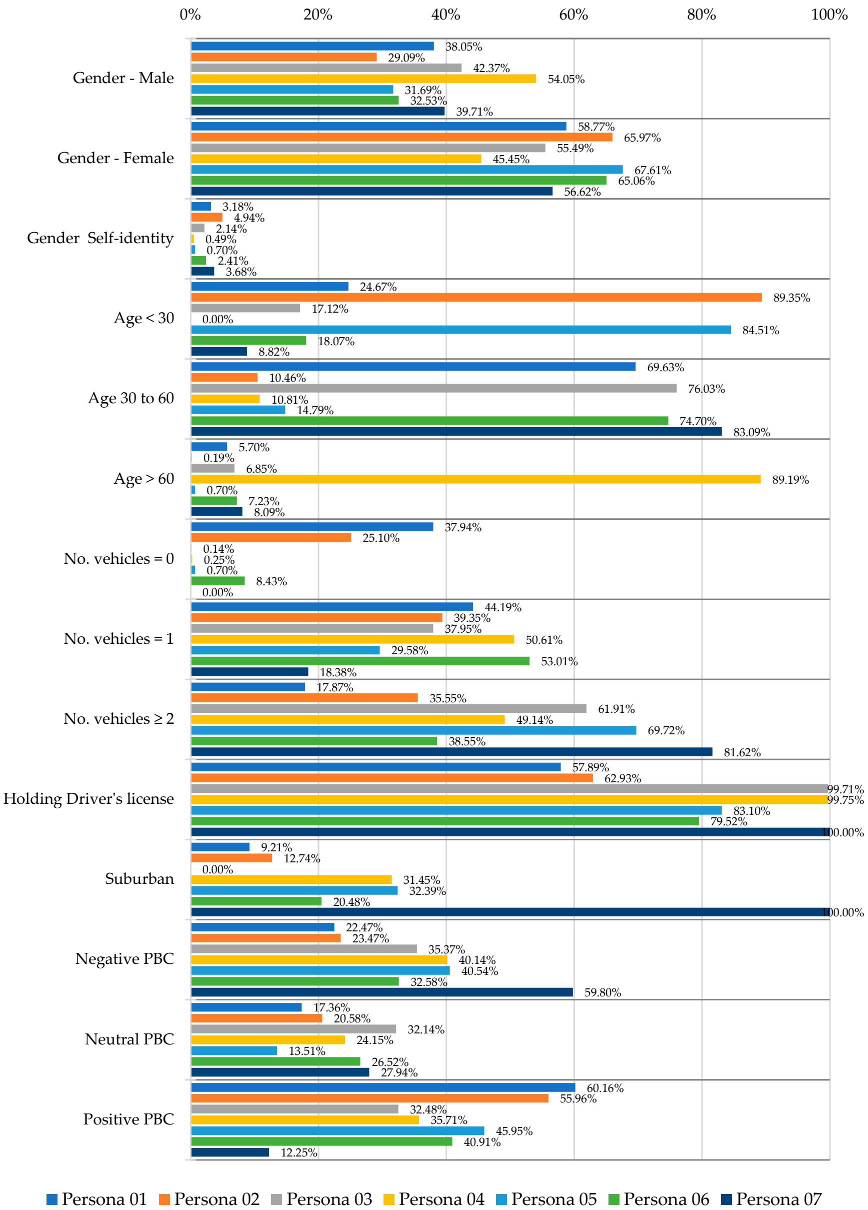


Figure 2. The profile of the seven adopted personas.

4. Results

4.1. Persona-Based Preferences

One inclusive EC interaction model was developed to estimate the influence of each attribute on the overall transit utility with respect to each persona and to explain personas' preferences and their statistically significant differences concerning service attributes. This, in turn, helps to identify the shared preferences versus the unique preferences associated with different transit market groups.

In our model, Persona 01 is considered the base category, and the results of the EC interaction model are shown in Table 3. The results include all personas' interactions with different service attributes in reference to Persona 01. The unique effects (coefficients) of service attributes with regard to each persona are presented in Table 4. The error component does not prove to be statistically significant; however, it is retained as a precautionary measure to account for the panel effect.

Table 3. Error component model estimates for personas' interactions.

Variable	Persona 01 (Ref.)	Persona 02 Interaction	Persona 03 Interaction	Persona 04 Interaction	Persona 05 Interaction	Persona 06 Interaction	Persona 07 Interaction
Journey time	−0.041 ***	*0.003*	−0.015 **	0.017 **	−0.005	−0.014	−0.011
Trip fare	−0.541 ***	*0.076*	0.099 *	0.184 ***	0.175 *	0.142	0.235 **
Walking time	−0.007	−0.022 **	−0.035 ***	−0.022 **	−0.017	0.004	0.002
Service headway	−0.039 ***	−0.003	0.005	0.027 ***	0.017 **	0.008	0.011
Number of transfers (2 transfers base category)							
One transfer	0.884 ***	−0.005	0.010	−0.115	−0.322 **	−0.243	0.344 **
Zero transfer	1.160 ***	0.032	0.384 ***	−0.092	−0.061	0.100	0.782 ***
Real-time information (No info. base category)							
Real-time info. onboard	0.388 ***	0.116	−0.067	−0.128	0.116	−0.058	0.080
Real-time info. at-stop	0.343 ***	0.026	−0.124	−0.265 ***	0.143	0.040	0.046
Error component				0.016			
Log-likelihood				−11,580.86			
Log-likelihood ratio test				2750.716			
Rho-square				0.106			

Note: ***, **, and * indicate significance at 1%, 5%, and 10% levels, respectively, and Table A1-Appendix A presents the detailed results for the model estimates.

Table 4. The unique effects (coefficients) of service attributes with respect to each persona.

Variables	Persona 01	Persona 02	Persona 03	Persona 04	Persona 05	Persona 06	Persona 07
Journey time	−0.041	−0.039	−0.057	−0.025	−0.046	−0.055	−0.052
Trip fare	−0.541	−0.466	−0.442	−0.357	−0.367	−0.400	−0.306
Walking time	−0.007	−0.029	−0.041	−0.029	−0.024	−0.003	−0.005
Service headway	−0.039	−0.042	−0.034	−0.011	−0.021	−0.030	−0.028
One transfer	0.884	0.879	0.894	0.769	0.562	0.641	1.230
Zero transfer	1.160	1.190	1.540	1.060	1.100	1.260	1.940
Real time info. onboard	0.388	0.503	0.321	0.259	0.504	0.329	0.467
Real time info. at stop	0.343	0.369	0.219	0.078	0.486	0.382	0.388

In the case of journey time, for all personas, transit utility is negatively affected by longer journey times. Persona 03 ($\beta_{03\text{-Journey time}}$: −0.0412 − 0.0153 = −0.0565) is the most sensitive to journey time, while Persona 04 ($\beta_{04\text{-Journey time}}$: −0.025) is the most tolerant. Persona 06 ($\beta_{06\text{-Journey time}}$: −0.055) and Persona 07 ($\beta_{07\text{-Journey time}}$: −0.052) are less sensitive to journey time than Persona 03 but more sensitive than all other personas. Persona 05 ($\beta_{05\text{-Journey time}}$: −0.046), Persona 01 ($\beta_{01\text{-Journey time}}$: −0.041), and Persona 02 ($\beta_{02\text{-Journey time}}$: −0.039) are only more sensitive to journey time than Persona 04.

