Pilot for Standing on Both Sides of Escalators

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Abstract. A pilot was carried out at Holborn Station on London Underground (LU) for standing on both sides of escalators exiting the station. The aims were: to improve safety by reducing slips, trips and falls; to reduce congestion by using the escalators more effectively; and to change customer behaviour. The data collected was both qualitative and quantitative. The data collected on safety was statistically insignificant. It was shown that using both sides of the escalators to stand on did reduce congestion and increased escalator capacity by approximately 30%. There was a change in customer behaviour for the duration of the pilot.

1 INTRODUCTION

In seeking to improve safety on LU's escalators, a series of initiatives were put into place. One of those initiatives was a three week series of tests at Holborn Station to encourage customers to stand on both sides of certain escalators. The aims of the tests at Holborn focussed on Congestion and Flow, and Customer Behaviour, in addition to Safety. Previous research affecting these areas underpins the methodology described. Calculations were made to predict how many extra customers might be carried by escalators with a vertical rise of 24 metres (as at Holborn): an increase in the region of 25-30%. This would be sufficient to increase flow in the station and reduce congestion and the associated station control measures normally in place. Many methods of data collection were available and it was decided to collect as much data as possible and analyse it both qualitatively and quantitatively. The outcomes are discussed and followed by a summary of the outcomes and conclusions.

2 AIMS

The aims of the tests were to see if changing the way that escalators were used could:

Improve safety by reducing slips, trips and falls

- Accidents happen every day on LU escalators. LU aims to improve safety by reducing accidents on escalators.
- Most accidents occur when customers have heavy luggage, or are mobility impaired.
- Walking on escalators exacerbates the risk of accidents.

Improve the flow of customers through the station in order to reduce congestion.

- LU places emphasis on safe evacuation from stations, focussing on customers exiting stations and managing numbers of customers entering.
- With an increasing frequency of trains passing through stations as the service improves, congestion is an issue at older stations with limited space and new, cost effective solutions are needed to ease the congestion.

Achieve customer behaviour change

- For more than 100 years LU customers have been requested to stand on the right and walk on the left of escalators. A significant change in behaviour would be necessary for the proposed tests to be carried out.

3 PREVIOUS RESEARCH

3.1 Improve Safety by Reducing Slips, Trips and Falls

The Safety Assessment Federation's 2011 paper providing guidelines on BS EN 115, which defines escalator safety requirements in the UK, stated that

"Slips trips and falls are the most common incidents on escalators … There are a number of reasons why they occur, which include: poor lighting, location of the installation, crowding, distraction, inappropriate footwear, poor judgment by users, horseplay, use of alcohol and drugs, loss of balance, spillages, debris, environmental conditions, use as a static staircase, or by unsupervised minors." [1]

In an article [2] it was identified that the highest risk group of slips, trips and falls on escalators were those aged 65 and over, and those aged 5 and under.

According to the South China Morning Post in August 2015 [3] it is now mandatory to stand only on both sides of the escalators on metros in Hong Kong and Japan. The practice was brought in to improve safety. *"According to the MTR, in the first seven months of 2015, 382 escalator accidents were recorded – about 12 per cent fewer than in the same period last year. Some 51 per cent of the accidents involved seniors and children due to loss of balance, standing too close to the step edge, or carrying heavy luggage."*

3.2 Improve the flow of customers in order to reduce congestion.

People need more space than the size of their physical bodies and how much space is needed varies from country to country. [4]

LU escalators have width of 1.01m and depth of 0.41m and height of 0.4m. These dimensions mean that it is uncomfortable for people to stand side by side. Two people, side by side, will require 1.22m width, where LU escalators have 1.01m available. One person on a step requires 0.457m, where LU escalators have step depth of 0.41m available. Again, this will make a person in this position very uncomfortable.

"…escalator utilisation and capacities are closely related to human factors such as shoulder width, personal space preferences, and ability to adjust to system speed. Even under heavy queuing, vacant steps can be observed on most escalators…" [5]

This is described as "the empty step phenomenon" and Fruin [4] explains this as why capacity is never as high as two people on every step would be. The two reasons he gives for this is the slight hesitation that people have when getting onto an escalator, and the innate desire for personal space. Fruin [4] also studied movement on stairs and observed that, in general, people keep two vacant steps in front of them when walking on stairs.

