Integration Of Quality Function Deployment (QFD) And Value Engineering In Improving The Quality Of Product : A Literature Review

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Abstract. Product development using the QFD method is often applied in the industry to meet customer satisfaction by improving quality. Quality improvement is an important factor for a company to be able to maintain its existence in the industrial world. Value engineering is used to provide improvements to the materials used to reduce production costs. This paper discusses the Integration of QFD with Value Engineering in the product planning process. QFD improves service/product performance based on customer requirements, whereas Value Engineering changes the cost of a service with product regardless of mode of work and quality. The combination of QFD and Value Engineering methods focuses on costs and improving services and products. This paper describes the integration of the two methods given the implementation simulation implementation. The methodology is used to collect, analyze, and display data used for the design process. This paper summarizes the experience gained during implementing QFD and Value Engineering for component redesign improvements. Research shows that this method is used to keep the team focused in carrying out the design.

1. Introduction

Customer desire is an important factor in the process of making products or services faced by all companies in the industrial sector in a competitive market as before. The ability to provide product designs or services that meet customer needs but at competitive prices is a great advantage for companies to compete in the market. For that, companies need to adopt a number of methods and tools to effectively operate capturing customer needs so they can achieve higher customer satisfaction. Quality Function Deployment (QFD) is a well-known methodology for customer-oriented design and product development reviews [1].

Quality Function Deployment is a technique utilizing to guarantee the quality in each creating items stages, beginning by the plan quality itself [18]. The QFD method is known by several names such as Quality house. The data information in the QFD chart is organized so that it shows the relationship between customer demand and product quality features. House of Quality (HOQ) displays the cross-relationship between customer needs and design changes as well as between the design variables themselves. Using HOQ for customer needs is converted into multiple technical requirements for a structured project level with an interrelated matrix [2].
Companies can analyze product functions to produce functional requirements at lower total costs without compromising product quality by using value engineering. Value Engineering is a method used to reduce production costs by calculating the value of components, equipment, and procedures [3]. Combining QFD with other techniques can solve product planning problems and can form the basis of further research. Integrated innovation methods combining QFD with other engineering tools can solve major contradictory problems in the process from product demand analysis to product design, production and application [4].

2. Theoretical Background

2.1. Quality Function Deployment

QFD is a way to improve the quality of goods or services by understanding the needs of consumers and then linking them with technical characteristics to produce goods or services at each stage of making the goods or services produced. QFD is used to help businesses focus on the needs of their customers when developing design and manufacturing specifications. QFD method is a quality engineering method by identifying consumer voices, determining consumer desires and involving them in the product or service development stage. QFD uses a questionnaire that contains customer needs or an investigation of customer satisfaction with products that are related to technical characteristics [5].

QFD was developed in Japan since 1996 by Yoji Akao, and is known as an effective method for product or process development. QFD is an approach to integrating customer voices into product design and development. It is applied in many industries such as automotive, electronics, construction and service sectors [6].

QFD is used to help businesses focus on the needs of customers when developing design and fabrication specifications. QFD is divided into four phases that are used to connect consumer needs with product design characteristics, and then translate them into part characteristics, manufacturing operations, and production characteristics. QFD identification stage of consumer needs, and the characteristics of the parts are applied at the product design stage. The main purpose of QFD is to determine the priority design criteria which are the main focus in product design and development. The main planning tool used in QFD is the House of Quality. House of Quality translates the customer's voice into design requirements that meet certain value targets and matches them to the organization or company that will design those design requirements [7].

The use of QFD for the product and service The design process is carried out by making of a matrix of product planning or HOQ. The QFD approach may likewise be extremely useful for scholastics intending to approve recuperation viability in the administration business [19].

![Figure 1. House of quality](image-url)
Part A: Room in the first of HOQ is the needs or customers’ desires. This phase uses the diagram of affinity process and then is arranged in a hierarchy with the lowest level of need to the highest level. Most development teams collect customer votes by interview and then arrange in a hierarchy.

Part B: The second part of HOQ (The Planning Matrix) and referred to as a place to determine product goals or objectives, based on the market research team’s interpretation. Goal setting is carried out with a combination of priority customer needs.

Part C: The part when HOQ is a technical response, describe products or services for development. Usually the pictures come from customer needs in the HOQ’s first section.

Part D: The HOQ’s fourth part is relationships, the biggest part in the matrix and the work. In the phase uses the priority matrix method.

Part E: The fifth part of HOQ is technical correlations, matrices that look like roofs. Used to help the QFD team find out which designs are experiencing bottlenecks and determine the key communication between the designers.

Part F: This section consists of three types of data namely:

- Priorities of Technical response, ranking order of importance (ranking) technical requirements.
- Competitive technical benchmark, inform the results of ratio of the technical requirements’ performance products produced by the company against the product performance of competitors.
- Technical targets, developing performance targets technical requirements for new products and services [8].

