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Quality Function Deployment in Tube Forming Industry: A Case Study

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Abstract—*Quality function deployment (QFD) is a customer-driven approach for processing new product developments in order to maximize customer satisfaction. Each engineering design characteristic is maximized for product performance according to the level of customer satisfaction.*

In this paper, an attempt has been made to examine the applicability of QFDas a strategic decision-making tool after the tube forming industry to determine the best marketing strategy, to make a comparison between the performances of different competitors and to transfer the experience gained from the current project to the forthcoming projects. For this purpose, a QFD team has been formed to collect and verify the expectations of the customer profile of the sample project, which was a high-rise forming industry (Suraj Tubes Pvt. Ltd) located in Nanded, Maharashtra. The case study findings demonstrated that QFD could be successfully applied in the forming industry as a strategic tool to facilitate marketing decisions. As a result of extensive literature review and the case study observations, finally critical success factorsare proposed to improve the performance of the QFD methodology in forming industry.

1. INTRODUCTION

Quality must be designed into the product, not inspected into it. Quality can be defined as meeting customer needs and providing superior value. This focus on satisfying the customer's needs places an emphasis on techniques such as Quality Function Deployment to help understand those needs and plan a product to provide superior value. Quality Function Deployment (QFD) is a structured approach to defining customer needs or requirements and translating them into specific plans to produce products to meet those needs.

While the Quality Function Deployment matrices are a good communication tool at each step in the process, the matrices are the means and not the end. The real value is in the process of communicating and decision-making with QFD. QFD is oriented toward involving a team of people representing the various functional departments that have involvement in product development: Marketing, Design Engineering, Quality Assurance, Manufacturing/ Manufacturing Engineering, Test Engineering, Finance, Product Support, etc. The active involvement of these departments can lead to balanced consideration of the requirements or "what's" at each stage of this translation process and provide a mechanism to communicate hidden knowledge - knowledge that is known by one individual or department but may not otherwise be communicated through the organization. The structure of this methodology helps development personnel understand essential requirements, internal capabilities, and constraints and design the product so that everything is in place to achieve the desired outcome - a satisfied customer. Quality Function Deployment helps development personnel maintain a correct focus on true requirements and minimizes misinterpreting customer needs. As a result, QFD is an effective communications and a quality planning tool. Quality function deployment (QFD) is a customer-oriented design tool with cross-functional team members reaching a consensus in developing a new or improved product to increase customer satisfaction. QFD starts with the house of quality (HOQ), which is a planning matrix translating the customer needs, into measurable product technical requirements (PTRs). The basic concept of QFD is to translate the desires of customers, i.e. the voice of customer, into product technical requirements (PTRs) or engineering characteristics, and subsequently into parts characteristics, process plans and production requirements. In order to establish these relationships QFD usually requires four matrices: product planning, parts planning, process planning, and production planning matrices, respectively. Product planning matrix translates customer needs into product design requirements; part planning matrix translates important design requirements into product/part characteristics; process planning matrix translates important product/part characteristics into manufacturing operations; production/operation planning matrix translates important manufacturing Operations into day-to-day operations and controls.

2. LITERATURE REVIEW

After World War II, the concept of product development evolved from copying and imitation to a product development based on originality. The importance of design quality became

apparent. This dramatic change entailed the development of a totally new concept, the QFD. QFD was first conceptualized in the late 1960s[1]. It was immediately adapted by various companies but it did not draw much public attention. A few years later, in 1972, QFD was implemented at the Kobe shipyards of Mitsubishi Heavy Industries Ltd. Even though its application was followed by successful implementations throughout Japan, e.g. at Toyota, it remained a Japanese tool until the early 1980s[1]. Each is generally defined to depend on a comparative judgment against the some standard which depends on disconfirmation of expectations. Thus dissatisfaction may be due to inherently poor service, or perhaps to competitive marketing of improved standards or changing customer tastes.