With respect to trip fare, the transit utility of all personas is negatively influenced by increasing trip fare. The most sensitive to trip fare is Persona 01 ($\beta_{01\text{-Trip fare}}$: −0.541), while the least sensitive is Persona 07 ($\beta_{07\text{-Trip fare}}$: −0.306). Persona 02 ($\beta_{02\text{-Trip fare}}$: −0.466) and Persona 03 ($\beta_{03\text{-Trip fare}}$: −0.442) are more sensitive to trip fare than all other personas except Persona 01. Persona 06 ($\beta_{06\text{-Trip fare}}$: −0.400), Persona 05 ($\beta_{05\text{-Trip fare}}$: −0.367), and Persona 04 ($\beta_{04\text{-Trip fare}}$: −0.357) are more sensitive to trip fare than Persona 07 and less sensitive than all other personas.

Walking time to/from bus stop does not prove to significantly impact transit service utility for Personas 01, 05, 06, and 07, which implies that these personas are lenient regarding walking time to/from bus stops. Nonetheless, the most sensitive persona to walking time is Persona 03 ($\beta_{03\text{-Walking time}}$: −0.041), while Persona 02 and Persona 04 ($\beta_{02,\ \&\ 04\text{-Walking time}}$: −0.029) are the second-highest most sensitive to walking time to/from the bus stop.

In regard to service headway (time between consecutive buses), the transit utility of all seven personas is negatively affected by less frequent transit services (higher headway). Persona 02 ($\beta_{02\text{-Service headway}}$: −0.042) is the most sensitive to service headway, while Persona 04 ($\beta_{04\text{-Service headway}}$: −0.011) is the least sensitive to service headway. Persona 01 ($\beta_{01\text{-Service headway}}$: −0.039) and Persona 03 ($\beta_{03\text{-Service headway}}$: −0.034) are more sensitive to service headway than all other personas except Persona 02. Persona 06 ($\beta_{06\text{-Service headway}}$: −0.030), Persona 07 ($\beta_{07\text{-Service headway}}$: −0.028), and Persona 05 ($\beta_{05\text{-Service headway}}$: −0.021) are only more sensitive to service headway than Persona 04.

With reference to the number of transfers, all the seven personas are positively affected by reducing the number of transfers from two to one transfer per trip. Persona 07 ($\beta_{07\text{-One transfer}}$: 1.230) is the most influenced by reducing the number of transfers from two to one per trip, while Persona 05 ($\beta_{05\text{-One transfer}}$: 0.562) is the least influenced. Persona 03 ($\beta_{03\text{-One transfer}}$: 0.894) is the second most influenced by the number of transfers, followed by Persona 01 ($\beta_{01\text{-One transfer}}$: 0.884) and Persona 02 ($\beta_{02\text{-One transfer}}$: 0.879). Persona 04 ($\beta_{04\text{-One transfer}}$: 0.769) and Persona 06 ($\beta_{06\text{-One transfer}}$: 0.641) are only more sensitive to the number of transfers than Persona 05.

Likewise, all seven personas are positively affected by reducing the number of transfers from two to zero per trip. Persona 07 ($\beta_{07\text{-Zero transfer}}$: 1.940) is the most influenced by reducing the number of transfers from two to zero per trip, while Persona 04 ($\beta_{04\text{-Zero transfer}}$: 1.060) is the least influenced. Persona 03 ($\beta_{03\text{-Zero transfer}}$: 1.540) is the second most influenced by reducing the number of transfers from two to zero per trip, then Persona 06 ($\beta_{06\text{-Zero transfer}}$: 1.260). Persona 02 ($\beta_{02\text{-Zero transfer}}$: 1.190), Persona 01 ($\beta_{01\text{-Zero transfer}}$: 1.160), and Persona 05 ($\beta_{05\text{-Zero transfer}}$: 1.100) are only more influenced by reducing the number of transfers from two to zero than Persona 04. It is worth noting that all personas prefer zero transfer trips over one transfer trip.

With regard to the provision of real-time information, transit utility for all personas is positively influenced by the provision of onboard real-time information. Persona 05 ($\beta_{05\text{-Onboard real-time}}$: 0.504) is the most affected by onboard real-time information provision, while Persona 04 ($\beta_{04\text{-Onboard real-time}}$: 0.259) is the least affected. Persona 02 ($\beta_{02\text{-Onboard real-time}}$: 0.503) and Persona 07 ($\beta_{07\text{-Onboard real-time}}$: 0.467) are the second and third highest influenced by onboard real-time information provision, respectively. Persona 01 ($\beta_{01\text{-Onboard real-time}}$: 0.388), Persona 06 ($\beta_{02\text{-Onboard real-time}}$: 0.329), and Persona 03 ($\beta_{02\text{-Onboard real-time}}$: 0.321) are only more influenced by onboard real-time information provision-than Persona 04.

As well, all seven personas are positively affected by the provision of at-stop real-time information. Persona 05 ($\beta_{05\text{-At-stop real-time}}$: 0.486) is the most affected by at-stop real-time information provision, while Persona 04 ($\beta_{04\text{-At-stop real-time}}$: 0.078) is the least affected. Persona 07 ($\beta_{02\text{-Onboard real-time}}$: 0.388) and Persona 06 ($\beta_{06\text{-Onboard real-time}}$: 0.382) are the second and third highest influenced by at-stop real-time information provision. Persona 02 ($\beta_{02\text{-At-stop real-time}}$: 0.369), Persona 01 ($\beta_{01\text{-At-stop real-time}}$: 0.343), and Persona 03 ($\beta_{03\text{-At-stop real-time}}$: 0.219) are only more affected by at-stop real-time information provision than Persona 04. It is worth noting that all personas prefer onboard real-time information provision over at-stop real-time information provision except for Persona 06.

Explained differently:

- Persona 01 (Full-time employee, Transit user, Positive PBC, Live in urban areas) is negatively affected by higher trip fare (the highest among all personas), longer journey time, and longer service headway, while positively affected by real-time information provision and reducing number of transfers. Nevertheless, Persona 01 is indifferent to walking time to/from bus stops.
- Persona 02 (Student, Transit user, Positive PBC, Live in urban areas) is negatively affected by longer service headway (the highest among all personas), higher trip fare, longer journey time,

and longer walking time, while positively affected by real-time information provision (the highest among all personas regarding onboard real-time info.) and reducing number of transfers.

- Persona 03 (Full-time employee, Car driver, Neutral PBC, Live in urban areas) is negatively affected by longer journey time (the highest among all personas), higher trip fare, longer walking time (the highest among all personas), and longer service headway, while positively affected by real-time information provision and reducing number of transfers.
- Persona 04 (Retiree, Car driver, Neutral PBC, Live in urban areas) is negatively affected by longer journey time (the least among all personas), higher trip fare, longer walking time, and longer service headway (the lowest among all personas), while positively affected by real-time information provision (the lowest among all personas) and reducing number of transfers.
- Persona 05 (Student, Car Driver/Passenger, Neutral PBC, Live in urban areas) is negatively affected by longer journey time, higher trip fare, and longer service headway, while positively affected by real-time information provision (the highest among all personas regarding at-stop real-time info.) and reducing number of transfers (the lowest among all personas). However, Persona 05 is indifferent regarding walking time to/from bus stops.
- Persona 06 (Full-time employee, Car passenger, Neutral PBC, Live in urban areas) is negatively affected by longer journey time, higher trip fare, and longer service headway, while positively affected by real-time information provision and reducing number of transfers. However, walking time to/from bus stops does not prove to be of influence on this persona.
- Persona 07 (Full-time employee, Car driver, Negative PBC, Live in the suburbs) is negatively affected by longer journey time, higher trip fare (the lowest among all personas), and longer service headway, while positively affected by real-time information provision and reducing number of transfers (the highest among all personas). However, walking time to/from bus stops does not prove to be significant for Persona 07.

The visualization of the preferences of all personas for various service attributes is shown in Figure 3. It contrasts the bearing of each service attribute on the overall transit utility for all personas.