The HOQ shows structure to design and form a cycle, and its shape resembles a house [9]. The advantages of using QFD can be seen, namely:

- QFD helps make product design decisions according to what customers want with capabilities production process.
- QFD promotes communication effectively.
- Improve the quality of a product.
- QFD increases customer satisfaction [10].

2.2. Value Engineering

Value Engineering was developed by Larry Miles during World War II to minimize. There are several types of value, namely use value, cost, price, and exchange rate. Value engineering is a method used to reduce production costs by calculating the value of components, equipment and procedures. The stages in value engineering are Orientation, Information, Functional, Creation, Evaluation, Development Stage, Presentation and Implementation [11].

In order to achieve the cost according to the cost calculated during the PDP, a methodology focused on Value Engineering techniques is proposed in three steps namely:

- Concept: conceptual product development as a focus with functional innovation goals
- Projects: product and process design is the focus, aiming for improvement during its development stage;
- Validation: the product and process validation stage and the production stage, aimed at improving the production process.

With the application of systematic Value Engineering, the potential for cost reduction and quality (function) improvement is addressed [12].
3. Research Methodology
The method used in this paper is a literature review study. This paper presents several works of literature on QFD with Value Engineering. The collected journals are journals that discuss the integration of QFD with Value Engineering. The journals are collected through the Google Scholar and Science Direct websites.

4. Result

4.1. Quality Function Deployment (QFD)
QFD is a method for translating requirements of customer become product or service’s technical features “a method for developing a design quality aimed at satisfying the customer and translating the consumers demand into design targets and major quality assurance points to be used throughout the production phase”. Another definition provided by Sullivan “a method that helps a manufacturing company to bring new products to the market sooner than competition with lower cost and improved quality”. The QFD can use for service industries. “even when a company is dealing with such intangibles as services, quality function deployment makes it possible to clarify, plan, and design the services to be offered and to conduct quality control activities”, QFD was first introduced in Japan by Mitsubishi in 1966. From then on there were many publications in Japan, for example for the first time in 1972 Nishimura and Takayanagi who have introduced quality graphics. QFD was introduced with seminars and articles for four days in 1983 in the USA, it is used by the Japanese companies that have become so successful in the last few years. This QFD is known with some of the most common names are customer voice (VOC) and house of quality. Fit a phase IV model, HOQ is the first of the four steps of QFD. HOQ is a matrix for obtaining customer requirements in the QFD method [13].

![Figure 2. Phase in QFD](image)

4.2. Value Engineering
The SAVE which was formed in 1959 and definition of Value Engineering according to The SAVE is “the systematic application of recognized techniques, which identify the function of a product or service, assign a monetary value to that function and provide the reliability of the required function at the lowest overall cost”. Value engineering, function refers to what makes a product more functional. The application of Value Engineering is more useful in the development steps, namely; the initial design stage. It was conveyed that Value Engineering analysis in design cost management was successfully achieved.

The application of Value Engineering in a project or product, ensuring that all the different alternatives to fulfill the function, have been considered. In this paper it is suggested that the best alternative should be selected, based on customer requirements and costs. This article integrates Value Engineering with QFD, which means that presenting an alternative to the required function is not sufficient for this alternative to be considered Value engineering is a technique that is useful for determining several conditions for making product and service. Value Engineering is applied in the
analysis and design of services / products. Various methods for carrying out Value Engineering have been used. This method consists of stages as shown below.

![Figure 3. Phases of value engineering](Image)

4.3. Integration Of QFD With Value Engineering

Value Engineering and QFD have different orientations. Value Engineering's goal is to reduce the operational costs of the organization's main and supporting processes and lead to lower cost prices. Value Engineering selects solutions that generate more value for customers. QFD focuses on customer needs and requirements and brings innovation in product and service design in a more satisfying way. This technique searches the changes that generate the greatest value based on the needs of the customer. Mentioned that out of the many possible solutions, QFD is a practical one (according to organizational capabilities) and economical (only requires a small investment cost). It goes without saying considering these two criteria (cost reduction & value addition) in the decision-making process could lead to the selection of better alternatives that does not enjoy higher value by the customer but imposes less costs at organization, the factor that assists to price stability, and lower costs of products and services. Value Engineering is carried out during planning stage, as 70% of future fee depending on this step. The best time to apply Value Engineering to a project is during this stage. The sequence of QFD with Value Engineering applied to the cases according to Figure 4. This sequence is made according to the characteristics of each tool. This study identifies gaps in information as the design step continues different stages. A brief explanation of each tool can be seen in the below figure.