Being able to perform new product development (NPD) in a short lead time and at a minimum cost isone of core factors for improving competitiveness in the global market. As far as product planning and development decisions are concerned, the use of quality function deployment (QFD) has gained extensive international support. QFD is a widely used customer-driven design and manufacturing tool originated in Japan in the late 1960s [1]. Generally QFD utilizes four sets of matrices called houses of quality (HOQ)to relate the customer requirements (CRs) to product planning, parts deployment, process planning and manufacturing operations [2]. When organizations direct their efforts towards meeting the customer requirements (CRs), internal conflict minimizes, development cycle time shortens, market penetration increases, product quality improves, and customer satisfaction increases, resulting in higher revenues.

HOQ matrices have been frequently used in the industry to help design team undergo product planning, i.e., capture the CRs by assessing customer preferences, convert those attributes into engineering characteristics (ECs) and then determine the target levels for ECs of new/improved products to match or exceed performance of all competitors in the target market with limited organizational resources[3]. It is a complex decision process with multiple variables to determine the target levels.

In practice, it is normally accomplished in a subjective, ad hoc manner, or a heuristic way, such as using prioritization-based methods to yield feasible design, rather than an optimal one. In order to enhance the QFD methodology, developing more reasonable and effective modeling approach for product planning to determine the target values for ECs of a product, towards the maximum degree of customer satisfaction within limited recourses is usually the focus in the HOQ [4].

The customer is the person or organization receiving the outcome of the operation. The quality of the service is realized with the customer and is interpreted/perceived by the customer. The main task of service development is to create the prerequisites for services which the customer perceives to be attractive [5]. This presupposes that the company has a thorough understanding of the customer's needs, expectations and perceptions of quality in relation to cost. Quality Function Deployment (QFD), as a customer-driven tool, is generally used in the early phase of new or improved products/services design process, and therefore most of the input parameters are highly subjective in nature. The five major input components of the QFD, which are laid in the House of Quality (HOQ), namely, the customer requirement, the technical attribute, the relationship matrix, the correlation matrix, and the benchmarking information, play a central role in determining the success of QFD team[6].

Essentially, the QFD starts and ends with the customer. The Voice of Customer (VOC) is the main driver and will be propagated through all subsequent downstream processes, and as a result, greater customer satisfaction is created in the end product/service. According to a study by the two most critical factors that determine the QFD's successful use in providing definite strategic product development benefits are the high commitment of all team members in all functional areas, and the paradigm that treats QFD as a cross-functional investment in people and information [7].The QFD technique can improve the accuracy and reliability of an assessment outcome instrument. This is mainly because the QFD technique is effective in prioritizing and assigning weight to the items in the scale. This research successfully developed a reliable risk assessment scale to diagnose neck and shoulder symptoms using QFD technique. This scale was proven to have high accuracy and closely represents reality [8].

3. HOUSE OF QUALITY

The primary element of QFD, the house of quality (HOQ) is a matrix style chart that correlates Customer attributes called ``what's'' with technical characteristics called "How's." The HOQ is a kind of conceptual map that provides the means for inter functional planning and communication. It usually has six sub-matrices including customer attributes, technical characteristics, a relationship matrix, a planning matrix, technical correlations, and a technical matrix.

