

QUALITY CONCEPTS IN PRODUCT DESIGN – SURVEY

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Abstract: Without quality, nothing can be accomplished in the current competitive world. Quality is one of the fundamental features in product design concepts. By building the design based on the concept idea, product design concepts enable the exploration of several ideas. The following factors, which are given below: 1. Beauty or outlook 2. Cost; 3. Performance 4. Guarantee and warranty 5. Life expectancy the degree of product design may be evaluated using a variety of quality management technologies, such as Quality Function Deployment (QFD), Six Sigma, and Statistical Quality Control Techniques. With the use of modelling software applications, prototyping and testing is a technique to confirm the quality of product design. Consumers will only purchase high-quality products, according to the literature. By structuring the survey questionnaire, a detailed survey on the fundamental characteristics of product design concepts has been attempted in this work. Employees of various organizations and students at higher education institutions and technical institutes are the respondents taken into account in this work.

1 Introduction

The foundation for CAD is the methodical and well-thought-out process of product design (Computer Aided Design). Product design is the process of sketching ideas to produce a 3D model as a prototype to present the full concept using modelling software. To optimize flexibility and provide effective part design that meets criteria, CAD drawings can be created. By using best practices, quality principles in product design encourage additional innovation. From the beginning of the development process, creating a sustainable product design ecosystem is not an easy undertaking. A key success factor in company nowadays is quality.

The quality of product design concepts vary greatly from one situation to another. Deming asserts that a product's fundamental qualities determine the standards and expectations for its service. Customer-focused quality meets the demands and expectations of the customer. The definition of new product development is a process to create, test, and guarantee the profitability of new products.

Academic have focused their attention on the topic of "Design Theory and Methodology," which has produced a sizable amount of findings.

One of the most difficult and creative aspects in the product design process is coming up with an initial shape design for unique product concepts. By giving the product designer with additional data from multiple corporate departments and a tool that enables the designer to explicitly declare the design objective of its design concept at a very early stage of geometric shape development, the technique attempts to help the designer.

In order to preserve their place in the market, it is only natural for all firms to be competitive. Maintaining consumer satisfaction with their products is the only strategy businesses have in a market that is very competitive.

Small and medium-sized enterprises struggle to manufacture high-quality goods within their limited financial and time restrictions due to a lack of staff and other resources. They have the opportunity to enhance their products as crowd sourcing becomes more popular by harnessing the knowledge of a large set of audiences, including their potential customers. High-quality products will help businesses stay competitive on a worldwide scale by improving user experience, delivering greater social and environmental benefits to our society, and satisfying the needs of manufacturing enterprises and varied users throughout the product life cycle.

Perceived quality is one of the crucial elements in product development that establishes a successful design. This study proposes a novel approach for doing so from the viewpoint of engineering by breaking perceived quality assessment into its component elements and developing a structure from the level of fundamental (or "ground") qualities. From this angle, it encompasses almost all facets of perceived quality. The study provides a novel method for evaluating the relative importance of perceived quality characteristics, resulting in a fair assessment of the finished product's quality under the given conditions. The suggested approach helps to reach the equilibrium of the product's quality equation while taking design work, time, and cost estimates into account. The Perceived Quality Framework (PQF), a taxonomy of perceived quality qualities, is presented by the authors.

Businesses develop new products to preserve their competitiveness and expand their market share. Thus, new product development, in the opinion of Kahraman et al., is an essential activity and crucial technique to retain competitiveness in the context of fierce competition.

Pricing and sales competitiveness should be taken into account while developing a future corporate strategy.

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nonetheless, to secure the long-term growth of the company.

The necessity for a product, which is determined by market and consumer demands, serves as the foundation for manufacturing. From the conception of the idea to the finished product, there are two main steps. Companies today face enormous pressure to develop and provide new products more quickly while keeping their prices low. To meet these business imperatives, businesses must manage a number of important difficulties related to product conception.

Design is at the core of every invention. Product design does not include employing design and development software or making things look nice.

The main goal of product quality control is to strike a balance between price and product quality. Product quality is a general phrase that can be evaluated from a variety of perspectives. Furthermore, quality control throughout production and actions that happen after a product is completed are frequently given too much attention in the literature that is now available. For instance, Anastasia shows how quality control of product quality is handled through production, controlling warranty costs through fault detection and maintenance, and minimizing the importance of product design quality. The following picture displays the many stages of the lifecycle management of product quality as indicated in figure 1.

