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4th International Symposium on

HUMAN BEHAVIOUR IN FIRE

Conference Proceedings

Robinson College, Cambridge, UK

13-15 July 2009

Proceedings of the 4th International Symposium on Human Behaviour in Fire 2009
held at the Robinson College, Cambridge, UK
13-15 July 2009

A conference organised by:
Interscience Communications Ltd
West Yard House, Guildford Grove,
LONDON SE10 8JT, England

Human Behaviour in Fire 2009

ISBN 978-0-9556548-3-1

p680, 134 tables and 276 illustrations

ORGANISING COMMITTEE

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AN INVESTIGATION OF PASSENGER EXIT SELECTION DECISIONS IN AIRCRAFT EVACUATION SITUATIONS

Madeleine Togher, Edwin R.Galea & Peter J. Lawrence
Fire Safety Engineering Group
University of Greenwich, London SE10 9SL, UK

ABSTRACT

This paper presents results from a questionnaire study of participant exit awareness and suggested exit selection in the event of emergency evacuations involving narrow body aircraft. The study involved 459 participants with varying flight experience. The results of this study supports the hypothesis that poor understanding by passengers of aircraft exit location and configuration may be a contributory factor in the resulting poor exit selection decisions made by passengers in emergency situations. These results have important safety implications for airlines and also provide important insight to evacuation model developers regarding the decision making process in agent exit selection.

INTRODUCTION

In aircraft accidents, 89% of passengers attempt to utilise their nearest exit during evacuation [1]. However, using the nearest exit is not necessarily the most efficient evacuation strategy, especially if there is a significant difference in exit flow rate capacity or exit performance between the available exits. The most common aircraft type in the world is the narrow body (single aisle) aircraft typically used for short haul flights. The most common examples of this type of aircraft are the B737 and A320 family of aircraft. These aircraft types typically have three pairs of exits, two in the front, two over the wing and two in the rear. The front and rear exits are large floor level exits that allow passengers to walk through the exit and jump onto the slide. These exits are usually of exit type Type-C and can typically produce an average flow rate of 64 people/minute. The over wing exits are smaller exits which require the passenger to climb through the exit. These smaller exits are of exit type Type-III and typically produce an average flow rate of 35 people/minute.

In an analysis of survivable aircraft accidents involving narrow body aircraft with three exit pairs [1] (based on data derived from the AASK database [2,3]) over 50% of passengers were found to use the over wing exit. On the one hand this is of little surprise as over 89% of passengers use their nearest exit, and the central exits are the closest to the majority of passengers. However, the centre Type-III exit is the smallest exit on the aircraft and is 45% slower than the larger Type-C exits in the front and rear. Furthermore, in the aircraft industry standard evacuation certification trial, we find that on average only 28% of passengers use the over wing exit. Thus we find that in aircraft accidents, the central small Type-C exits tend to be over used, while in the industry standard evacuation certification trial, a smaller more appropriate proportion of passengers utilise the exit, representing the slower flow rate capability of the exit.

The most probable reason for the difference in exit usage between certification trials and real accidents lies in the behaviour of the passengers. Essentially, in real accident situations passengers have a higher motivation to escape than they do in evacuation trials and tend to do so by what they perceive to be the most direct method – their nearest exit. In certification trials, cabin crew procedures work quite well and achieve a well-balanced and highly efficient evacuation with most of the exits working in a near optimal manner. However, in real emergency situations, where passengers may have a choice of directions in which to escape, they may ultimately ignore crew commands – or not even be aware of the crew commands due to adverse environmental conditions - and attempt to use what they perceive to be their best exit i.e. their nearest exit. This would appear to be a logical behaviour as it is reasonable to assume that by travelling to your nearest exit you are likely to minimise your evacuation time – assuming that all the exits have similar flow capabilities. It is also possible that while passengers may be aware of the location of their nearest exit, they may not be aware of the flow capabilities of the various exits and so are unaware that their nearest exit may be an inherently slow exit due to its physical characteristics. The pre-flight safety briefing makes no mention of the size of the exits and the impact this may have on evacuation times. It is conjectured that in real emergency situations the disproportionably large number of passengers utilising the over wing exits are due to a lack of passenger knowledge concerning the size and flow capabilities of the Type-III exit. They are simply moving towards their nearest exit without taking into consideration the flow capabilities of the exit.