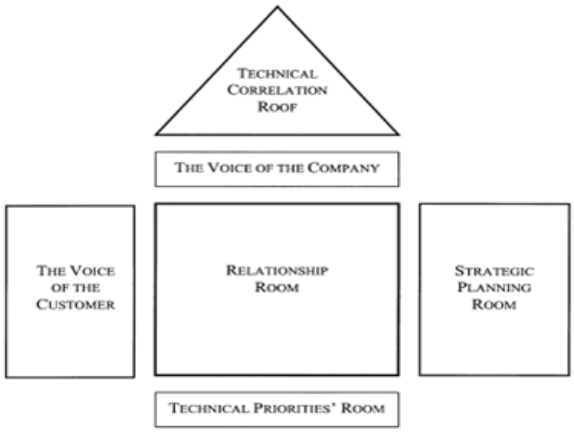

Fig. 1: House of Quality

The "voice of the customer" is the term to describe these stated and unstated customer needs or requirements. The voice of the customer is captured in a variety of ways: direct discussion or interviews, surveys, focus groups, customer specifications, observation, warranty data, field reports, etc. This understanding of the customer needs is then summarized in a product planning matrix or "house of quality". These matrices are used to translate higher level "what's" or needs into lower level "how's" - product requirements or technical characteristics to satisfy these needs. Most of the data that QFD uses are linguistic in nature. For example, customer requirements are often vague and loosely stated, such as: ``easy to use," ``safe," and ``comfortable". QFD is broadly a total quality management (TQM) implementation technique requiring clear assessment of client/end-user expectations apart from the basic needs of a project to convert them into design targets.

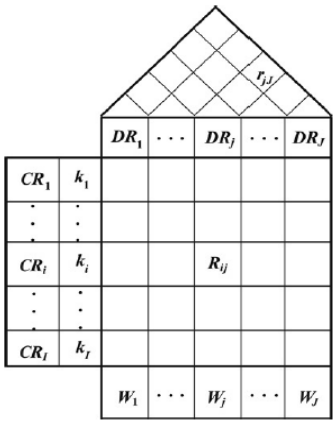

Fig. 2: QFD Format [3]

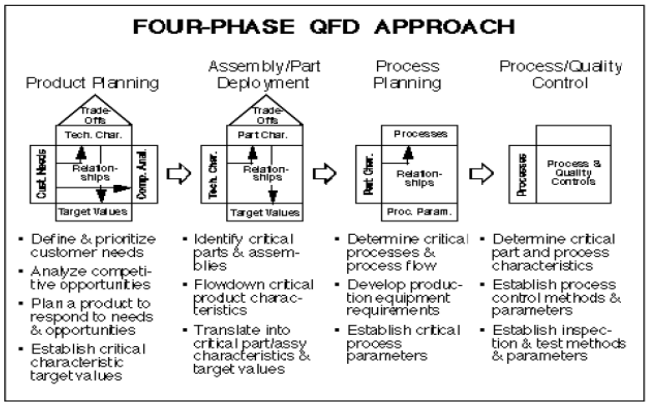

Fig. 3: Four Phases of QFD [3]

4. QFD METHODOLOGY

Once customer needs are identified, preparation of the product planning matrix or "house of quality" can begin. The sequence of preparing the product planning matrix is as follows:

I] Insure the customer needs or requirements reflect the desired market segment(s). Address the unspoken needs (assumed and excitement capabilities). If the number of needs or requirements exceeds twenty to thirty items, decompose the matrix into smaller modules or subsystems to reduce the number of requirements in a matrix. For each need or requirement, state the customer priorities using a 1 to 5 rating. Use ranking techniques and paired comparisons to develop priorities.

II] Evaluate prior generation products against competitive products. Use surveys, customer meetings or focus groups/clinics to obtain feedback. Include competitor's customers to get a balanced perspective. Identify price points and market segments for products under evaluation. Identify warranty, service, reliability, and customer complaint problems to identify areas of improvement.

III] Establish product requirements or technical characteristics to respond to customer requirements and organize into related categories. Characteristics should be meaningful, measurable, and global. Characteristics should be stated in a way to avoid implying a particular technical solution so as not to constrain designers.

IV] Develop relationships between customer requirements and product requirements or technical characteristics. Use symbols for strong, medium and weak relationships.

V] Develop a technical evaluation of prior generation products and competitive products. Get access to competitive products to perform product or technical benchmarking. Perform this evaluation based on the defined product requirements or technical characteristics.

