

## Automotive Product Design and Development of Glove Box

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### ABSTRACT

Quality Function Deployment (QFD) it is the best way to transform customer requirements and needs into quality characteristics and develop and design quality products. In comparison, globalization has led to an increase in competition in the automobile market. All this drives companies to shorten their product development cycles while boosting innovation while reviewing the existing product. This research article presents some methodologies for accelerating mechanical design and development using knowledge-based techniques to modify the automotive glove box.

A common product development method has been developed to achieve the final glove box design, which went through the following steps. First of all, data collection was adopted to gather as much data as possible from the existing products. Then, a list of target values of the product specifications was defined as per the development of products. The next step was to create several concepts of glove box mechanism that were suitable to improve the design. The concept was further developed by generating the cost-effective parameters analyzed based on manufacture, assembly, weight, and size using the DFMA (Design for Manufacturing Assembly) method. The failures and effects were analyzed from DFMEA (Design Failure Mode and Effect Analysis) method.

**Keywords:** Glove Box; Product Design and Development process; Quality Function Deployment

## INTRODUCTION

The automotive industry plays a crucial role as the backbone of any country's economy. Automotive Glove Box is one of the most important parts in vehicle interior parts. One of the business strategies is finding out what you want from this product and help them achieve customer satisfaction[1]. The specification for choosing a Glove Box unit is analyzed with the customer's preference and converted into engineering characteristics[2]. Glove Box is provided with suitable functions to make the passenger comfortable to sit. The glove box is one of the main parts of the car's inner component and plays a very important role in several aspects like safety, reliability, user-friendly, technology and appearance, etc. The progress of the glove compartment and its changes in recent decades has had a significant impact on the automotive industry in terms of technology, techniques, and material required designing a dashboard and glove box for the automobile. In order to achieve

these targets, consider the present scenario; many practices are going on in design and development and maximizing comfort satisfaction, and minimizing the cost[3].

The main problem is that increasing the inner dimension and modifying the current design to add a multi-compartment partition.

Secondly, for safety purpose to add knee airbag and lastly to add cooling unit in glove box as per customer requirement to storage cold beverages and some miscellaneous items.

This article aims to study the development of glove box to gather information from existing products and improve a product or add new functions to meet customer needs and expectations[4]. A proper glove box can satisfy the customer's needs and increase the company's income (Figure 1).

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Figure1: Glove box and its feature

### Problem Definition

The automotive glove box is provided with suitable functions to make the passenger comfortable and easy to seat and use of glove box. The progress of the car's dashboard or glove box and its changes in the past few decades has had a significant impact on the automotive industry in terms of technology, techniques, and materials needed to design products. Many practices occur in design and development to achieve these objectives and maximize comfort satisfaction and minimize costs [5]. The definition of the problem of this article is the development of the glove box by providing new functions or modifying current conditions and meeting customer's needs and expectations. First, find the function that needs to be modified on the car dashboard. Second, find new features that need to be put in the glove box.

Mass: In terms of the mass of the glove box should be lightweight and strong; this may also incorporate in the instrumental panel to improve fuel efficiency.

Vibration observation: One of the customers' problems is that the glove box must absorb vibration and not produce noise at high speed and uneven roads. So, we can increase the height of ribs at the backside of the glove box due to the generation of vibration and noise between instrumentation panel and glove box and also overcome the existing problems we need to design concept of the multi-compartment next-generation glove box so, by using quality function deployment we can improve the design as shown in figure 3.

### METHODOLOGY

The methodology chosen for this report is the spread of quality functions deployment (QFD), product development, and its strategy with the purpose of design and development of glove boxes by bringing an increase or adding new functions to meet customer needs[6]. The implementation of the quality function is the platform for the customer's and specialist's voices. It is an important development tool with a wide range of applications to achieve product development, improve the quality and reduce the cost and time to design and manufacture the product[7]. The Steps are shown in Figure 2.

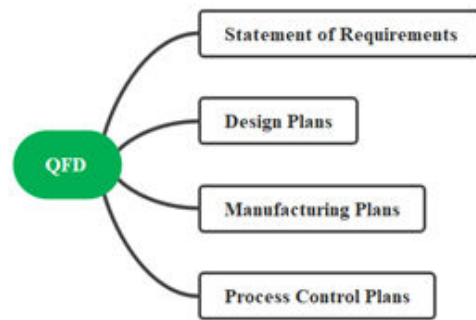


Figure2: QFD Steps

### Concept Development

Good concept development is crucial. So, during this stage, we target market scenarios, then competitive products are reviewed, we need to consider the latest technology, innovation, and techniques and increase comfort and convenience in glove box and suggest the addition of rib to the glove box.