It is important to understand why passengers over utilise these exits in order to provide better safety briefing instructions for passengers allowing them to make more informed exiting decisions. Furthermore, in order to improve the decision making capabilities of aircraft evacuation models such as airEXODUS [4] it is important to understand the decision making process involved in the exit selection process. To better understand the decision making process associated with passenger aircraft exit selection the authors have developed a questionnaire which they did administered to members of the travelling public. This paper describes the results from the analysis of the participants' responses to the questionnaire.

AIRCRAFT EVACAUTION QUESTIONNAIRE AND SAMPLE POPULATION

A total of 488 members of the public were approached to complete the questionnaire, of which 459 people were considered eligible to take part in the analysis. The questionnaire consisted of 16 multi-part questions and required approximately 20 minutes to complete. The questionnaire focused on narrow body aircraft with a single passenger aisle and a pair of large Type-C exits in the front and rear with a pair of Type-III exits over the wing as shown in Figure 1. Two pilot trials were conducted prior to launching the main campaign.

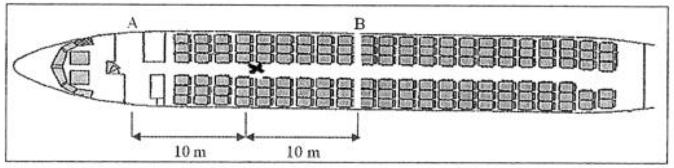

Figure 1: Aircraft layout as presented to the participants in Question 8 without exit size or type information. The "X" marks the location of the participant which is equi-distant between two exits.

The first pilot trial, involving 25 participants revealed some inconsistencies in the questions and highlighted several difficulties that the participants had in addressing the questions. These were corrected and a second pilot was conducted, again involving 25 participants which revealed that the questionnaire was acceptable. The first five questions in the questionnaire were intended to establish

the flying experience of the participant; the next two questions were intended to ascertain the understanding the participant had of the aircraft layout with regards to the number of exits on board the aircraft, the location of the exits and the size of the exits. The participant was later told the correct number and location of the exits, but not the size of the exits, and the next four questions asked the participant to identify which exit they would use if they were placed at an equal distance between two exits (the position "X" in Figure 1). The question was asked twice, once with no other passengers in their way (to remove the complication of queuing) as in Figure 1 (i.e. question 8 for forward and over wing exit) and with eight other passengers queuing up at each exit (i.e. question 9 for the forward and over wing exit). This was repeated for the rear exits (i.e. questions 10 and 11). The participant was then told which were the large and small exits and was shown a picture of the various exits. The next two questions then repeated the exit selection questions relating to the forward two exits (i.e. question 12 without queuing passengers and question 13 with queuing passengers).

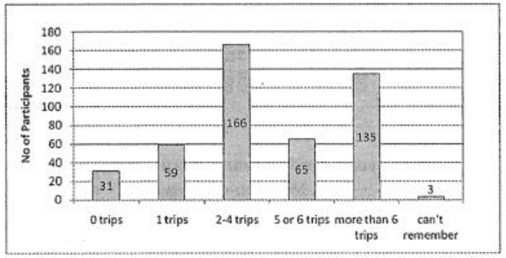

Figure 2: Number of return trips of participants in the last 3 years

The participant was then asked to estimate how long they thought it would take for a single person to exit through the smaller Type-III exit if they required 1 sec to pass through the large Type-C exit (question 14). This was intended to establish if the participant could come up with a reasonable estimate for the flow rate of the smaller exit. The participants were then told what the correct relative performance of each exit would be and were then asked to repeat the exit selection process for the forward exits (i.e. question 15 without queuing passengers and question 16 with queuing passengers).

