USING A LATENT-CLASS MODEL TO EXAMINE SENSITIVITY OF LOCAL CONDITIONS ON STAIR AND ESCALATOR CHOICE IN TORONTO SUBWAY STATIONS

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Paper submitted for presentation at the 2014 Annual Meeting of the Transportation Research Board and publication in Transportation Research Record.

Submission Date: August 1, 2013
Word Count: Abstract (250), Paper (5272) + 5 figures/tables (1250) = 6672

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ABSTRACT

Understanding the rationale behind routing decisions for pedestrians in complex spaces remains a technical challenge for space design and crowd management. The ability to correctly predict crowd usage of passages, open spaces and vertical transport (e.g. stairs, escalators) would allow for better design and operation of such facilities. To date, minimal research has been performed examining vertical transport choice in the context of pedestrian path finding, and existing models have been static in nature. This study aimed to better understand the relative weighting pedestrians give to an initial predisposition versus that based on more dynamic conditions (e.g queueing) at the entrance of the facility. Two types of discrete choice models were estimated, a standard binomial logit, which assumes a homogeneous population, and a latent-class model, which allows for population segmentation. The latter was formulated to consider the process as a combined decision based on information available before and after reaching the facility. A strong aversion to stair use was found, with an additional dampening effect of increasing opposing flow. Conversely, approaching from the staircase side, having preceding pedestrians take the stairs and higher flows or escalator queues were found to increase the chance of stair use. The latent-class model also elucidated a relatively minor influence of dynamic conditions on overall choice. Significant predictive differences were not found between the models; however, the ability of the latent class model to identify the relative weight of local dynamic conditions allows for insight into the decision process of pedestrians.
INTRODUCTION
Understanding the driving forces and rationale behind routing decisions for pedestrians in complex spaces remains a technical challenge for space design and crowd management. Research into routing has traditionally focused on road traffic, where physical constraints of the road and the car limit both routing decisions and the behavioural variability of the drivers. Pedestrian movement is rather different, where path choices exist in continuous space, interactions are numerous, and the effects of physical and behavioural variations between people can be very large in how they move and make decisions.

Developing a proper understanding of pedestrian choice behaviour is particularly important in contexts that consistently experience large movements of people and have multiple levels, such as in mass transit stations. The ability to correctly predict crowd usage of passages, open spaces and vertical transport (e.g. stairs, escalators, elevators) would allow for better design and operation of such facilities.

In modelling such behaviour, researchers break down the process into three steps: destination choice, tactical (mid-range) routing and next-step (short-range) movement. To date, most research efforts have focused on the latter, developing models to mimic the kinematics of walking and collision avoidance as people navigate through a possibly crowded area. Meanwhile, path choice formulations have mainly borrowed from traffic and network theory, considering traditional cost measures like distance and travel time. While this may be sufficient for at-level paths, for vertical movement elements, additional factors (e.g. congestion, personal preference, effort) are at play, creating a need for a more expansive choice model.

To fill this observed gap in research, a research programme was initiated to examine how pedestrians choose between adjacent stair and escalator facilities, through an analysis of the behaviour of pedestrians in subway stations in Toronto, Canada. The initial step of the programme involved modelling stair vs. escalator choice in the aggregate to be more easily applicable for use in facility planning studies, while the second phase adopts a bottom-up approach to improve sensitivity and range of application, modelling choice at a disaggregate level, arriving at aggregate results via incorporation into a pedestrian simulation software. The initial step was completed, producing four aggregate models, separated by direction and the presence of individuals which had restricted mobility, predicting 10-second stair-escalator splits (1).

Based on visual observations made during the study, it was apparent that where pedestrians had predetermined choices of which facility to use, they were also influenced, some more than others, by the dynamic conditions present when they reached the entrance. Prior to proceeding with the second stage of developing a individual-level discrete choice model, it was, therefore, decided to examine the relative weighting of these static versus dynamic factors on a subset of the collected data with facilities of equal dimensions. The analysis was also confined to the ascending direction, both due to feasibility (the collected variables were more easily apparent in the ascending direction) and because of the stronger transport preference when ascending found in the initial work (1). Two types of discrete choice models were estimated, a standard binomial logit and a discrete mixture of binomial logits. The latter type, also known as a latent-class model, was formulated to be able to examine the difference in weighting between static and dynamic factors by considering the process as a combined decision based on information available before and after reaching the facility.
EXISTING VERTICAL TRANSPORT CHOICE MODELS