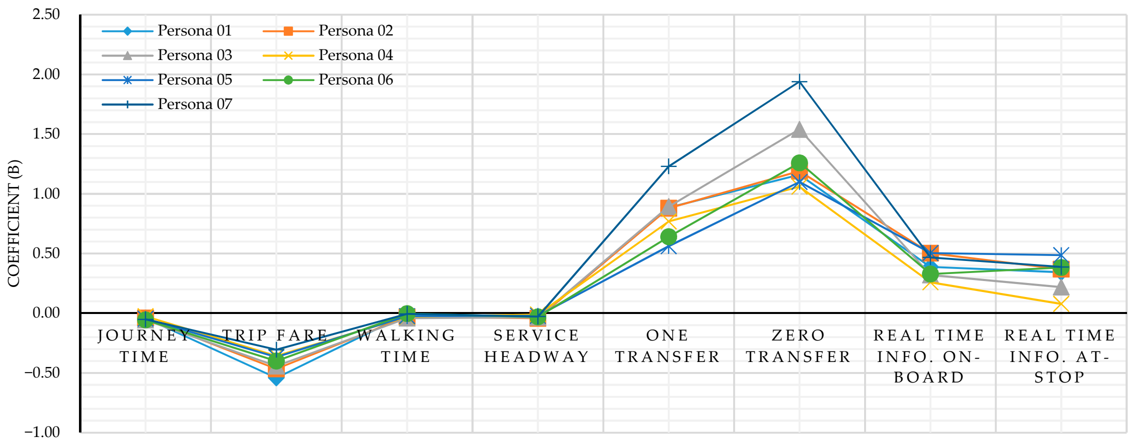


Figure 3. Bearings of service attributes on the overall transit utility across personas.

4.2. Willingness to Pay

The willingness to pay (WTP) for service improvements is essential for policy-makers as it enables them to adopt service improvements that are consistent with users' preferences elicited from the SP experiment. Despite the flexibility of SP experiments in testing new scenarios, proposed improvements, and a wide range of attributes/levels [60], the SP experiments have a hypothetical bias, which is grounded on the differences between the actual behaviour and the stated choices [50,61]. Loomis [61] highlighted that such a hypothetical bias might, in some cases, result in higher WTP estimates compared to real life, which should be considered by policy-makers.

The WTP estimates were derived based on the ratio of population means, in Canadian dollars (CAD), and based on the trip fare parameter. Persona-specific WTP estimates for various service improvements are presented in Table 5.

Table 5. WTP estimates based on the EC model.

	Pers. 01	Pers. 02	Pers. 03	Pers. 04	Pers. 05	Pers. 06	Pers. 07
Reduction in Journey time ($ per minute)	$0.076	$0.084	$0.129	$0.070	$0.125	$0.138	$0.170
Reduction in Walking time ($ per minute)	$0.000	$0.062	$0.093	$0.081	$0.000	$0.000	$0.000
Reduction in Service headway ($ per minute)	$0.072	$0.090	$0.077	$0.031	$0.057	$0.075	$0.092
Trip with One transfer ($ per trip)	$1.634	$1.886	$2.023	$2.154	$1.531	$1.603	$4.020
Trip with Zero transfer ($ per trip)	$2.144	$2.554	$3.484	$2.969	$2.997	$3.150	$6.340
Prov. of Real-time info. onboard ($ per trip)	$0.717	$1.079	$0.726	$0.725	$1.373	$0.823	$1.526
Prov. of Real-time info. at-stop ($ per trip)	$0.634	$0.792	$0.495	$0.218	$1.324	$0.955	$1.268

For journey time, Persona 07 (the highest among all personas) would pay around $1.70 to save 10 min in trip time, while Persona 04 (the lowest) would pay only $0.70. The second-highest willingness to pay for a 10 min reduction in travel time is Persona 06 ($1.38), then Persona 03 ($1.29). Persona 01 and Persona 02 have the second- and third-lowest WTP estimates, $0.76 and $0.84, respectively, for a 10 min reduction in travel time.

The WTP to save 10 min of walking time to/from bus stops is around $0.93 (the highest) for Persona 03, while around $0.62 for Persona 02 (the lowest). Persona 04 is willing to pay $0.81 for a 10 min reduction in walking time, while Personas 01, 05, 06, and 07 are not willing to pay anything for a walking time reduction, as walking time to/from bus stops is not significantly affecting their choice.

Regarding reducing service headway (time between consecutive buses) by 10 min, Personas 02 and 07 are willing to pay around $0.90 (the highest), while Persona 04 would pay only $0.30 (the lowest). Persona 03 and Persona 02, which have the second- and third-highest estimates, respectively, would pay $0.77 and $0.75 to reduce service headway by 10 min. Persona 01 is willing to pay $0.72 for reducing service headway by 10 min. The second-lowest WTP estimate is associated with Persona 05, which would pay $0.57 for a 10 min reduction in service headway.

The WTP for reducing the number of transfers from two to one per trip is around $4.00 (the highest) for Persona 07, while $1.53 (the lowest) for Persona 05. Persona 04 and Persona 03 are the second- and third-highest estimates, willing to pay $2.15 and $2.00, respectively, to reduce the number of transfers from two to one per trip. Persona 02 would pay around $1.88 for reducing the number of transfers from two to one. Persona 06 and Persona 01, roughly the second-lowest estimates, are willing to pay around $1.60 for reducing the number of transfers from two to one.

With respect to reducing the number of transfers from two to zero per trip, Persona 07 would pay around $6.30 (the highest), and Persona 01 would pay around $2.14 (the lowest). Persona 03, the second highest, would pay around $3.50 to reduce the number of transfers from two to zero. Personas 04 and 05 are willing to pay around $3.00 for reducing the number of transfers from two to zero, while it is slightly higher for Persona 06 ($3.15). The second-lowest WTP estimate ($2.55) for reducing the number of transfers from two to zero is for Persona 02.

The WTP for onboard real-time information provision is around $1.52 (the highest) for Persona 07 and around $0.72 (the lowest) for Personas 01, 03, and 04. Persona 05, the second highest, would pay nearly $1.37 for onboard real-time information provision, while Persona 06, the second lowest, would pay $0.82. Persona 02 would pay around $1.08 for onboard real-time information provision.

With regard to at-stop real-time information provision, Persona 05 would pay nearly $1.32 (the highest), while Persona 04 would pay only around $0.22 (the lowest). Persona 07 and Persona 06, the second and third highest, would pay $1.27 and $0.95, respectively, for at-stop real-time information provision, while Persona 02 would pay $0.79. Persona 03 and Persona 01, the second and third lowest, are willing to pay $0.49 and $0.63, respectively, for at-stop real-time information provision.

A related point to mention is that the WTP estimates for potential users (Personas 03, 04, 05, 06, and 07) are more likely to be higher than the WTP estimates for current users (Personas 01 and

02). For instance, Persona 07 has the highest WTP for all service improvements except for the at-stop real-time information provision, whereas the highest WTP belongs to Persona 05, which is also a potential user. However, current users (Personas 01 and 02) have higher WTP estimates for at-stop real-time information provision than some potential users (Personas 03 and 04). Figure 4 shows the distribution of the WTP estimates for service improvements for all personas.

