Conceptual Design of an Intra-City Microcar for 2030

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Abstract

Increase in population is observed in developed countries with overcrowded roads and lesser parking spaces in cities. Conventional resources are getting depleted hence the need of other resources such as electric vehicles is in more demand in terms of ecological, renewable and fast commuting solution. Hence this project is focused on the development of microcar for the year 2030. The impacts of microcars were assessed for a number of scenarios that reflects various possible features. Extensive literature surveys were conducted to identify problems associated in current urban transportation scenario. Customer requirements were identified from customer surveys at different cities. The major problems identified were found to be compactness, comfort and convenience drive etc. The design of microcar is based on several design considerations which includes customers feedback, literature survey etc.. Design of car seat and doors were based on ergonomic aspect by considering anthropometric dimensions using standard manikins which range from 5th percentile female to 95th percentile male. The ingress and egress aspects in this vehicle were found to be easy for both driver and co-passenger. Hence the proposed design of the microcar is found to be well packaged to meet the present urban driving conditions.

Key Words: Compact, Packaging, Ingress, Egress, Ergonomic

1. INTRODUCTION

As a result of the high population density, traffic congestion during the peak hour became natural. In addition, people driving to work alone are growing, there are countless people who travel alone but ride in a coupe that is meant for four or more people, this not only occupy more road area but also consume a lot of other useful resources like fossil fuel. It is having a bad impact on the city environment. Cities are the locations having a great level of concentration and accumulation of economic activities. By 2030, six out of every 10 people will be city residents. [1] Standard of leaving has improved with the growth of automobiles, but also adds to the difficulties of it too. In a country around one third of its population live in city and town hence usage of vehicles will be more. [2]

Electric vehicles were designed to do whatever the transportation needs were wanted in the past and can be designed and refined to do whatever is needed in the future. [3] As a mean to eliminate congestion and minimize pollution in urban area, most vehicle in the future will eventually be a compact car.

2. PROBLEM DEFINITION

Automobile use is noticeable in urban areas because of variety of advantages such as on easy mobility, comfort, convenience and quick commutes. Several factors influence the growth of the number of vehicle in cities, such as economic growth. Traffic congestion creates significant problem in urban areas as shown in Fig. 1.

3. METHODOLOGY

Following steps were carried out

- Literature were collected through various journals, books, magazines, articles etc.
- Emerging trends and customer requirements on existing cars were analyzed through a customer's interaction
- QFD matrix were obtained and PDS for a micro car were developed
- Ideation sketches were generated one was selected by weighted ranking method
- Virtual 3d model is developed with ergonomic analysis using standard manikins
- Validated by creating a scaled down physical model

Fig. 1 Challenges faced in urban transportation

4. DATA COLLECTION

4.1 Product Study

The trends of microcars were studied to capture the features and user group. This type of car can accommodate one or two occupants which provides viable solution in personal transportation.

4.2 Market Study

In any product development process market study is one of the important step while designing product. In almost every cities, the mode of road transport is found to be 2-wheeler or 4-wheeler, with 4-wheeler being in large

number compared to public transport systems for daily commutes.

4.3 Customer Interaction

While designing any product it is essential to know the customer's needs. This requirements were collected through customer survey by interacting at various urban areas at Karnataka and Kerala regions. The survey includes face to face interview with different user group and inspection of the user's product to identify the real problems faced while using the products. Customer feedback were considered for the designing a new microcar for urban areas.