Product service systems (PS2 or PSS) are often combined with the product to provide services connected to the product, such as maintainability, repair, update, and quality warranty over the whole life cycle, in order to better satisfy user requirements. In this case, a standalone product is not sufficient to meet client needs. As a result, we sum up maintainability, design quality, manufacturing quality, and recycling when defining product quality. As a result, we think that a product's life cycle has four stages: design, manufacture, maintenance, and recycling. The relationship between these notions is seen in Figure 2.

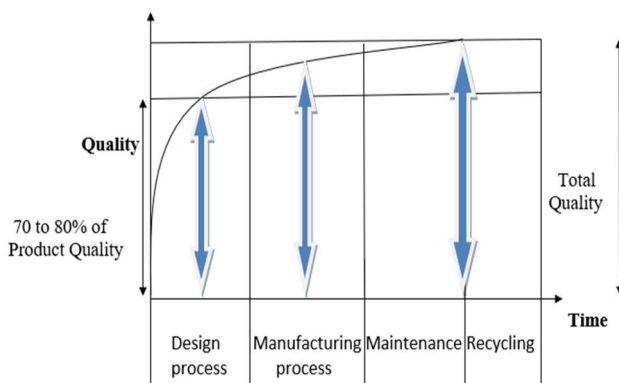


Figure 1 Product Life Cycle Management



Figure 2 The connections between quality-related variables across the course of a product's life cycle

The manufacturing industry has conducted a large number of studies to ensure the quality of the finished product from a variety of perspectives, including manufacturing methods and modelling approaches, the influence of human factors, and crucial technologies of intelligent design for customized products. There are two categories of significant variables that influence manufacturing quality: hard and soft factors. After-sale services, such as maintenance and recycling, are crucial to the successful marketing of many products since they enable customers to get the most out of the products.

After-sale services are designed to assist consumers with problems including product failure restoration and usage concerns that, if not effectively addressed, could result in dissatisfaction. In light of the expanding significance of after-sale service, Rolstadaas et al. investigated a number of after-sale service-related themes, including company strategy, service-delivery methodology, performance measurements, service portfolio, and product planning and control. According to Markeset et al., cost consideration, technological consideration, human considerations, statutory requirements, accidents, and other factors are the key factors affecting maintainability. Takeuchi and Quelch provided a list of the practices used to guarantee the caliber of the after-sale services. The manner in which items are collected, local government resources, pricing practices, financial support, and geographic location are all regarded to have an impact on the quality of recyclables.

Although design for manufacturing, design for assembly, and design for disassembly are recommended as design guidelines, comparatively fewer studies have been done on how to integrate product design quality into product after-service qualities at the maintenance and recycling stages than on manufacturing.

We are dealing with a complicated, multilayered adaptive system where a person is the primary agent when we talk about perceived quality. Reaching the best perceived quality level within the constraints of available technologies, development time, production system capabilities, and financial constraints is the truly difficult task. A lot of businesses employ high-quality products as a competitive advantage and a way to boost performance (Reed, Lemak, & Mero, 2000). In terms of financial metrics and stock market valuation, companies that have received quality awards typically perform better than other

companies (Hendricks & Singhal, 1997). The only way to deal with this uncertainty is to build a long-term relationship with clients, as customers may have second thoughts after completing a purchase (Flynn, Belzowski & Haas, 2002).

An internal design team made up of individuals with varied design expertise commonly completes product design tasks in traditional design contexts. Because they lack the qualified staff and auxiliary resources to support their product design processes, small and medium-sized firms (SMEs) cannot benefit from this type of design collaboration method. Small and medium-sized businesses (SMEs) have demonstrated a high interest in using platforms based on crowd sourcing to carry out product design chores or improve their products because of the benefits of crowd sourcing, such as its low cost and widespread participation of crowds. The holes created by SMEs' lack of employees and other resources may be filled via crowdsourcing.

Quality control practices have been demonstrated to enhance organizational performance for both product and service businesses (Powell, 1995). In research done in 2001 by Lars, Michael, and Anders, 482 Swedish businesses were split into organizations focused on products and those focused on services. Euphemia and Sian are researching how the retail service quality dimension and the product quality dimension affect customer loyalty in Hong Kong (2010).