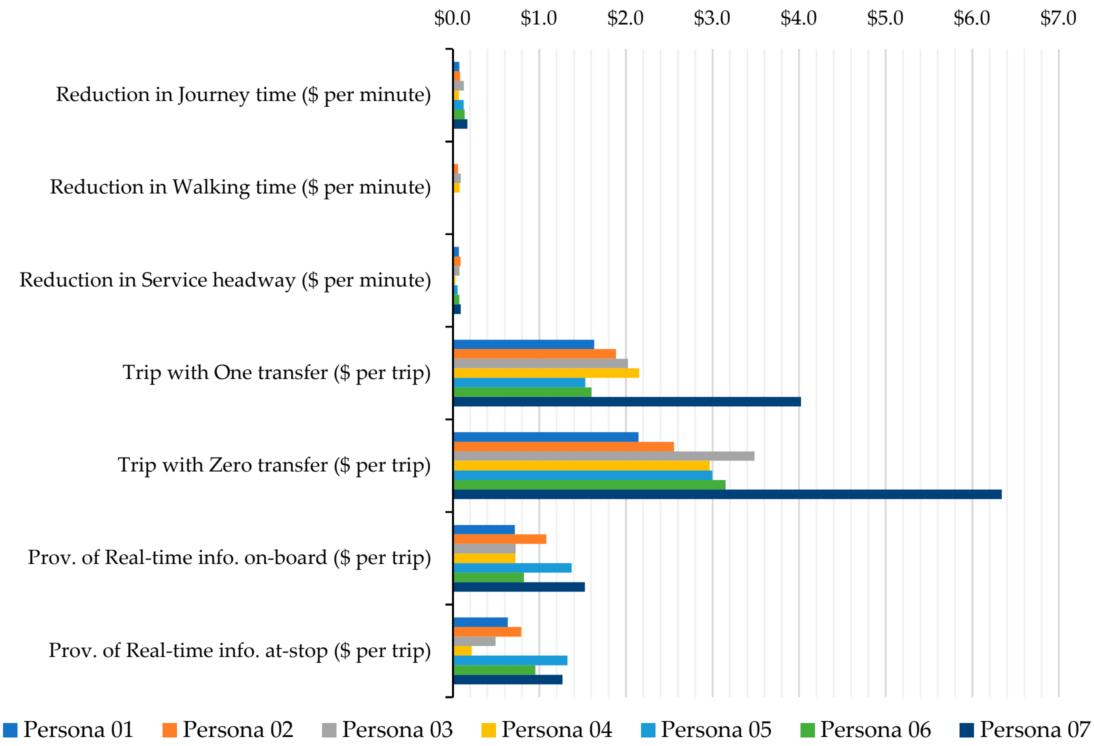


Figure 4. Distribution of WTP estimates for each Persona.

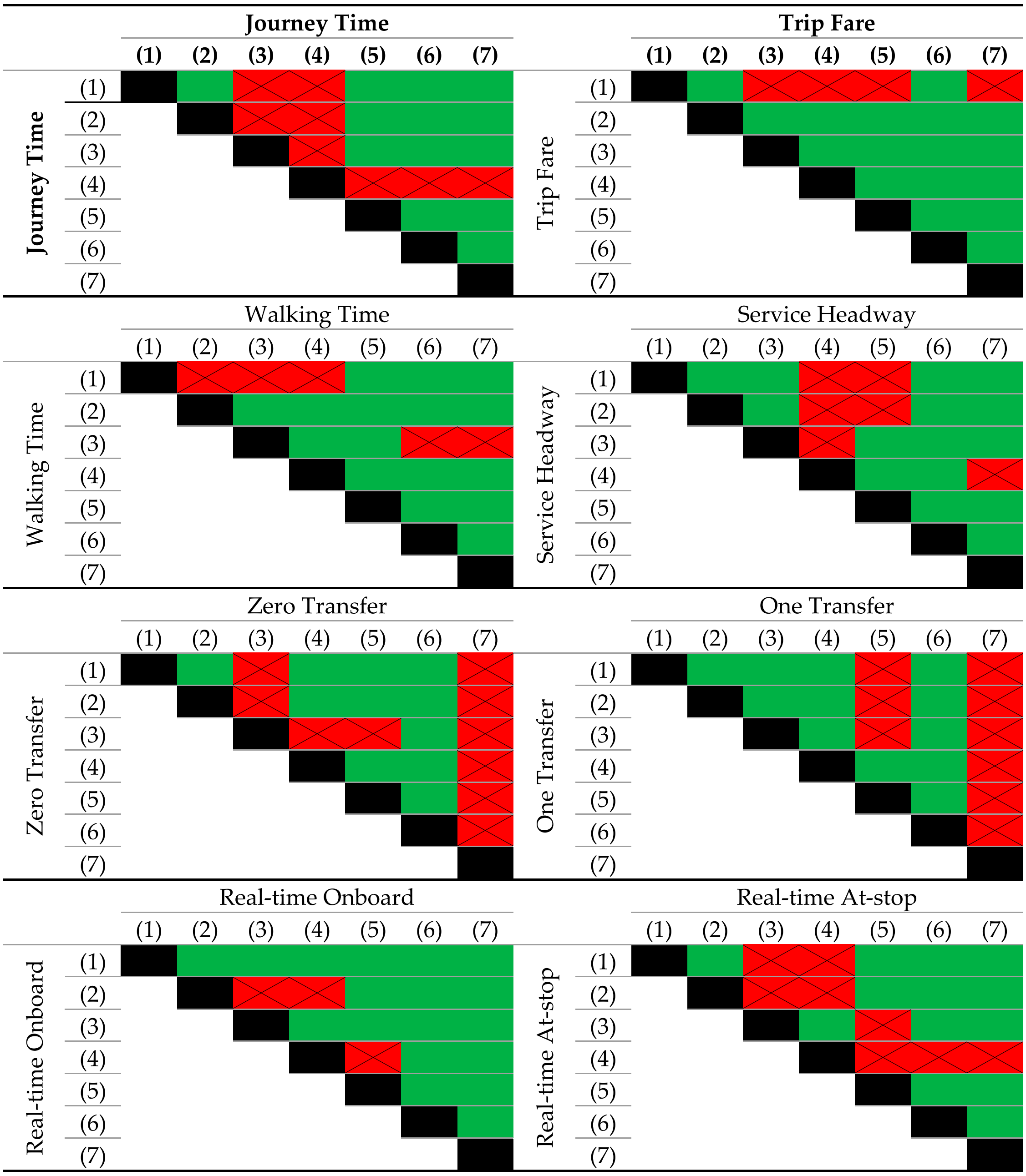
5. Discussion of Shared and Unique Preferences

The integration between the persona-based approach and discrete choice models presented an opportunity to further inspect the preferences of a wide spectrum of transit market segments towards service quality. Therefore, we identify the shared versus unique preferences associated with various service attributes and exhibited by each persona. Such identification enables service providers to target numerous market segments with the same service improvements.

In this respect, shared and unique preferences for service attributes are identified in the light of the statistical significance of the differences, or the lack thereof, among all personas. Statistically significant difference implies unique preferences, and insignificant difference implies shared preferences. MNL interaction models with different base categories were used, as the panel effect does not prove to be significant, to test the statistical significance of the differences among personas, as shown in Table A2-Appendix B.

Table 6, elicited from the MNL interaction models in Table A2-Appendix B, presents a mosaic of the statistically significant and insignificant differences among all seven personas, arranged with respect to each service attribute. The threshold for statistically significant differences is a 90% confidence level.

Table 6. Unique preferences versus shared preferences (symmetric).



Red Crossed: Significantly different (Unique preference) and Green: Not significantly different (Mindshare).

For instance, adopting an attribute-based interpretation (e.g., journey time) of the results presented in Table 6, Personas 01, 02, 05, 06, and 07 are not significantly different from each other; therefore, they share the same preference for journey time. Whereas, Persona 04 is significantly different from all other personas, and hence it has a unique preference for transit journey time. Also, Persona 03 is significantly different from Personas 01, 02, and 04 regarding most service attributes and insignificantly different than Personas 05, 06, and 07.

From a persona-based interpretation perspective, it could be argued that Personas 01 and 02 (both are transit users) have shared preferences regarding most service attributes, yet they have unique preference for walking time to/from bus stops. Personas 03 and 07 (both are full-time employees and car drivers) have shared preferences for many service attributes, but they have unique preferences regarding the number of transfers and walking time to/from bus stops. This might be attributed to their distinct PBC towards transit service and their different location of residence (i.e., suburbs and urban areas). Personas 02 and 05 (both are students) have shared preferences regarding all service attributes except for service headway and reducing the number of transfers from two to one per trip. Persona 07 has its own unique preference regarding the number of transfers with respect to other personas. As well, Persona 04 has a unique preference for journey time than other personas.

