Passenger interior cabin design of executive mobile meeting microbus

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Abstract

The passenger interior cabin of Executive Mobile Meeting (EMM) microbus has been designed with the concept that not only as a passengers transportation, but also intended to held a meeting or gathering in mobile activities. The existence of EMM microbus is the development of the first LIPI electric microbus prototype that has been made previously. The user target of this vehicle is an officer or leader of a company or institution. The interior concept is different than the interior concept of the common passenger microbus. The capacity is reduced from 15 passengers to only 8-10 passengers. Thus, it needs the appropriate image and form of interior design to fulfill the passenger function and requirement based on the activities performed. The image design also creates the impression that represents the user of EMM microbus. The initial process of interior design was started by determining the design concept and interior dimensions of EMM microbus. There are some possibilities of seating configuration that can be applied into the interior. The best seating configuration is obtained by accessing some parameters. Based on the chosen configuration, the process continues to the phase of the interior layout study of main component and sub-component. Furthermore, detailed design of each main component was conducted. The final result of the process is the integrated design which is used as a reference for the process of making the research prototype.

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1. Introduction

The research on LIPI electric microbus has initially begun since 2011. The research have resulted a research-prototype of electric microbus for passenger transportation with the capacity of 15 passengers. The passenger seating layout consists of 2 passengers in the driver area and 13 passengers in rear/passenger cabin. The first microbus prototype and its seating configuration layout can be seen in figure 1. This type of vehicle is being used as a reference platform for further development.

Fig 1. The first prototype of LIPI electric microbus for passenger transportation and the seating layout.

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In today’s fast moving business world employees who spend much of their working day out on the road often need, or are expected, to do office work in their car [1]. At 2012, based on the initial microbus in figure 1, there was a development in vehicle function to be a mobile meeting transportation. The Electric Mobile Meeting (EMM) microbus will be used by executives, leaders of a company or institution for conducting a meeting or conference while in a journey to the destination point. The existence of EMM Microbus is because of the needs of work activities while being trapped on huge traffic congestion as it is always happened in the big cities of Indonesia. At that condition, the passengers usually do nothing, so a lot of time will be wasted and useless. With the existence of EMM microbus, the passenger is expected to utilize the traffic condition to do the working activities effectively.

The EMM microbus design refers to the platform of first microbus. The available dimension of passenger interior of first microbus is 4100 mm length, and 1500 mm width. The passenger seat of the first microbus is facing to the front. Since it was going to be applied to EMM microbus, it should be a change of the passenger seating layout and the interior dimension to accommodate the passenger activities and vehicle function.

The design focus of the EMM microbus is on the passenger interior. The interior layout is arranged to accommodate the conference or meeting activities. Meeting or conference place typically have a multi-media audio-visual system, with seats and tables oriented so that people can easily interact each other [2]. Conference rooms provide a comfortable place to present information and share knowledge with team members, colleagues, clients and visitors [3]. A workstation is a place designed for a specific task or activity from where work is conducted or operations are directed [4]. All of the requirement should be provided on the EMM bus to gain the convenient passenger area.

The paper discusses about the process of designing the interior cabin of EMM microbus. The process is focused on design concept, dimension of passenger cabin, layout and interior design of EMM microbus by analyzing passenger’s activities as a passenger and a meeting participant. The result of components layout is used as a reference for design phase.

2. Method

Determining the design concept is the first step conducted on the process. The outputs are the identification of functions, activities, user requirements, facilities and image design. The result of the identification is used as a reference for the study of the component layout and creating the image impression based on the user.

In the phase of determining the interior dimensions, there are three seating configuration possibilities. Anthropometric analysis is conducted to determine the appropriate configuration that can be applied to the existing interior. The result shows that only two seat configuration possibilities that can be applied to the interior. Next, to choose the best seating configuration, there are five parameters to be assessed. Each parameter has different value and point. The alternative with the biggest total percentage is used for the seating configuration of EMM Microbus.

Furthermore, there is a determination of product components that divided into categories of main component and sub-component. The main components accommodate the sub-components that are attached to it. The selected layout of main component is used as a reference for the layout of sub-components. There are two types of components according to the activities, which are individual and group activity. The individual and group activities generate the individual and group components respectively.