Quality techniques have been demonstrated to enhance organizational performance in both product and service organizations (Powell, 1995). Lars, Michael, and Anders (2001) investigated the distinctions between key internal quality practices for product versus service organizations using data from 482 Swedish businesses. Euphemia and Sian examined how factors affecting consumer loyalty in Hong Kong in their 2010 study.

2 Literature review

The following section illustrates the detailed review of literature on importance of quality concepts in product design applications. The following survey has broadly categorized into two levels such as National and International levels as discussed here (Figure 3).



Figure 3 Classification of Quality levels

2.1 Classification of Product Quality concepts in design based on National level

2.1.1 Literature works on Quality concepts in Product Design Using Quality Function Deployment

M. MuthuKumaran et al. [2016] The deployment of quality functions is reviewed in the literature in this essay (QFD). The introduction and background of the QFD survey are discussed first, then the methodology for deploying the quality function. Then, a categorical analysis of the functional fields, applicable industries, and methodological development of QFD is carried out. It is hoped that by providing a concise overview of QFD in this work, academics and practitioners will be able to more easily access the relevant QFD studies and applications, which will encourage further advancement in quality deployment.

P. Sivasankaran [2021] By analyzing several studies from renowned journals, this essay investigates the importance of quality concepts in product development. In order to improve the quality of product design, the tool QFD (Quality Function Deployment) is used to analyze the various aspects of product design, including cost, service life, maintenance, and visual appeal. Analysis is carried out in QFD to enhance the calibre of the product design in accordance with the customer's evaluation. QFD assists the product development management team in making decisions on the product quality by analyzing and enhancing its qualities. A cross-functional team made up of members from design, safety, quality, and maintenance will be present in every company. With the help of the cross-functional team member's suggestions, it will be possible to improve the product's usefulness, design, and safety.

Amit Adhaye [2013] This article has looked at the efficiency of the customer-focused quality engineering technique known as "Quality Function Deployment (QFD)". Given the extensive evaluation of QFD and its potential areas for development, the possibility of more research may emerge. It has been found that QFD is the most extensively used method for analyzing customer satisfaction and quality design. This study's objective is to synthesize the methodology and the benefits of adopting QFD by reviewing a number of research studies.

Ravi Kumar Singh et al [2018] In order to determine whether Quality Function Deployment (QFD) may be utilized to alter customer expectations in favor of design quality, this study will look into this possibility. This goal entails identifying the requirements of the consumer and the details of the product through direct interviews, observation, and data analytics. Utilizing a precise ratio-scale priority, the hierarchy diagram is utilized to quantify and rank client desires. Prior to converting the requirements into quality attributes, customer needs were first classified and given a priority ranking. Utilizing quality function deployment, product design specifications are created using the acknowledged quality qualities

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(QFD). In this study, the automobile industry is implemented using the QFD technique, which is employed in a variety of industries. The connection between the product and the client's requirements

Eshan S. Jaiswal [2012] Quality Function Deployment (QFD) was first developed in Japan in the late 1960s and adopted to North America and Europe in 1983. In this article, a quick overview of the QFD process and methodology for product development will be provided. After becoming familiar with the tool, a case study that applies the method to actual situations will be presented. The case study will show how the QFD approach was applied to create a new tape product and provide guidance to others who may want to utilise it. A process called Quality Function Deployment (QFD) "transforms user needs into design quality, deploys functions creating quality, and deploys methods for achieving the design quality into subsystems and component parts, and eventually to specific elements of the design."

S. A. Puviyarasu [2016] The main objective of this study is to use the concept of quality function deployment methodologies to enhance the existing offered product. A method for developing designs with high levels of customer satisfaction that redesign products to satisfy consumer demand is called the quality function deployment (QFD). It's also a methodical or planned strategy to make sure that the customer's opinion is taken into account when developing a procedure, good, or service. This study focuses on understanding the QFD idea and applying it to redesigns that satisfy customer needs.

2.1.2 Implementation of House of Quality in product design concepts

Praveen Shrivastava [2013] The House of Quality (HOQ) is one of the matrices used in the iterative process known as Quality Function Deployment (QFD). It is the driving force behind the entire QFD process. The House of Quality Matrix is the most well-known and frequently used tool for new product design. It transforms customer requirements into the appropriate number of technical goals that must be attained by a new product design utilizing benchmarking data and marketing research. A multidisciplinary team, including members from the most crucial divisions of the business, such as manufacturing engineering, design engineering, and marketing, is in charge of carrying it out. Automobile, electronics, integrated circuits, and apartment manufacturers like Toyota, Ford, GM, Hewlett-Packard, AT&T, ITT, and others have all made significant investments.