Overall, identifying shared preferences versus unique preferences among personas is crucial to transit agencies. Such identification enables service providers to better target their key customer segments and alter their marketing plans accordingly.

6. Conclusions

The study aimed at the following: *first*, Understanding the preferences of the dominant transit market segments considering a persona-based approach, and *second*, Advancing the use of the persona-based approach through quantifying personas' preferences and estimating their willingness to pay for service improvements. The study adopted an Error Component (EC) interaction model to investigate personas' preferences in a bus service desired quality choice experiment, while accounting for the panel effect, and to estimate the influence of each attribute on the overall transit utility with respect to each persona. The study adopted the preliminary seven personas, based on semistructured interviews, that best describe the key groups of the targeted transit market within the city of Hamilton. The personas capture four main characteristics: travel behaviour, employment status, geographical distribution, and Perceived Behavioural Control (PBC). The study utilized a subsample size of 2907 respondents, pulled from a larger dataset (5238), which encompasses the seven personas.

The results of the EC interaction model show that all personas are, all else being equal, negatively affected by longer journey times, higher trip fares, longer service headways, while positively affected by reducing the number of transfers per trip and real-time information provision. Nevertheless, only Personas 02, 03, and 04 are negatively affected by walking time to/from bus stops while other personas are indifferent to walking time. To use precise distinctions:

- Persona 01 (Full-time employee, Transit user, Positive PBC, Live in urban areas) is the most influenced by higher trip fares ($\beta_{01\text{-Trip fare}}$: −0.541) among all personas.
- Persona 02 (Student, Transit user, Positive PBC, Live in urban areas) is the most impacted by longer service headways ($\beta_{02\text{-Service headway}}$: −0.042).
- Persona 03 (Full-time employee, Car driver, Neutral PBC, Live in urban areas) is the most affected by longer journey times ($\beta_{03\text{-Journey time}}$: −0.057) and longer walking times to/from bus stops ($\beta_{03\text{-Walking time}}$: −0.041).
- Persona 04 (Retiree, Car driver, Neutral PBC, Live in urban areas) is the least influenced by longer journey times ($\beta_{04\text{-Journey time}}$: −0.025), longer service headways ($\beta_{04\text{-Service headway}}$: −0.011), real-time information provision ($\beta_{04\text{-Onboard real-time}}$: 0.259 & $\beta_{04\text{-At-stop real-time}}$: 0.078), and reducing number of transfers from two to zero per trip ($\beta_{04\text{-Zero transfer}}$: 1.060).
- Persona 05 (Student, Car Driver/Passenger, Neutral PBC, Live in urban areas) is the highest influenced by at-stop real-time information provision ($\beta_{05\text{-At-stop real-time}}$: 0.486), while the least influenced by reducing number of transfers from two to one per trip ($\beta_{05\text{-One transfer}}$: 0.562).
- Persona 06 (Full-time employee, Car passenger, Neutral PBC, Live in urban areas) is among the least-affected personas regarding walking time to/from bus stops.

- Persona 07 (Full-time employee, Car driver, Negative PBC, Live in the suburbs) is the most influenced by reducing the number of transfers per trip ($\beta_{07\text{-Zero transfer}}$: 1.940 & $\beta_{07\text{-One transfer}}$: 1.230), and the least affected by higher trip fares ($\beta_{07\text{-Trip fare}}$: −0.306).

The willingness to pay (WTP) estimates for service improvements were calculated for each persona in CAD and based on the ratio of the population means. The WTP estimates show that, in general, potential users (Personas 03, 04, 05, 06, and 07) are more likely to have higher values compared to current users (Personas 01 and 02). For instance, Persona 07 has the highest WTP for all service improvements except for the at-stop real-time information provision, where the highest WTP belongs to Persona 05, which is also a potential user. This echoes the findings of [20] that the WTP estimates for potential users are greatly higher than the estimates for current users. However, current users (Personas 01 and 02) have higher WTP estimates for at-stop real-time information provision than some potential users (Personas 03 and 04). Additionally, it is worth noting that there is no consensus within the current users (Personas 01 and 02) nor within the potential users (Personas 03, 04, 05, 06, and 07) on WTP estimates for service improvements.

Shared and unique preferences for service attributes are identified in the light of the statistical significance of the differences among personas based on MNL interaction models. The results show that Personas 01 and 02 (both are transit users) have shared preferences regarding most service attributes, yet they have unique preferences for walking time to/from bus stops. Personas 03 and 07 (both are full-time employees and car drivers) have shared preferences for many service attributes, but they have unique preferences regarding the number of transfers and walking time to/from bus stops. This might be attributed to their distinct PBC towards transit service and their different location of residence (i.e., suburbs and urban areas). Personas 02 and 05 (both are students) have shared preferences regarding various service attributes except for service headway and reducing the number of transfers from two to one per trip.

In view of the findings of this study, transit agencies should be able to tailor their improvement plans as well as their marketing/educational campaigns with a better understanding of their key customers' needs and based on quantified measures.

Author Contributions: G.E.: conceptualization, methodology, formal analysis, data curation, writing—original draft, writing—review and editing. M.M.: conceptualization, methodology, writing—original draft, writing—review and editing, supervision. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. EC model estimates for personas' interactions.

Variable	Coefficient(β)	β/Std. Err.	*p*-Value
Journey time	−0.0412	−9.490	0.000
Journey time × Persona 02	0.0025	0.352	0.725
Journey time × Persona 03	−0.0153	−2.390	0.017
Journey time × Persona 04	0.0167	2.210	0.027
Journey time × Persona 05	−0.0045	−0.408	0.683
Journey time × Persona 06	−0.0139	−0.906	0.365
Journey time × Persona 07	−0.0108	−0.808	0.419
Trip fare	−0.5410	−12.500	0.000
Trip fare × Persona 02	0.0756	1.140	0.254
Trip fare × Persona 03	0.0990	1.640	0.102
Trip fare × Persona 04	0.1840	2.640	0.008
Trip fare × Persona 05	0.1750	1.720	0.085
Trip fare × Persona 06	0.1420	1.030	0.305
Trip fare × Persona 07	0.2350	2.050	0.041
Walking time	−0.0069	−1.220	0.222
Walking time × Persona 02	−0.0224	−2.410	0.016
Walking time × Persona 03	−0.0346	−4.040	0.000
Walking time × Persona 04	−0.0224	−2.250	0.024
Walking time × Persona 05	−0.0172	−1.110	0.266
Walking time × Persona 06	0.0035	0.156	0.876
Walking time × Persona 07	0.0023	0.140	0.888
Service headway	−0.0385	−11.200	0.000
Service headway × Persona 02	−0.0030	−0.539	0.590
Service headway × Persona 03	0.0046	0.921	0.357
Service headway × Persona 04	0.0271	5.060	0.000
Service headway × Persona 05	0.0172	1.980	0.047
Service headway × Persona 06	0.0080	0.790	0.430
Service headway × Persona 07	0.0107	1.270	0.203
Number of transfers (2 transfers base category)			
One transfer	0.8840	16.100	0.000
One transfer × Persona 02	−0.0052	−0.057	0.955
One transfer × Persona 03	0.0103	0.121	0.903
One transfer × Persona 04	−0.1150	−1.190	0.233
One transfer × Persona 05	−0.3220	−2.110	0.035
One transfer × Persona 06	−0.2430	−1.310	0.191
One transfer × Persona 07	0.3440	2.020	0.044
Zero transfer	1.1600	14.900	0.000
Zero transfer × Persona 02	0.0324	0.256	0.798
Zero transfer × Persona 03	0.3840	3.290	0.001
Zero transfer × Persona 04	−0.0922	−0.708	0.479
Zero transfer × Persona 05	−0.0610	−0.305	0.760
Zero transfer × Persona 06	0.0997	0.386	0.700
Zero transfer × Persona 07	0.7820	3.440	0.001
Real-time information (No info. Base category)			
Real-time info. Onboard	0.3880	8.340	0.000
Real-time info. Onboard × Persona 02	0.1160	1.470	0.141
Real-time info. Onboard × Persona 03	−0.0665	−0.934	0.351
Real-time info. Onboard × Persona 04	−0.1280	−1.560	0.118
Real-time info. Onboard × Persona 05	0.1160	0.867	0.386
Real-time info. Onboard × Persona 06	−0.0584	−0.395	0.693
Real-time info. Onboard × Persona 07	0.0800	0.595	0.552
Real-time info. at-stop	0.3430	6.500	0.000
Real-time info. at-stop × Persona 02	0.0262	0.302	0.762
Real-time info. at-stop × Persona 03	−0.1240	−1.530	0.125
Real-time info. at-stop × Persona 04	−0.2650	−2.890	0.004
Real-time info. at-stop × Persona 05	0.1430	1.020	0.307
Real-time info. at-stop × Persona 06	0.0395	0.231	0.818
Real-time info. at-stop × Persona 07	0.0457	0.308	0.758
Error Component	0.0158	1.150	0.252
Log-Likelihood		−11580.86	
Log-Likelihood ratio test		2570.716	
Rho-square		0.106	