The interior design process is started after the interior layout is determined. For further development, the process used CAD as a computer modeling. Also in the detailed design stage, where a real-size physical model is made, the final appearance of a car is fixed, and its CAD model is generated, all the operations are done in consideration of accurate dimensions [5]. Working directly in CAD from initial concept sketches allows the designer to engage at an early stage with the three-dimensional characteristics of design [6]. 3-dimensional (3D) digital modeling is used to analyze the 3D form earlier in computer [7].

The result of main and sub-components layout study are analyzed and designed on Rhinoceros as 3-D CAD software. The digital design is useful for earlier identification of seeing the product in 3-D. It is also useful for product prototyping process. Next, the step of design integration is conducted from the main components design. The step is conducted with some design constraints. The design is also apply the image impression of the product. The integration process caused some design adjustment of main component, so it could be integrated each other. There is a creation process involving the accessories addition in interior design until it forms into the expected design. The prototype of EMM microbus interior is made by referring the result of 3-D digital design that made before.

3. Design Process

3.1. Design concept analysis

Design concept is made as a reference, summary of a number of statements that come from the conclusions resulting from the implementation process of the analysis that has been made before [8]. The interior concept of passenger area is to
accommodate meeting or conference activities during the journey on the vehicle into the destination place. For that, the passenger will utilize the available journey time effectively. The user of this vehicle is the executive of company or institution. Hence, the design and the features should impress the executive class and luxurious. Convenience is one factor that should be present in the luxurious concept. Thus, to gain the comfort of passenger movement, the passenger capacity is reduced from 15 passengers to 8-10 passengers.

There are two types of activity exist on the vehicle. The first activity is the main activities or group activities related to the function of the EMM Bus. The types of activities are the activities of conference or meeting. Almost all group activities are related to communication, for example a form of communication between passengers or to communicate something from a presentation media. The second activities are individual activities such as entertainment and leisure activities that are considered as the general activities of a passenger in the vehicle. All activities did in the vehicle include other sub activities therein.

Based on the activities, the requirement and facility are made to obtain the product component [9]. The interior main facilities are the seating, storage, and multi-media audio-visual system. Based on 3 main facilities, it is elaborated into detail components including accessories of each facility.

The aesthetic of design is considered important to visualize the design idea. The image that is applied based on the user type. Elegant-luxurious impression plays the role to form the future interior image. It is important to attract the occupant by serving the aesthetic aspect based on familiarity. At the same time, people have always been attracted by new, unfamiliar, and original things, partly to overcome boredom and saturation [10].

3.2. Interior dimensions

Considering the passenger cabin as a workplace, there are some general actions to be anticipated, such as reach, sight, placement of product, and body position [11]. Determining the seating configuration is based on the available interior dimension and ergonomics guidance [11, 12]. According to the Indonesian regulation of vehicle [13], the maximum width of medium bus is 2100 mm or not exceeded the maximum base dimension.

The seat type used in the interior is sofa or couch type. According to Panero [14], based on 95th percentile data, the maximum body breadth dimension is 57.9 cm, with a nude subject. Allowing for clothing and some body movement as well as change in posture and position, a minimum dimension of 71.1 cm is suggested as a width allowance for a seated person. It means that for 3 and 4 seated sofa, the minimum dimensions of sofa are 213.3 and 284.4 cm respectively. Using the buttock-popliteal length of the smaller person and adding a similar allowance of 15.2 to 22.9 cm, for the backrest construction a minimum zone in front of the sofa for foot movement, an overall depth dimension of 106.7 to 121.9cm is suggested. Without adding a backrest construction of 22.9 cm, the depth dimension of 83.8 to 99 cm is a minimum dimension, while Woodson recommends seat depth of 48.3 cm for a minimum dimension. For the seat height, Woodson [15] prefers 43.2cm with the range of 40-46 cm. Openshaw and Taylor [11] and Tilley [16] recommend that minimum seat height including shoe allowance is 38.1cm. Considering 95th shoulder breadth of 52.6 cm [14], the maximum seat width provided each for the EMM microbus is 56 cm.

There are three alternative possibilities of seating configuration that can be applied for this type of interior. The first is the face-to-face configuration with the position of monitor in the front. The second is the L-shape configuration with the position of the monitor also in the front. The third is U-shape configuration with the monitor position on the side of the vehicle. The three alternatives of seating configuration can be seen in figure 2.