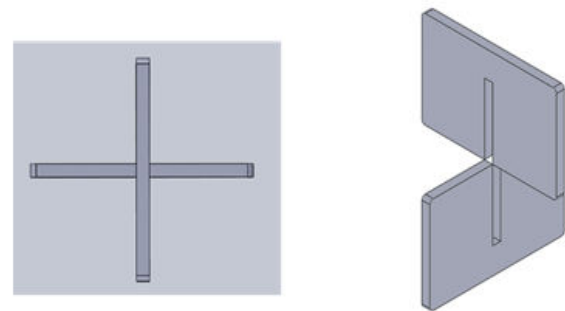


Figure3: Concept of Multi-Compartment

On the other hand, the development of the glove box meets customer needs and expectations by improving the existing glove box or developing a new one. To make a platform to have a conceptual solution, the appropriate investigation is needed by analyzing data and information about the glove box comfort as well as this should meet the needs and expectations of customers.

The important feature of the design is to increase the inner dimension and modify the current design to add multi component partition to change and replace the partition so that the passenger in the car can be used accordingly. Another important feature is that to add a cooling unit and add knee airbag for safety purposes.

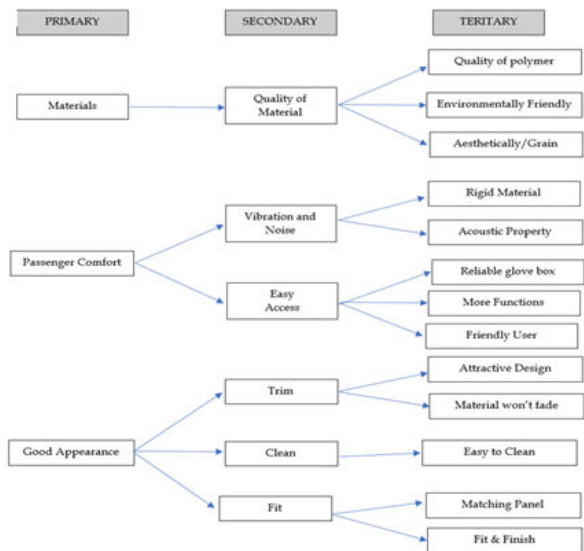
The problem is taken to be the first consideration, namely the trim of the quality of the glove box and resolves the problem with the principle of design.

- We can optimize the use of materials and keep.
- We can achieve higher satisfaction of customers.

- We can remove parts/features that are not needed for customers and save cost and material.
- The customer will be satisfied because they get what they want, and on the other hand, the company will save money and generate income because they develop the product according to the customer's needs.
- We can also limit the risk of impact on the environment using appropriate materials.
- The Company's voice is the next step, which describes the technical specification of the glove box that must be coordinated with the customer's voice. The company will carry out the customer's voices through analysis, and the final glove box model is developed, ensuring customer needs. The expected result, a newly developed glove box by the production team, will generate a quality function deployment matrix that will comply with the customer's specifications.

**Affinity diagram**

Customer requirements are arranged in three groups using an affinity diagram. This affinity diagram will help us identify customer requirements. Customer requirements are categorized and convince customer satisfaction. The market area told us what to do, and the engineering area told us how to do it. Tree / Affinity Diagram Objectives determine detailed customer requirements in detail (Figure 4).

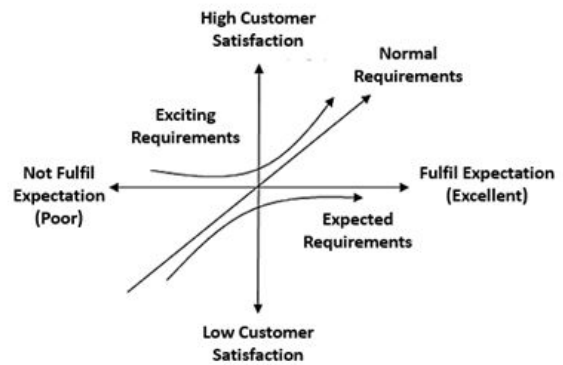


**Figure4:** Affinity Diagram for glove box

Further, we conduct two surveys. In Survey 1, figure out features or functions which need to be improved at our end. In survey 2, to find out customer needs about features and functions. The Collection of data from Survey 1 and Survey 2 Converted into customer requirements. Customer requirements are held to preferences (Figure 5). The next step is the product development stage. Information collected from surveys about customer needs, technical specifications, and preferences will help build the house of quality diagram for glove boxes (Table 1).

