Review   **JoWET**

A Fuzzy Integrated Web-based Quality Function Deployment Application: A Conceptual Analysis

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Abstract

The 'voice of customers' drives the Quality Function Deployment (QFD) process, which is a customer-focused product development method. Making decisions is a critical component of the QFD process. Although QFD aids decision-making, its subjectivity results in ambiguity and uncertainty, resulting in less accurate and consistent findings. Fuzzy ideas must be incorporated to deal with the ambiguity and uncertainty inherent in the QFD process. This will result in better decision-making. Businesses can benefit from web-based apps in a variety of ways. As a result, this research presents a web-based fuzzy integrated QFD application. It examines QFD and Fuzzy concepts in this regard, as well as the existing software and web resources. It then goes on to discuss the faults of the existing ones as well as the features that are necessary. The study then concludes with the proposed web application's applicability as a strong decision support tool that will allow designers and engineers in the QFD process to evaluate decision making with respect to process and effectively guide design decisions. PHP and MySQL could be used to create the application.

INTRODUCTION

Quality Function Deployment (QFD) is a customer-centric strategy aimed at improving quality and consumer satisfaction [1]. QFD is a customer-oriented method that is used to increase customer satisfaction and organizational capabilities. In the late 1960s, Yoji Akao developed QFD in Japan. It operates on the principle of customer satisfaction and the transformation of customer requirements into design goals. Throughout the development cycle, QFD assists teams in focusing on the needs of the customers [2]. QFD started with manufacturing but later got widely accepted in a diverse area [3]. The QFD's central tool is the House of Quality (HOQ) matrix chart. HOQ thoroughly examines customer requirements and converts them into developer-friendly language [4]. Despite the fact that the QFD can significantly increase quality, the use of linguistic terms and the typical crisp scoring approach by the QFD results in imprecise and inconsistent findings, which have a significant impact on decision-making. Fuzzy integration must be done in QFD to handle the problem. QFD, which consists of numerous matrices, is a laborious process that includes enormous data and complex calculations. Thus, handling the data manually is time-consuming and inconvenient. This complexity and time-consuming nature of QFD generates the requirement for suitable software [5]. Also, the existing QFD software have limited functionality and do not offer fuzzy support. This gives rise to the need of Fuzzy-QFD (FQFD) based software tool [6]. When compared to desktop applications, web-based applications provide numerous business benefits. These applications can be accessed via the internet from any

computer, rather than having to be installed on each computer from which you want to access them [7]. Furthermore, because QFD is a team tool as well as group process, geographically dispersed members of team may encounter difficulties in common practice and usage [8]. Second, QFD facilitates the translation of customer voices into technical languages. However, it is only available to internal organization members. The web based QFD application addresses this shortcoming by allowing experts from both inside and outside organizations to contribute and share knowledge [9]. In light of above, this study proposes a fuzzy integrated web based QFD application. In this regard, it examines QFD and Fuzzy concepts as well as the available software or web tools. It then discusses the shortcomings of the existing ones as well as the features that are required. The study then concludes with the applicability of the proposed web application as a robust decision support tool that will allow designers as well as engineers of the QFD process to evaluate decision making with respect to process and also effectively guide design decisions. The application could be built with PHP and MySQL.

QUALITY FUNCTION DEPLOYMENT (QFD)

QFD is a customer-oriented method that is used to increase customer satisfaction and organizational capabilities. In the late 1960s, Yoji Akao developed QFD in Japan. It operates on the principle of customer satisfaction and the transformation of customer requirements into design goals. Throughout the development cycle, QFD assists teams in focusing on the needs of the customers [2]. QFD began in manufacturing, but over time, it has gained widespread acceptance in a variety of fields. The use of QFD along with Data Mining as forecasting tool has been demonstrated by Purohit and Sharma [10, 11]. QFD can be seen as a four-phase model that includes various planning like product planning, component planning, process planning, and production planning [12]. House of Quality (HOQ) is at the heart of QFD. From ambiguous customer needs, this tool produces precise, ranked, and quantifiable technical requirements. The HOQ matrix is the most common type of QFD. A multidisciplinary team uses it to translate a set of customer requests into a sufficient number of prioritized technical requirements that a new product design must meet. HOQ is used to thoroughly assess the customer's requirements before translating them into the developer's language [4]. Prioritization is a key process in QFD and QFD encompasses prioritization of customer requirements and technical requirements [1]. QFD being a decision support tool greatly helps in decision making for the suitable evaluation of CNs, TRs, establishing correlations etc. [13].

