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ARTICLE

ASSESSMENT OF AIRCRAFT PASSENGERS' COMFORT WITH VARYING SEAT PITCH

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Abstract: In-flight comfort has become an important issue among aircraft passengers. Over the years, the seat pitch used in the passenger cabin has been gradually reduced, which is believed to be the main source of in-flight discomfort among the passengers. A sitting comfort experiment is conducted in this study using available aircraft cabin mock-up at the Aerospace Design Simulation Laboratory, Universiti Putra Malaysia, Malaysia. 30 volunteers participated in the experiment whereby they assigned their level of sitting comfort for five different seat pitch arrangements: 66.04 cm (26 in.), 73.66 cm (29 in.), 81.28 cm (32 in.), 88.90 cm (35 in.) and also 96.52 cm (38 in.). Their sitting comfort rating is assigned using the standard 5-point Likert scale and the collected data is then statistically analyzed using the MINITAB software. From the conducted statistical analysis, it is concluded that the seat pitch setting has a very significant effect on the passengers' in-flight sitting comfort.

Keywords: seat pitch; flight comfort; statistical analysis; aircraft cabin; sitting comfort

1. Introduction

Air transportation industry is progressively growing worldwide over the years as more people are using aircraft as their selected travel option. This situation also increases the level of market competition between airlines since air travelers are now provided with plethora of air travel services to choose from. The quality of offered services by the airlines has been indicated as the key consideration by passengers in their travel selection, which ultimately becomes the critical competitive factor for the airlines [1]-[2]. In general, a good quality flight service is often taken as the one that fulfills the needs and/or expectancy of the passengers [3]. Among the factors that directly contribute towards passengers' perception on the quality level of flight services provided by the airlines, in-flight comfort is one of the important criteria. As indicated in Ref. [4], in-flight sitting comfort is a key element for in-flight service quality. Therefore, it is imperative for airlines to ensure that their aircraft cabin is capable to provide adequate comfort for their passengers throughout the flight trip.

In general, comfort is defined as the pleasant state or relaxed feeling of the human body in response to the surrounding physical environment while discomfort is the opposite unpleasant feeling [5]. It has also been argued that comfort and discomfort are separate sensations, which indicates that the absence of discomfort does not necessarily mean comfort [6]. To date, many complaints of in-flight discomforts by passengers can be attributed to limited legroom available at their seat, which is directly linked to the setting of the cabin seat pitch. From ergonomists' point of view, seat pitch is a critical comfort element in aircraft cabin design as it influences the easiness of passengers adopting a comfortable sitting posture during flight [7]. As depicted in Figure 1, seat pitch is a measure of the distance between one point of the seat to the exact same point of the seat in front or behind it. These days, airlines usually reduce the cabin seat pitch of their aircraft to further accommodate more passengers inside the cabin per flight in order to maintain profitability amid rising flight operation costs. It can be observed that the aircraft seat pitch, particularly in the economy class seating arrangements, has been gradually reduced over the years.

For instance, the seat pitch for many American airlines used to be around 78.74 to 88.90 cm (31 to 35 in.) in the 1970s and that has generally reduced to only 71.12 cm (28 in.) in most of these airlines today [8]. A smaller seat pitch subsequently means much lower legroom available for passengers at their seat, contributing to their discomfort feeling during flight.

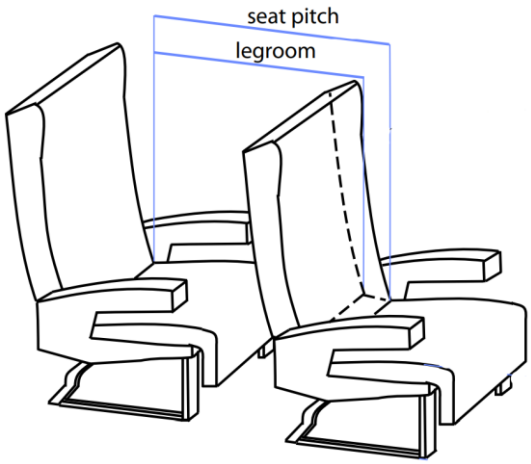

Figure 1: Seat pitch and legroom measurement [9]