The questionnaire was completed by 459 members of the public. The sample consisted of 61% (280) males and 39% (179) females with 25% (115) in the 18-30 year age bracket, 52% (240) in the 31-50 age bracket and 23% (104) in the over 50 age bracket. Over 93% of the sample had flown at least once in the past three years (Figure 2). Results were analysed as a function of age, gender, flight experience and aircraft knowledge. Here we present an overview of the results.

MAIN RESULTS

The analysis presented here will first consider the participants knowledge of the cabin layout and then will examine the exit choices made by the various participants. The analysis will be based on the participants' frequency of travel and knowledge of cabin layout.

Participant knowledge of cabin layout

Of the entire sample population, 78% (357) could correctly identify that there are three exit pairs on the aircraft while 75% (344) could correctly identify the location of the three exit pairs (see Table 1).

This indicates that a quarter of the participants (25% or 115) did not know that the aircraft had three exit pairs and where they were located. Presented in Figure 3 is an example of some of the erroneous exit information provided by the participants.

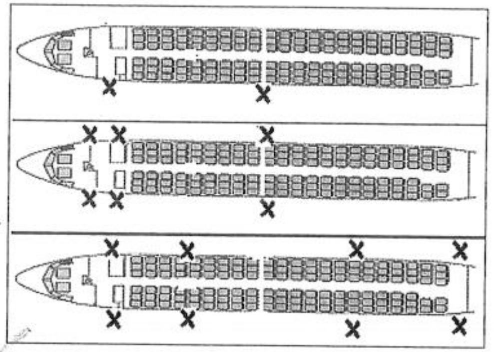

Figure 3: Example exit locations suggested by participants who did not know correct number and location of exits.

When asked if all the exits were the same size, only 37% (172) of the population realised that the exits were not the same size. This suggests that a significant proportion of the sample population - over three fifths (287) - did not know that the exits were of different sizes. ***Of greater concern was the fact that only just over one fifth of the entire population - 22% (99) – knew the number, location and relative sizes of the three exit pairs*** (see Table 1). These results clearly indicate that the sample population have a poor configurational awareness of the aircraft. It is suggested that this poor level of understanding is a contributory factor in the poor exit selection decisions made by passengers in emergency situations.

It is often claimed that frequent fliers have a good knowledge of the aircraft and that recent fliers also have a good knowledge of the aircraft layout. This possibility was examined by comparing the sub-populations who had flown in the past 12 months (367 participants) with those who had not flown in the past 12 months (92 participants), and frequent flyers who had flown in the past 12 months (194 Participants) with infrequent flyers who had flown in the past 12 months (173 Participants). For this analysis, frequent flyers are defined as those people who have flown five or more return trips in the past three years. From Table 1 we note that the results for the sub-population that have flown within the past 12 months ("recent flyers") are not significantly different to the results for the entire population. This is because 80% (367 participants) of the sample have flown within the past 12 months. Thus the conclusions drawn for the entire population apply equally well to those who have flown within the previous 12 months. In particular, ***just under a quarter of the "recent flyer" sub-population - 23% (84) – knew the number, location and relative sizes of the three exit pairs*** (see Table 1).

We can also compare the sub-population who has flown within the past 12 months (367 participants) with those who have not flown within the past 12 months (92 participants). Here we find that the correct knowledge of the number and location of the exits is almost identical, with the proportion of those having flown in the past 12 months only being some 3% greater than the proportion of those who had not flown in the past 12 months. ***Simply having flown recently does not convey good knowledge of the aircraft layout.***

