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A Hybrid Interface For Generating Improvement Ratio In Quality Function Deployment

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Abstract

Quality Function Deployment is a systematic tool used by various product development teams to incorporate the customer voice encapsulated with competitor assessment for product development. The first customer input as well as the technical input phase of QFD requires the generation of improvement ratio based on various parameters like goals or targets defined for the product, customer competitor ratings, competitor technical rating etc. This improvement ratio plays a major role in the final importance ratings and hence an error free and realistic value of improvement ratio is a must for any deployment system. This paper introduces a hybrid interface enabled with fuzzy logic, cuckoo algorithm and artificial intelligence to strengthen the improvement ratio generation in an environment called Global Remote Quality Function Deployment Object framework (GRQFDO). The interface is established with the help of java programming language which has various packages that incorporates fuzzy and artificial algorithms. The framework is implemented on a Sesame oil production company which has given significant results to prove its credibility.

Keywords: Quality Function Deployment, Hybrid Improvement ratio interface, GRQFDO, AI based goal setting.

Introduction

The complexities of product design and development is a major challenge for every product design and development team. The software packages available for design and further development has made the table on an engineer a better place if he is given all the parameters for design and development. This phase is preceded by the capturing of customer demands and upper hand of the competitors that has to be taken into account before the actual development begins.

Quality Function Deployment (QFD) is a systematic approach in converting customer voices to product features which also tackles the competitor assessment along with it. It is employed to translate customer expectations, in terms of specific requirements, into directions and actions, in terms of engineering characteristics, which can be deployed through four distinct phases such as product planning part development, process planning, production planning and service [1, 2]. The product planning phase is a critical phase where the customers voices are captured in a systematic way and the technical features needed to incorporate that voices are evaluated using a matrix called house of quality matrix. The calculation of final importance rating to prioritize the customer demand and the technical descriptors is the main aim of this matrix [3]. The final importance rating depends on various parameters as discussed in next section. One of the main parameter is the improvement ratio which is derived from the customer competitive rating, goal setting and product performance. These values are either generated by an expert or by a QFD team looking at the previous data regarding the product performance against the competitors [4].

A hybrid interface for generating the improvement ratio is illustrated in this paper which provides an error free platform for the generation of customer competitive rating and goal setting. This interface is built on fuzzy numbers and logic with entropy method also being applied for customer competitive ratings [5]. The entropy method results are then verified Artificial intelligence algorithm before being used for deployment [5, 6]. The goal setting and improvement ratio is further enhanced with cuckoo algorithm [7, 8]. This interface is made an integral part of a framework called Global Remote Quality Function Deployment Object (GRQFDO) [9].

The GRQFDO is a large framework which encapsulates all the necessary phases of QFD which can be used by any QFD team for continuous improvement and development of a product [9] .A sesame oil company is identified for the validation of this framework, being a common consumable product with large competition in the market it is observed that the hybrid competitive interface produced better results which are illustrated in this paper.

Product Planning Phase of GRQFDO

The innovative program that enables different phases of QFD process is shown in figure 1. This object is a general architecture for QFD using fuzzy numbers and logic, Artificial Intelligence and Genetic algorithm.