Davis and Dutta [6] carried out a study of escalator capacity on LU which observed that escalators with a greater vertical height have fewer people walking up them. Other factors apart from vertical height affect how escalators are used: where there is more than one escalator, and where escalators are next to a corner which reduces the approach space to the escalator. Non-commuters also have an effect, as they tend to stand rather than walk up escalators.

3.3 Achieve customer behaviour change

Larcom et al [7] looked at the effects of forcing behaviour change on commuters by LU workers strike action, where commuters under-experiment with routes in normal times. The implication is that people do not naturally seek change for improvements in their journeys i.e. do not want to

change their behaviour. However, if forced to change their behaviour, people can recognise benefits and make changes.

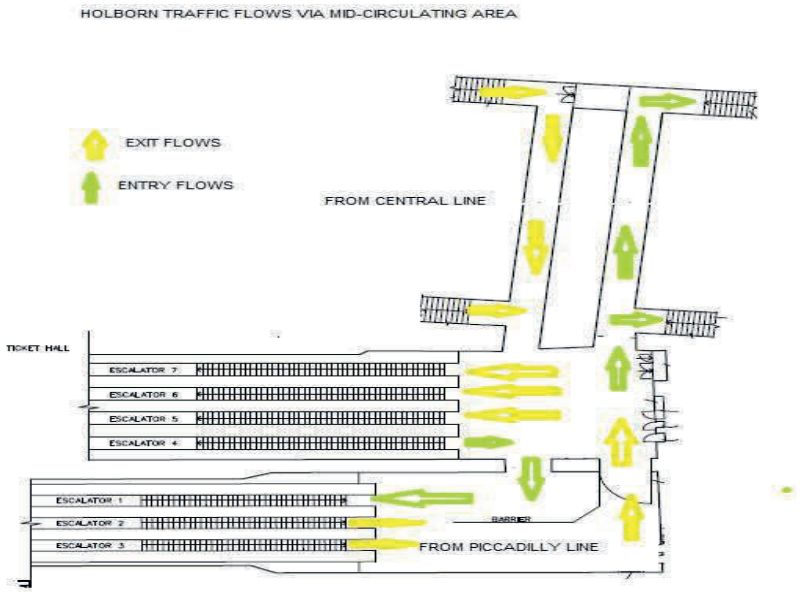
In work carried out by Dolan et al [8], which drew on academic evidence of what influences behaviour, suggestions for innovative interventions were made:

"…much of behaviour change is about battling habits…Habits …usually develop when actions are repeatedly paired with an event of context (e.g. drinking coffee after waking up)… …the most effective way of changing…habits is by going with the grain of behaviour: harnessing the same automatic effects to nudge people onto a different, self-sustaining, track, without always explicitly stating the need to pursue a particular goal." [8]

LU customers' habits of walking, or standing, are very entrenched. A gradual progression on tests with one escalator only, followed by two, then three over the three weeks was decided on in an attempt to introduce the standing on both sides slowly, leaving the option to walk open until the third week of tests. It was decided to use staff to "encourage" customers to stand on the left of the escalators instead of walk.

4 METHODOLOGY

A start date for three weeks of testing was agreed for the 23rd November as this would permit two weeks of tests before Tottenham Court Road re-opened to Central Line trains, which was expected to result in a reduction of customer numbers at Holborn.



