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Product Based Competitive Benchmarking For Quality Improvement Using Graphical Methods And QFD

A Project Report

Submitted by

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TO WHOMSOEVER IT MAY CONCERN

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ABSTRACT

The key to business success is doing the right things faster and better and more effectively than the competitor. In order to perform it, some management and engineering tools like Benchmarking and Quality Function Deployment were used. Benchmarking is recognized as an essential tool for continuous improvement of product quality, processes and services. This paper discussed about the external benchmarking and the way of improving the quality of a product called, AUTO SWITCH.

The methodology recommended by an International Benchmarking association, is used for benchmarking of the product. Some generic graphical tools are used to compare the potential partners and provide a comprehensive profile of the partner's characters. This is for facilitating the management for a strong strategic focus and providing some flexibility in achieving the goals. A questionnaire is used to identify the customer requirement. House of quality (HOQ) correlates the identified customer attributes (What's) with the product features in a matrix form is also presented. Customer satisfaction benchmarking in QFD for quality improvement can help decision makers to identify areas for improvement. This paper used Cause and Effect diagram for analysis of the production cost.

ஆய்வுச் சுருக்கம்

தொழிலில் வெற்றி அடைவதற்கு சரியான திறவுகோலாக இருப்பது சிறப்பானவற்றை வேகமாக செய்வதிலும். சிறப்பாகவும் நம்முடைய போட்டியாளரைவிட மேலானாதாக எடுக்கும் முடிவும் ஆகும். இவ்வாறு செயல்படுவதற்கு சில நிர்வாக மற்றும் பொறியியல் உபகரணங்களான பெஞ்ச்மார்க்கிங் மற்றும் குவாலிட்டி பங்ஷன் டிபிளாய்மெண்ட் பயன்படுகிறது. பெஞ்ச்மார்க்கிங் என்பது பொருளின் தரம், செய்முறை மற்றும் சேவை ஆகியவற்றின் தொடர்ந்து முன்னேற்றத்திற்கு மிகவும் முக்கியமான உபகரணம் ஆகும். இந்த ஆய்வில் வெளி பெஞ்ச்மார்க்கிங் மற்றும் ஆட்டோ ஸ்விட்ச்சின் தரத்தை உயர்த்துதல் போன்றவைகள் விளக்கப்பட்டுள்ளது.

சர்வதேச பெஞ்ச்மார்க்கிங் கழகம் சிபாரிசு செய்த ஒரு வழி முறையை பயன்படுத்தப்பட்டுள்ளது. சில பொதுவான படவிளக்க உபகரணம் மூலம் நமது போட்டியாளர்கள் மற்றும் அவர்களின் செயல்களை அறிய முடிகிறது. இம்முறையானது நிர்வாகிகளுக்கு அதிகமான வழிமுறை மற்றும் நெகிழ்ச்சி மூலம் நிர்வாகத்தின் குறிக்கோள்களை அடைய உதவி செய்கிறது. கேள்வி-பதில் முறையில் வாடிக்கையாளர்களின் தேவைகளை அறிய முடிகிறது. ஹவுஸ் ஆப் குவாலிட்டி ஆனது வாடிக்கையாளர்களின் தேவைகளையும். பொருளின் சிறப்பம்சத்தையும் இணைக்கிறது. வாடிக்கையாளர்கள் திருப்தி அடைய பெஞ்ச்மார்க்கிங் என்பது குவாலிட்டி பங்ஷன் மூலம் பொருளின் தரத்தை உயர்த்தவும் மற்றும் எந்த பகுதியின் தரத்தை உயர்த்துவது என்று அறியவும் பயன்படுகிறது. இவ்வாய்வில் காரணங்களும் அதன் விளைவுகளும். வரைபட்டத்தின் மூலம் பொருளின் விலையையும் ஆராயப் பயன்படுகிறது.

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CHAPTER 1

INTRODUCTION

The markets today are moving fast, competition is increasing, customers are more aware and demand more, and change is occurring at an unprecedented rate. In this circumstance to survive in the next decade, organizations need to rethink their structures, products, processes, and markets. They must re-establish themselves to be quicker to market, customer focused, innovative, nimble, flexible, and be able to handle rapid change. A major weapon to face these challenges is benchmarking.