A.S. Khangura and S. K. Gandhi [2012] In a time of intense competition, it is crucial to implement the established quality system at all levels of the organization and to achieve the highest possible quality standards at all levels. These quality improvements are based on customer input concerning new and existing products in the market as well as benchmarking data from rival companies. A high-quality, inexpensive product that better meets

consumer wants is to be designed using a systematic process, which will also increase the product's competitiveness. The majority of businesses have changed in response to product development. A quality tool called Quality Function Deployment (QFD) aids in translating customer feedback into new goods that precisely meet their needs.

Peetam Kumar Dehariya et al [2015] In the paper, a logical and useful approach to Green Quality Function Deployment (GQFD), a quality management system with routine product development improvement based on customer-focused survey data, is discussed. GQFD serves as an example of how to balance product development with environmental preservation. GQFD is not applied to determine their properties and levels. GQFD records what product designers "think" will best satisfy customer needs while taking environmental considerations into mind. The use of an air conditioner served as a case study for the application of GQFD in this study. When constructing a new air conditioner, use GQFD to identify the parameters and functions that are most important to the client before deciding on the technical specifications. These critical requirements are subsequently submitted to the quality control division, where a relationship is established.

2.2 Classification of Product Quality concepts in design based on international level

2.2.1 Literature works on Quality concepts in Product Design Using Quality Function Deployment

Chenggang Yin et al [2019] Investors must first identify the appropriate market opportunities early in the firm strategy in order to support subsequent technical efforts in the product design and development (PD&D) process. A variety of processes are included in the product design and development (PD&D) process, such as business strategy, concept generation, detail design, prototype & test, production, after-sale support, etc. In the Background section of this article, processes for product design and development (PD&D) and survey technique were introduced. With the aim of developing non-destructive testing robots utilised for on-site inspection of wind turbine blade flaws, this study provided a case study product development project. 34 second-year undergraduate students who were involved in the case study project responded to the survey and questionnaire that the author had developed.

Dara Schniederjans and Marc Schniederjans [2015] Due to the escalating competition in the market, organizations seek for greater innovation in their products and services. Quality management has the power to reenergize an organization's product, process, and administrative innovation when properly matched with internal circumstances. This essay will address the relationship between social and technical quality management and innovation. Additionally, this study undertakes an empirical analysis of confounding factors

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including task difficulty, organizational size, and managerial ethics that influence the relationship between quality management and innovation. Based on an empirical analysis, we discover that social quality management practices—not technical quality management practices—are positively related to creativity. We also find that technical and social quality management have a beneficial reciprocal relationship. Furthermore, our research reveals a connection between quality management and innovation.

Olga A. Shvetsova et al. [2021] Business-to-business (B2B) firms must choose new product concepts carefully because it will greatly affect the eventual success and reputation of the product in terms of quality and functionality. Determining the best mathematical strategy for choosing a new product's design concept in the face of fierce competition and resource limitations is the research challenge. In order to increase the effectiveness of design product decisions, this study's main objective is to present an integrated analytical strategy that integrates data envelopment analysis (DEA), analytic hierarchy process (AHP), and quality function deployment (QFD). The suggested approach uses mathematical methods to carefully evaluate and strategically select the best new product concept while taking into account the characteristics of the B2B product.

Rosnani Ginting et al. [2022] Quality Function Deployment is a method for producing goods with the needs of the consumer in mind (QFD). The QFD planning process aids in the correct implementation of various technical support solutions, which helps the business prioritize each issue. The QFD House of Quality (HOQ) tool is used to set design criteria, illustrate the relationship between respondent needs and the matrix to address those needs, and highlight the design team's attention on producing high-quality products. In order to review the QFD literature and provide background information on the history of the QFD method's development and its application to product design and development, the study will use sources that have been compiled. Planning for process quality is a key tactic for regulating product quality during the product development process.

Marvin E. Gonzalez et al. [2003] The design of school furniture in underdeveloped countries is examined using a quality function (QFD) analysis using Costa Rica as the baseline. The dynamic hierarchy process model for QFD helped the product development team achieve client expectations while working within the limitations of scarce resources. The total quality management (TQM) solution for school furniture was developed using a number of TQM technologies. A flexible, cross-functional team structure was used to complete it. A simple type of quality function deployment was used to define the intended product design, safety attributes, and service features.