FUZZY CONCEPTS

Fuzzy logic is designed to simulate logical reasoning by using vague or imprecise statements such as "John is young (rich, tall, hungry, etc.)". It is a multi-valued logic in which truth-values are construed as degrees of truth. Lotfi Zadeh pioneered the theory of fuzzy sets, which spawned fuzzy logic (1965). A fuzzy set assigns a degree of membership to elements of a universe, typically a real number from the interval {0, 1} [14]. Fuzzy Logic (FL) is a method of reasoning that is similar to human reasoning. FL's method is based on how humans make decisions, and it considers all possible outcomes between the digital values YES and NO. The traditional logic block, which can be understood by a computer, accepts precise input and performs calculations [15]. Fuzzy analysis can deal with qualitative or imprecise inputs such as "good", "poor", "medium", and so on. Based on fuzzy set theory, these linguistic terms can be characterized and manipulated. Fuzzy concepts have long been used in a variety of fields. Cao and Li created an intelligent fuzzy-based recommendation system for consumer electronic products [16]. Lin *et al.* proposed a fuzzy-based decision-making procedure for data warehouse system selection [17].

QFD SOFTWARE TOOLS

QFD can be made easier to use with the help of a few software tools. Among the QFD software tools available in the German and international markets are Qualica Software GmbH's 'QFD Capture 3.1' and 'HyperQFD'. Qualisoft in the United States provides 'QFD Designer 3.15', while Total Quality Software in the United Kingdom provides 'QFD work'. 'QFD DesignerQS' by QS Software.

The 'QFD Builder' program is a web-based tool that allows users to create, save, and share their HOQ online. The NOWECO 'PathMaker' software supports in the definition of all of the steps required to run QFD. IDEACore offers a Windows-based software called 'QFD Designer v 4.0'. Despite the fact that these software offer numerous features that could help the QFD team's designers and engineers, neither of them facilitates much-required fuzzy support option to deal with the ambiguity and uncertainty [1]. The QFD software should not only allow you to enter data into matrices and print, but it should also assist you in the generation, computation, and analysis of data. In order to reap the benefits, a web based QFD application should be used. It will result in improved team communication and collaboration, as well as a shorter and smoother product development lifecycle. The only limitation of commercial QFD software on the market today is that it can only draw matrices. The existing commercial QFD software do little more than manipulating a HOQ. Furthermore, their instruction manuals show QFD as it was used more than 20 years ago [18]. Furthermore, the HOQ tool is completely ignored by some applications. Some people even use spreadsheet software to create their HOQ.

WEB BASED QFD APPLICATION

A Web application (Web app) is software that is stored on a remote server and distributed over the internet via a browser interface. Web applications can be produced for a variety of reasons and used by anyone, from businesses to people. Web applications have numerous applications, and with those applications come a plethora of potential benefits. The following are some of the most common benefits of Web apps: Allowing multiple users to access the same version of an application; web apps do not require installation; web apps can be accessed through various platforms such as a desktop, laptop, or mobile; and web apps can be accessed through multiple browsers [19]. Web-based applications have grown in popularity, replacing desktop applications, and have become an important tool for small and large businesses worldwide [20].

The web based QFD application will improve accuracy and reliability and so it should focus on the following primary characteristics:
- Deliver robust communication with the database, mainly for storing and retrieving data.
- Develop construction policies.
- Provide a high level of operability.
- Customized user interface.
- Improved user experience.
- Shorten Product development cycle.
- Deliver support for required update and delete actions.
- Reduce error handling.

A software application can be produced with a variety of programming tools; nevertheless, what matters is the flexibility and efficiency it gives, not the task's completion. PHP and MySQL can be used to create the application. To deal with uncertainty and ambiguity, Trapezoidal, Triangular, Symmetrical Triangular Fuzzy Numbers (STFNs), and other fuzzy numbers can be used. STFNs are preferred over others because they can better quantify linguistic data, and are easy to compute, understand, and implement [6]. Furthermore, STFNs can be implemented in any programming language due to their nature. In PHP, fuzzy integration is simple to implement. STFNs appeared suitable choice to be employed in the web-based application. Similarly, PHP can be used to improve the performance of the other required features. As a result, PHP is appropriate for developing the proposed web application.

CONCLUSION

This research has proposed fuzzy integrated web based QFD application for better results and improved decision making. In this regard, it presented thorough analysis of tools and techniques needed for development of web based QFD application. The study has highlighted the issues with the

existing tools through reviewing the available tools. The research findings suggests that to cope up with the issue of uncertainty and vagueness in QFD, fuzzy concepts need to be integrated with QFD. For this, STFNs appeared to be proper choice. QFD uses the set of matrices, and these can be worked out efficiently in online mode. The proposed application will make it easier for experts both inside and outside of organizations to contribute and share knowledge. The proposed application will help geographically distributed team members to work on QFD task and thus provide improved user experience. It is realized that the web-based application will offer numerous benefits and strongly assist the designers and engineers involved in QFD process to come up with effective and improved decision making.

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