Benchmarking is defined as a continuous improvement process of measuring their products, process, services and practices against the toughest competitors to improve the quality. It is an ongoing effort of identifying and implementing world best practices that are done to get superior quality for delivering customer satisfaction. In this process of comparison, the Benchmarking team will measure the progress of the organization periodically to find out the magnitude of the performance gap and where the gap is occurring. It highlights the critical success factors as well as vital problem areas, which form the undercurrent of design of advantageous action plans. Investigation of the competitor's practices reduces the benchmarking gap as well as for improves the quality. Successful benchmarking is based on achieving several important factors and managerial behaviors.

Benchmarking encourage copying, adapting, and learning from other's best practices is becoming virtually mandatory for future success. It promotes superior performance by providing an organized framework through which organizations learn how the "best in class" do things, understand how these best practices differ from their own, and implement change to close the gap. The essence of benchmarking is the process of borrowing ideas and adapting them to gain competitive advantage.

Customer satisfaction level is one of the critical success factors for benchmarking. Customer satisfaction level is measured through listening the voice of the customer, quality function deployment (QFD) is a systematic methodology for quality improvement and product development. In this study, a questionnaire is used to identify the customer requirement. QFD can incorporate benchmarking information by extending the traditional matrix. House of quality (HOQ) correlates the identified customer attributes (What's) with the technical characteristics (How's) in a matrix form. The HOQ is a kind of conceptual map that provides a means for inter functional planning and communications. It usually has six sub-matrices including customer attributes, planning matrix, technical characteristic, relationship matrix, technical correlations, and technical matrix. Cause and effect analysis is a practical tool for cost analysis and cost reduction that complement engineering techniques to enhance target costing.

CHAPTER 2

LITERATURE REVIEW

According to Chetan (1999) Benchmarking is understand, what is the 'best' the others are doing that satisfies customers wants & at what level we are working. It further helps to plan the strategy to bridge this gap & improve oneself. It is a judgment process & it would prove vital in achieving success in global competition for an organization.

Rama Mohan (1996) suggested, Benchmarking is a new technique emerged to improve the quality of not only the products, but also processes and services. It will search for best practices in industry which will lead to get superior quality. With the growing emphasis on quality, it has got much significance in the present competitive world. To get continuous quality improvement, it is being found out to offer promising solutions. Number of step by step approaches have been given different researchers who are authorities in benchmarking.

According to Dutta (2005) Benchmarking, a term used frequently to mean a yardstick, has assumed a very special significance in today's competitive world. It is now recognized as an effective approach towards improvement in Productivity, Quality and other dimensions of performances that are determinants of competitiveness. It is an organized way of learning from others.

Anil Puri and Bali (2000) suggested, Benchmarking is the most appropriate concept and technique for this purpose. It is an ongoing effort at all levels of business of identifying and implementing world best practices, the key things that are done to deliver customer satisfaction. To achieve the required level of customer satisfaction one needs to identify the features delivered by the competitor.

According to John Bank (2003) comparing one company's performance with that of another is a reflex of TQM. Competitive benchmarking is a continuous management process that helps firms assess their competition and themselves and to use that knowledge in designing a practical plan to achieve superiority in the market –place. To strive to be better than the best competitor is the target. The measurements takes place along the three components of a total quality programme – products and services, business processes and procedures, and people.

Bhimaraya (2004) says, benchmarking is the need of the hour to improve the overall performance. Benchmarking helps in identifying areas that need improvement, further, it analyses what others are " doing right".

According to Jaffer Razmi (2000) graphical techniques have been developed for use in benchmarking partner selection, and are based on multi-attribute decision-making tools. Graphical techniques is that they allow decision makers to compare the potential benchmarking partners based on individual attributes and finally, provide a comprehensive profile of all the partners characteristics in an understandable manner.

Rama Mohan and Padmashri (1997) suggested, the benchmarking technique can be applied to increase customer service in which practices of the firm is compare with that of the practices of the competitors.

According to Shen et al (2000) QFD can incorporate benchmarking information by extending the traditional matrix. It utilizes benchmarking information primarily in the form of customer satisfaction benchmarking in the planning matrix and technical performance benchmarking in the technical matix.

CHAPTER 3

BENCHMARKING PROCESS

3.1 NEED FOR BENCHMARKING

To achieve competitive advantage, the most critical things to decide is as to which of the following strategies the business shall have to pursue.

