

IMPLEMENTATION OF QUALITY FUNCTION DEPLOYMENT IN CONSTRUCTION PROJECTS

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Abstract— The manufacturing sector, companies have successfully applied concurrent engineering tools, including Quality Function Deployment to determine customer needs for the design at its early stages of development. Quality Function Deployment is a powerful development methodology with a wide range of applications. The main purpose of QFD in this study was to apply in construction a method of customer oriented design used in other industries. In this report, an attempt has been made to examine the applicability of QFD as a strategic decision making tool in design phase and after the construction stage of a housing project 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. The data collected for the application of QFD is for the small construction company, mainly in housing sector. The data collected for this study is in accordance with the middle class requirement.

Index Terms— Function Deployment, House of Quality, New Product Design, Product Development, Customer Needs, Voice of the Customer.

I. INTRODUCTION

Improving customer satisfaction has identified as one of the most important challenges facing businesses over the past decade. As industries and companies worldwide face increasing competition, slower growth rates, and price pressures, greater attention continues to be placed on customer satisfaction. Private business entities are looking for magic ways to improve the quality of their products and services in order to survive in the keenly competitive world. The public sector is facing similar challenges regarding the quality of products and service provided, as one of its paramount responsibilities is to ensure that the community gets maximum value from the available resources. Over the past decade, Quality has been a differentiating factor within the construction industry. It has been demonstrated that despite the constraints on quality differentiation efforts like project budget, rules and regulations etc, Many companies are competing using quality differentiation strategy and sustaining their competitiveness in the long run. Achievement of client satisfaction, however, necessitates the management

of quality systematically, which further necessitates utilization of quality tools and techniques for this purpose. Quality function deployment(QFD) is one of these techniques to deal with customer needs and expectations more systematically for achieving the most important objective of a construction company, satisfaction of clients. QFD is broadly a total quality management(TQM) implementation technique requiring clear assessment of client or end user expectations apart from the basic needs of a project to convert them into design targets. Construction facilities are usually made to order products that are based on the specific requirements of clients. These requirements are related to the ultimate need that the facility is intended to fulfil. For example , the need for office space for a business enterprise is satisfied by a building. Thus, the requirements for such a building must reflect the requirements of the ultimate need .i.e, office space, if it is to fully satisfy the client. The realization of the clients vision of proposed facility are defined and communicated to the design team.

Quality function deployment (QFD) is a quality improvement technique that deals with quality problems from the outset of the product design and development stage and assures that customers requirements are accurately translated into appropriate technical requirements and actions. The emphasis on “voice of the customer is the key to QFD. This makes good sense in the construction industry, as every construction project is unique. Each building is custom made to meet the requirements and needs of the client. As the construction matures, the ability to understand and translate the needs of the client into a finished building or product is fast becoming a prerequisite for the long term viability of a company.

II. MAIN IDEAS AND TECHNIQUES

Several factors make it difficult to present a coherent overview of the ideas and techniques of the new production philosophy. The field is young and of constant evaluation. New concepts emerge and the content of old concepts changes. The same concept is used to refer to a phenomenon on several levels of abstraction. It is not clear where to place the boundaries between related concepts.

A. NEED FOR QUALITY FUNCTION DEPLOYMENT IN CONSTRUCTION SYSTEM

Industries such as manufacturing have shown that adopting new business processes such as QFD will increase productivity and improve overall quality. Although QFD was originally intended to help manufacturing companies improve, it has also been successfully implemented with construction industry and is rapidly becoming popular. The difficulty however is how to build the technique into one of projects which are so unique they require a totally different approach to building unlike housing for example which in some respects is more sequential and methodical.

The construction of building ranges from building an extension to constructing a high rise tower. The main obstacle within construction however is the client who often requires processes carried out in their own way. As many projects are unique, so are the processes used to built them, QFD will only work in construction if team works together to mass produce buildings or design construction processes so they become more sequential . within the construction industry processes cannot be as easily changed as they can in the manufacturing industry. Many firms work on a client bespoke order basis in the future this attitude will need to be changed from a more passive role to that of a more active role where contractors etc. will need to work and cooperate more closely with clients to develop new development methods and ways of working.