The face-to-face configuration requires at least twice the length of buttock-to-popliteal human dimension, which are 167.6 to 198 cm [14]. Allowing a backrest construction of 15.2 cm, the minimum overall width for the face-to-face configuration is 182.6 to 213.2 cm. On contrary, the interior width of L and U-shape require only 106.7 to 121.9 cm minimum. So, the available space can be used for the furniture. Based on the result of interior dimension analysis, practically only the L and U-shape configurations that can only be applied to the interior dimension of microbus EMM with some adjustment on the dimension and seating posture. In order to accommodate the comfort and the movement, interior dimension is set to 4100x1700 mm. The inner height of 1600cm is considered adequate according to the Indonesian regulation [13] by 1500 mm.

![Fig 2. Seating configuration possibilities](image-url)
Fig 3. Assessment of seating configuration parameters
3.3. Main component layout study

The outcome of the study activity produces some components that have been classified to be main components, which are Seating, Storage, and TV monitor. These main components will accommodate some sub-components that are attached to it. To determine the proper configuration for the ideal interior layout,

The L and U-shape configuration as in figure 2 is considered possible to apply in the EMM interior. To determine the best configuration between L and U-shape configuration, the assessment is made by valued the parameters. The parameters are:

- Seeing the TV monitor as media of presentation and entertainment.
- Clearance and comfort.
- Meeting as the main function. Ease in communication.
- Passenger ingress and egress.
- Storage

The assessment of each parameter can be seen in Table 1 for alternative 1 and Table 2 for alternative 2. According to the table 1 and 2, it indicates that the 2nd alternative (U configuration) is a better configuration to be adopted in the recent project. Table 1 and 2 show the percentage of alternative A and B by 75.875% and 85.312% respectively. Based on the highest percentage value, the 2nd alternative is applied for the component layout. The TV monitor position located on the left side of the vehicle near the rear door of the cabin. The arrangement allows each passenger to be able to interact with each other and look at the screen better. In terms of passenger ingress and egress, 1st alternative is better than the 2nd alternative, but the overall total points, the 2nd is the best alternative.

As the chosen alternative, the simulation of the U-shape seating configuration is shown in Figure 4. It consists of 1 set of 4 seated type (type A), and 2 sets of 3 seated type (type B). The type A-seat is located directly faced to TV monitors. The type B-seats are next to TV monitor with a seat position facing each other.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>% Quality</th>
<th>Point</th>
<th>Total Point</th>
<th>Point/Total Point</th>
<th>% Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interaction</td>
<td>30</td>
<td>52</td>
<td>64</td>
<td>0.8125</td>
<td>24.375</td>
</tr>
<tr>
<td>Seating comfort</td>
<td>30</td>
<td>500</td>
<td>800</td>
<td>0.625</td>
<td>18.75</td>
</tr>
<tr>
<td>Seeing TV</td>
<td>20</td>
<td>590</td>
<td>800</td>
<td>0.7375</td>
<td>14.75</td>
</tr>
<tr>
<td>Storage</td>
<td>10</td>
<td>21</td>
<td>24</td>
<td>0.875</td>
<td>8.75</td>
</tr>
<tr>
<td>Ingress/egress</td>
<td>10</td>
<td>740</td>
<td>800</td>
<td>0.925</td>
<td>9.25</td>
</tr>
<tr>
<td>Alternative 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>75.875</td>
</tr>
</tbody>
</table>

Table 1. The percentage of assessment parameters of 1st alternative.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>% Quality</th>
<th>Point</th>
<th>Total Point</th>
<th>Point/Total Point</th>
<th>% Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interaction</td>
<td>30</td>
<td>58</td>
<td>64</td>
<td>0.90625</td>
<td>27.1875</td>
</tr>
<tr>
<td>Seating comfort</td>
<td>30</td>
<td>550</td>
<td>800</td>
<td>0.6875</td>
<td>20.625</td>
</tr>
<tr>
<td>Seeing TV</td>
<td>20</td>
<td>740</td>
<td>800</td>
<td>0.925</td>
<td>18.5</td>
</tr>
<tr>
<td>Storage</td>
<td>10</td>
<td>24</td>
<td>24</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Ingress/egress</td>
<td>10</td>
<td>720</td>
<td>800</td>
<td>0.9</td>
<td>9</td>
</tr>
<tr>
<td>Alternative 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>85.3125</td>
</tr>
</tbody>
</table>

Table 2. The percentage of assessment parameters of 2nd alternative.
3.4. Details of sub-component layout

According to table 3, the components are divided into two types. The first are components to support the individual activities and the second are components to support the group activities. Both individual and group components cannot attach each other. Component determination is based on its function. In table 3, storage is different than the two main components. It could be an individual or group components. So it can be attached adjacent to all main components.