**House of quality**

Fill the house of quality with customer attributes, engineering characteristics, and technical specifications. This relationship matrix will help us understand the advantages and disadvantages of the glove box. This information will help the manufacturer find out the improvement of the glove box is needed and satisfy the customer[8].



**Figure5:** KANO Models for Voice of the Customer

**Customer Requirements (What's and Engineering Characteristics (How's**

The initial steps to implement the QFD must place the customer's needs, technical specifications, and relationships between customer needs and technical specifications.

The importance of the customer needs showing in table 1. The ranking is listed based on customers obtained from the customer's voice and the survey's. The final step in identifying the customer needs is to think about the process and results. The method of determining customer needs and collecting information is not the exact way; it depends on the product to product and also depends on the thinking approach of the product development team.

**Table1:** Customer needs to Engineering Characteristics

Customer Needs	Engineering characteristics
Glove box and its functions should be easy to use	Structure and geometry
Good ergonomics	Trim and finish
Superior looks	Quality of material
Glove Box plastic should have good texture and rigid	Type of plastic material used and its weight and thickness
Noise and vibration should be reduced in the cabin	Acoustic properties
The system should be durable and reliable	Operation cost
Spares should be easy to replace	Cost of material
Knee Airbag	Safety

The above analysis reflects the usefulness of the quality function deployment analysis in determining the product requirements that should be changed to provide a glove box design that meets the needs and expectations of the customer, which also helps the analysis concept generation and selection phase.

The below Table 2 (WHAT'S) shows the rating of customer requirements, In the range of 1 to 5, where 5 is the highest and 1 is the lowest, the score is based on the customer's preferences.

The information collected from the HOW'S customer needs survey is listed in Table 3 below according to the needs[9].

**Table2:** Customer Requirements rating

Customer Requirements (What's)	Importance Ratings
Plastic Material	5
Attractive design	3
Good ergonomics	3
Less vibration and noise in the cabin	4
Rigid and strong material	3
Durability	1
Texture and color of the plastic	3
Wear and tear resistance	2
Scratch proof	2
User-friendly glove box	3
Reliable design/ flexible design	4
Structure / geometry / mechanism	3
Efficient operating system	5

**Table3:** List of Engineering Characteristics

Engineering (How's)	Characteristics	Units
Material quality		Subjective
Number of components		Subjective
Design and modify		Subjective
Adjustable Partition		Subjective
Dimension		mm

Distance to access	mm
Depth of the container	mm
Diameter	mm
Area of the glove box	mm <sup>2</sup>
Operation time	Seconds
Clamping force	Newton

These two tables Rating and list, which is used to build the house of quality matrix. Product requirements that should be changed are arranged to be a good design for the glove box that meets customers' needs and expectations. This also helps to analyze concept generation and selection phases.

### Analysis

The analysis done on the glove box is to understand customer perspective to provide appropriate design features. First of all, the customer information should be collected. We get structured, quantitative information such as surveys, customer tests, and other random and qualitative information such as visitors, vendors, employees, and suppliers. Then the HOQ matrix is simplified and analyzed. After customer requirements and technical specifications are placed in a quality matrix, the product development team engineer finds the appropriate solution. Engineering characteristics rating is calculated according to the value of the customer importance and the relationship symbols value. Each symbol holds the value, and the value 5 means strong, 3 medium, and 1 for weak. The ratings are calculated by adding each customer's importance rating and value to the correlation symbol. The data that has been collected and organized must be analyzed, and value must be finalized.

### Product generation phase

The product generation stage is a process based on the results of the HOQ diagram. The following steps in the product generation phase[10]

- Clarification of problem: it is done by the functional decomposition of the system.
- Development of design criteria: the following criteria should be kept in mind during the product generation phase of the glove box such as easy to use, a minimum number of parts, easy to manufacture, efficient operating system, should not affect the vehicle performance, user friendly and low operating and manufacturing cost.
- Schematic diagram of the concept: the diagram and working concept should be clearly understood.
- Computer-Aided Design (CAD) model or any other software of the product: the models should be designed by using software and modified accordingly.