Number of respondents = 2907, number of observations = 11,628.

Appendix B

Table A2. The estimation of MNL interaction models.

Variable	Persona 01 (Ref.)	Persona 02 (Ref.)	Persona 03 (Ref.)	Persona 04 (Ref.)	Persona 05 (Ref.)	Persona 06 (Ref.)	Persona 07 (Ref.)
Journey time × Persona 01	−0.041 ***	−0.003	0.015 **	−0.017 **	0.005	0.014	0.011
Journey time × Persona 02	0.003	−0.039 ***	0.018 **	−0.014 *	0.007	0.016	0.013
Journey time × Persona 03	−0.015 **	−0.018 **	−0.057 ***	−0.032 ***	−0.011	−0.001	−0.004
Journey time × Persona 04	0.017 **	0.014 *	0.032 ***	−0.025 ***	0.021 *	0.031 **	0.028 **
Journey time × Persona 05	−0.005	−0.007	0.011	−0.021 *	−0.046 ***	0.009	0.006
Journey time × Persona 06	−0.014	−0.016	0.001	−0.031 **	−0.009	−0.055 ***	−0.003
Journey time × Persona 07	−0.011	−0.013	0.004	−0.028 **	−0.006	0.003	−0.052 ***
Trip fare × Persona 01	−0.541 ***	−0.076	−0.099 *	−0.184 ***	−0.175 *	−0.142	−0.235 **
Trip fare × Persona 02	0.076	−0.466 ***	−0.023	−0.109	−0.099	−0.066	−0.159
Trip fare × Persona 03	0.099 *	0.023	−0.442 ***	−0.085	−0.076	−0.043	−0.136
Trip fare × Persona 04	0.184 ***	0.109	0.085	−0.357 ***	0.010	0.043	−0.051
Trip fare × Persona 05	0.175 *	0.099	0.076	−0.010	−0.367 ***	0.033	−0.060
Trip fare × Persona 06	0.142	0.066	0.043	−0.043	−0.033	−0.400 ***	−0.094
Trip fare × Persona 07	0.235 **	0.159	0.136	0.051	0.060	0.094	−0.306 ***
Walking time × Persona 01	−0.007	0.022 **	0.035 ***	0.022 **	0.017	−0.004	−0.002
Walking time × Persona 02	−0.022 **	−0.029 ***	0.012	0.000	−0.005	−0.026	−0.025
Walking time × Persona 03	−0.035 ***	−0.012	−0.041 ***	−0.012	−0.017	−0.038 *	−0.037 **
Walking time × Persona 04	−0.022 **	0.000	0.012	−0.029 ***	−0.005	−0.026	−0.025
Walking time × Persona 05	−0.017	0.005	0.017	0.005	−0.024 *	−0.021	−0.020
Walking time × Persona 06	0.004	0.026	0.038 *	0.026	0.021	−0.003	0.001
Walking time × Persona 07	0.002	0.025	0.037 **	0.025	0.020	−0.001	−0.005
Service headway × Persona 01	−0.039 ***	0.003	−0.005	−0.027 ***	−0.017 **	−0.008	−0.011
Service headway × Persona 02	−0.003	−0.042 ***	−0.008	−0.030 ***	−0.020 **	−0.011	−0.014
Service headway × Persona 03	0.005	0.008	−0.034 ***	−0.022 ***	−0.013	−0.003	−0.006
Service headway × Persona 04	0.027 ***	0.030 ***	0.022 ***	−0.011 **	0.010	0.019	0.016 *
Service headway × Persona 05	0.017 **	0.020 **	0.013	−0.010	−0.021 ***	0.009	0.006
Service headway × Persona 06	0.008	0.011	0.003	−0.019	−0.009	−0.030***	−0.003
Service headway × Persona 07	0.011	0.014	0.006	−0.016 *	−0.006	0.003	−0.028 ***
Number of transfers (2 transfers base category)							
One transfer × Persona 01	0.884 ***	0.005	−0.010	0.115	0.322 **	0.243	−0.344 **
One transfer × Persona 02	−0.005	0.879 ***	−0.016	0.110	0.317 **	0.238	−0.349 **
One transfer × Persona 03	0.010	0.016	0.894 ***	0.125	0.332 **	0.253	−0.334 **
One transfer × Persona 04	−0.115	−0.110	−0.125	0.769 ***	0.207	0.128	−0.459 ***
One transfer × Persona 05	−0.322 **	−0.317 **	−0.332 **	−0.207	0.562 ***	−0.079	−0.666 ***
One transfer × Persona 06	−0.243	−0.238	−0.253	−0.128	0.079	0.641 ***	−0.587 ***
One transfer × Persona 07	0.344 **	0.349 **	0.334 **	0.459 ***	0.666 ***	0.587 ***	1.230 ***
Zero transfer × Persona 01	1.160 ***	−0.032	−0.384 ***	0.092	0.061	−0.100	−0.782 ***
Zero transfer × Persona 02	0.032	1.190 ***	−0.352 ***	0.125	0.093	−0.067	−0.750 ***
Zero transfer × Persona 03	0.384 ***	0.352 ***	1.540 ***	0.476 ***	0.445 **	0.284	−0.398 *
Zero transfer × Persona 04	−0.092	−0.125	−0.476 ***	1.060 ***	−0.031	−0.192	−0.875 ***
Zero transfer × Persona 05	−0.061	−0.093	−0.445 **	0.031	1.100 ***	−0.161	−0.843 ***
Zero transfer × Persona 06	0.100	0.067	−0.284	0.192	0.161	1.260 ***	−0.683 **
Zero transfer × Persona 07	0.782 ***	0.750 ***	0.398*	0.875 ***	0.843 ***	0.683 **	1.940 ***
Real-time information (No info. base-category)							
Real-time info. Onboard × Persona 01	0.388 ***	−0.116	0.067	0.128	−0.116	0.058	−0.080
Real-time info. Onboard × Persona 02	0.116	0.503 ***	0.182 **	0.244 ***	−0.001	0.174	0.036
Real-time info. Onboard × Persona 03	−0.067	−0.182 **	0.321 ***	0.062	−0.183	−0.008	−0.146
Real-time info. Onboard × Persona 04	−0.128	−0.244 ***	−0.062	0.259 ***	−0.245 *	−0.070	−0.208
Real-time info. Onboard × Persona 05	0.116	0.001	0.183	0.245 *	0.504 ***	0.175	0.036
Real-time info. Onboard × Persona 06	−0.058	−0.174	0.008	0.070	−0.175	0.329 **	−0.138
Real-time info. Onboard × Persona 07	0.080	−0.036	0.146	0.208	−0.036	0.138	0.467 ***
Real-time info. at-stop × Persona 01	0.343 ***	−0.026	0.124 *	0.265 ***	−0.143	−0.040	−0.046
Real-time info. at-stop × Persona 02	0.026	0.369 ***	0.150 *	0.291 ***	−0.117	−0.013	−0.020
Real-time info. at-stop × Persona 03	−0.124 *	−0.150 *	0.219 ***	0.141	−0.267 **	−0.163	−0.170
Real-time info. at-stop × Persona 04	−0.265 ***	−0.291 ***	−0.141	0.078	−0.408 ***	−0.304 *	−0.311 **
Real-time info. at-stop × Persona 05	0.143	0.117	0.267 **	0.408 ***	0.486 ***	0.104	0.098
Real-time info. at-stop × Persona 06	0.040	0.013	0.163	0.304 *	−0.104	0.382 **	−0.006
Real-time info. at-stop × Persona 07	0.046	0.020	0.170	0.311 **	−0.098	0.006	0.388 ***
Log-likelihood				−11,580.88			
Log-likelihood ratio test				2387.56			
Rho-square				0.0934			