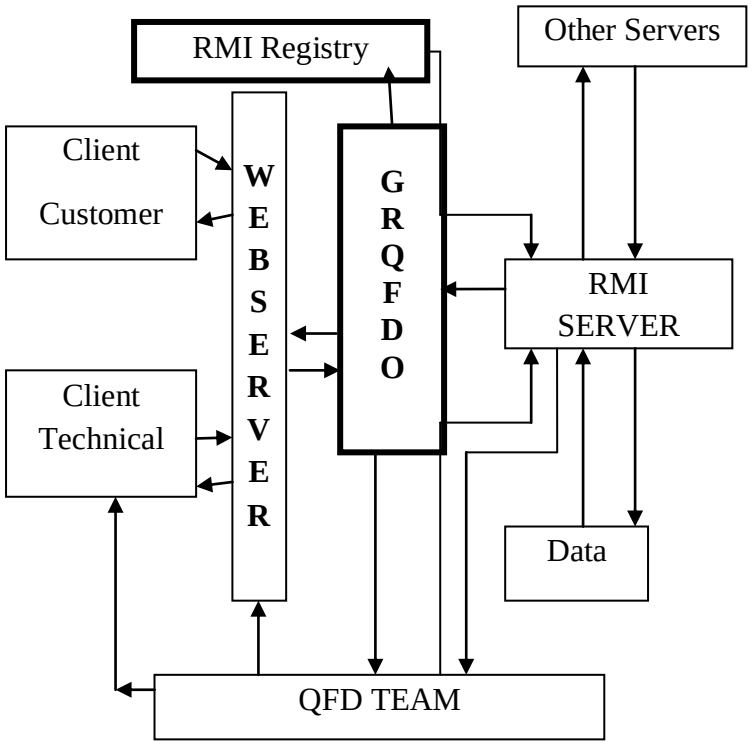

Figure 1: GRQFDO Architecture

The GRQFDO has to be broken down into its components which include product planning interface, part deployment interface, process planning and production planning interface. The last two phases are directly coupled with the in house process and production planning software interfaces and there is not much difference from the traditional approach. The product planning phase in the one which needs innovation as it has incorporate customer demands, technical descriptor for each demand, competitor assessments and tradeoffs.

Product Planning Phase

This phase starts with customer surveys, interviews, data mapping and other data collection methods to get the various product features that can attract the customer. This data is again put to prioritization with selected customer ends. In the traditional approach selected number of customers will be involved and the data inserted were directly taken for deployment. In the GRQFDO approach there will be multiple customer ends where data can be inserted. The Genetic algorithm based data filter will pass on the best feasible data to the product planning matrix. Once the data is available with the database, the QFD team can run the program to select those customer requirements to be prioritized for the next phase. This prioritization requires the customer competitor ratings, goal rating and there by improvement ratio. The hybrid interface perfectly fits in this slot as this is the primary matrix of the QFD process which should be error free and realistic.

The Hybrid Interface

The flow chart of product planning phase using the proposed interface is shown in figure 2. The hybrid interface forms the middle tier of the framework. The first two blocks are fuzzy generator and algorithms. The fuzzy generator generates fuzzy numbers for the corresponding crisp values entered for all levels of data. Data for relative importance ratings, Initial Technical Ratings, Customer competitive analysis, Technical Competitive analysis, priority rating etc. are converted to fuzzy numbers by the fuzzy generators [5]. The fuzzy algorithms available in the Java software packages are used to due fuzzy calculations to arrive at solutions for importance ratings [10]. There are various programs in the form of 'classes' in Java programming package which users can directly use by making custom variations to the source codes. Some of the packages that are the creation of this interface are Fuzzy, JFuzzyLogic and XFuzzy [11].