Research has shown that QFD can work within the construction industry. The research looked into the impact of implementing QFD in low cost housing. This is an overall process that can become very sequential, i.e., design all the homes the same way, give all the homes the same specification. An aspect where the construction industry could improve is its ability to accurate. determine customer's requirements and successfully into plans. This paper ensure that the product is produced as quickly and efficiently as possible.

III. OBJECTIVES

- To understand the QFD technique and its step by step implementation in the planning and design phase of construction projects.
- To examine the feasibility of using QUALITY FUNCTION DEPLOYMENT as a project management tool in the planning and design phase of construction project.
- To examine the planning and design requirements of apartment building
- To develop a QFD application model that can be implemented in the design of apartment building.
- Developing a QFD application model that can be used in the planning and design of housing sector (apartment building) through a case study.

IV. DEFINITION OF QFD

Quality has been defined by its originator Yogi Akao as “a method for developing a design quality aimed at satisfying the customer and then translating the customer's demands into design targets and major quality assurance points to be used

throughout the production phase”.

QFD according to the American Supplier Institute(ASI), is defined as “A system for translating customer or user requirements into appropriate company requirements at every stage from research, through product design and developments to manufacture, distribution, installation and marketing, sales and service”.

QFD is a way of making the voice of the customer heard throughout an organization. It is a way systematic process of capturing customer requirements and translating them into requirement that must be met throughout the supply chain –Hutton (2001)

QFD is a quality improvement technique that deals with quality problems from the outset of the product design and development stage and assures that customer's requirements are accurately translated into appropriate technical requirements and actions.

QFD is sometimes referred to by other names, such as the voice of the customer or the house of the quality (HOQ). In a few words, the voice of the customer translated into the voice of the engineer.

A. BENEFITS OF QFD

The main process“ benefits of using QFD are:

- Improved communication and sharing of information with in a cross functional team charged with developing a new product. This team will typically include people from a variety of functional groups, such as marketing, sales, service, distribution, product engineering, process engineering, procurement and production.
- The identification of „holes“ in the current knowledge of the design team.
- The capture and display of a wide variety of important design information in one place in a compact form.
- Support for understanding, consensus, and decision making, especially when complex relationships and trade-offs are involved.
- The creation of an informational base which is valuable for repeated cycles of product improvement.

B. The main ‘bottom line’ benefits of using QFD are:

- Greater likelihood of product success in the marketplace, due to the precise targeting of key customer requirements.
- Reduced overall design cycle time, mainly due to a reduction in time consuming design changes. This is powerful benefits. Customer requirements are less likely to have changed since the beginning of the design projects and more frequent design cycle mean that products can be improved more rapidly than the competition.
- Reduced overall cost due to reducing design changes, which are not only time consuming but very costly, especially those which occur at a late stage.
 - Reduced product cost by eliminating redundant features and over design.

V. QFD PROCESS

Quality Function Deployment begins with product planning; continues with product design and process design; and finishes with process control, quality control, testing, equipment maintenance, and training. As a result, this process requires multiple functional disciplines to adequately address this range of activities. QFD is synergistic with multi-function product development teams. It can provide a structured process for these teams to begin communicating, making decisions and planning the product. It is a useful methodology, along with product development teams, to support a concurrent engineering or integrated product development approach.

Quality Function Deployment, by its very structure and planning approach, requires that more time be spent up-front in the development process making sure that the team determines, understands and agrees with what needs to be done before plunging into design activities. As a result, less time will be spent downstream because of differences of opinion over design issues or redesign because the product was not on target. It leads to consensus decision, greater commitment to the development effort, better coordination, and reduced time over the course of the development effort. QFD requires discipline. It is not necessarily easy to get start with. The following is a list of recommendations to facilitate initially using QFD.