- Cost strategy,
- Value strategy,
- Hybrid of the above two

The factors listed below need to be considered before adopting any of the above three strategies.

- Value that has to be delivered to the customers.
- Cost of the customer will have to pay for this value.
- Customer's perceptions about performance of the product(s) or value of the services provided.

3.2 OBJECTIVES OF BENCHMARKING

Following are the main advantage of benchmarking:

- Achieving competitive strength
- Understanding customer requirements and developing abilities to meet them.
- Designing, developing and implementing realistic measure of productivity.
- Establishment of ambitious performance goals.
- Continuous awareness and exploitation of business best practices.

3.3 PRE-REQUISITIES OF SUCCESSFUL BENCHMARKING

- A permanent keenly aware and committed to Benchmarking.
- Willingness to improve and change as per findings of Benchmarking.
- A realization of the fact that the state of competition is ever changing and any disregard of this fact endanger your survival.

- ❖ Willingness and honesty in sharing information with Benchmarking partners.
- ❖ Dedicated adherence to the Benchmarking process.

Willingness to seek and adopt new ideas, creativity and innovativeness for around improvement of existing process.

3.4 BENCHMARKING PROCESS STEPS

Major steps of benchmarking process which is the formalized and disciplined application of these basic steps to Improvement of company operations for the achievement business superiority are exhibited in Fig 3.1 (Anil Puri & Bali 1999)

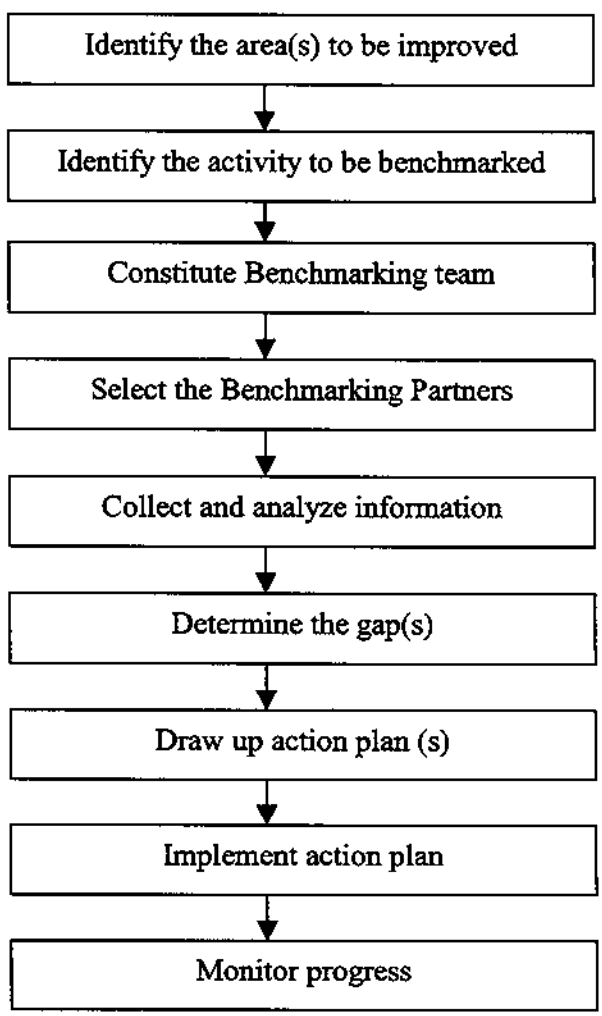


FIGURE 3.1 BENCHMARKING PROCESS STEPS

3.5 LEARNING FROM THE DATA

Learning from the data collected in a benchmarking study involves answering a series of questions:

- Is there a gap between the organization's performance and the performance of the best-in-class organizations?
- What is the gap? How much is it?
- Why is there a gap? What does the best-in-class do differently that is better?
- If best-in-class practices were adopted, what would be the resulting improvement?

Benchmarking studies can reveal three different outcomes. External processes may be significantly better than internal processes (a negative gap). Process performance may be approximately equal (parity). Or the internal process may be better than that found in external organizations (positive gap). Negative gaps call for a major improvement effort. Parity requires further investigation to determine if improvement opportunities exist. It may be that when the process is broken down into sub-processes, some aspects are superior and represent significant improvement opportunities. Finally, the finding of a positive gap should result in recognition for the internal process.