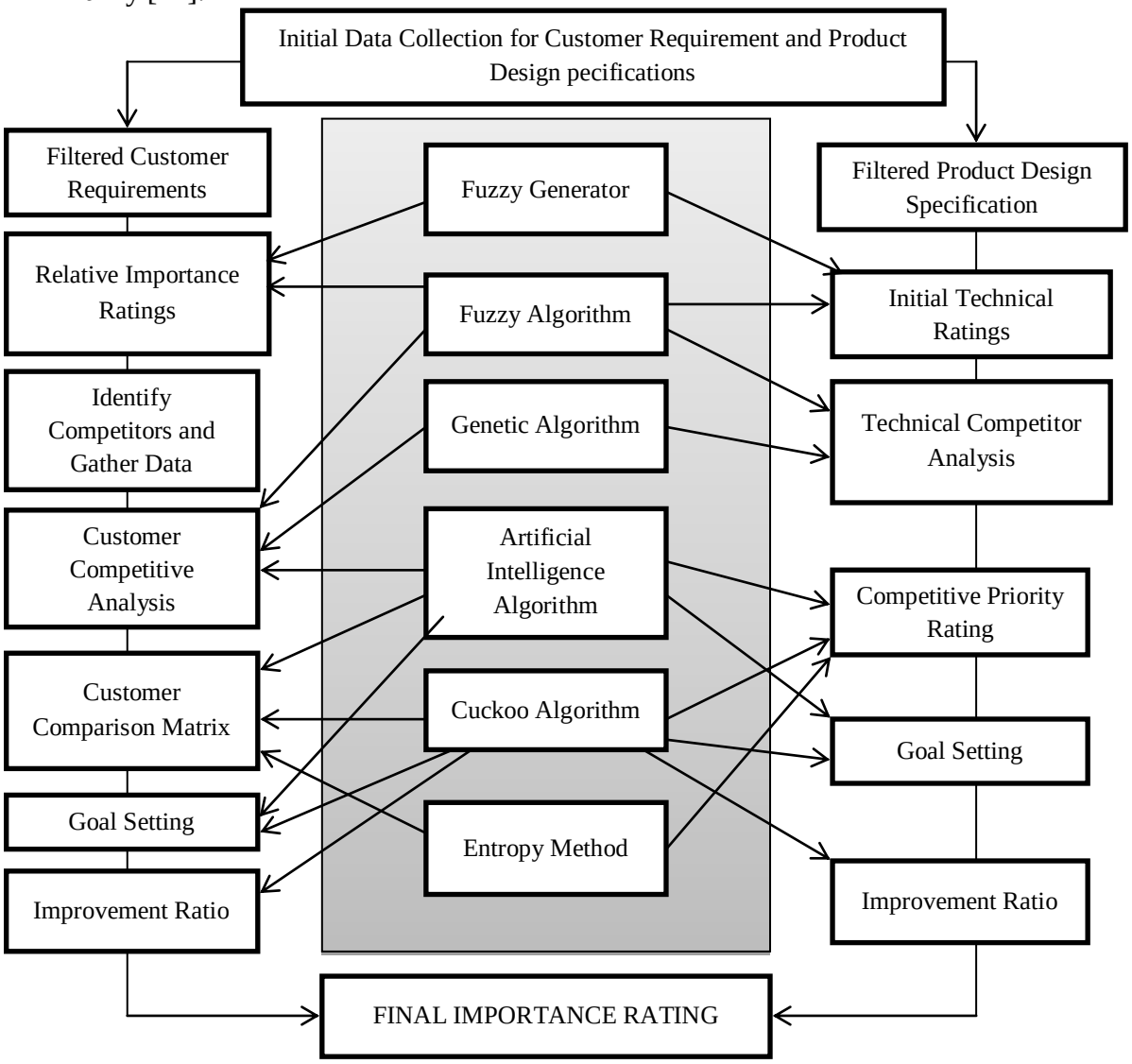

Figure 2: Product Planning Phase with Hybrid Interface

Genetic algorithm is induced in the interface with the help of packages like Java Genetic Algorithm Package (JGAP) along Genetic Algorithm Java Implementation Toolkit and GAJIT [12, 13]. The AIMA packages available in the cyber world provided more than thirty different interfaces that can be implemented with the users interface for breathing in artificial intelligence into the framework [14]. Various standalone classes and interfaces are available for Cuckoo algorithm which forms an integral part in optimizing the values generated for goal setting and improvement ratios [7, 15]. Entropy method is common method adopted in dealing with customer priority rating and technical priority ratings which is deal in depth in various text book and journals [5, 8]. This method is also available in class format in various java open source code websites which with minor modification included in this interface.

Results and Discussions

The hybrid interface is exposed to a real deployment situation to prove its credibility. A company manufacturing Sesame oil is selected, the main reasons being a fast moving item, easiness in gathering customer data and competitor data, less parameters involved in product design specification and easy to understand engineering parameters. Ten customer requirements and Twelve Technical descriptors were filtered for the product planning phase. The customer requirements being designated as R_1, R2…R_{10} and technical being designated as H_1, H_2….H_{12}.