- Obtain management commitment to use QFD.
- Establish clear objectives and scope of QFD use. Avoid first using it on a large, complex project if possible. It will be used for the overall product or applied to a subsystem, module, assembly or critical part.
- Establish multi-functional team. Get an adequate time commitment from team members.
- Obtain QFD training with practical hands-on exercise to learn the methodology and use a facilitator to guide the initial efforts.
- Schedule regular meetings to maintain focus and avoid the crush of the development schedule overshadowing effective planning and decision making.
- Avoid gathering perfect data. Many times significant customer insights and data exist within the organization, but they are in the form of hidden knowledge- not communicated to people with the need for this information.
- On the other hand, it may be necessary to spend additional time gathering the voice of the customer before beginning QFD. Avoid technical arrogance and the belief that company personnel know more than the customer.

Quality Function Deployment is an extremely useful methodology to facilitate communication, planning, and decision making within a product development team. It is not a paperwork exercise or additional documentation that must be completed in order to proceed to the next development milestone. It not only brings the new product closer to the intended target, but reduced development cycle time and cost in the process.

VI. DEFINING CUSTOMER'S :

- Users who are mainly concerned with functionality
- Management who is concerned with financial and strategic issues
- Sales people who are concerned with features (those items that attract attention)
- Investors who are concerned with financial issues and priorities
- Distribution and purchasing agents who are concerned with purchase transaction and availability issues
- Internal workers who are concerned with how the product/service and associated decisions will affect the quality of their life.

VII. THE HOUSE OF QUALITY

QFD is applied across all the sequential phases for developing a product / service like product/ service planning, design planning, process planning and production planning. Each phase is represented in a QFD matrix, also called as the "House of Quality".

1. The left side of the above matrix consists of the customer requirements or the voice of the customers (the what's). This is a structured list of requirements obtained through customer feedback, market research and benchmarking studies.
2. The top of the matrix consists of the organization's requirements or the voice of the company,(the how's) which is a structured set of relevant and measurable product characteristics.
3. The right side of the matrix gives the planning considerations to give the outputs (the whys). This illustrates customer perceptions observed in market surveys. Includes relative importance of customer requirements, company and competitor performance in meeting these requirements.
4. The centre of the matrix describes the relation between customer requirements and design requirements. This illustrates the QFD team's perceptions of interrelationships between technical and customer requirements. An appropriate scale is applied, illustrated using symbols or figures. Filling the portion of the matrix involves discussions and consensus building within the team and can be time consuming. Concentrating on key relationships and minimising the requirements are useful techniques to reduce the demands on resources.
5. The top most part or the triangular roof of the matrix represents the fourth phase (inter-relationships between the technical descriptors).
6. This is used to identify where technical requirements support or impede each other in the product design.
7. The bottom of the matrix indicates the targets. It is used to record the priorities assigned to technical requirements by the matrix, measures of technical performances achieved by competitive products and the degree of difficulty involved in developing each requirement. The final output of the matrix is a set of target values for each technical requirement to be met by the new design.

These are linked back to the customer's demands.

The "House of Quality" can be used as a stand-alone tool to generate answers to a particular development problems. Alternatively it can be applied within a more complex system in which a series of tools are applied for each stage of the product/service development. The outputs of the first give the product/service design specifications (the How's). These in turn form the inputs (or What's) for the second stage of development. This sequences repeats at every stage and the outputs of the fifth and final phase are the production requirements for the product/service.

THE HOUSE OF QUALITY is build up from 6 interrelated matrices:

1. THE CUSTOMER ATTRIBUTES: Describing what the product must do, a structured list of needs and wants, determined by market research. Represents the voice of the customer.

2. THE ENGINEERING CHARACTERISTICS: Describing how the product may achieve its required performance in general terms which are not solution specific. Represents the voice of the Designer.

3. RELATIONSHIPS: Between the customer attributes and the engineering characteristics, indicating where there are strong, moderate or weak relationships.

4. TECHNICAL MATRIX: Indicating the technical priorities based on the relationships between customer requirements and engineering characteristics. Also providing quantitative design targets for each of the engineering characteristics, based on the technical priorities and competitive benchmarking.

5. TECHNICAL CORRELATIONS: Recording how the engineering characteristics may be wither mutually supporting or contradictory.

6. PLANNING MATRIX: Providing quantitative market data for each of the customer attributes. Values can be based on user research, competitive analysis or team assessment.