Table 1: Knowledge of cabin configuration for various sub-populations

Configurational knowledge	Entire Sample (459 people)	Sub-population – flown in the previous 12 months (367 people)	Sub-population – NOT flown in the previous 12 months (92 people)	Sub-population – frequent flyers who have flown in the previous 12 months (194 people)	Sub-population – infrequent flyers who have flown in the past 12 months (173 people)
Correct number of exit pairs	78% (357)	79% (289)	74% (68)	89% (172)	72% (125)
Correctly locate the three exit pairs	75% (344)	76% (277)	73% (67)	82% (159)	68% (118)
Knew that exits were of different sizes.	37% (172)	40% (145)	30% (27)	45% (91)	31% (54)
Correctly identify number, location and size of exit.	22% (99)	23% (84)	16% (15)	27% (53)	18% (31)
If 1 sec to pass through L, a little more to pass through S	62% (285)	62% (228)	60% (55)	62% (121)	62%(107)
If 1 sec to pass through L, much more to pass through S	12% (55)	13% (46)	13% (12)	13% (25)	12%(21)
If 1 sec to pass through L, approx the same to pass through S	19% (87)	19% (68)	22% (20)	18%(34)	20%(34)

However, we find that those who have flown in the past 12 months have a better understanding of the difference in size of the exits than those who have not flown in the past 12 months, the difference in knowledge between the two groups being some 10%. We find however that this is not significantly different (note, all χ^2 analysis presented in this paper are two tailed and make use of the Yates correction, χ^2 test, $X^2 = 3.32$) at the 5% confidence limit, thus the null hypothesis, that having flown within the past 12 months does not imply better knowledge of the size of the available exits on the aircraft is supported. When we compare the complete configurational knowledge of the two sub-populations, we find that 7% more of the sub-population that has flown in the past 12 months could identify the three key configurational facts relating to; the number of exits, the location of the exits and that the central exits were smaller in size. This reduces from 23% (84) for the sub-population that has flown in the past 12 months to 16% (15) for the population that has not flown in the past 12 months (see Table 1). However, we find that this difference is not statistically significantly different (χ^2 test, $X^2 = 2.034$), which does support the null hypothesis that having flown within the past 12 months does not convey a better configurational knowledge. ***Once again, simply having flown recently does not imply that people will have a good knowledge of the aircraft exit layout and configuration.***

Comparing the response of frequent flyers who have flown in the previous 12 months (194 participants) ("recent frequent flyers") with infrequent flyers who have flown in the past 12 months (173 participants) ("recent infrequent flyers") does present some interesting differences. Of the recent frequent fliers sub-population, 89% (172) could correctly identify that there are three exit pairs on the aircraft compared with 72% (125) for the recent infrequent flyer sub-population – a difference of 17%. We find that this is statistically significantly different (χ^2 test, $X^2 = 15.93$) at the 0.01% confidence limit, thus there is a strong departure from the null hypothesis of no association between the flight frequency of those passengers who have flown in the last 12 months and the knowledge of the correct number of exits on the aircraft. The greater observed than expected result of the recent frequent flyers strongly suggests that they are likely to have better knowledge of the correct number of exits than do recent infrequent fliers. Furthermore, 82% (159) of the recent frequent fliers compared with 68% of the recent infrequent fliers could correctly locate all three exit pairs – a difference of 14%. We find that this is statistically significantly different (χ^2 test, $X^2 = 9.34$) at the 0.5% confidence limit, thus there is a departure from the null hypothesis of no association between the flight frequency of those passengers who have flown in the last 12 months and the knowledge of the correct location of the exits on the aircraft. The results strongly suggest that recent frequent fliers have a much better understanding of the exit locations than do recent infrequent fliers. ***More than four fifths (82%) of frequent fliers who have flown in the previous 12 months can locate the position of the three exit pairs.***

When asked if all the exits were the same size, only 45% (91) of the recent frequent fliers realised that the exits were not the same size, while only 31% (54) of the recent infrequent fliers knew. This suggests that over half the population of recent frequent fliers do not know that the exits are of different sizes. Furthermore, only 27% (53) of the recent frequent fliers could identify the three key configurational facts relating to; the number of exits, the location of the exits and that the central exits were smaller in size. This compared to only 18% (31) for the recent infrequent fliers. We find that this difference is statistically significant (χ^2 test, $X^2 = 4.61$) at the 5% confidence limit, thus there is a departure from the null hypothesis of no association between flight frequency of those passengers that have flown in the last 12 months and the knowledge of the number, location and size of the exits on the aircraft. The observed result of the recent frequent flyer is higher than its expected result, strongly suggesting that this type of flyer has a much better knowledge of the number, location and size of the exits on the aircraft.