Final Importance Rating of Customer Requirements

Each stage of estimating the final importance rating is done meticulously using the interface to obtain the result as shown in the table 1. The advantage of using fuzzy numbers and equations can be clearly seen from the data. This fuzzy range helps the GRQFDO in case of a tradeoff situation [10]. The deployment clearly gives results which are close to the traditional deployment value. Five trials are conducted to check for the precision of the interface which also found satisfactory. The table shows the importance rating of R6, R8 and R1 are showing comparability and their importance, relative to one another. The traditional deployment done manually by collecting data from customer accepting rating data from team of engineers, adjustments made for inaccurate data, mismatch of data due to individual skills and input of engineers and managers.

Table 1: Customer Requirements- Final Importance Rating

WHATs	FIR		Scaled FIR	
	Crisp	Fuzzy	Crisp	Fuzzy
W1	0.7852	0.6791,0.8913	0.9313	0.7096,0.9313
W2	0.6779	0.5685,0.7872	0.804	0.5941,0.8225
W3	0.7078	0.5937,0.8220	0.8396	0.6203,0.8589
W4	0.6453	0.5258,0.7647	0.7653	0.5494,0.7991
W5	0.6137	0.4603,0.7671	0.7279	0.481,0.8076
W6	0.8431	0.7292,0.9570	1	0.7619,1
W7	0.7081	0.5860,0.8302	0.8399	0.6123,0.8675
W8	0.8095	0.6789,0.9400	0.9601	0.7904,0.9823
W9	0.3787	0.2673,0.4901	0.4492	0.2794,0.5121
W10	0.2966	0.1825,0.4107	0.3519	0.1907,0.4292

These data tend to give different results for a deployment done on a single time span which creates a decision lag from the top management and most of the time the product design stage gets affected. The proposed method avoids all such disadvantages to make the data handling and insertion environment error free, editable and transparent.

Final Importance Rating of Technical Parameters

The final importance rating obtained for a trial is shown in table 2.

Table 2: Technical- Final Importance Rating

Hows	Final Technical rating		Scalled Technical Ratings	
	Crisp	Fuzzy	Crisp	Fuzzy
H1	4.6595	3.1736,6.4709	0.8229	0.4083,0.8326
H2	5.0541	3.4313,7.0324	0.8926	0.4415,0.9048
H3	2.5948	1.3741,4.1451	0.4583	0.1768,0.5333
H4	2.425	1.2321,3.9402	0.4283	0.1585,0.5069
H5	5.6622	3.8956,7.7724	1	0.5012,1
H6	3.4637	2.0223,5.2558	0.6117	0.2602,0.6762
H7	3.2933	1.9086,5.0075	0.5816	0.2456,0.6443
H8	4.1163	2.6774,5.8689	0.727	0.3445,0.7551
H9	4.5758	3.1192,6.7447	0.8403	0.4013,0.8678
H10	2.1254	1.2112,3.8747	0.4129	0.1458,0.4965
H11	2.6571	1.2678,3.7447	0.4225	0.1547,0.5214
H12	2.9765	1.3751,3.4578	0.4156	0.1445,0.4876

This rating also showed the same trend as the customer requirements final rating. The complexity of matching the customer requirements against the technical specification is noticeably reduced. The AI interface acts as a virtual engineer in rating the technical specifications that improved the efficiency of the deployment process. The heavy dependency on individual team members to rate in this phase was considerable reduced by the proposed interface.

Conclusion

The challenging stage of product design can be effectively done with the aid of Quality Function Deployment. Product planning is the first and most important phase of QFD in which the customer requirement data is captured and are converted to design specifications. The customer competitive rating, goal setting and improvement ratio plays a major role in finding the final importance ratings of this phase. An innovative interface encapsulating fuzzy numbers and logic, Genetic algorithm, artificial intelligence and Cuckoo algorithm is framed. This interface is exposed to a real time deployment on Sesame oil product development phase. The results generated show the credibility of proposed framework and prove that it can be extended to all the four phases of QFD.

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