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Economy Class Passenger Seat Design Concept for Flights in Indonesia

Erwin Nurrizki [1], Agus Edy Pramono [2,*]

[1] Magister Program in Applied Manufacturing Technology Engineering, Politeknik Negeri Jakarta, Jl. Siwabessy, Kampus UI, Depok 16425, Jawa Barat, Indonesia
* Correspondence: agus.edypramono@mesin.pnj.ac.id

Abstract: Aircraft seat bench concept is designed with three adjustment points—armrests, backrest, and the middle of the backrest—and is equipped with a headrest to support the passenger's head and neck comfort. These features aim to enhance passenger comfort without limiting the movement space of neighboring passengers, which is often a concern in conventional aircraft seat designs. To reduce production costs and maintain efficiency, the materials used are commonly available in the market. The seat frame is made of lightweight yet strong aluminum, the seat cushion and backrest utilize polyurethane (PU) foam for comfort, and the outer covering uses synthetic leather, which is affordable yet visually appealing. This material selection facilitates mass production and simplifies maintenance. Structural testing using Autodesk Inventor software indicates that the design is safe for use, achieving a safety factor of 3.62, which signifies strong resistance to stress and load during usage.

Keywords: Aircraft Chair, Economy Class, MSDs, Adjustable chair.

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1. Introduction

This design is motivated by the need to improve passenger comfort, especially in economy class which generally has the lowest comfort compared to business class or first class[1]. Economy class passengers often experience discomfort when sleeping during the trip, which not only affects the quality of sleep, but also has the potential to cause disorders of the muscular and skeletal systems (Musculoskeletal Disorders/MSDs). In addition, the position of the head that does not lean properly can disturb other passengers around it. Therefore, redesigning economy class airplane seats by considering ergonomic and comfort aspects is urgently needed.

From this background, the idea emerged to design a more ergonomic and comfortable economy class airplane seat, especially when passengers are in a sleeping position. This design will also allow adjustments to several parts of the seat, such as the headrest and body tilt angle, without disturbing the space of other passengers behind it.

The problems that need to be solved through this design include the need for a new seat design that can improve passenger comfort, the need for an adjustable headrest to reduce the risk of MSDs[2], and a mechanism for adjusting the passenger's body position while sleeping so that it remains comfortable without sacrificing limited cabin space.

The design concept of this chair combines comfort and ergonomics, with the use of materials that are specifically selected to support these functions. The chair frame will be made of strong but lightweight aluminum and composite materials. The seat cushions will use polyurethane foam for comfort, while the outer layer will use synthetic leather that is durable and easy to clean. The structure of the headrest will be made of strong but flexible polycarbonate material to allow for adjustment of the passenger's head position.

Overall, the goal of this design is to create an economy class airplane seat that is not only comfortable to use on long-distance trips, but also able to reduce the possibility of injury or muscle tension due to non-ergonomic sitting or sleeping positions. With the adjuster feature on the backrest and headrest, this chair is expected to provide a more comfortable flying experience for economy class passengers without sacrificing space efficiency in the aircraft cabin.

In previous research, the layout of the aircraft cabin is characterized by the arrangement of components for entertainment or media, for example, the arrangement of monitors, speakers, or control facilities. Arrangement of communication facilities for cabin crew or passengers, Display of navigation data on the monitor for passenger information[3].

Aircraft seat designed with a rail base that allows fore-and-aft movement on the cabin floor rails. Above it is an adjustable seat and backrest, with pivot joints allowing free movement in all directions. The seat is also equipped with adjustable armrests, and an adjustment system for raising or lowering the seat, adjusting the curvature and vertical position of the backrest. All adjustments can be controlled via a panel in the armrest[4].

Next is a passenger seat recline mechanism that includes a fixed seat frame member supporting a pivot axis around which there is a seatback joint and a tray table joint that rotate independently, a seatback pivotally connected to the seatback joint such that the seatback joint rotates forward when the seatback is reclined, and a tray table leg pivotally connected to the tray table joint such that the tray table joint rotates together with the seatback joint when the tray table leg is stowed and rotates independently of the seatback joint when the tray table leg is deployed[5].