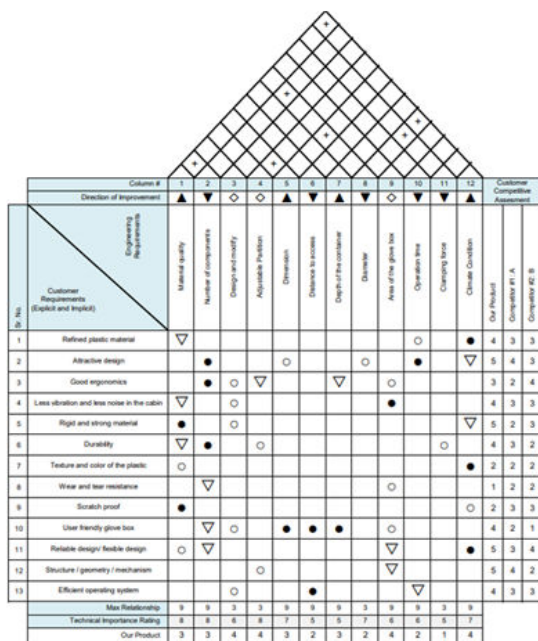
**Design criteria**

- The most important customer segment in terms of business strategy and marketing strategy.
- A most important area of customer needs and satisfaction.
- Which needs do competitors satisfy better?
- Strong correlation between needs meeting criteria and design element.
- Design elements have a strong correlation with multiple important needs.

**RESULT AND DISCUSSION**

To meet customer needs and requirements as much as possible, the major planning tool we used to find customer opinion is the house of quality matrix. This tool helped us to identify and translate the customer's voice into the design requirements and match the customer's needs given in figure 6. Achieving high-level technical specifications of customer needs is one of the best business strategies. From the evaluation and analysis, we understand the areas from the house of the quality matrix where the company needs to modify or change its design to satisfy the customers[11].

Areas to be improved by the company from the customer point of view or on the basis of customer priority:



**Figure6:** House of Quality diagram

- The main aspect is to increase inner dimension and features.
- The compartment partition used in the glove box should be comfortable and convenient to use for the passenger. We need to improve, add, and make the partition more suitable to use in this area and need to be modified. In these areas, the company can have added advantage against competitors. By giving plenty of features, it's easy for the customer to understand and use. Customers like more features and appreciate it if it is loaded in the car and user-friendly. As a result, by making the control system a friendlier user interface

- with more features, the company can get added advantage with the other company.
- The second factor plays an important role in decreasing noise and vibration.
- The dashboard should be rigid enough to sustain vibration while driving on a rough road or at high speed. The trim quality of the glove box can be improved by changing the specific dimensions and increase the rib.
- The third factor is to improve the material quality.
- The material used for the dashboard and glove box should last for many years and have high wear and tear resistance. The surface quality of the dashboard and glove box outer lid should remain glossy for many years and scratch-proof. The glove box should be less likely to fail with continuous usage such as living hinges and handle and should be free from customer requirements.

In the above context, the company should improve from other companies and make the product more unique. We calculated according to the weightage and multiplied the customer index to the factors assigned by the importance. The above factor will help to improve the design characteristics and innovate to make it more competitive[12]. This is achieved by using a target value that will rate accordingly to the customer perspectives to increase the competitiveness.

**CONCLUSION**

Overall, the above discussion about the Quality Function Deployment is a perfect method to solve the current problem, and the HOQ matrix is developed with meeting customer demands means more than improving product performance. The new product development requirements are identified from the market survey, and the voice of the customer is converted into the customer's requirements. Three important developments in car glove box material quality, cooling unit and increasing the inner dimension and modifying the current design to add a multi-compartment partition and knee airbag should be in the right place and convenient to use according to the customer's expectations. There are many advantages of QFD, such as a short development cycle, fewer engineering changes, and initial costs. QFD forces the company to make the product according to customer requirements, and also another improvement should also be taken into consideration.

**RECOMMENDATION ACTIONS**

The recommendation actions for the following area to be considered where company can overcome and can catch up to their competitors.

- Based on the Quality Function Deployment analysis results, the material property of the car dash board and glove box should be improved in terms of plastic quality, texture and colour. This will help to look the interior more graceful and attract the customer. The texture of the plastic should give the premium look and the colour should match with the other interiors. The materials recommended are polypropylene, styrene maleic anhydride, and polycarbonate and acrylonitrile

butadiene styrene. This development in the car dash board can help the company to catch up their competitors.

- The dimensions should be maintained accurately so that the finish can be acquired. The trim quality of the glove box should be improved and taken care according to the customer's requirements.
- The material for car dashboard should be used which is enough strong and rigid to sustain the vibration and should not produce noise.
- The material used for the car dash board should be lightweight so that there will be better fuel efficiency. The customer will be more satisfied if they get better fuel efficient vehicle. Approximately 7 kg of plastic used for car dashboard to manufacture, this can be reduced by 1 or 2 kg by using different kinds of materials to the another product like glove box etc. Company should develop light weight products and cars this will be added another advantage for the company. Light weight products or cars can only help the company to exceed from another company and to get a good position in the market.

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