![Figure 4. QFD and value engineering in relationship](Image)

QFD is made to support the process of developing a product begins conception to manufacturing. House of quality is graphic tools those are all around related to QFD and is used to create display designs analysis results: correlation of customer desires and product technical specifications; customer perceptions of the product. Value engineering, namely products that are analyzed in connection with the functions performed. Costs are associated with these functions, in which case costs for function benefits are identified for the purpose of improvement. Analysis Functional Systems Engineering Diagram (FAST) is closely related to Value Engineering, which shows the functionality of a product. For this diagram, functions classified for intrinsic functions and support functions.

QFD meets customer satisfaction and causes sales to increase for more profit. Then Value Engineering to get more profit through reducing costs without changing the main function and product quality. The main objective of incorporating QFD & Value Engineering techniques in product also service design/production processes is the suitable alternatives selection that can increase customer value without increasing product / service costs. So, the planning process based on QFD starts with the needs and requirements of the customer.
The results QFD Phase II are entered Value Engineering. That data includes the quality factor of the product components and subsystems. Alternatives in the data sequence, innovated and selected, are determined and evaluated, the best alternative. The data recapitulated the results from the QFD are entered into the QFD (Enhanced Product) stage. The first step of Value Engineering applied at opening stage of QFD. Because after choosing best alternative, the fifth stage of Value Engineering is also eliminated. HOQ is an important graphical tool in QFD which is useful for showing analysis results at the design step: waiting for customer preferences with the technical specifications of a product; user perceptions of the product in relation to product competitors; and area opportunities. In Figure 5, the integration of QFD & Value Engineering is shown in detail. This diagram describes identifying customers and needs. Then reviewed in the table of needs and questions about who, how, why, where, and what was answered. The HOQ matrix is formed when the table is completed. there is a relationship between the factors with customer needs that influence it is analyzed in matrix. The data is obtained from the first matrix called technical features of the product or the service and a value added into the phase II matrix (HOQ). For relationship matrix between technical analysis and solutions of research products / services. Its purpose is to look at the technical impact of solutions on products and services and to review alternatives. After that comes the process of Value Engineering. The output generated from QFD phase II identifies a list of values and solutions. The value of each solutions determined based on the impact on technical features by products or services.

![Figure 5. Relationship between HOQ and value engineering](image)

This stage estimates the cost of the solution from the alternatives provided. The order of the solutions on this list demonstrates that meeting customer needs at minimum cost is important. Value engineering is the analysis of a product with respect to its proper function and does not change its function and quality. Costs are associated with these functions, in which case costs for the benefit of the function are identified and targeted to obtain the desired improvements. The Functions Analysis System (FAST) Engineering Diagram shows the product's functionality. Functions are classified as primary (the product must perform) as well as support functions in this diagram. Interest function vs. The cost function graph is used to show the difference in value in Value Engineering [14].

Rosnani Ginting discuss the function of quality, distribution and value engineering in the planning process of a texon cutting tool. The QFD Process is applied to product planning, it can be done through improvements in the quality of the materials used to better satisfy customers in the use of product design such as by changing the material of the blade and anvil and change the material rod presses with smaller thickness as well as the use of components of the paint with the selection of cheaper prices using the other brand [15].
Suryanarayana dan Emmanuel the integration of QFD with Value Engineering is known in the product planning process. The QFD process is implemented for product planning and identifying product projections in the market. The Value Engineering process is carried out to estimate the cost then the cost to value ratio is calculated and the best alternative based on this ratio is selected. A value engineering analysis was carried out on the Samsung Galaxy Note 3 to reduce the price from $ 232.50 to $ 198 /- per piece. The final cost reduction amount helps identify unnecessary investments into various components and further improves the quality of those components where the customer has great interest such as battery, camera and audio output, while achieving the best part of $ 198 i.e., the price of 16GB iPhone 5s, one of the best Samsung’s main competitor in the smartphone industry in 2013 [16].

Yegenegi, di al QFD & Value Engineering was first introduced and an integration of this method was proposed. Quality Function Deployment selects the one that is helpful and profitable. The Value Engineering Process is not very well executed, but the solutions and their relative values are combined from the quality house of phase II to the second stage of Value Engineering. Value engineering is applied during the planning stage. Application costs are calculated and cost comparisons are taken for the estimated value and the best choice [17].

5. Discussion
Methods that can be used to produce products at low cost and do not reduce functionality and product quality are QFD and Value Engineering. Through QFD it can help organizations determine what customers want and the Value Engineering method is a technique that identifies the functions of products and services concerned with price.

6. Conclusion
QFD and Value Engineering have different orientations to apply. QFD benefits by meeting customer satisfaction so that more sales are earned and Value Engineering focuses on increasing profits through reducing costs by not reducing product quality and not changing the main function. The main objective is to integrate QFD and Value Engineering for better alternatives in product / service planning by generating higher value for customers and not increasing product / service costs. QFD identifies product functions that need improvement.

The advantages and benefits obtained by integrating the methodology are getting better results and showing the difference in the product / service to be designed. Shows that each method has its respective roles to produce a better product / service after improvement.

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