Note: ***, **, and * indicate significance at 1%, 5%, and 10% levels, respectively.

References

1. Eboli, L.; Mazzulla, G. Discrete choice models as a tool for transit service quality evaluation. *Electron. J. Appl. Stat. Anal. Decis. Support Syst. Serv. Eval.* **2011**, *2*, 65–73. [CrossRef]
2. De Oña, J.; De Oña, R.; Calvo, F.J. A classification tree approach to identify key factors of transit service quality. *Expert Syst. Appl.* **2012**, *39*, 11164–11171. [CrossRef]
3. Allen, J.; Muñoz, J.C.; de Dios Ortúzar, J. Modelling service−specific and global transit satisfaction under travel and user heterogeneity. *Transp. Res. Part A Policy Pract.* **2018**, *113*, 509–528. [CrossRef]
4. Mahmoud, M.; Hine, J. Using AHP to measure the perception gap between current and potential users of bus services. *Transp. Plan. Technol.* **2013**, *36*, 4–23. [CrossRef]
5. Mahmoud, M.; Hine, J. Measuring the influence of bus service quality on the perception of users. *Transp. Plan. Technol.* **2016**, *39*, 284–299. [CrossRef]
6. Abenoza, R.F.; Cats, O.; Susilo, Y.O. Travel satisfaction with public transport: Determinants, user classes, regional disparities and their evolution. *Transp. Res. Part A Policy Pract.* **2017**, *95*, 64–84. [CrossRef]
7. Deb, S.; Ali Ahmed, M. Determining the service quality of the city bus service based on users' perceptions and expectations. *Travel Behav. Soc.* **2018**, *12*, 1–10. [CrossRef]
8. Beimborn, E.A.; Greenwald, M.J.; Jin, X. Accessibility, Connectivity, and Captivity Impacts on Transit Choice. *Transp. Res. Rec.* **2003**, *1835*, 1–9. [CrossRef]
9. Krizek, K.; El-Geneidy, A. Segmenting preferences and habits of transit users and non-users. *J. Public Transp.* **2007**, *10*, 71–94. [CrossRef]
10. Venter, C. Are We Giving Brt Passengers What They Want? User Preference and Market Segmentation in Johannesburg. In Proceedings of the 35th Southern African Transport Conference (SATC 2016), Pretoria, South Africa, 4–7 July 2016; pp. 658–672.
11. Van Lierop, D.; El-Geneidy, A. A new market segmentation approach: Evidence from two Canadian cities. *J. Public Transp.* **2017**, *20*, 20–43. [CrossRef]
12. Grisé, E.; El-geneidy, A. Where is the happy transit rider? Evaluating satisfaction with regional rail service using a spatial segmentation approach. *Transp. Res. Part A* **2018**, *114*, 84–96. [CrossRef]
13. Eboli, L.; Forciniti, C.; Mazzulla, G. Spatial variation of the perceived transit service quality at rail stations. *Transp. Res. Part A Policy Pract.* **2018**, *114*, 67–83. [CrossRef]
14. Nikel, C.; Eldeeb, G.; Mohamed, M. Perceived Quality of Bus Transit Services: A Route−Level Analysis. *Transp. Res. Rec. J. Transp. Res. Board* **2020**, *2674*. [CrossRef]
15. De Oña, R.; López, G.; de los Rios, F.J.D.; de Oña, J. Cluster Analysis for Diminishing Heterogeneous Opinions of Service Quality Public Transport Passengers. *Procedia Soc. Behav. Sci.* **2014**, *162*, 459–466. [CrossRef]
16. De Oña, J.; de Oña, R.; López, G. Transit service quality analysis using cluster analysis and decision trees: A step forward to personalized marketing in public transportation. *Transportation* **2016**, *43*, 725–747. [CrossRef]
17. Dell'Olio, L.; Ibeas, A.; Cecin, P. The quality of service desired by public transport users. *Transp. Policy* **2011**, *18*, 217–227. [CrossRef]
18. Eboli, L.; Forciniti, C.; Mazzulla, G.; Calvo, F. Exploring the Factors That Impact on Transit Use through an Ordered Probit Model: The Case of Metro of Madrid. *Transp. Res. Procedia* **2016**, *18*, 35–43. [CrossRef]
19. Eboli, L.; Mazzulla, G. Willingness−to−pay of public transport users for improvement in service quality. *Eur. Transp.* **2008**, *38*, 107–118.
20. Bellizzi, M.G.; Dell'Olio, L.; Eboli, L.; Mazzulla, G. Heterogeneity in desired bus service quality from users' and potential users' perspective. *Transp. Res. Part A* **2020**, *132*, 365–377. [CrossRef]
21. Eldeeb, G.; Mohamed, M. Quantifying Preference Heterogeneity in Transit Service Desired Quality Using Random Parameter Logit and Latent Class Choice Models. *Transp. Res. Part A J.* **2020**. under review.
22. Metrolinx. *2041 Regional Transportation Plan*; Greater Toronto and Hamilton Area, ON, Canada, 2018; ISBN 9781775137924.
23. OXD TransLink Customer Experience Research. Available online: https://oxd.com/work/translink-customer-experience-research/ (accessed on 7 March 2020).
24. UX Planet Using Design Thinking to Improve Bus Accessibility. Available online: https://uxplanet.org/ux-for-a-better-public-transport-23b81ccc56de (accessed on 7 March 2020).