3.6 FOLLOW UP STRATEGY

The assumption that everything is going well on its way can produce dangerous results. So there should be a follow up strategy after implementing the action plan. The importance of follow up strategy can be understood from the following clues:

- Deficiencies in various activities can be sought out
- Areas creating trouble can be detected.
- Many new insights can be obtained.
- The Benchmarking process can be made more efficiency.

One should be careful about one thing that before preparing the follow up strategy all steps of Benchmarking should be reviewed carefully. (Anil Puri & Bali 1999).
Figure 3.2 shows the follow up strategy for benchmarking.

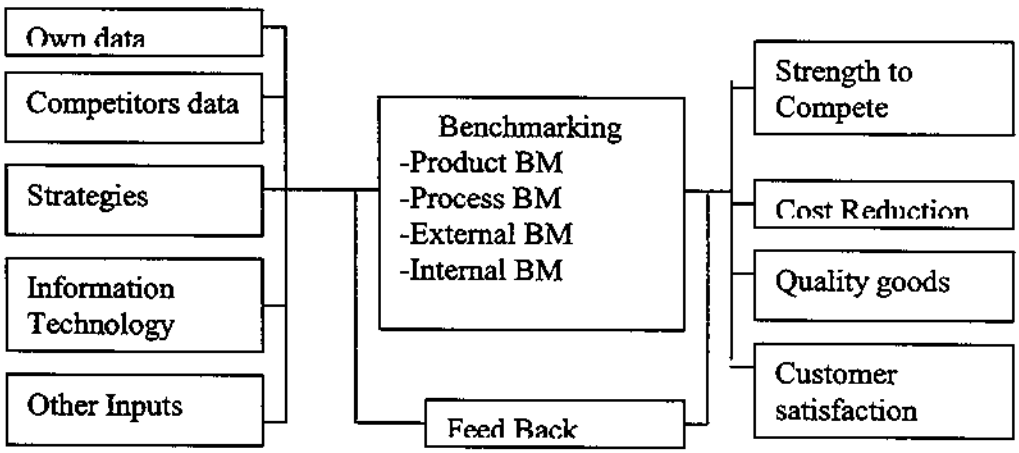


FIGURE 3.2 FOLLOW UP STRATEGY FOR BENCH MARKING

3.7 INDIAN EXPERIENCE IN BENCHMARKING

Some of the Indian firms have tried benchmarking technique to improve their corporate performance by removing problematic factors. A summary of the work areas, strategic directions, and benchmarking partners attempted is presented in the accompanying table.

TABLE 3.1 BENCHMARKING APPLICATIONS IN INDIA A SUMMARY

No	Company	Area of operation	Benchmarking Partner	Parameters of Benchmarking
1	RPG Group	35 Companies spanning seven different business Rs.5,500 –Crore group	Companies within the group	Purchase Management, Energy saving, Demand Forecasting, Value Engineering, Pricing strategy
2	City Bank	Banking Services	Non competitors Indian companies	Business Development, Human Resource Management, Environment Management, Customer service
3	Modi Xerox	Manufacturing Xerox Machines	Rank Xerox portugal	Satisfaction Level of Customer
4	Arvind Mills	Denim & Textile Makers	P & G HL Ltd	Shareholder Returns