Thus, simply having flown recently or simply being a frequent flyer does not in itself convey a better knowledge of the aircraft exit configuration and layout. However, being a recent frequent flyer does convey a better understanding of the aircraft exit configuration and layout. While being a recent frequent flyer conveys better knowledge of the aircraft exit configuration and layout, ***of great concern is the result that only a little more than a quarter of the recent frequent flier sub-population - 27% (53) - could correctly identify the number of exits, locate their position and identify their relative size*** (see Table 1). These results clearly indicate that even having flown recently and frequently does not mean that passengers will have a good configurational awareness of the aircraft.

When asked to estimate how much longer would it take to pass through the smaller over wing exit, approximately 62% correctly stated that it would take a little longer to pass through (up to twice as long). Approximately 13% thought it would take significantly longer (more than twice as long).

These responses were uniform across all groups of participants. Thus approximately 75% of the population correctly estimated that it take longer to pass through the smaller over wing exit. This suggests that three quarters of the entire population (74% or 340 participants) understood that the smaller exit meant a slower egress time through the exit. ***However, a quarter of the entire population (26% or 119 participants) thought that the smaller exit would allow them to pass through in approximately the same amount of time or quicker than the larger exit. This result appears to be independent of flyer experience.***

Not only does approximately three quarters of the sample population have a poor configurational awareness of the aircraft, a quarter of the sample population does not appreciate that the smaller exit will produce a slower egress rate. It is suggested that this lack of knowledge contributes to poor exiting decisions in aircraft accidents.

Participant exit selection decisions

Thus far we have demonstrated that the participant population had a poor understanding of the exit configuration and layout. In this part of the analysis we investigate the exit choices the participants would make under a variety of conditions (see Table 2).

When asked which exit they would select if they were alone on the aircraft and equi-distant between the forward (Type-C) exit and the central over wing (Type-III) exit, 72% (333) of the entire population (459) correctly selected the forward exit (see Table 2). This exit is the correct exit to select as it is the larger of the two exits and has a better exit flow rate. When the question was repeated for the central over wing (Type-III) and rear (Type-C) exits, a smaller proportion, 52% (239) correctly selected the rear exit. ***On average almost two fifths (38% or 346 taking both forward and aft exits) of the entire population elect to use the centrally located smaller over wing exit rather than the larger forward/rear (Type-C) exits.*** When we consider the sub-population with the most flying experience, the "recent frequent flyer" group, the percentage electing to use the over wing exit decreases slightly to one third (33% or 129). However, we find that this difference is not statistically significantly different (χ^2 test, $X^2 = 2.35$) supporting the null hypothesis that flyer experience does not make a difference in exit choice.

The question is then repeated but this time, eight people are shown to be queuing at each exit. The correct reply to this question is that the larger forward/aft (Type-C) exits should again be used, in fact there is an even greater compulsion to use the large exits as the queue will take some time to pass through the centrally located smaller (Type-III) exit. We find that even fewer people elect to use the forward (Type-C) exit (68% or 310) and slightly more people elect to use the rear (Type-C) exit (54% or 247). ***Even with a queue at each exit, on average, almost two fifths (39% or 361 taking both forward and aft exits) of the entire population again elect to use the centrally located smaller over wing exit. These results clearly demonstrate that a significant proportion – two fifths - of the general population do not correctly perceive that it will take them longer to exit via the smaller over wing exit.***

However, it should be recalled that a significant number of the population are not aware of the differences between the exits and the implications that these differences may have on exit performance. To test whether or not the participants would change their answers if they were presented with detailed information concerning the size and flow rate these questions were repeated progressively providing the participants with more information concerning the exit configurations.