25. Fergnani, A. The future persona: A futures method to let your scenarios come to life. *Foresight* **2019**, *21*, 445–466. [CrossRef]
26. Cooper, A. *The Inmates Are Running The Asylum*; Sams: Indianapolis, IN, USA, 1999; Volume 43, ISBN 0-672-32614-0.
27. Miaskiewicz, T.; Kozar, K.A. Personas and user−centered design: How can personas benefit product design processes? *Des. Stud.* **2011**, *32*, 417–430. [CrossRef]
28. Nielsen, L. *Personas—User Focused Design*, 1st ed.; Springer: London, UK, 2013; ISBN 978-1-4471-5903-2.
29. Pruitt, J.; Grudin, J. Personas: Practice and Theory. In Proceedings of the 2003 Conference on Designing for User Experiences, San Francisco, CA, USA, June 2003; pp. 1–15.
30. Miaskiewicz, T.; Luxmoore, C. The Use of Data−Driven Personas to Facilitate Organizational Adoption–A Case Study. *Des. J.* **2017**, *20*, 357–374. [CrossRef]
31. Marshall, R.; Cook, S.; Mitchell, V.; Summerskill, S.; Haines, V.; Maguire, M.; Sims, R.; Gyi, D.; Case, K. Design and evaluation: End users, user datasets and personas. *Appl. Ergon.* **2015**, *46*, 311–317. [CrossRef]
32. Beyer, S.; Müller, A. Evaluation of Persona−Based User Scenarios in Vehicle Development. In *Proceedings of the Human Systems Engineering and Design*; Ahram, T., Karwowski, W., Taiar, R., Eds.; Springer International Publishing: Cham, Switzerland, 2018; pp. 750–756.
33. Vosbergen, S.; Mulder−Wiggers, J.M.R.; Lacroix, J.P.; Kemps, H.M.C.; Kraaijenhagen, R.A.; Jaspers, M.W.M.; Peek, N. Using personas to tailor educational messages to the preferences of coronary heart disease patients. *J. Biomed. Inform.* **2015**, *53*, 100–112. [CrossRef]
34. Boyce, R.D.; Ragueneau−Majlessi, I.; Yu, J.; Tay−Sontheimer, J.; Kinsella, C.; Chou, E.; Brochhausen, M.; Judkins, J.; Gufford, B.T.; Pinkleton, B.E.; et al. Developing User Personas to Aid in the Design of a User−Centered Natural Product−Drug Interaction Information Resource for Researchers. *AMIA Annu. Symp. Proc.* **2018**, *2018*, 279–287.
35. Jones, M.C.; Floyd, I.R.; Twidale, M.B. Teaching Design with Personas. *Interact. Des. Archit.* **2008**, *3–4*, 75–82.
36. Canham, S.L.; Mahmood, A. The use of personas in gerontological education. *Gerontol. Geriatr. Educ.* **2019**, *40*, 468–479. [CrossRef]
37. Lindgren, A.; Chen, F.; Amdahl, P.; Chaikiat, P. Using Personas and Scenarios as an Interface Design Tool for Advanced Driver Assistance Systems. In *Proceedings of the Universal Access in Human−Computer Interaction. Ambient Interaction*; Stephanidis, C., Ed.; Springer: Berlin/Heidelberg, Germany, 2007; pp. 460–469.
38. Schäfer, C.; Zinke, R.; Künzer, L.; Hofinger, G.; Koch, R. Applying persona method for describing users of escape routes. *Transp. Res. Procedia* **2014**, *2*, 636–641. [CrossRef]
39. De Clerck, Q.; van Lier, T.; Messagie, M.; Macharis, C.; Van Mierlo, J.; Vanhaverbeke, L. Total Cost for Society: A persona−based analysis of electric and conventional vehicles. *Transp. Res. Part D Transp. Environ.* **2018**, *64*, 90–110. [CrossRef]
40. Kong, P.; Cornet, H.; Frenkler, F. Personas and Emotional Design for Public Service Robots: A Case Study with Autonomous Vehicles in Public Transportation. In Proceedings of the 2018 International Conference on Cyberworlds (CW), Singapore, 3–5 October 2018; pp. 284–287. [CrossRef]
41. Chapman, C.N.; Milham, R.P. The personas' new clothes: Methodological and practical arguments against a popular method. *Proc. Hum. Factors Ergon. Soc.* **2006**, *50*, 634–636. [CrossRef]
42. Turner, P.; Turner, S. Is stereotyping inevitable when designing with personas? *Des. Stud.* **2011**, *32*, 30–44. [CrossRef]
43. Madsen, A.; Mckagan, S.B.; Sayre, E.C.; Martinuk, M.; Bell, A. Personas as a Powerful Methodology to Design Targeted Professional Development Resources Methodology: Creation of Personas. *arXiv* **2014**, arXiv:1408.1125v2.
44. Chapman, C.N.; Love, E.; Milham, R.P.; Elrif, P.; Alford, J.L. Quantitative evaluation of personas as information. *Proc. Hum. Factors Ergon. Soc.* **2008**, *2*, 1107–1111. [CrossRef]
45. Ben-Akiva, M.; Bolduc, D. Multinomial Probit with a Logit Kernel and a General Parametric Specification of the Covariance Structure; 1996. Available online: https://eml.berkeley.edu/reprints/misc/multinomial.pdf. (accessed on 13 April 2020).
46. McFadden, D.; Train, K. Mixed MNL models for discrete response. *J. Appl. Econom.* **2000**, *15*, 447–470. [CrossRef]
47. Ben-Akiva, M.; Lerman, S. *Discrete Choice Analysis Theory and Application to Travel Deamnd*, 3rd ed.; The Massachusetts Institute of Technology: Cambridge, MA, USA; London, UK, 1985; ISBN 0-262-02217-6.

48. McFadden, D. Measuring willingness to pay for transportation improvements. *Theor. Found. Travel Choice Model.* **1998**, *339*, 364.
49. Rizzi, L.I.; Ortúzar, J.D.D. Stated preference in the valuation of interurban road safety. *Accid. Anal. Prev.* **2003**, *35*, 9–22. [CrossRef]
50. Ortúzar, J.D.D.; Willumsen, L.G. *Modelling Transport*, 4th ed.; John Wiley & Sons, Ltd.: West Sussex, UK, 2011; ISBN 9780470760390.
51. Hensher, D.A.; Greene, W.H. The Mixed Logit model: The state of practice. *Transportation* **2003**, *30*, 133–176. [CrossRef]
52. Bierlaire, M. *PandasBiogeme: A Short Introduction*; Technical report TRANSP-OR 181219. Transport and Mobility Laboratory, ENAC, EPFL; Switzerland, 2018.
53. Hess, S.; Train, K.E.; Polak, J.W. On the use of a Modified Latin Hypercube Sampling (MLHS) method in the estimation of a Mixed Logit Model for vehicle choice. *Transp. Res. Part B Methodol.* **2006**, *40*, 147–163. [CrossRef]
54. Hensher, D.A.; Rose, J.M.; Greene, W.H. *Applied Choice Analysis A Primer*, 1st ed.; Cambridge University Press: Cambridge, UK, 2005; ISBN 13 978-0-521-84426-0.
55. City of Hamilton Hamilton Street Railway. Available online: https://www.hamilton.ca/hsr-bus-schedules-fares (accessed on 6 June 2018).
56. Eldeeb, G.; Nikel, C.; Ferguson, M.; Mohamed, M. Service Quality and Consumers Preferences for Hamilton Street Railway (HSR); City of Hamilton, ON, Canada, 2019. Available online: https://www.researchgate.net/publication/338750510_Service_Quality_and_Consumers_Preferences_for_Hamilton_Street_Railway_HSR_-_Executive_Summary (accessed on 13 April 2020).
57. Bliemer, M.C.J.; Rose, J.M. *Designing Stated Choice Experiments: State-of-the-Art*; Emerald: Bingley, UK, 2006.
58. Kuhfeld, W.; Tobias, R.; Garratt, M. Efficient experimental design with marketing research applications. *J. Mark. Res.* **1994**, *31*, 545–557. [CrossRef]
59. Mohamed, M.; Higgins, C.; Ferguson, M.; Kanaroglou, P. Identifying and characterizing potential electric vehicle adopters in Canada: A two−stage modelling approach. *Transp. Policy* **2016**, *52*, 100–112. [CrossRef]
60. Hensher, D. Stated preference analysis of travel choice: The state of practice. *Transportation* **1994**, *21*, 107–133. [CrossRef]
61. Loomis, J.B. Strategies for overcoming hypothetical bias in stated preference surveys. *J. Agric. Resour. Econ.* **2014**, *39*, 34–46. [CrossRef]