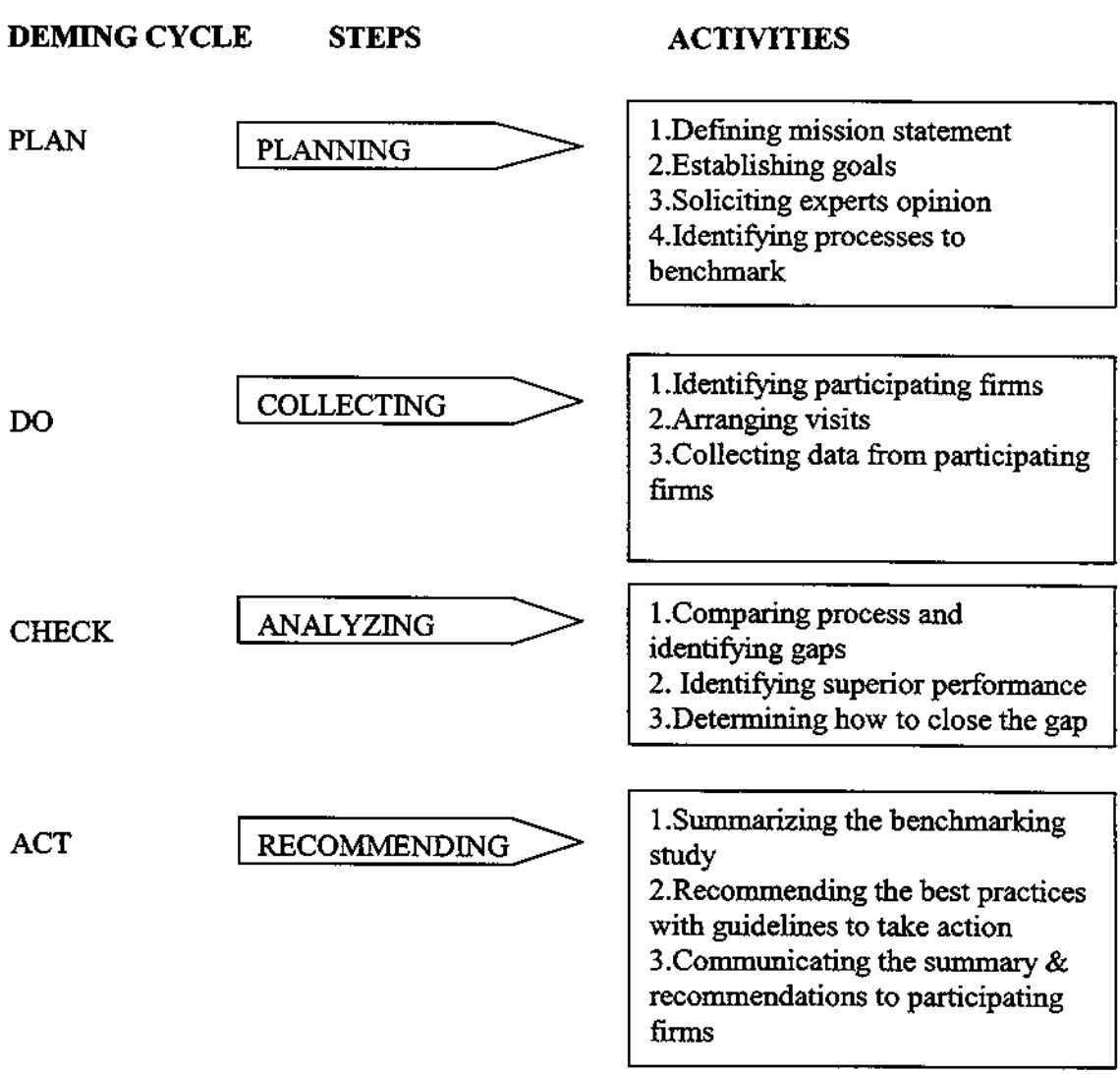


FIGURE 3.3 DEMING CYCLE

3.8 IMPLEMENTATION OF BENCHMARKING

The various steps adopted in implementing Benchmarking are as follows (Rama Mohan 1996):

1. Permission from top management
2. Creating awareness
3. Understanding present system
4. Identification of critical factors
5. Selection of competitors
6. Developing action plan
7. Feasibility analysis
8. Getting management approval
9. Implementation and Follow up

1. **Permission from top management**: Before starting the study, the Benchmarking team has to get the permission from the top management by explaining its benefits.

2. **Creating awareness**: Awareness is to be created in the middle management and to other people in the industry by explaining the benefits of Benchmarking and how the company can become competitive in the market after implementing the study.

3.**Understanding present system**: The present system should be studied thoroughly and the products that are manufactured, the processes that processes that are used to manufacture should be noted down. Quality control measures and customer needs are also to be noted.

4. **Identification of critical factors**: For conducting Benchmarking study, a product or department or a strategy or any other important factor can be selected.

5. **Selection of competitors**: Companies which are the leaders in the market are to be selected for Benchmarking. Depending on the capacity of the firm, the Benchmarking partner is selected from local level, national level or global level.

6. **Developing action plan**: There are innumerable ways to conduct Benchmarking investigations. Most data are readily and easily available. Data can be collected from the competitors itself or from consultants, dealers and experts. The company practices should be compared with the competitors practices with the help of collected data; from which best practices will come into existence. The dimensions of performance gap between the two companies can be obtained by answering the questions like why is the competitor better? How to match his superiority?