Table 2: Participant exit selection for various sub-populations based on frequency of flight

Which exit would you use?	Entire Sample (459 people)	Sub-population – flown in the previous 12 months (367 people)	Sub-population – NOT flown in the previous 12 months (92 people)	Sub-population – frequent flyers who have flown in the previous 12 months (194 people)	Sub-population – infrequent flyers who have flown in the past 12 months (173 people)
A - Forward Type I empty	72% (333)	74% (270)	69% (63)	78% (152)	68% (118)
A – Forward Type I queue	68% (310)	69% (253)	62% (57)	73% (141)	65% (112)
Large – forward Type I empty	88% (402)	89% (327)	82% (75)	90% (175)	88% (152)
Large – forward Type I queue	90% (415)	91% (335)	87% (80)	92% (178)	91% (157)
Large fast – forward Type I empty	91% (420)	92% (338)	89% (82)	92% (179)	92% (159)
Large fast – forward Type I queue	93% (427)	93% (342)	91% (84)	96% (186)	90% (156)
C - Rear Type I empty	52% (239)	52% (190)	53% (49)	55% (107)	48% (83)
C – Rear Type I queue	54% (247)	55% (201)	50% (46)	58% (112)	51% (89)

When the population is informed that the forward and rear exits are larger than the over wing exit, the proportion electing to use the forward Type-C exit increases to 88% (402), and further increases to 90% (415) when there is a queue at each exit (see Table 2). The population is then informed that the larger exit is also faster than the smaller over wing exit. We now find that the proportion electing to use the forward Type-C exit increases to 91% (420) and further increases to 93% (427) when there is a queue present at each exit. When compared with the case where the participants are given no additional configuration information, we find that the proportion of participants selecting the larger exit is statistically significantly different (χ^2 test, $X^2 = 44.35$) at the 0.0000005% confidence limit, thus there is a very strong departure from the null hypothesis that providing additional exit configuration and performance information does not result in better exit selection. ***These results clearly show that the participants are capable of making an appropriate choice if they are provided with the appropriate configurational and exit performance information.***

All flight experience groups, produce similar results, suggesting even recent frequent flyers make significantly better decisions if they are provided with appropriate exit configuration and performance information. To better address the question of level of prior knowledge, the exit selection analysis was repeated with the analysis focusing on level of configuational knowledge rather than flight experience (see Table 3).

In Table 3 we present the breakdown of the exit choice decisions for the entire population (459), the sub-population with complete exit knowledge i.e. with knowledge of the number, location and sizes of the exits (99) and the sub-population with incomplete exit knowledge i.e. at least aspect of exit number, location or size unknown (360). We note from Table 3 that the sub-population with incomplete exit knowledge make similar exit choice decisions to those of the entire population while the exit choice decisions of those with complete exit knowledge appear to be different to those with incomplete exit knowledge.

Table 3: Participant exit selection for various sub-populations based on configurational knowledge

Which exit would you use?	Entire Sample (459 people)	Entire sample complete configurational knowledge (99 people)	Entire sample incomplete configurational knowledge (360 people)
A - Forward Type I empty	72% (333)	78% (79)	71% (254)
A – Forward Type I people	68% (310)	78% (77)	65% (233)
Large – forward Type I empty	88% (402)	87% (86)	88% (316)
Large – forward Type I people	90% (415)	91% (90)	90% (325)
Large fast – forward Type I empty	91% (420)	94% (93)	91% (327)
Large fast – forward Type I people	93% (427)	95% (94)	92% (332)
C - Rear Type I empty	52% (239)	71% (70)	47% (169)
C – Rear Type I people	54% (247)	73% (72)	49% (175)