Pedestrian modelling is a relatively new area in the field of transportation modelling, emerging in the late 1980s with the development of the Social Forces and Cellular Automata motion models. The early efforts have focussed primarily on these motion models; however, more recently, pedestrian specific formulations of route choice have also emerged. With respect to the use of stairs and escalators (which can be thought of as a mode choice when they are adjacent), the use of discrete choice models has been popular in recent years. Nevertheless, research in this particular section of pedestrian modelling has been relatively sparse, limited to a few applications of logit techniques specifically attempting to predict choice between adjacent facilities (2-4) and broader studies examining vertical choice in the context of overall route choice in stations (5, 6). While recent studies have aimed at moving away from simple logit formulations to more advanced mixed-logit structure that enable capturing heterogeneous taste variations (4), these have been limited in application.

The earliest documented effort was in 1998, where Cheung and Lam investigated pedestrian choice between escalators and stairs in six subway stations in the Hong Kong Mass Transit Railway (MTR) (2). The facilities under observation were adjacent (stair beside escalator), with the ability to approach from either side, and were of standard physical dimensions across sites. Data was collected for pedestrian movement both upwards and downwards on the staircases and escalators, as well as the walkways leading to the facilities from either direction. In formulating their models, the researchers considered that only perceived travel time would influence a person’s choice of facility. It was in turn assumed that individuals would have a model of expected travel time internally, which they would then use to mentally estimate travel time differences between stairs and escalators in making their choice (2). The choice between stair and escalator was estimated using a logit-type choice model. The parameter values indicated varying sensitivity to direction in the choice to use the escalator, with increased sensitivity to delays in the descending direction. Likewise, in the ascending direction, pedestrians were found much more apt to choose the escalator and less sensitive to escalator delay (2).

Several years later, in contrast to the prior research, Daamen et al (2005) focussed on the influence of the presence of different types of level change facilities on the route taken by pedestrians navigating a subway station. Instead of examining pedestrian choices only in the area surrounding the vertical transport, the researchers followed individuals in two Dutch railway stations throughout station facilities. Route choice was examined under various configurations of trip length and trip factors, in particular those related to vertical routing (stairs, escalators, ramps), while ignoring any issues of congestion a priori as not being significant. Data was collected in late fall and winter, and included route characteristics (length, type, number of turns), personal characteristics (gender, age, luggage, familiarity), trip characteristics, and other factors such as the day and weather conditions. A total of 925 individuals were followed, but heavily weighted to one of the two stations. However, the mathematical model (a multinomial logit with a path-size variable added to handle overlapping routes), used only observed travel time on each of the segments of the trip (levels, stairs, ramps, escalators) and the direction of travel. Travel time parameters were all found to be significant. (5)

Most recently, two groups refocussed on the question of adjacent stair-versus-escalator choice. Zhang & Zhang (2011) investigated choice of pedestrians between stairs and escalators in three stations in Nanjing, China with varying heights and escalator directions. Data collection occurred during morning and afternoon peak travel with vertical facilities that had a range of physical dimensions, with 300-450 samples for each direction at each station. Data collection focussed on the physical dimensions of the
facilities and the pedestrian-specific information of gender, age, walking distance and walking time. A disaggregate binary logit model was used, with utility functions for stair or escalator use incorporating the aforementioned walking distance, walking time, gender and age, along with a dummy variable to represent inherent bias towards either mode. Gender was generally not found to be significant, age was found only to be significant for a single station (marginally), while walking distance was also not significant in the downward direction for all stations; all other variables were found to be significant. In addition, a consistently positive and significant value for the dummy variable representing bias towards escalators was found, illustrating a key preference. (3)

Lastly, one of the most recent studies dealing with examination of pedestrian vertical transport choice was conducted in Austria. The scope of the data collection effort was relatively small compared to some of the previously mentioned studies, focusing on a single station, the “Westbahnhof”, and with only around 200 people observed. The researchers observed some traditional variables (age, gender); however in place of actual travel time, a revealed preference survey was conducted by interviewing people after they had ascended their choice of facility to acquire their trip purpose, frequency of visit to the location, self reported walking speed and education level. In addition, an attempt was made to also consider some dynamic factors in choice, but taking note of the number of people queuing at the base with and without luggage at the time the choice was taken. In addition to this revealed preference study, the authors also investigated the use of the stated preference (SP) method in determining how people choose between the two facilities. For this SP study, pedestrians were shown six different video sequences of the same location with different levels of crowding and asked to choose between using stairs or escalators. (4)