4.1 Calculations for a Theoretical Increase in Capacity of Escalators at Holborn

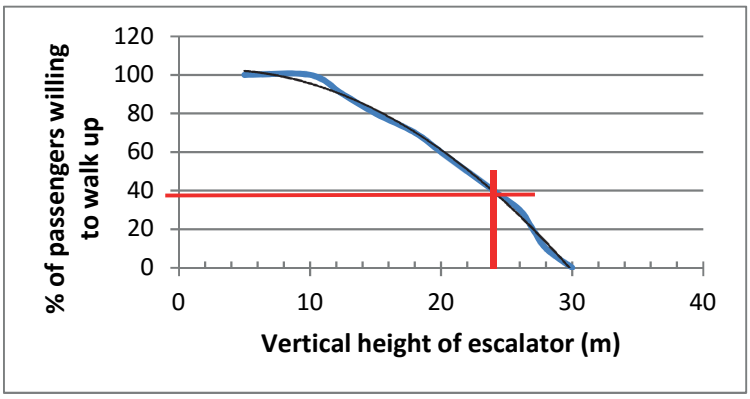
Simple calculations were made to show escalator capacity. LU escalators have a speed of 0.75m/s and a step height of 0.4 m which gives the number of steps/minute as 112.5. With customers standing on both sides of the escalator and occupying every step this gives a theoretical maximum of 225 customers/minute. However, looking at the right hand, stand only, side; and taking into account the empty step previously discussed, this gives a capacity of 56.25 customers/minute.

On the left hand, walking side, with an assumed walking speed of 0.5m/s, an escalator speed of 0.75m/s gives a walking speed of 75m/minute. Given a step rise height of 0.4m this gives a walking

speed of 187.5 steps/minute. Taking into account the two step vacancy described by Fruin for stair walking, the speed for walkers on the left hand side of the escalator is calculated to be 62.5 customers/minute.

These calculations do not take into account the vertical height of escalators. It is assumed for the purpose of this calculation that there is a decreasing percentage of passengers willing to walk up a high machine.

The percentages given below are partly based on observations at Canary Wharf with a 10m vertical rise, together with observations of customer walking behaviour on escalators with a greater vertical rise than 10 metres. The graph below shows vertical height vs % of passengers willing to walk. At Holborn the escalator rise is 24 m which gives an estimated amount of 40% of customers willing to walk.



% of Passengers	Vertical height (m)
100	5
100	10
90	12.5
80	15
70	18
60	20
50	22
40	24
30	26
20	27
10	28
0	30

40% of customers walking on the left is 40% of 62.5 customers/minute, which totals 25 customers/minute. If customers stand on both sides of the escalator this gives a rate of 112.5 customers/minute. The difference between rates for standing on both sides of the escalator, or leaving one side for walking is 31.25 customers/minute. In theory, passengers standing on left and right of escalator at Holborn should increase number of passengers per minute by 27.8%

4.2 Data collection

It was decided to collect data from as many sources as possible:

- Numbers of customers counted off escalators
- Observers to note crowd behaviour and use of escalators
- Staff de-briefs after each test
- Dwell times and headways of all services
- Gate line exits
- Timed walks from platforms
- Incident comparison
- Customer feedback

The data was to be analysed both qualitatively and quantitatively.

4.3 Mechanics of tests and staffing

Two or three members of staff were placed at the bottom of escalator 5, 6 and 7 to encourage customers to stand on both sides of the escalator/s being used to stand on both sides. An observer stood at the back wall of the mid-circulating area to monitor crowd behaviour and assist as necessary. People were located at the top of the escalators to count customers leaving the escalator

using a "clicker" counter. A second observer was located where they could observe crowd behaviour and assist as necessary.

Staff: The tests were carried out by a combination of the Special Requirements Team (SRT) and "volunteers" from Lifts & Escalators (L&E) and Strategy & Service Development – Customer Strategy (S&SD). Non-operational staff were identified by pink hi-vi tabards. Station staff were not to be taken from their normal duties.

4.4 Variations to the Planned Tests

Variations to the tests were made over the three weeks. After the first days of tests loud hailers were used for three days, followed by use of the local PA system in order to be heard. After suggestions from various sources, including customers, some staff in plain clothes volunteered to stand on the left of the test escalators to stop people walking up. This had the added benefit of the plain clothes staff hearing comments from customers on the escalators.

4.5 Unplanned Incidents

Day one: escalator 7 had been chosen as "stand only", but was out of service. The test was not carried out on that day.

Day four: 58 minutes suspension on the Piccadilly Line (smoke from a train at Kings Cross).

Day six: escalator 6 taken out of service because a fault at 08:32. Escalator 6 was used as a walk down staircase, escalator 4 reversed to "up", with standing on both sides "encouraged" on escalators 5 and 7.