4.4 Outcomes

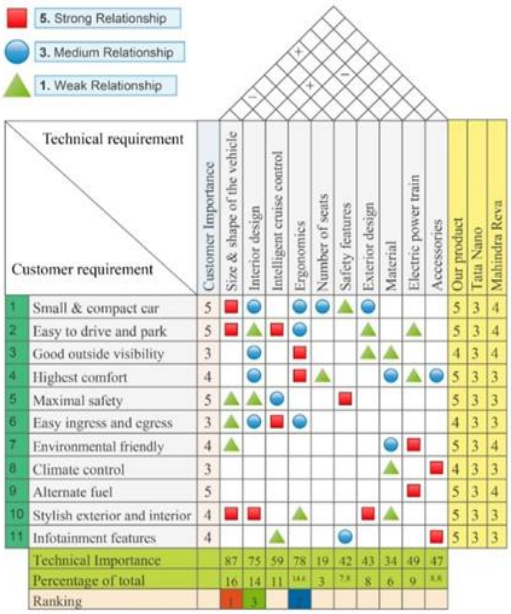
The major outcomes from data collection were found to be: many companies are trying to bring electric vehicles for short range in the cities. Small size car have lesser traffic fatalities than with conventional cars due to compactness. The cities in 2030 will be one in which people can be able to travel easily and efficiently. Across the world electric cars will be used in increasing proportions, rising to 50 to 60% by 2030. More use of advanced and biodegradable materials like soy products, coconut husks in vehicle development. Lithium iron-phosphate will be the future battery.

5. PRODUCT DEVELOPMENT

5.1 Quality Function Deployment (QFD)

In order to know the priority of various customer's requirements QFD matrix is used to map between customer and technical requirements. From Table 1 it can be observed that size and shape of the vehicle is found to be at highest priority while designing the vehicle. Secondly ergonomics is found to be the next highest priority to be considered while designing.

Table 1. QFD Matrix



5.2 Product Design Specifications (PDS)

The output from QFD matrix reveals that the highest priority which needs to be considered while designing product design specifications as shown in Table 2.

Table 2. Product Design Specifications (PDS)

Sl. No.	Factors	Design Specification
1	Type	Personal vehicles
2	Occupancy	2 seater
3	Drive	Electric
4	Drive train	In-wheel-motor
5	Door	Scissor type
6	Battery pack	Winston Battery Thunder sky Li-ion battery model-3.3v/200Ah
7	Material	Recyclable, eco-friendly and lightweight material soy products, coconut husks
8	Features and options	Automatic climate control, Keyless entry, Video cameras, Ultrasonic sensors, Short and long range radar, Central computer
9	Overall size (L x W x H)	2526mm x 1800mm x 2007mm

5.3 Concept Generation

Customer requirements were identified through customer surveys and those requirements are prioritized with the help of QFD matrix. Life style board, mood board and visual theme board were created to get inspired while generating concepts.

5.3.1 Life Style Board

Life style board is created by gathering some of the life events from the daily life of people living in urban areas. Fig. 2 shows different activities of people in cities and their life style of the proposed vehicle. People who are living in cities are the target customers.

Fig. 2 Life style board

5.3.2 Mood Board

The mood board is derived from life style board, which express the mood of the target people. Mood board helps to obtain the expression from the collage image shown in Fig. 3.

Fig. 3 Mood board

5.3.3 Visual Theme Board

Visual theme board consist of the images of product with the similar expressions as of the proposed concept. Fig. 4 shows some products, those were inspired for generating concepts.

Fig. 4 Visual theme board

5.3.4 Concept Sketches

Concept sketches of microcar were generated based on the customer's requirements includes small and compact vehicle, easy to drive and park, good visibility, highest comfort etc. Fig. 5 shows several ideation sketches of microcar concept. Out of which few concepts were further refined to develop into a final concept shown in Fig. 6.

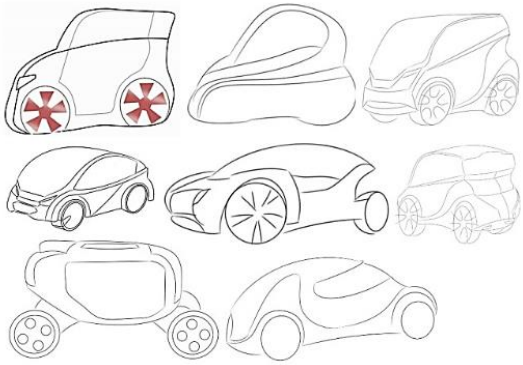


Fig. 5 Ideation sketches

Fig. 6 Concept inspired by housefly

One concept was selected by using weighted ranking method shown in Table 3. And the final concept was carried further to build virtual 3d model and to validate package was designed shown in Fig. 7.