In contrast to previous research, this group was the first to use a mixed-logit model to examine taste variation. Estimation was performed using a joint RP/SP estimation process by normalizing the variance between the two data sets via a scale factor, but also examining the separate models alone as standard logit models (SP and RP). The SP logit model showed significant parameters for age, speed, and the presence of queuing with and without luggage, as well as taste variation in the mixed logit formulation for age (significant variance parameter). In contrast, the RP data showed only the queuing with luggage variable to be significant. Of note, while age and reported speed were significant in SP, the actual RP results showed no such significance. In general, there was a severe overestimation by individuals in their claim to use the stairs compared to what actually occurred. (4)

More aggregated regression methods have also found their place in relating rates of stair and escalator use to physical variables. These techniques which are simpler in use and application are of particular interest in the health and well being field, where there’s a wish to promote stair use to improve overall health. They, however, have elucidated some interesting behaviour and relationships with respect to pedestrians and stair-escalator choice. Of particular note are findings of behavioural mimicry within stair/escalator choice (pedestrians are more likely to use stairs if observing others using stairs when they arrive) (7), diminishing return of stair usage with increasing stair width (8), and the ability to influence choice with motivational signs (9-11).

In addition to research focused on vertical mode decisions, more general research into pedestrian behaviour is also of importance. These include Helbing’s foundational research on the observation of general pedestrian behavioural patterns. Helbing (2001) found that pedestrians have a strong preference for a direct route, even in the presence of a faster choice, an aversion to excess effort, preference to be spaced out, can be creatures of habit, and tend to move together when in a group (12). Other research has found that locations of bottlenecks (such as the entrance to stairs and escalators) result in chaotic
situations that are difficult to predict and require microsimulation (13), and cultural or geographic
differences in how pedestrians behave (14).

MODELLING FRAMEWORK

As detailed earlier, this study fit two types of discrete choice logit models in an attempt to predict the
choice of stair versus escalator for pedestrians in subway stations. The first model was a standard binary
logit; this type of model is appropriate where two choices are available with no correlation in the error
terms of the utility functions between the two choices. Such is the case of the choice between adjacent
stairs and escalators, where complications resulting from choices that are not co-located (overlapping
routes, differences in sources and destinations, etc.) are not of concern. The mathematical formulation for
the binary logit is shown below:

\[ P_{str} = \frac{e^{V_{str}}}{e^{V_{str}} + e^{V_{esc}}} \]  \hspace{1cm} (1)

where \( P_{str} \) is the probability of taking the stairs, and \( V_{str} \) and \( V_{esc} \) are the utilities of taking the stairs or
escalator, respectively. These utility functions are specified as a linear combination of the independent
indicator variables and a constant term for base preference. For the binary-logit model, parameters are
constant throughout all individuals. This results in identical utility functions across all individuals. Since
the utility functions are defined relative to each other, one can set \( V_{esc} \) to zero, resulting in the following
simplified version for the probability of taking the stairs for each pedestrian:

\[ P_{str} = \frac{1}{1 + e^{-V_{str}}} \]  \hspace{1cm} (2)

The second model examined was the latent-class logit (or mixture of discrete logit) model. Latent-class
models attempt to handle the issue of heterogeneity in the population by segmentation of the
underlying population into specific classes of agents, each with different utility functions. This is in
contrast to mixed-logit models, where taste heterogeneity is captured with a continuous distribution for
each parameter, and the binary-logit model, where a homogenous population is assumed. In the latent-
class formulation, there is, instead, a discrete number of classes; however, the association of a specific
agent with each class is unknown, and the underlying choice model for each class is usually simple (for
example, multinomial logit). (15) Mathematically, the mixture model is specified as follows:

\[ P_j = \sum_{i=1}^{n} w_i P_{ji} \]  \hspace{1cm} (3)

where \( P_j \) is the probability of choosing alternative \( j \), \( P_{ji} \) is the probability of choosing alternative \( j \) for class
\( i \), and \( w_i \) is the probability of being in class \( i \). Determining class ownership can be handled in different
ways. One is to have indicator variables that can be used to formulate a probability of an individual
belonging to a specific class. If, however, no such information is available, the class probabilities \( w_i \) can
be left as parameters for estimation.
This latter method was used for this study, where the latent-class logit model structure is used to determine the relative weight of the sensitivity of pedestrians to the dynamic conditions faced when arriving at the stair-escalator facility in contrast to deciding beforehand based on a predisposition to use either the stairs or escalator (Figure 1). One can also interpret the resulting weight as the proportion of pedestrians who decide based on predisposition to the escalator or based on the crowd volume, versus those who are open to either mode, and decide based on the conditions (escalator queuing, opposing flow, etc.) at the time of arrival.