4.6 Service Provision

Leading into the tests, both Central Line and Piccadilly Line Fleets had technical problems requiring a large number of cancellations. The Piccadilly Line had up to 13% cancellations the first week, 8% the second week, falling to a maximum of 4% on the third week. The Central Line had a steady maximum of 4% cancellations on all three weeks. Both lines have 78 trains per hour scheduled at this time of day.

5 QUALITATIVE OUTCOMES

5.1 Observations on Safety

Observers noted that there were several issues around customer behaviour that posed a potential safety risk. Many customers began to prepare themselves for exiting the station on the escalator, but on leaving the escalator, would drop items, such as ticket holders, etc., and would stop to pick them up without regard for the surge of people behind them. The same effect was caused by customers with wheeled suitcases, where they would lift the case off the escalator in front of them, hesitate while they extended the handle and then move forward around their case so as to pull it behind them. These little interruptions to the flow of customers exiting escalators had the potential to cause a "pile up". There were no customer injuries.

Tottenham Court Road, which is the next station from Holborn on the Central Line, had no Central Line trains stopping while upgrade works were being done. This caused increased numbers of customers at Holborn which led to congestion: the station response to this was to implement "station control" by holding customers exiting from the Piccadilly Line in the lower circulating area at the bottom of escalators 2 and 3 while congestion cleared in the mid-circulating area. During the escalator tests, "station control" was only implemented once and this was during the first week. There were few gate line problems over the three weeks and none of them led to over-crowding of the ticket hall.

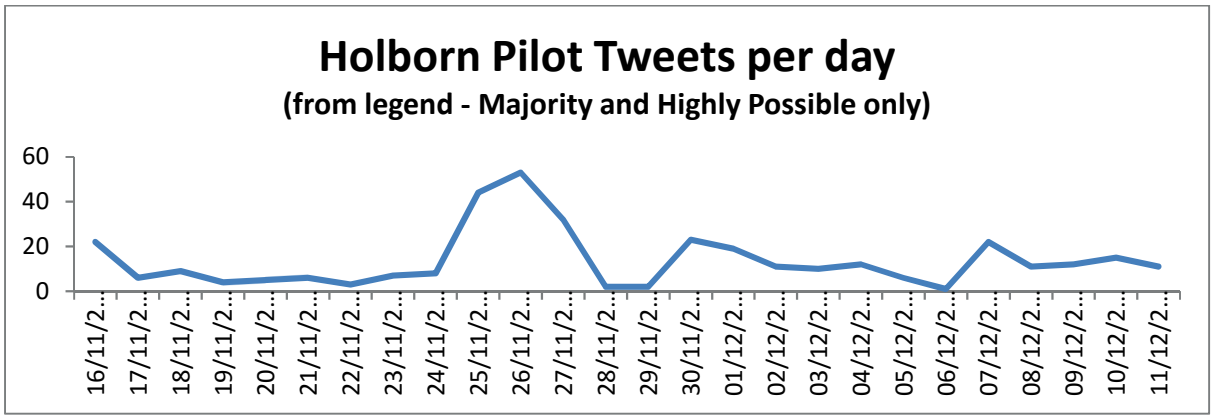
5.2 Customer Feedback

5.2.1 Customer Contact Centre and Email

Six customers gave feedback received via the Customer Contact Centre and seven customers from other sources (e.g. phone or direct email). Recurring themes were that the tests would not work (to relieve congestion); people feel deprived of the choice to walk and/or exercise; and that it delays their journey. Three customers understood and supported the tests, but felt that the choice to walk up at least one escalator should remain.

5.2.2 Twitter

Twitter comments were selected based on certain keywords: Holborn, both side, escalator, pilot, stand, test and trial. The date range was selected to include a period prior to the first day that escalator tests were carried out on Tuesday 24th November. There was a large increase in tweets on the first two days of tests. The number of tweets fell sharply at the weekend to none and then rose sharply on Monday, but not to as high a level as the previous week. Again, the number of tweets fell gradually over the week, briefly reaching zero over the weekend. On the final week there was a peak on the Monday which fell over Tuesday and Wednesday.



Each week the tweets peaked on the first day of tests. These coincide with the expansion of numbers of escalators included in the tests. The tweets fall off over the week as customers became accustomed to the new restrictions placed upon them. Less than half of the tweets looked at were negative. Others were humorous, neutral or questioning.