When asked which exit they would select if they were alone on the aircraft and equi-distant between the forward (Type-C) exit and the central over wing (Type-III) exit, 78% (79) of the sub-population with complete exit knowledge (99) correctly selected the forward exit (see Table 3). When the question was repeated for the central over wing (Type-III) and rear (Type-C) exits, a slightly smaller proportion, 71% (70) correctly selected the rear exit. ***On average almost one quarter (24% or 24) of the population with complete exit knowledge elect to use the centrally located smaller over wing exit***

rather than the larger forward/rear (Type-C) exits. When we compare the responses of the sub-population with incomplete exit knowledge with the sub-population with complete exit knowledge, we find the difference is statistically significantly different (χ^2 test, $X^2 = 9.54$) at the 0.5% confidence limit, thus there is a strong departure from the null hypothesis that there is no association between complete/incomplete exit knowledge and correct exit selection. Results suggest that having complete exit knowledge appears to result in significantly better exit selection.

The question is then repeated but this time, eight people are shown to be queuing at each exit. We find that the same number of people elect to use the forward (Type-C) exit (78% or 77) and slightly more people elect to use the rear (Type-C) exit (73% or 72). ***Even with a queue at each exit, on average, one quarter (25% or 25) of the sub-population with complete exit knowledge elect to use the centrally located smaller over wing exit. These results clearly demonstrate that a significant proportion – one quarter - of the sub-population with complete exit knowledge do not correctly perceive that it will take them longer to exit via the smaller over wing exit***

When the sub-population with complete exit knowledge is informed that the forward and rear exits are larger than the over wing exit, the proportion electing to use the forward Type-C exit increases to 87% (86), and further increases to 91% (90) when there is a queue at each exit (see Table 3). The population is then informed that the larger exit is also faster than the smaller over wing exit. We now find that the proportion electing to use the forward Type-C exit increases to 94% (93) and further increases to 95% (94) when there is a queue present at each exit. When we compare the case where the participants are given no additional configuration information with the case where the participants are given complete configurational information for the sub-population who have complete exit knowledge, we find that the proportion of participants selecting the larger exit is statistically significantly different (χ^2 test, $X^2 = 8.68$) at the 0.5% confidence limit, thus there is a strong departure from the null hypothesis that providing additional exit configuration and performance information does not result in better exit selection, even for the sub-population that has complete exit knowledge.

These results clearly demonstrate that even participants with a good knowledge of the exit configuration are capable of making a more appropriate exit choice if they are provided with configurational and exit performance information.

DISCUSSION

The main findings of this work can be summarised as follows. Regarding participant knowledge of the aircraft exit configuration:

- Just under a quarter - 23% (84) – of the sub-population, "people who had flown in the previous 12 months", had good understanding of the aircraft exit layout and configuration i.e. knew the number, location and relative sizes of the three exit pairs.
- Having flown recently (within the previous 12 months) does not imply a better understanding of the aircraft exit layout and configuration when compared with those who have not flown recently.
- Being a recent frequent flyer does imply a significantly better understanding of the aircraft exit layout and configuration when compared with being a recent infrequent flyer.
- However, just over a quarter - 27% (53) - of the sub-population, "people who have flown recently who are also frequent flyers", knew the number, location and relative sizes of the three exit pairs.

These results are of great concern as they suggest that of the most experienced fliers (recent frequent fliers) a little more than a quarter understand the aircraft exit layout and configuration prior to boarding. This inherent lack of exit knowledge is likely to have a negative impact on overall evacuation efficiency and hence passenger safety. From a general view of aircraft passenger safety,

it is suggested that the pre-flight safety briefing should more strongly emphasise the location and type of exits available on the aircraft. Furthermore, rather than simply point out the location of the exits on board, the affordance of the exits should be enhanced, perhaps through lighting systems that could be used to emphasise the location of the exits to seated passengers. For example, a halo of lights could be used to surround the exit frame and in addition, an arch of lighting could be placed in the aisle perpendicular to the exit plane. In addition, these results clearly demonstrate that even the frequent flier community – who have a tendency to ignore pre-flight briefings because of their perceived "experience" and "knowledge" – lack a detailed understanding of the exit configuration on board aircraft. The pre-flight briefing should emphasise that even frequent flyers do not fully appreciate the nature of the exit configurations and so they should take note of the briefing. Finally, the safety cards used on board aircraft should focus on emphasising the location and type of exits available on board the aircraft.