Table 3. Concept selection by weighted ranking method

Concept scoring				
Criteria	**Weight factor**	**Rating**	**Rating**	**Rating**
Compactness	0.3	4.0	4.5	3.5
Ergonomics	0.2	3.5	4.0	4.0
Aesthetics	0.1	3.5	4.5	4.25
Features	0.2	3.75	4.0	4.0
Safety	0.2	3.5	4.0	3.75
Total	1	3.65	4.2	3.9
Ranking		3	**1**	2

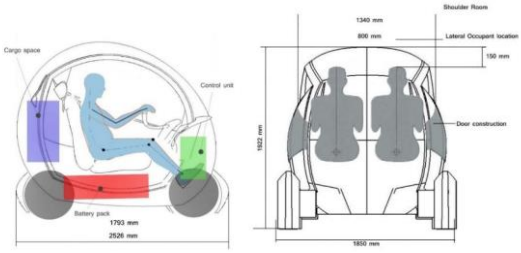


Fig. 7 Packaging layout in longitudinal and lateral direction

5.4 Modelling of the Concept

Modelling of the concept is an important stage in the product development. It gives a better visualization of the product. Final concept was built in to 3D model using Alias design tool. Modelling of the exterior was done based on the final concept sketch shown in Fig. 8.

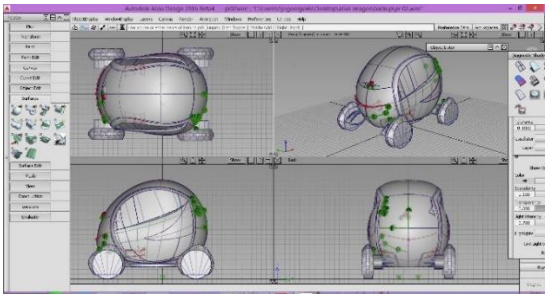


Fig. 8 Alias 3D modelling

6. VALIDATION STUDIES

Ergonomics analysis was performed in the CATIA tool. Standard manikins range from 5th percentile female to 95th male were used for the ergonomic analysis. The manikins were positioned in the vehicle to analyze the performance of both the driver and passenger shown in the Fig. 9.

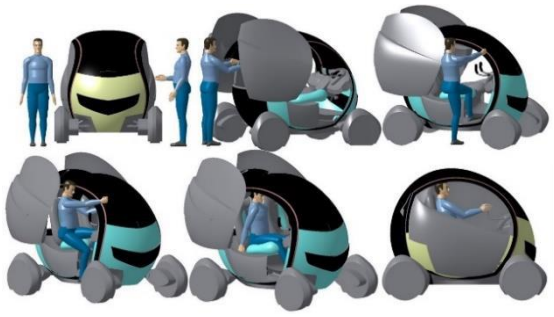


Fig. 9 Task simulation

6.1 Summary of Ergonomic Analysis

It is observed from the ergonomic analysis that the vehicle dimensions are appropriate. Ergonomic analysis is performed in sitting posture, reachability, visibility, ingress and egress etc. RULA analysis result shows the score 4, it seems the low risk by changing some interior dimensions.

7. RESULTS AND DISCUSSIONS

The most important transportation problems are mostly related to urban areas. For variety of reasons current vehicles cannot satisfy numerous requirements of urban motilities [4].

7.1 Drafting of Final Model

The virtual 3d model is used to develop the final draft of concept with major dimensions of the vehicle as shown in the Fig. 10.

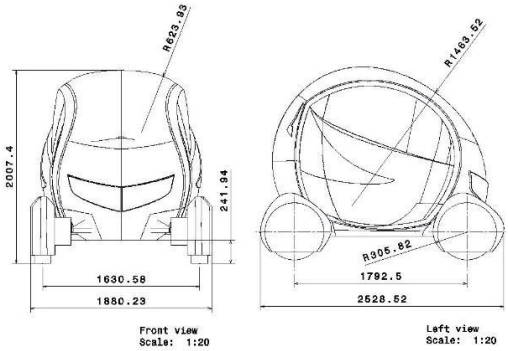


Fig. 10 Drafting

8. CONCLUSION

The project is aimed to design a Microcar for intra-city commutes for 2030. The final concept generated was found to be compact and interior is ergonomically designed. From the ergonomic analysis it is found that the vehicle dimensions were appropriate. From analysis it is said to be that the concept developed is validated.

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