5.2.3 Media

On the second day of the test period the media began to take an interest, with journalists going to Holborn station and taking covert footage and interviews. The intense media interest had an impact on the tests. The most positive impact was that customers were given an explanation of how the tests were aiming to improve flow and reduce congestion.

Once media reporting began, customers affected by the tests began to verbally express their opinions, both positive and negative, in an uninhibited way and to take films of their ride on the escalators on their mobiles. Customer behaviour changed as they felt observed.

5.2.4 Customers at Holborn

Customer response directly given at Holborn during the tests was wide-ranging. There was frequent non-verbal communication in the form of head-shaking, particularly if the person concerned met the eyes of a member of staff. Many people gave short, negative feedback, e.g. “This is a stupid idea”;

"This is not working"; "You are making me late". Initially there was a high frequency of people asking for information and saying that it would not work. After the first week, the comments changed from saying that it would not work, to saying that they did not like it or did not want to do it, implying a level of acceptance and compliance. Another theme that was mentioned frequently was that customers felt they were being deprived of exercise and the choice to walk.

There was also a significant amount of positive feedback with customer comments that the flows from the platforms had improved and suggestions on how the tests could be improved. Some customers suggested that staff/students be used to "enforce" the standing, by standing on the left in front of customers. By the third week, SRT staff reported that some regular customers said good morning and made a point of standing on the left of the escalators.

5.3 Observations on Customer Flow, Congestion and Customer Behaviour

The first day of week one brought the most resistance from customers and it took the longest to gain compliance. By the third week, most customers were compliant by Tuesday. From the first days of the tests it was observed that the mid-circulating area cleared much more quickly. Apart from one day during the first week, no "station control" was required.

Over the three weeks there were various staff, with different styles, assisting with "encouraging" customers to stand on both sides of the escalators concerned. Most noted that humour worked best in achieving compliance. One member of staff encouraged couples to stand side by side and hold hands. It was observed that if customers stood side by side and talked, or held hands, customers behind them did not attempt to pass them.

It was observed that those customers who really wanted to walk found a way to do so e.g. weaving between other customers on both sides of escalator. One man pushed a child aside so that he could walk, demonstrating how strongly ingrained the habit of walking can be that overcomes the social norm that prohibits the touching of other people's children. Standing on both sides of the escalators was most effective when the mid-circulating area was congested.

6 QUANTITATIVE OUTCOMES

6.1 Safety

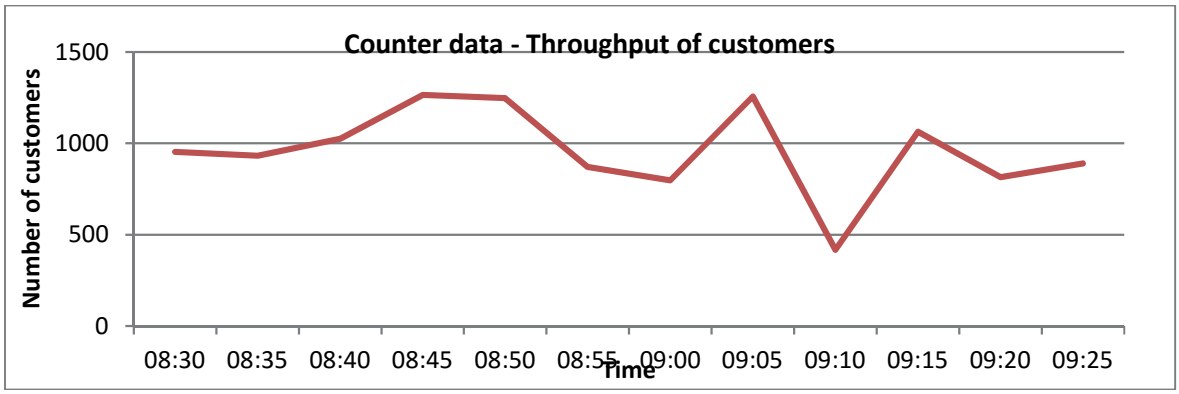
Incident reports from LU Safety and Environmental Analysis (LUSEA) were run which allowed comparison between the three weeks of tests and the previous three weeks, and the three corresponding weeks from the previous year. There were only two customer related escalator incidents reported: one on the 22/11/15 and one on the 29/11/14, with none reported during the trial period. With such small numbers this is not considered significant.