From an evacuation modelling view, these results are extremely important as they suggest that the majority of passengers (approximately 75%) have poor inherent exit knowledge. Agent based decision models used to select which exit an agent may decide to use must reflect this lack of inherent exit knowledge. Factors such as opportunistically "seeing" an exit, following the crowd, following instructions or simply going to the nearest exit may be appropriate drivers for the majority of passengers/agents.

Regarding participant exit choice:

- On average two fifths – 39% (361) – of the entire population (459) would elect to use the centrally located smaller over wing exit rather than the larger forward/rear exits, even when faced with a queue at each exit.
- Being a recent frequent flyer – the most experienced sub-population – does not statistically significantly alter this decision.
- When provided with complete exit information (size and flow rate), less than one tenth – 7% (32) – of the entire population elect to use the centrally located smaller over wing exit rather than the larger forward exit, even when faced with a queue at each exit.
- On average one quarter – 25% (25) – of the sub-population (99) with complete exit knowledge would elect to use the centrally located smaller over wing exit rather than the larger forward/rear exits, even when faced with a queue at each exit.
- Having complete exit knowledge does statistically significantly alter the decision to use the centrally located smaller over wing exit.
- Providing the sub-population "with the best exit knowledge" with information relating to the size and flow rate capability of the exits resulted in only a twentieth – 5% (5) - of the sub-population electing to use the centrally located smaller over wing exit rather than the larger forward exit, even when faced with a queue at each exit.

These results are of great concern as they suggest that irrespective of participant flight experience, two fifths (39% or 361) of the participants would elect to use a sub-optimal exit. This high number of participants electing to utilise the over wing exit supports the observation from real accidents that a significantly high number of participants elect to utilise the over wing exit. Perhaps of greater surprise, a quarter (25% or 25) of the sub-population that demonstrated complete knowledge of the aircraft exit layout and configuration also elected to use a sub-optimal exit. ***However, it was shown that by providing the participants with complete knowledge of the size and performance capabilities of the exits, the proportion making sub-optimal exit decisions could be reduced to less than one tenth (7% or 32) of the population.*** A similar result was found even for the knowledgeable sub-population. When this sub-population was provided with additional information relating to the exit size and performance capabilities, the proportion electing to use the sub-optimal exit fell to only one twentieth (5% or 5) of the sub-population.

These findings support the hypothesis that poor understanding of cabin layout is a contributory factor to sub-optimal exit selection decisions made by passengers in emergency situations. Furthermore, the results demonstrate that providing participants – even apparently knowledgeable participants – with additional information concerning the size and flow capabilities of the exits greatly improves the exit selection capabilities of the participants. Even providing information simply related to the relative size of the exits significantly improves exit selection capabilities. These observations support the earlier suggestion of improving the nature of the pre-flight briefing, the affordance of exits and the safety cards provided on aircraft. From an evacuation modelling perspective, these results suggest that as many as 39% of passengers will make sub-optimal exit selection decisions. It is suggested that these poor exit decisions are due to poor understanding of the exit layout and performance capabilities. It is further suggested that these factors should be taken into consideration when developing agent decision models concerned with identifying which exit to use.

CONCLUSIONS

The results from this survey suggest that even the most experienced fliers - recent frequent fliers – have little inherent understanding of aircraft exit configuration – only 27% (53) correctly knew the number, location and relative sizes of exits on narrow body aircraft. Furthermore, irrespective of flight experience, a substantial number (39% or 361 considering both forward and aft exits) of participants would elect to use a sub-optimal exit in the event of an emergency evacuation. It was shown that by providing participants with good knowledge of the exit layout, involving location, relative size and performance of the exits, the proportion making sub-optimal exit decisions could be dramatically reduced (to 7% or 32). These results have important safety implications for airlines and the nature of the pre-flight briefing and to evacuation model developers.

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