As with other logit-based models, estimation of the latent-class, discrete-mixture can be performed using Maximum Likelihood Estimation. This involves minimizing the log-likelihood function for the latent-class discrete-mixture model, over all observations j and classes i, defined as:

$$LL = \sum_j \log \left( \sum_{i=1}^{n} w_i \frac{1}{1 + e^{-V_i}} \right)$$

(4)

DATA COLLECTION PROCESS & QUALITATIVE OBSERVATIONS

Toronto Transit Commission (TTC) Network

The TTC subway network consists of 69 stations spread across 4 subway lines, serving almost 900,000 passengers daily. It is fully integrated with TTC bus, streetcar and WheelTrans networks with daily patronage of approximately 1.6 million passengers. The stations vary in layout and design, but generally consist of a platform level, a surface-street interchange level and an intermediate concourse level. Multiple stair, escalator and elevator options exist at most stations for passenger transition between levels, and stairs and escalators are frequently paired.
Study Locations

The study area for this research were stair-escalator pairs in the two busiest downtown stations within this Toronto network, namely St. George Station and Bloor-Yonge Station (Figure 2). Both stations are interchanges, permitting transfer of pedestrians between trains of the two major lines in the city (the u-shaped Yonge-University-Spadina line and east-west Bloor-Danforth line). In addition, the lower platforms where observation was made for both are also centrally located, serving trains in both directions along the adjacent line; therefore, crowds can approach the vertical transport facilities from either direction. In addition, the locations analyzed within this study had identical configurations: staircase widths of 1.7m, 30 steps each of which were 16cm in height, a positive escalator offset of 2m (staircase entrance receded with respect to the escalator), and escalators moving in the upward direction. Video recordings were made on April 14, 2012 for 15 min segments of time at one stair-escalator pair at each of the locations, observing flow during Saturday afternoon from 12-4 PM.

Data Processing

For each location, video was manually processed to extract the following information for each individual as they approached (within a few steps of entrance) and entered the facility:

- the number of other pedestrians queuing at the escalator
- the number of other pedestrians queuing at the stairs
- the number of pedestrians visible on the first 10 steps of the escalator
- the number of pedestrians visible on the first 10 steps of the stairs in the direction of the escalator
- the choice made between taking the stairs or escalator
- the direction of approach (stairs, escalator or head-on)
In addition, the opposing flow values were taken as the number of individuals reaching the bottom of the staircase in the opposite direction in the next 10 seconds (the approximate time for pedestrians to traverse half the staircase). All values were divided by the observed number of lanes (2 for escalator, 2.5 for staircase) to get the density per lane. Lastly, total flow density was calculated as the total number of pedestrians queueing and on the first ten steps (sum of the first four extracted variables) divided by the total number of lanes. The choice of examining only the first 10 steps of either escalator or staircase as the relevant measure of facility occupancy was both due to a limitation in the collection method (the video was only able to capture a certain initial section as shown in Figure 2), and based on an assumption that only the more immediate population ahead would influence an individual’s decision. A summary of the collected data is presented in Table 1.

**TABLE 1 Summary of Collected Data**

<table>
<thead>
<tr>
<th>Station</th>
<th>Total # of Observations</th>
<th>% Taking Escalator</th>
<th>% Taking Stairs</th>
<th>% With Opposing Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>St. George</td>
<td>163</td>
<td>84</td>
<td>16</td>
<td>26</td>
</tr>
<tr>
<td>Yonge/Bloor</td>
<td>363</td>
<td>73</td>
<td>27</td>
<td>53</td>
</tr>
</tbody>
</table>

**METHOD OF ANALYSIS & MODEL ESTIMATION**

The method of model estimation for both models involved three steps: (1) processing the data with appropriate calculations to determine queue lengths per channel and facility densities (2) a step-wise subtractive method to develop the binary logit and latent-class binary logit models (3) validation of the model by evaluation of prediction accuracy on the provided data-set, goodness-of-fit and the appropriateness of the final coefficients.