7. **Feasibility analysis**: All the findings are analysed to see whether the findings can be implemented practically and whether it is financially feasible. The new practice is whether suitable to practice in the industry or not is also studied.

8. **Getting Management approval**: The Benchmarking team has to get approval from the top management by presenting findings clearly and convincingly supported by creditable data. What will be the cost incurred and the returns are also explained to the management.

9.**Implementation and Follow up**: An action plan which will suit the organizations is developed and communicated to all employees. The old practices are to be replaced by new practices and the output is tested to find whether there is any improvement over the old product. There is to be regular follow up to see that there is no deviation from the practices.

3.9 TYPES OF BENCHMARKING

Benchmarking consists of following constituents:

1. External Benchmarking
2. Internal Benchmarking
3. Product Benchmarking
4. Process Benchmarking

3.9.1 External Benchmarking

External Benchmarking is the comparative analysis of competitors products with the companies products. Here the industry leaders can be chosen from local competitors or competitors at the National level or competitors at the Global level depending upon the capacities of the firm.

The external benchmarking is again classified as competitive benchmarking and cooperative benchmarking. The competitive benchmarking refers to collecting specific information about competitor's products, services, processes strategies and business results and marketing comparisons with those of benchmarking firms. It is useful in positioning the firm's products and services in the market place. The cooperative benchmarking focuses on sharing experiences with and identifying best

practices of organizations, which are willing to cooperate. These organizations, may or may not be direct competitors.

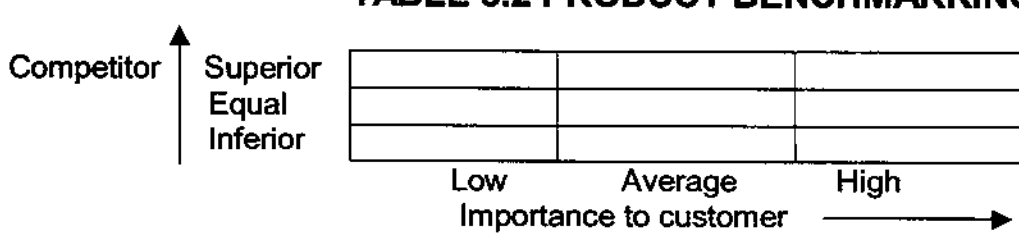
3.9.2 Internal Benchmarking

This is the comparison between functions, departments or a similar organization as a means of improving performance. The usual aim is to optimize process performance by the removal of errors.

3.9.3 Product Benchmarking

Product Benchmarking is the comparative analysis of the product performance of competitors products. Catalogues are the main sources of information. The main focus is on the capabilities of products with reference to their pricing strategies. Such comparison leads to identification of the features to be improved. Product Benchmarking generally leads to redesign of product to build into it the desired strength. To achieve the required level of customer satisfaction one needs to identify the features delivered by the competitors. Usually, a matrix of the type shown in figure is used as a part of product Benchmarking. On horizontal axis the importance to customers and on the vertical axis the quality as compared to competitors (for a specific feature of product) is plotted. The various features are plotted on this matrix, from where the attributes or features that have to be improved can be identified.

TABLE 3.2 PRODUCT BENCHMARKING



3.9.4 Process Benchmarking

Process Benchmarking refers to comparison of processes. It helps to identify the troublesome activities in the process. Thus, it leads to redesign of the process to increase the value delivered to the customer and to enhance the market share.

3.10 BENEFITS OF BENCHMARKING

The benefits that a company will get by implementing Benchmarking study are

1. If best practices are followed the customer requirements can be met easily.
2. Proper implementation of Benchmarking results in getting good quality products.
3. When customer's requirements are properly met, the sales of the company will increase which has encouraging impact on the profitability of the company.
4. There is increase in productivity of the company because of the following of best practices that are available.

The higher profitability leads to higher earnings of the employees. So their involvement in the company will become more.

CHAPTER 4

PRODUCT SELECTION - AUTO SWITCH

The company LAKSHMI ELECTRICAL CONTROL SYSTMS, Coimbatore, a public limited company of ISO 9001/9002 accredited more popularly recognized as LECS was set up in the year 1981. LECS is a part of 1000 crore LMW group which is the third largest manufacturers of textile machinery in the world. LMW group is know for its quality of products and fine engineering practices.