VI] Develop preliminary target values for product requirements or technical characteristics.

VII] Determine potential positive and negative interactions between product requirements or technical characteristics using symbols for strong or medium, positive or negative relationships. Too many positive interactions suggest potential redundancy in "the critical few" product requirements or technical characteristics. Focus on negative interactions - consider product concepts or technology to overcome these potential tradeoff's or consider the tradeoff's in establishing target values.

VII] Calculate importance ratings.

XI] Develop a difficulty rating (1 to 5 point scale, five being very difficult and risky) for each product requirement or technical characteristic.

X] Analyze the matrix and finalize the product development strategy and product plans. Determine required actions and areas of focus. To maintain focus on "the critical few", less significant items may be ignored with the

subsequent QFD matrices. Maintain the product planning matrix as customer requirements or conditions change.

5. CASE STUDY: QFD IN TUBE FORMING INDUSTRY

QFD implementation we selected one medium scale Tube forming industry in Nanded, Maharastra. QFD team has been formed to collect and verify the expectations of the customer. profile of the sample project, which was a high-rise forming industry Suraj Tubes Pvt. Ltd. located in Nanded, Maharashtra. Is the one of the leading producers and suppliers of steel pipes, hollow sections, tubes and a variety of other galvanized products.

Problem Statement:

Objective:

The case study findings demonstrated that QFD could be successfully applied in the forming industry as a strategic tool to facilitate marketing decisions. As a result of extensive literature review and the case study observations; finally critical success factors are proposed to improve the performance of the QFD methodology in forming industry. Following are the some customer requirements, they collected through different customers feedback & verify it.

- Customer Requirements
    1. Robust Feature
    2. Dimensional Stability
    3. Corrosion Resistance
    4. Durability
    5. Aesthetic look
    6. Short lead time
    7. Chemical coating
    8. Cost
    9. Hardness
    10. Easy to use/ Safety
- Technical Requirements
    1. Chemical Composition
    2. Supply chain Management
    3. Tolerance
    4. Physical/ Material Properties
    5. Mechanical Properties
    6. Quality
    7. Cycle time
    8. Manufacturing Process
    9. Temperature/ Coolant
    10. Maintenance
    11. Design & Analysis.

According to above Technical & Customer requirements formed QFD's House of Quality. They are following :

Following House of Quality shows that two parameters are most important for work on it.

According to Customer requirements

1. Dimensional Stability
2. Hardness

According to Technical Requirements

1. Material Properties
2. Quality

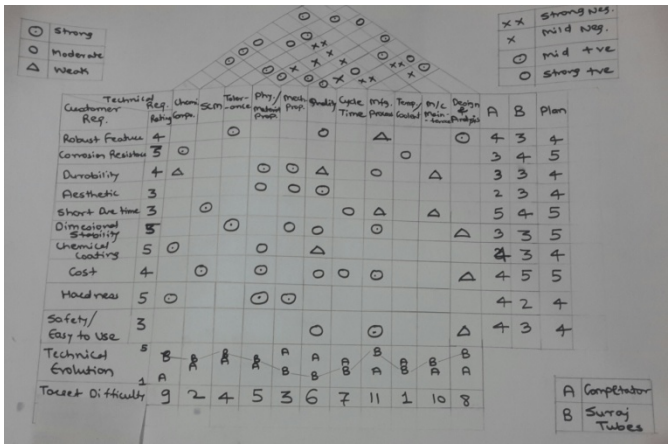

Fig. 4: House of Quality in Tube Forming Industry

6. CONCLUSION

It is observed that two main customer requirements are Dimensional Stability, Hardness.

For this, we need to fulfill other technical requirements like Tolerance, Material Properties, Chemical Composition, & Quality. Quality Function Deployment (QFD), is a customer-driven tool, is generally used in the early phase of new or improved products.

7. FUTURE SCOPE

QFD in tube forming industry improved by using Fuzzy technique.

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