Estimation was performed using BIOGEME, a software written to estimate discrete choice models using maximum likelihood estimation, and with the capability to handle latent class models(16). A summary of the resulting model estimation is provided below (Table 2).

**TABLE 2 Summary of Model Estimation**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
<th>Std. Error</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Binomial Model</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>0.613</td>
<td>0.130</td>
<td>4.730</td>
</tr>
<tr>
<td>OD</td>
<td>-0.504</td>
<td>0.178</td>
<td>-2.830</td>
</tr>
<tr>
<td>SS</td>
<td>0.990</td>
<td>0.239</td>
<td>4.140</td>
</tr>
<tr>
<td>ASC</td>
<td>-2.780</td>
<td>0.316</td>
<td>8.800</td>
</tr>
<tr>
<td>EQ</td>
<td>0.108</td>
<td>0.052</td>
<td>-2.100</td>
</tr>
<tr>
<td><strong>Latent Class Model</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASC-STR1</td>
<td>-12.700</td>
<td>4.430</td>
<td>-2.870</td>
</tr>
<tr>
<td>F</td>
<td>0.809</td>
<td>0.329</td>
<td>2.460</td>
</tr>
</tbody>
</table>
Binomial Logit Model

The initial model, a standard binomial logit, modelled the influence of approaching direction, stair and escalator density, opposing staircase density, escalator queue length, overall flow and intrinsic preference. Following estimation, stair density, opposing flow density, approaching from the stair side, escalator queue length and the alternate specific constant were found to be significant; escalator density and overall flow were not significant. The resulting utility function for stair use was as follows:

\[
V_{str} = -2.78 + 0.613 \times SD - 0.504 \times OD + 0.99 \times SS + 0.108 \times EQ,
\]

where SD is the stair lane density in the upward direction, OD is the stair lane density in the downward direction, EQ is the escalator queue per lane and SS is a dummy variable representing whether the pedestrian approached from the staircase side.

Latent-Class Binomial Logit Model

The subsequent model estimated was the latent-class model. As detailed earlier, this involved two separate binary logits with different utility functions, jointly estimated with their weights. The first logit model consisted of variables believed to be available on approach to the facilities, or incorporate predisposition: the approach side, the overall flow preceding the pedestrian and a constant term reflecting predisposition to the use of the staircase. All three parameters were found to be significant, resulting in the following utility function, where SS is the dummy variable representing approach from the staircase side, and F is the total number of people preceding the pedestrian in the previous 10 seconds:

\[
V_{str1} = -12.7 + 4.36 \times SS + 0.809 \times F
\]

For the local conditions binary logit, variables for escalator and staircase densities, escalator queue and opposing density were included. Only staircase density and opposing flow density were found to have significant parameters, resulting in the second utility function:

\[
V_{str2} = -2.22 \times OD + 5.92 \times SD
\]

Lastly, the weight parameter was found to be significant with a value of 0.268 for the latter logit model. The final latent class model is as follows:

\[
P_{str} = 0.732 \left( \frac{1}{1 + e^{-V_{str1}}} \right) + 0.268 \left( \frac{1}{1 + e^{-V_{str2}}} \right)
\]
ANALYSIS

A standard binomial logit model provided a baseline comparison for the latent-class model. The estimated standard binomial showed, for the likelihood of taking the stairs, significant positive influences of existing staircase pedestrian density, existing escalator queue, and when approaching from the staircase side, a significant negative effect of opposing staircase density and a base aversion to stair use.

These trends agreed well with observations made during collection. During collection, it was observed that there was a clear preference for the escalator, even in the face of growing queues, with pedestrians waiting to use the escalator, even if the staircase was clear; the staircase was not seen to ever have a queue in the off-peak data collection period. There were, however, times where stair use was fairly high, even on moderate flow, and this generally occurred when several early individuals made the choice to use the stairs, enticing others to do the same in a possible case of mimicry. This tendency of pedestrians to mimic prior choice provides an explanation for the peculiar positive influence of staircase density on the utility of using the staircase, even in the presence of opposing flow, where upward channels were observed forming. Stair choice was visibly higher for crowds alighting from trains and approaching from the staircase side, but quickly reduced when opposing flow in the downward direction occurred; this was counteracted at times if sufficient individuals pushed their way to form upward lanes. Lastly, those with luggage, strollers, elderly and travelling in groups were found to markedly prefer the escalator as expected; however, these personal characteristics were not quantified at this stage.