The manufacturing products of LECS are switchgears, control panels for textile machines, plastic components, CNC systems, DOL sorters, star-delta starters, motor panels, contactors, limit switches and relays. The company can design & produce any type of panel board.

Quality Policy of the company is LECS provides value and satisfaction to the customer specification and requirements, baked by optimum after sales and services. This is achieved through a systematic training, development, and excellent motivation of the employees. To this end the company has established and is maintaining quality systems on documented policy.

4.1 PURPOSE OF AUTO SWITCH

Auto switch is a Electronic product which is used to protect the motors used in Pump Industries.

This device protects motor during the following occurrences:

1. Single phasing prevention
2. Reverse sequence prevention
3. Unbalance protection
4. Auto and Manual option

4.1.1 Single Phasing Prevention

As long as the motor is operating on 3 Phase Voltage, the coil of the motor will remain in a healthy condition. If any phase of the 3 Phase supply fails or disconnected due to any reason, the motor could still continue to run on 2 Phase Volage. This is dangerous as it results in over current and burden to the coil of the Motor leading to a burnout. LECS Auto Switch will prevent such single phasing within 4 seconds and disconnects to protect the motor.

Single phasing prevention

		Disconnected Phase Details			
R	Y	B	RY	YB	BR
P	P	P	P	P	P

4.1. 2 Reverse Sequence Prevention

If the 3 phase supply is connected in a wrong sequence (YRB,BRY,RBY), reverse voltage would passes through the coil and the Motor runs in the reverse direction. Accidental happening of such reversal can cause damage to the equipment connected to the motor. LECS Auto Switch senses such a condition and prevents the motor to start and run. It will allow the motor to start only when the motor is connected with proper sequence (RYB).

Reverse Sequence Prevention

	Reverse Phase Details	
YRB	BYR	RBY
P	P	P

4.1.3. Unbalance Protection

This feature will protect the Motor from Voltage unbalances between the phases (>60V).

5.3.1 Shaded circles to portray scorecard-type result

This is a technique offers a more visual presentation of the result. Instead of writing the outcomes of each alternative in the matrix in number format, those outcomes will be presented here by shaded circles. In this case the alternative with more shaded areas is considered the best. This method offers a more understandable interpretation as it is visually based. Table 5.1 illustrates the outcomes for three alternatives and attributes.

5.3.2 Alternatives to alternatives scorecard

A scorecard is a matrix in which alternatives (the alternatives can be considered potential partners/candidates) are shown in the first row and attributes are shown in the first column, and the outcomes of each alternative are described by number between 0.00 to 10.00 with respect to each attribute. Then the easy of interpretation of the scorecard, the best alternative for each attribute is highlighted by symbol and/or color. If the user would like to determine their own organisation's rank amongst those best practices, arbitrarily, they can place the described number for their own organisation in the first row. In this manner, in one glance the best practice performer can be highlighted based on any chosen attribute. Furthermore, the weaknesses and strengths of the organisation can be revealed. Table 5.2 shows the matrix of results for three alternatives and four attributes.

TABLE 5.2 ALTERNATIVES TO ALTERNATIVES SCORECARD

No	Product	Flexibility	Price	Serviceability	Product feature
1	Our company	6.8	5	8.1	7.5
2	Competitor I	3.1	7.5	7.5	5.6
3	Competitor II	3.1	10	5	4.5
4	Competitor III	3.1	10	5	4.1

TABLE 5.1 SHADED CIRCLES TO PORTRAY SCORECARD

Factor	Attributes	Our company	Competitor I	Competitor II	Competitor III
Flexibility	Air circulation holes in enclosure				
	Flexibility: 1.Switch position				
	2. Button type				
	Power supply & control board				
Price	Price (Rs)				
Serviceability	Dimensions (mm)				
	Weight (gms)				
	Mounting (Din,Screw)				
	Easily separate, trouble shoot				
Product feature	Standards conforms to IEC-61000-4-2,3,4,5,8				
	Types of Auto switch				
	Fault Identification time (sec)				
	Power ON & healthy LED indication				
	On Delay Time (min) for restart				
	Enclosure Material				
	Auto/Manual Indication				
	Surge & in rush current protection				
	Single phase prevention				
	Reverse sequence protection				
	Unbalance between phases				
	Ambient temp. range				

5.3.3 Ranking the alternatives

In this technique, candidates are compared in pairs against each different attribute or decision criterion. For each attribute, the organization must decide which of the two candidates being compared is more advanced. The preferred alternative gets allocated one full score, and in case of a tie, half point is given to each alternative. When all alternatives (company) have been compared based on all individual attributes, the results are summarized by a chart. The candidate with the higher rank will be selected as the partner of choice. In the example provided, our company is the best organization based upon the chosen attributes.