2.2.2 Implementation of House of Quality in Product Design concepts

XiaolongLi et al. [2014] To improve customer happiness in creative product design, a topological structure of consumer criteria is constructed, and a novel product approach is recommended. Designers have enough guidance from the topological framework to adequately document customer wants. Analysis of the importance of client requirements is done using the analytical hierarchy process (AHP). Quality function deployment (QFD) is used to convert client requirements into requests for product and process design in order to identify the technical requirements that need rapid improvement. The product is produced in a way that is more customer-focused in this way. The TRIZ principle of creative problem solving can help designers come up with original solutions. A case study of a vehicle steering system is offered to clarify the application.

Aimin Zhou et al. [2022] Traditional product form design study frequently begins with a single factor, such as aesthetics, ergonomics, or Kansei engineering, and lacks a thorough analysis of numerous restrictions. A product form optimization design strategy focused on aesthetics and ergonomics is suggested as a solution to this issue. First, a quantitative product form aesthetic index system is constructed based on the notion of computational aesthetics. the thorough evaluation of product form aesthetics using the entropy method. By calculating the difference between the standard values and the actual values of the design parameters, the ergonomic evaluation is conducted. The Nash equilibrium is then solved to achieve product form optimization using the aesthetic and ergonomic evaluation as game players in a non cooperative game model.

Chetan Mehta & Benwang [2001] GQFD-II (Green Quality Function Deployment II) is a state-of-the-art procedure for making environmentally conscious products. However, a number of problems with the GQFD-II make it difficult to utilise. Because the LCA (Life Cycle Analysis) is complex and time-consuming, GQFD-II designers must possess a solid foundation in environmental science. Furthermore, GQFD-II product comparisons are based on a complex decision-making algorithm without a reliable quantitative base. These shortcomings are what motivated the creation of GQFD-III. The Green House in this study incorporates a Life Cycle Impact Assessment methodology, and the AHP is used to select the optimal product design (Analytical Hierarchy Process).

2.2.3 Summary of literature

Detailed survey on quality concepts in product design has been conducted by considering various tools like Quality Function Deployment and House of Quality concepts. Survey was conducted both national and International level as discussed above.

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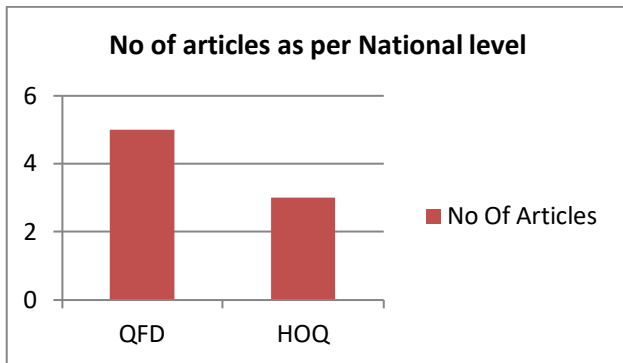


Figure 4 Number of articles categorized as per National Level

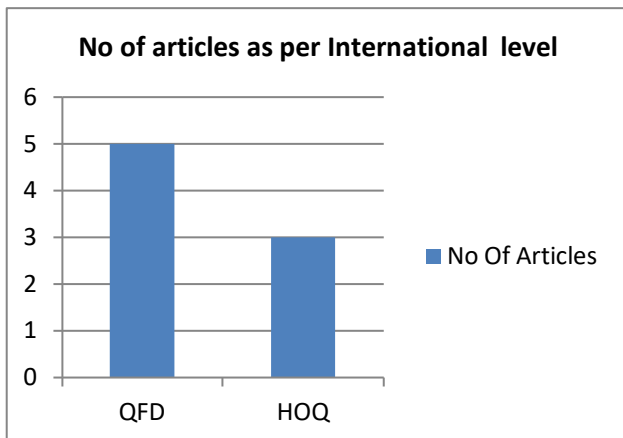


Figure 5 Number of articles categorized as per International Level

Using methods like Quality Function Deployment (QFD), the House of Quality, and the Analytical Hierarchy Process, the articles in Figures 4 and 5 describe quality principles in product design at both the national and international levels.