With increasing importance of passengers' in-flight comfort toward the market competitiveness of offered flight services, it is thus necessary for airlines to strike a balance between operational profitability and perception of their service quality by their passengers. Among others, this means that the seat pitch in their passenger cabin seating arrangement has to be set by also considering the passengers' comfort. In view of this, the study presented in this paper aims to assess the underlying relationship between in-flight comfort and seat pitch, with a focus on Malaysian population. By understanding this relationship, airlines can better design their aircraft cabin arrangements such that their passengers are provided with adequate level of flight comfort.

2. Methodology

An aircraft sitting comfort experiment is conducted using a cabin mock-up available in Aerospace Design and Simulation Laboratory, Universiti Putra Malaysia. The cabin mock-up is as shown in Figure 2. Voluntary participants for the experiment are contacted through promotional 'call for participants' postings on several social media outlets such as WhatsApp and Facebook. The main selection criteria for the participants include that they must be Malaysian citizen and must have previous experiences in using commercial flight services prior to the experiment. Overall, among all of the responses received, 30 volunteers have been down selected and invited to participate in the experiment.

For the comfort sitting experiment, the participants are asked to individually sit in the aircraft cabin mock-up, one at a time. Each participant sat through five different parts of the experiment where the seat pitch is adjusted at the end of each part, from 66.04 cm to 96.52 cm (26 in. to 38 in.) Assessment of their perceived comfort level in each part of the experiment, hence the comfort of sitting at several different seat pitch settings, is provided by participants at the end of each part. This assessment is done using a prepared comfort survey that is adopted from another study in Ref. [10]. However, considering the differences between how the sitting comfort experiment is conducted in this study and the reference study, only the elements tabulated in Table 1 are included into the comfort assessment survey. In the meantime, standard 5-point Likert scale rating shown in Table 2 is applied in the assessment. It is noted that comfort assessment is also often associated with activity-based evaluation. However, for this study, the aim is to mainly have a general comfort assessment and thus the participants are given the freedom

to conduct whatever activities that they wanted during the sitting experiment. This means that the rating that they provided is of general aspect in terms of their overall feeling and is not associated with any specific in-flight activities such as eating or using a laptop.

Figure 2: Aircraft cabin mock-up used in this study

Table 1: Assessment elements of in-flight sitting comfort (adopted from [10])

Comfort Assessment Categories	Survey Elements
Postural Sensation	• I can easily adopt a comfortable sitting posture • I can easily change from one sitting posture to another
Spatial Perception	• I don't feel restricted • I don't feel restricted by the distance of the seating row • I don't feel like sitting in front of a wall
Privacy	• I don't feel lost because of the distance of the seating row
Present Mood	• I don't feel stressed out because of the distance of the seating row

Table 2: Likert scale for comfort assessment

Rating	Description
1	• I strongly disagree with the statement
2	• I disagree with the statement
3	• I feel neutral with the statement
4	• I agree with the statement
5	• I strongly agree with the statement

3. Results and Discussion

Table 3 presents descriptive statistics of the obtained results from the sitting comfort experiment. In addition, using the collected experimental data, correlation analysis between seat pitch and comfort assessment criteria is conducted using statistical software, MINITAB. Correlation analysis is a standard statistical method that is used to study the strength of relationship between two variables or parameters [11]. In this study, it is of high interest to observe the strength of influence of seat pitch on the comfort of passengers, which is reflected by its relationship to the different aspects of comfort assessment. The results of correlation analysis are tabulated in Table 4, which shows the Pearson correlation coefficient that measures the strength of the linear relationship between the seat pitch and the comfort rating.