VIII. IMPLEMENTATION OF QFD

QFD is a five-stage process that transforms customer requirements into a definite plan or schedule to produce a product/service.

- The first stage is to identify customer requirements. These include characteristics directly attributable to the product/service. For instance, parameters like how a product compares with competition.
- In the second stage, the requirements are transformed into technical specifications with the help of technical experts.
- In the third stage, the technical specifications are further to arrive at the end product specifications. Termed as „critical part characteristics“ these are both sufficient and necessary to lead to a product/service that meets customer requirements.
- The fourth stage designs processes that

convert the above specifications into product and service.

- The fifth stage comprises all activities done to produce the required output.

IX. OVERCOMES FUNCTIONAL BARRIERS

Throughout this multi-phase approach, all members of the QFD team (design, manufacturing, marketing, Quality Control) are able to understand the manner in which their individual inputs contribute to meet and satisfy customer requirements. This helps to improve and overcome inter-departmental functional barriers resulting in better communication and faster processes.

Using QFD facilitates collection of all data required to generate good production definition, design, processes, and production and delivery decisions early in projects. The data and the inter-relationships between requirements, specifications and other activities to evolve the final product/service are presented in a highly visible form and this communicates the overall plan effectively.

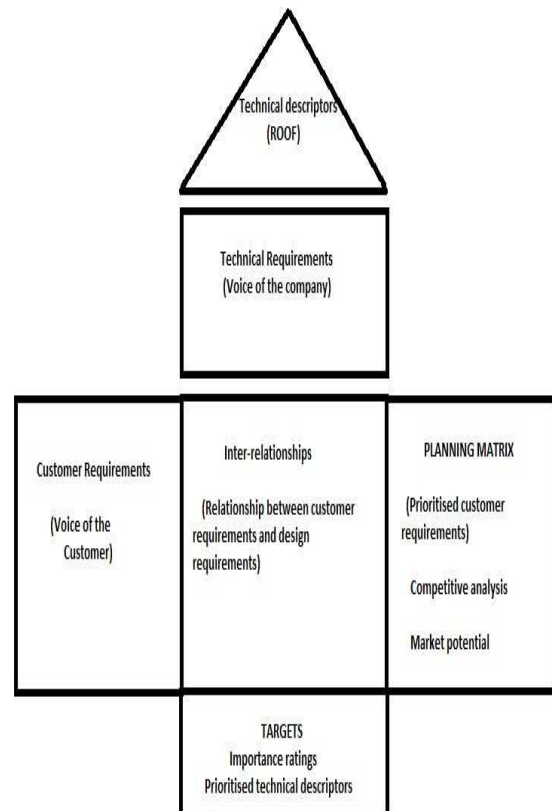


Figure: HOUSE OF QUALITY

A. MAJOR ISSUES & SOLUTIONS IN QFD

Companies that have spent the effort to really understand and apply it have achieved excellent results with it. Many other companies have merely dabbled with it or perhaps concluded that it is a series of complex matrices that take a lot of time with little to show for it.

One of the common issues with this latter group of companies is that they have not understood what QFD really is not what it can do for them. If one explores the common issues companies face with new product development, one can better

understand how QFD can fit into the development process to address these issues.

ISSUE 1: CURRENT AND FUTURE CUSTOMER NEEDS ARE NOT ADEQUATELY UNDERSTOOD.

Innovation based companies may focus on pushing a technology into the marketplace without truly understanding customer needs. Companies with existing products, assume they understand their customer needs. Or needs may rapidly evolve, but the company doesn't recognize this situation. Marketing may understand the needs, but this knowledge is not passed on to the development team.

B. QFD SOLUTION

Voice of the customer (VOC)-the effort to investigate and analyze customer needs is a prerequisite for a QFD effort. With QFD, VOC data is reduced into a set of critical customer needs using techniques such as affinity diagrams, function analysis, etc., defined and documented in customer needs data dictionary, and prioritized. This VOC effort is also the opportunity to recognized unfulfilled needs that can provide, at a minimum, competitive advantage, and potentially, a break-through product or true value innovation. A basic principle of QFD and any other system is "garbage in, garbage out". If adequate effort is not spent in understanding customer needs, the result of QFD, as well as the entire development effort, will be a less than optimum product.