3 Methodology

In this section brief survey was conducted from different respondents say students, Employees and other peer groups. The following are the factors framed in questionnaire using Google forms as illustrated below.

1. Name of the Employee
2. Contact address (Preferably mail)
3. Respondent sense of perception in terms of questions.

These are the above information much useful for analyzing the quality perception in product design.

The format of questionnaire was listed as given below:

Q1. Express your Opinion about the design quality of product.

- a. Aesthetics
- b. Cost
- c. Performance
- d. Reliability
- e. None

Q2. How will you measure the potential use of product?

- a. Increased Performance
- b. Long Service Time
- c. Good Maintenance
- d. None

Q3. What are the ways to validate the efficiency of product Design?

- a. Quality Function Deployment
- b. Statistical Quality Control
- c. Quality Control
- d. None

These are the above pattern of questionnaire was developed and circulated to various respondents nearly 14 respondents have given their perceptual view on quality aspects in product design.

4 Results and discussion

Based on the statistical results shown in figures 6, 7, 8 it was observed that 72.09% of the respondents given preference to performance characteristics of product , 50% of the respondents given preference to long service time and good maintenance and 62.9% of the respondents given preference to quality control techniques to validate the efficiency of product design.

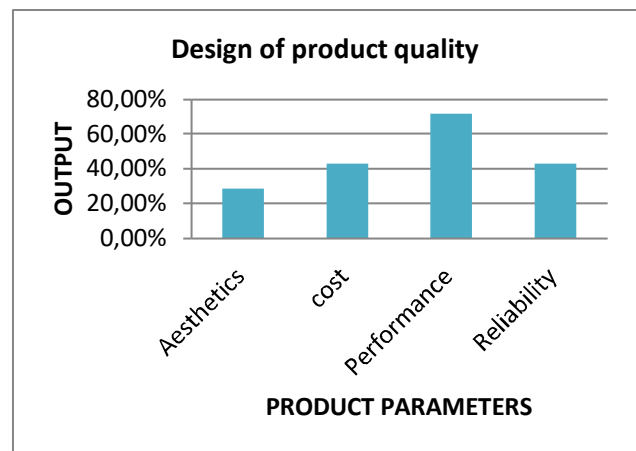


Figure 6 Design parameters of product quality

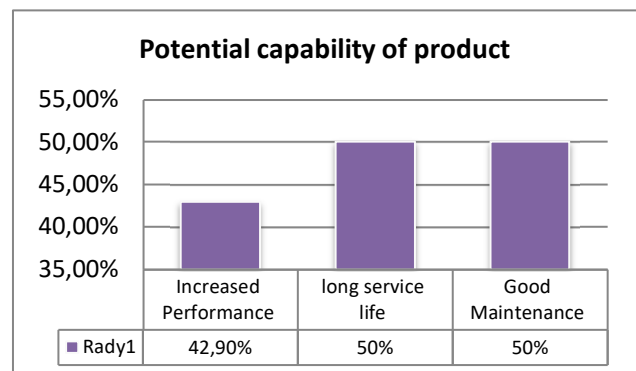


Figure 7 Potential capability of product

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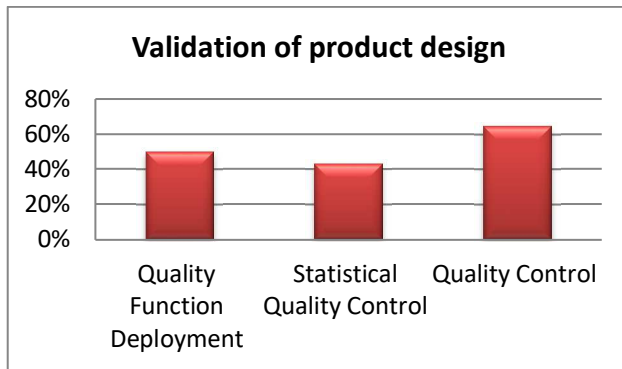


Figure 8 Validation of product design efficiency

5 Conclusion

In the current climate, nothing can be accomplished without quality because it is deeply ingrained in nature. By raising the bar for performance and quality, such as cost, dependability, and maintenance requirements, quality raises the bar for product design excellence. An effort has been made in this study to conduct a survey on several product design quality attributes. The survey's findings make it abundantly evident that a product's design quality is dependent on maintenance and safety.

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Review process

Single-blind peer review process.