Table 3: Average comfort ratings

Comfort Assessment Categories	**Seat Pitch (in cm)**				
	66.04	**73.66**	**81.28**	**88.90**	**96.52**
Postural Sensation	1.40	2.63	4.07	4.57	4.85
Spatial Perception	1.27	2.30	3.20	4.09	4.24
Privacy	4.43	4.03	3.73	2.97	2.80
Present Mood	1.33	2.33	3.23	3.97	4.47

Table 4: Correlation analysis between seat pitch and comfort assessment

Comfort Assessment Categories	**Assessment Elements**	**Correlation Coefficient with Seat Pitch**
Postural Sensation	I can easily adopt a comfortable sitting posture	0.824
	I can easily change from one sitting posture to another	0.850
Spatial Perception	I don't feel restricted	0.832
	I don't feel restricted by distance of seating row	0.703
	I don't feel like sitting in front of a wall	0.747
Privacy	I don't feel lost with distance of seating row	-0.476
Present Mood	I don't feel stressed out with distance of seating row	0.802

It can be seen from Table 3 that average comfort ratings for postural sensation, spatial perception and present mood appear to monotonously increase with increasing seat pitch. In contrast, for privacy, its comfort rating appears to decrease with the increasing seat pitch. As the seat pitch is increased, the available legroom has also increases. During the experiment, with increased legroom, it can be observed that the participants could easily adopt their own preferred sitting postures and this has made them felt more comfortable. Furthermore, as the distance between the rows becomes larger, the participants also felt more unrestricted by their limited seating space, particularly since the back of seat in front of them was not too close on their face. This situation apparently also helped to improve on their present mood as reflected by the trend of the assigned comfort rating with seat pitch for this assessment category. On contrary, having a small seat pitch seems to allow more privacy for the participants at their seat. As the distance between the rows becomes larger, the level of privacy also diminishes since there is now more available room or space at their seat. This allows a higher probability that other passengers can invade their personal space at their seat and also makes the passengers feel more exposed. All in all, based on the presented ratings in Table 3, it can be taken that the best compromise is probably at a seat pitch of

32 inches where all of the assigned ratings for each of the comfort assessment elements are all above 3, which is at acceptable or neutral level.

From the resultant correlation coefficient tabulated in Table 4, it can be taken that the relationship of seat pitch and comfort is highly correlated. This means that the setting of the seat pitch can greatly influence the passengers' comfort from several different aspects. The positive correlation coefficient is indicating that the relationship is in tandem or in the same direction, i.e. increasing seat pitch will also increase the level of comfort in that aspect. This situation is true for all elements of postural sensation, spatial perception and also present mood, which are in line with the observed trend of assigned comfort rating in Table 3. In the meantime, parallel to the opposite trend that is observed in Table 3 for privacy assessment, the correlation coefficient between seat pitch and privacy is negative. Furthermore, value of the coefficient is also relatively low, meaning that the assigned comfort rating by participants in this aspect at each seat pitch setting was rather inconsistent to each other. This can be taken to indicate that the participants may have fairly different ideas of privacy. While increasing seat pitch generally reduces their sense of privacy, the perceived effects on their sitting comfort were considerably at different levels. More discussion on the possibly subjective and personal nature of this passengers' comfort assessment can also be found in Ref. [12].

4. Conclusion

Passengers' comfort today has become a great competitive service factor between airlines and it is therefore important for airlines to be able to provide adequate comfort level to their passengers during flight. The findings in this study has shown that the setting of the cabin seat pitch has a great impact to the level of sitting comfort to the passengers, which is reflected by the high value correlation coefficient. A higher seat pitch will improve postural sensation, spatial perception and present mood of passengers, though it might also reduce their perception of privacy level. A compromise may need to be considered and in this study, the seat pitch of 81.28 cm (32 in.) could be taken to obtain a favorable comfort rating simultaneously for all assessment criteria. As an initial study to highlight the significant influence of seat pitch towards the aircraft passengers' comfort, this objective has been successfully achieved. However, moving forward, more detailed study should be conducted to appropriately establish and estimate the effects of seat pitch on the passengers' comfort level, especially by also including other comfort factors such as passengers' anthropometric measures into account.

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