2. Materials and Experiment Methods

The design of the economy class airplane seat that has been drafted each has the following specifications:

A. Frame : Aluminum and composite
B. Seat foam : Polyurethane Foam
C. Seat upholstery : Synthetic Leather
D. Headrest structure : Polycarbonate

The reason for choosing these materials is to minimize the budget for making the chair, with common materials available on the market so that it can be considered so that this concept can be continued to the production stage.

The design was analyzed using Autodesk Inventor and Autocad software using the Rapid Upper Limb Assessment (RULA) method to assess ergonomic risks to the upper body. The design was then simulated to measure its performance and comfort. The results of this simulation process form the basis for compiling conclusions and suggestions, which summarize the research results and provide recommendations for further development.

The research begins with observation to understand the initial conditions of the aircraft passenger seat design[6]. After that, problem identification is carried out to find the main issues that need to be addressed in design development. A literature study is then conducted to obtain relevant scientific and technical foundations. Furthermore, data is collected quantitatively and qualitatively to dig deeper into information about passenger needs and comfort. The data obtained is used to analyze passenger sitting postures[7], which are very important in understanding the effect of sitting position on comfort and health, especially on long-haul flights. Based on the results of the analysis, CAD software[8] and the Rapid Upper Limb Assessment (RULA)[9] method will be implemented to assess ergonomic risks to the upper body.

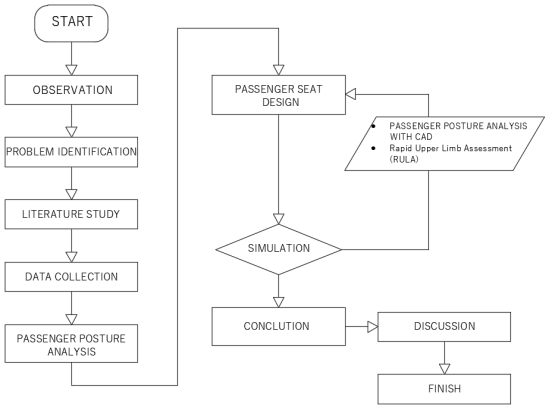

Figure 1. Design Diagram

3. Results and Discussion

3.1. Posture Analysis

Based on the search results regarding the standard airplane seat and comparison with data from one of the Indonesian airlines[10], there is a discrepancy because the author has not found the SNI standard for airplane seats for the Indonesian region, therefore the size of the seat will be adjusted to the reality in the field according to one of the airlines in Indonesia. The following is an ergonomic analysis of the seat. The seat design that is made is simulated with the human position in several conditions.

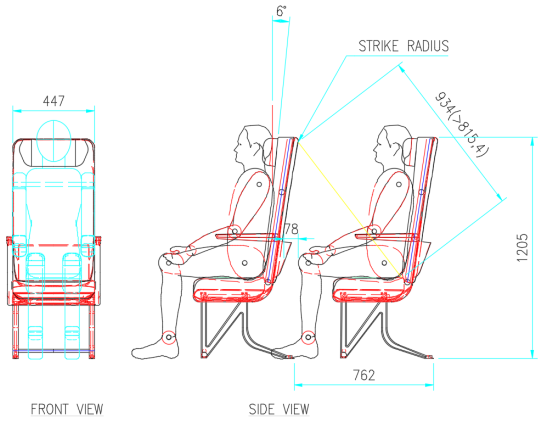

Figure 2. Passenger position when initial conditions, take off, landing, and turbulence

In this position, it can be seen that the passenger is in a comfortable position and the distance between the knee and the front seat is 78 mm, so that the legs still have room to move, then it will be shown when the passenger wants to adjust his sitting position.