Storage somehow becomes the most indispensable component especially in mobile office. Lack of storage in the car is one of the problems associated with office work in a car [1]. So that in both individual and group activities should be facilitated by bigger glove compartment as a solution of poor storage facilities.

Table 3. List of individual and group components

<table>
<thead>
<tr>
<th>Individual Components</th>
<th>Group Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seat (main component)</td>
<td>TV Monitor (main component)</td>
</tr>
<tr>
<td>Electrical packages:</td>
<td>Electrical Packages:</td>
</tr>
<tr>
<td>• Output 200 V (plug)</td>
<td>• Output 200 V (plug)</td>
</tr>
<tr>
<td>• Audio system</td>
<td>• DVD player</td>
</tr>
<tr>
<td>Individual Storages :</td>
<td>• AM/FM/CD</td>
</tr>
<tr>
<td>• Laptop case / belonging</td>
<td>• Refrigerator</td>
</tr>
<tr>
<td>• Coat hanger</td>
<td>• Dispenser</td>
</tr>
<tr>
<td>• Cup holder</td>
<td>• General purpose storage</td>
</tr>
<tr>
<td>• General purpose storage</td>
<td>• Magazines rack</td>
</tr>
<tr>
<td>• Trash can</td>
<td>• Trash can</td>
</tr>
<tr>
<td>• Mini bar</td>
<td>• Mini bar</td>
</tr>
</tbody>
</table>

Individual components are applied to each passenger seat area. It should be facilitated by components that support individual activities. Seat which categorized as an individual main component is being attached to sub-components that support the individual activities. It is also being equipped by individual storages for a place to store an individual belonging. The individual storages are coat hanger, laptop case, and cup holder. The electrical plugs are also used in the seat to support the activities. Since on the back of type A-seat is a side-window glass that covered by privacy shades, the coat hanger is only available on type B-seat. On the coat hanger at type B1-seat, there is a window glass for communication between the driver and passengers. The design of seat configuration is simulated on Rhinoceros software as in figure 5.

Group components are located on the area where the entire passengers can use it. As a main group component, TV monitor is located on the side of inner body, attach to the general-purpose-storage. At the storage, it includes some electronic components such as audio, fridge, plugs, trash can, and table. The mini bar, fridge and trash can are also located in the general purpose storage, so that all passenger can use the components equally. The design of general-purpose-storage can be seen in figure 6.

![Fig 5. The detail design of the seat](image-url)
3.5. Design integration

The design integration of main components is shown figure 7. It is the result of main components integration that forms into interior cabin. The process is not only conducted components integration, but also conducted detail design adjustment of available interior space. The detail components are the privacy shades, floor and the background of monitor that are attached to the ceiling. Image design plays important role in this design stage. Luxurious and Elegant are chosen to represent the user’s image. To deliver the image, it must be supported by the selection of material, selecting the right color, and the lighting arrangement.

Wooden floor and leather seat cushion combined with chrome ornament are expected to emphasize the elegant and luxurious image. Brown is dominating the color for representing the elegant image. The lightings are installed in several positions including on the ceiling, a coat hanger, cabinet and the main entrance stairs. The arrangement of lighting strengthens the elegant image. The prototyping of EMM Microbus interior is based on the result of 3-dimensional digital model. The results of EMM microbus interior research-prototype can be seen in Figure 8.
4. Conclusion

The existence of EMM microbus is a function development of the first electric microbus made by LIPI. The first electric microbus platform is used as a reference for building the EMM microbus. The user of the microbus is intended for the leader of the company or institution. So, all features are made with a consideration of convenient and luxurious. By using this facility, the passenger still can do the work activity while in the journey. For that, the interior design of EMM microbus is totally different than the first prototype. With the ergonomic consideration, the interior width being is being expanded and the capacity is reduced to only 8-10 passengers. The image design of the interior plays the important role of the entire product design. The design creates the impression that represents the passenger. The design of EMM microbus interior is based on the passenger activities. All activities create a requirement which is facilitated by the components. All components should support the individual and group activities. With the available interior space, the U-shape seat configuration is considered suitable to apply in the EMM microbus interior. The position of TV monitor is located on the side of inner body next to the entrance. With the arrangement, it is possible for occupant to interact each other, to hold a presentation and to gain the entertainment. After determining the type of components, the process move into the detail design of main component. The additional accessories in the integration process give the additional values of the interior design.

References