6.2 Congestion and Flow

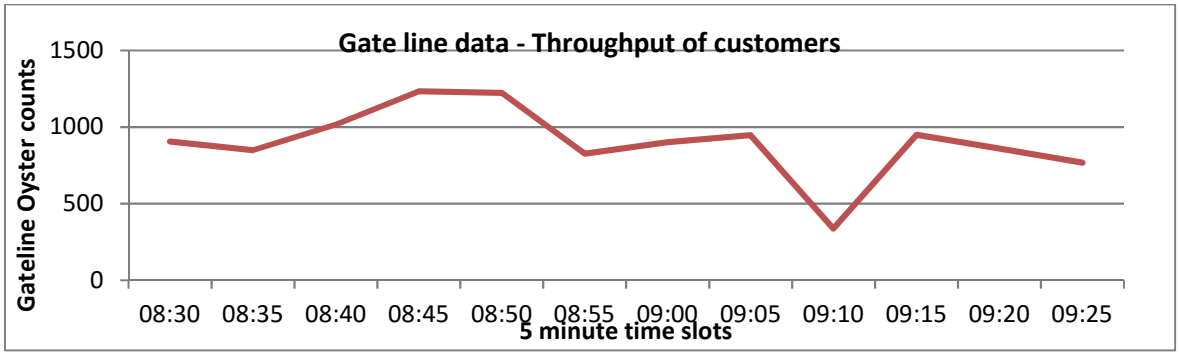
To compare escalator usage of standing and walking, simple calculations were completed to understand if there was an improvement in customer throughput. In week 2, Escalator 5 gave customers the option to walk up the escalator; the total amount of people that used this escalator was approximately 12,745 customers. In week 3 when escalator 5 was standing only, approximately 16,220 customers used it. This is around a 30% increase in the throughput of customers, matching our predictions.

On Tuesday 8th Dec (Week 3, Day 2) all escalators were standing only, meaning the gate line data and physical counting was very similar. Human error accounts for an approximate 8% discrepancy between the two. Graph 5 shows the counter data of the three escalators. Graph 6 shows the gate line data. The peaks in customers are at 8:45, 9:05 and 9:15 and low flows at 8:35, 8:55, 9:10 and 9:25. The headways show that the Piccadilly line had delays between 8:55- 9:00. Trains from both directions came in at 9:01 after a five minute gap in the service, which explains the dips and the

peaks at 9:05. Between 9:08 and 9:11, there were delays on both lines in both directions, causing the exaggerated dip on the graphs.



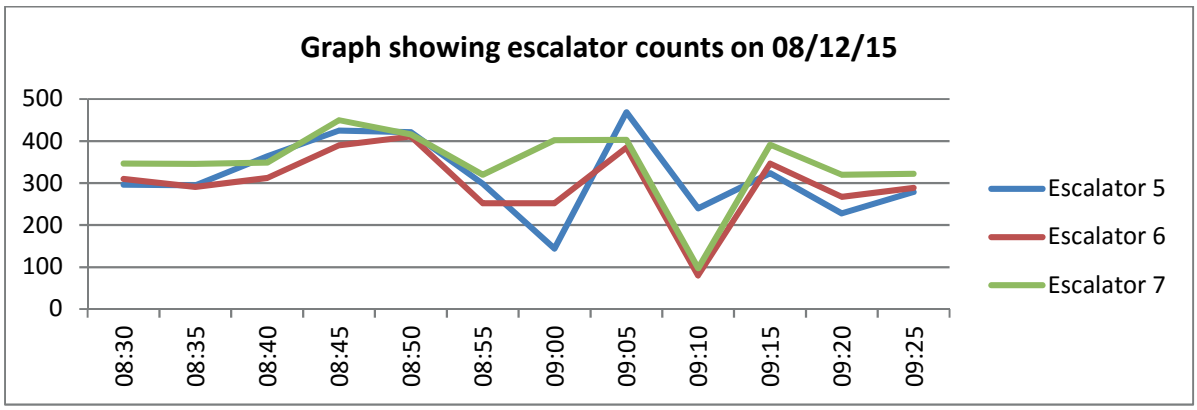
Graph 1 Throughput of customers on all 3 escalators