ISSUE 2: THE COMPETITIVE SITUATION IS NOT UNDERSTOOD NOR ADEQUATELY CONSIDERED.

Marketing may understand the competition, but this knowledge is not transferred to the team. No formal data collection or analysis is performed. This can lead to non-competitive or me-to products or products that rapidly lose their competitive advantage.

C. QFD SOLUTION

Once customer needs are defined, the second major step with QFD is to perform competitive analysis. This includes not only analyzing current competitive strengths and weakness, but also considering future directions of competitors. It also involves mapping competitor's positions against market and demographic characteristics and against key product characteristics to recognize threats and opportunities. This analysis is a key part of planning the new product.

ISSUE 3: INADEQUATE ATTENTION IS PAID TO DEVELOPING A PRODUCT STRATEGY AND VALUE PROPOSITION.

There may be an implicit strategy understood by management, Marketing, or some team members, but not all team members understand this strategy, leading to sub optimal decisions. In the absence of competitive analysis and strategy, the team may want to exceed competitive product's performance parameters in all areas, leading to a more costly product or a risky development project. The product may be aimed at the wrong market niche or miss the opportunity that exists.

QFD SOLUTION:

A third step in the QFD process is to develop the product strategy and value proposition. The objective is to get the "most bang for the buck" out of the development effort. This strategy needs to be explicitly defined, understood and agreed to by all participants. The strategy should reflect where the team will focus its development effort to achieve the customer value proposition (e.g. improvement goals, etc.). Use of related tools such as conjoint analysis can also help to validate the value of certain capabilities to the customer.

ISSUE 4: PRODUCT REQUIREMENTS AND SPECIFICATIONS ARE NOT CAREFULLY BALANCED AGAINST NEEDS AND IMPLICATIONS.

Marketing wants it all when they create a marketing requirements document. Specification target can be arbitrarily established to exceed the competition without regard to cost or the value proposition. Inadequate consideration may be given to tradeoffs among product parameters leading to additional cost and development effort. A requirement may be established because the developer thinks it would be a good idea.

D. QFD SOLUTION

Requirements (technical characteristic) are only established in response to customer needs (stated or unstated but recognized). Technical benchmarking is performed to help understand the competitive position and establish appropriate specifications (target values). Trade-offs and cost drivers are analyzed in the interaction matrix. Risk and difficulty is considered in establishing specifications (target values). In short, there is a rigorous consideration of a variety of factors in objectively developing requirements and specifications.

ISSUE 5: INSUFFICIENT ATTENTION IS GIVEN TO DEVELOPING COLLABORATION AND TEAMWORK.

Team members are assigned and thrown together in an investigation or feasibility stage, but frequently little explicit effort is given to develop collaboration and teamwork.

E. QFD SOLUTION

QFD is a planning and decision making methodology that is performed by the product team. It forces early communication, planning and decision making among team members. It requires open sharing of information, overcoming the hidden knowledge that can otherwise plague a team. It bridges the gap between Marketing, Engineering, Manufacturing and Quality. Team member's knowledge is "levelled" through this process. The initial product planning with QFD leads to rapidly developing collaboration, teamwork, and commitment to the product strategy and plan.

ISSUES 6: IN THE RUSH TO DEVELOP A NEW PRODUCT, INADEQUATE ATTENTION IS GIVEN TO DEVELOPING AND EVALUATING CONCEPT ALTERNATIVES.

Traditional architectures, technologies, and concepts are

assumed as the basis for the new product because time is short

F. QFD SOLUTION

QFD is oriented toward defining requirements (technical characteristics in a global manner) Independent of a particular technical solution so that multiple concept alternatives can be considered and the best one selected. After the product planning matrix is completed, the QFD process includes a concept development and evaluation step with an emphasis on developing alternatives. The intent is to identify a more optimal, and perhaps even a break through solution rather than continuing with the traditional concept used for past products. QFD provides a concept selection Matrix using the requirements as a basis for decision criteria. QFD places an emphasis on innovation and providing innovative and exciting capabilities to customers.

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