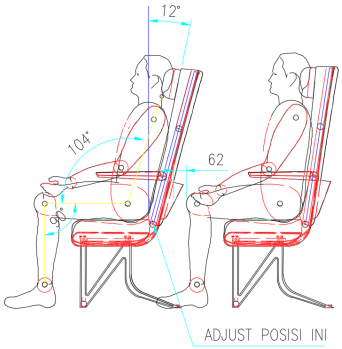

Figure 3. Passenger position when adjusting the seat back

In this position, the passenger angle increases by 6º so that the reclining position can be more comfortable, while the distance between the rear passenger's legs is reduced to 62 mm so that there is still room for the rear passenger to move. Then for the next time when the passenger wants a wider angle, they can adjust the middle part of the backrest

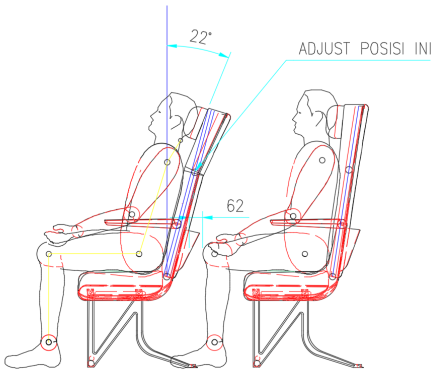

Figure 4. Passenger position when adjusting the middle backrest of the chair

In this position, when the passenger wants to sleep, they can also adjust the headrest to increase comfort, and not disturb the passenger next to them, because sometimes the sleeping passenger will lean against the passenger next to them.

3.2. Load Analysis

The chair was tested for loading assuming a maximum passenger load of 100 kg (1000 N) on the seat base, and a backrest weight of 20 kg (200 N), using Autodesk Inventor software. The following are the test results with the software:

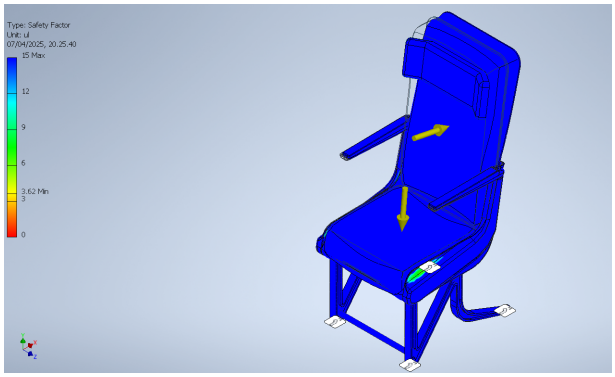

Figure 5. Safety factor test results

A safety factor of 3.62 was obtained, which means it is very safe for passengers because it can be assumed to be able to withstand a load of up to 3.62 times the test load.

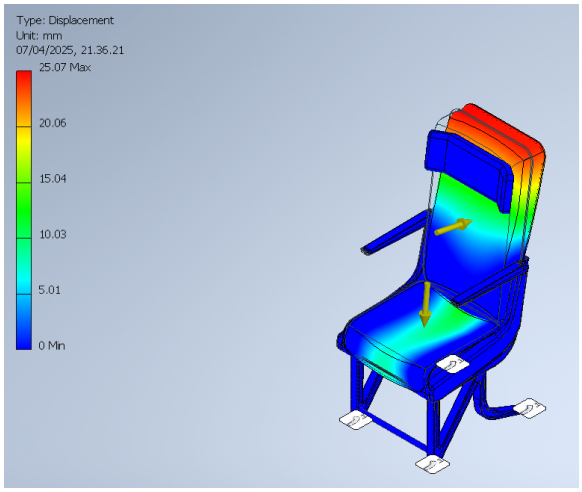

Figure 6. Displacement test results

The displacement that occurred the furthest on the seat back was 25 mm, this is common because the seat must have high deflection to increase passenger comfort.

4. Conclusions

The concept of an airplane seat using 3 adjuster points (armrest, backrest, and middle backrest) and the addition of a headrest can optimize passenger comfort without disturbing other passengers. In this case, to reduce the production budget, the materials used are only common materials on the market such as aluminum frames, PU foam, and synthetic leather can be the solution.

The test results using Autodesk Inventor software show that the design concept is safe to use with a safety factor value of 3.62. In the future, because this is only a concept, R&D is still needed if this will be continued into a product, because it is necessary to test the finished product against the response from correspondence and a feasibility test to be made into a product in accordance with applicable regulations.

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