With mimicry providing an explanation for the positive effect of staircase density (beyond any correlation with escalator queue density), all parameter signs and magnitudes are reasonable and expected. However, the variables used represented intentionally a subset of those which should be included in modelling vertical transport choice. The dimensions of the facility, particularly height, should play a significant role in stair use, but its effects were not examined. With the purpose of this immediate study to examine how pedestrians weigh static versus dynamic factors in making their choice, the static variables were kept constant by limiting observations to those made at locations with identical physical dimensions and similar layouts. The influence of the direction of travel and the level of mobility of the individual should also be investigated, either as explanatory variables or via segmentation, with specific models made for each direction and mobility type.

The latent class model showed similar results with respect to significant explanatory variables on stair choice as the binomial logit. The only difference was the inclusion of a positive influence of increasing overall flow in the initial choice model in place of escalator queue density in the local conditions model, with higher total flow most likely occurring with some level of queuing for the escalator. The static-vs-dynamic weight parameter showed a dominance of the initial choice model with local dynamic conditions playing a relatively minor role. This result can be explained in two ways based on the interpretation of the model. Under the first interpretation, the initial choice based on static conditions is primary for a pedestrian, with the chance of using a stair increasing only marginally from a choice based on more dynamic factors. With the second interpretation, this implies that most individuals tend to make their choice solely on their basic preference of stair-vs-escalator, the overall flow entering the facility and their direction of approach. Only a small segment of pedestrians instead make their choice by considering the decisions made by other pedestrians who had gone immediately in advance and the level of opposing flow.

Goodness-of-fit measures of rho-squared and likelihood ratio were very similar for both models at 0.372/0.384 and 281/292 for the standard logit and latent class models, respectively. While the latent class model had a slightly higher rho-squared, both values were acceptable.
Using the estimated models, Monte Carlo simulations were performed on the initial data set to evaluate the ability of the models to examine how well the models reproduce the observed choices. The two were found to have very close predictive ability at a moderate level, slightly over 70%, with the standard logit model producing marginally better, but not noticeably different results (Figure 3). For such a dynamic situation, with significant variability between individuals, the lack of a high predictive ability is not surprising.

The similarity of goodness-of-fit and predictive ability of the two models appears to imply that there is no practical benefit in the use of the latent class model over the standard binomial logit for the stair-vs-escalator choice situation, given its added level of complexity. Segmenting the population into two classes did not increase predictive ability, at least where the same revealed preference data was used for both the latent class and standard binomial logit models. Whether the availability of panel information (time series data) available at the various points of the decision making process would improve the result is an open question; however, acquiring such information would necessitate a stated preference survey, impractical for such a dynamic situation. Nevertheless, the latent-class model does still serve an informative purpose, indicating that the majority of pedestrians are not influenced by choices of other pedestrians.

CONCLUSIONS
This study examined modelling the pedestrian choice between ascending stairs and escalators of transit commuters in two major Toronto subway stations during off-peak service. In contrast to prior research, in order to better capture the highly dynamic nature of the decision to take the stairs or escalators, the process was modelled by basing choice in part on the dynamic conditions faced by individuals. Two types of discrete choice models were estimated, a standard binomial logit and a discrete mixture of binomial logits (latent-class), the latter treating the process as a combined decision based on information available before and after reaching the facility. Of key interest was the examination of the difference in how pedestrians weigh static and dynamic factors when making their choice.
The goodness-of-fits of the models were found to be adequate, with a moderate ability to predict actual splits found, but only marginal difference between the two model types. The ability, however, of the latent class model to identify the relative importance placed on local, dynamic conditions by pedestrians does hold some value by providing a measure of the level of stickiness of pedestrians to an initial choice. In this study, it was found that the permanent characteristics of the facilities largely dominated the choice of which facility was chosen by individuals. In situations where a clear preference is found, such as the use of the escalator when ascending, this would imply underutilization of the secondary choice even if space is available, diminishing the practical capacity of the facility.

It remains to be seen how models based on dynamic variables would perform in predicting aggregate splits between stairs and escalators for a variety of flow situations and environments. This would include how well such a model would perform in more diverse physical situations (varying heights, widths, etc) and crowd flows, especially in high volume peak periods, to be useful for capacity analysis. Given the dynamic nature of the presented models, a pedestrian simulator is required to produce these aggregate measures to examine overall accuracy in the context of its specific movement model. This examination, using the full data set collected and testing its effectiveness after incorporation within the MassMotion pedestrian simulation software, constitutes the final stage, and is left as future work.

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