Graph 2 Throughput of all customers exiting the station

6.3 Customer Behaviour

It was observed that customers exiting the Central line would normally use escalator 7, and customers exiting the Piccadilly line would use escalator 5. Escalator 6 is between them and was used by customers from both lines, but mainly the Central Line. Using headway data for 08:30-09:30 from the final week of the trial it can be seen that delays in the service of the different lines demonstrate customer's preference for particular escalators.



Graph 3 Counts for each escalator on 8/12/15

Graph 3 has a high peak between 9:05 - 9:10 on Escalator 5. A train on the eastbound Piccadilly line came in after a 4 minute delay. These customers arrived at the escalators at 9:06, showing that customers from the Piccadilly Line tend to use Escalator 5.

Between 9:10 - 9:15, there were very few customers on escalators 6 and 7. Only one Central Line train arrived at this time; there were no Central line customers exiting the station for 4 of the 5 minutes, demonstrating that Central line customers tend to use Escalators 7 and 6.

7 SUMMARY OF OUTCOMES

7.1 Safety

During the tests over the three weeks at Holborn, no injuries relating to escalators were reported. When compared to the period prior to the tests and against the same period last year, the data was not statistically significant.

Some customer behaviour was observed which posed some risk to themselves and others. When exiting escalators, customers tended to show a lack of awareness regarding the flow of customers behind them e.g. stopping to pull a case in a different direction, etc. With increased flows the need to keep customers moving becomes more of a priority.

7.2 Congestion and Flow

Observations by station staff and those implementing the tests confirmed that encouraging customers to stand on both sides of escalators does improve the flow of customers and relieves congestion. These observations were confirmed quantitatively with an approximate increase of 30% matching the prediction of increased capacity for standing on both sides of escalators at Holborn.

“Station control” was only implemented on one day during the first week of tests. Prior to the tests implementing “station control” was something which happened on an almost daily basis. This is a good indicator that flows had improved. Service provision had a significant impact on customer flows.

7.3 Customer Behaviour

There was a wide variety of customer behaviours during the tests which were exacerbated by the intense media interest in the tests. Customers expressed concerns about prevention of exercise, lateness, not believing that improving the flow in this way worked. The media attention appeared to make customers feel less inhibited in expressing their feelings, but also had a major benefit of explaining what the tests were trying to achieve. There were a significant number of customers who were interested and/or positive about the tests. Some observed that they could see that the flows from the platforms had improved and others suggested ways to improve the tests. Very few customers submitted feedback to TfL: there were 13 submissions from an approximate 130,000 customers affected by the tests.

It was noted by staff that humour worked best in achieving compliance and when customers stood side by side and talked, or held hands, customers behind them did not attempt to pass them. Those customers who really wanted to walk found a way to do so. One man pushed a child aside so that he could walk, demonstrating how strongly ingrained the habit of walking can be that overcomes the inhibition of touching of other people’s children. Standing on both sides of the escalators was most effective when the mid-circulating area was congested and minimal encouragement was used to get customers to stand on both sides of the escalators.

8 CONCLUSIONS

Regarding safety there were no significant incidents or injuries reported. Customer behaviours at the exit points of escalators do present some concern where interruption to customer flows are concerned.

The tests were successful in easing congestion and improving customer flows. However, the tests required a large number of staff to implement. This is a consideration in how to take this forward.

Customer behaviour was only changed for the duration of the tests, with "normal" escalator usage resuming when the tests were over. Some strong emotions were displayed by customers who wished to continue in their habitual routine, although most were compliant. Significant numbers of comments related to wanting a "walking" escalator for the purpose of speed, exercise and in case of lateness.

It is clear that implementing "standing only" escalators would not be suitable for all locations given that shorter escalators achieve greater efficiency when walking is permitted; not all locations have congestion issues which would benefit from this approach; and, each location varies in physical characteristics which could affect the efficiency of how the escalator is used.

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BIOGRAPHICAL DETAILS

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