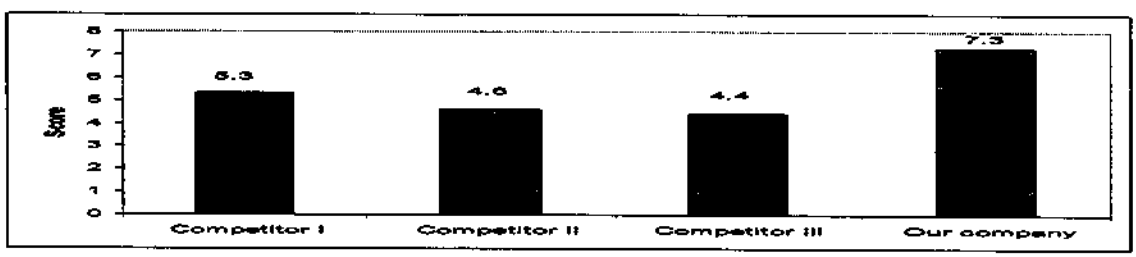
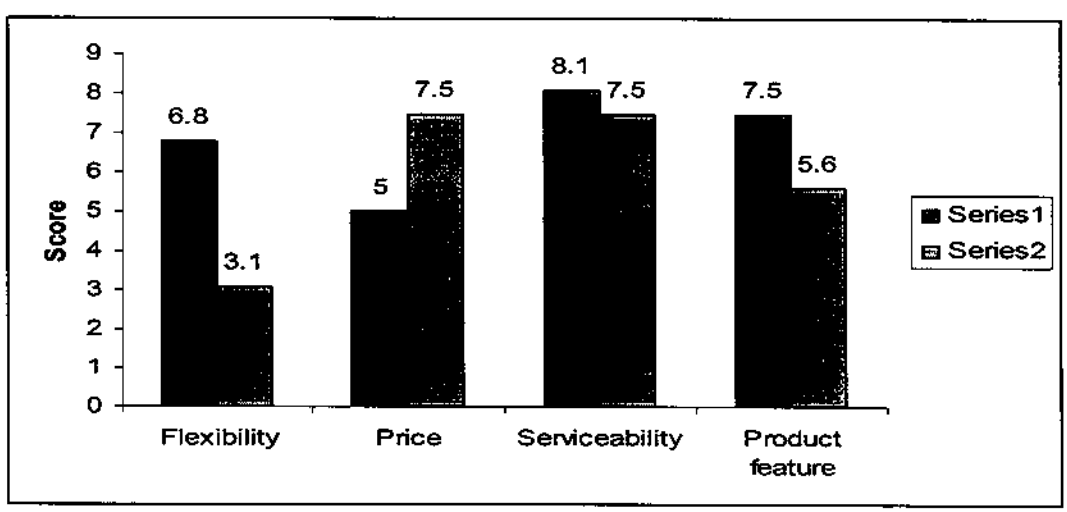


FIGURE 5.2 RANKING THE ALTERNATIVES



Note: Series 1(our company), Series 2(Competitor I)

FIGURE 5.3 COMPARISON OF PERFORMANCE

5.4 USE OF HIERARCHICAL BENCHMARKS

Benchmarking is a useful tool when products with the best-in-class features are used for comparison purposes. Best-in-class refers to the best product or service in a similar price classification and market segment. On the other hand, it is never easy to achieve world-class performance. Although in the long run to be world-class is the goal and should be included in a company's vision statement, it may be unrealistic for a product or service to achieve the same level of performance by merely comparing against world-class companies, especially for most small to medium-sized enterprises.

The use of hierarchical benchmarks proposed in this paper may provide a step-by-step method to approach/realize the eventual goal of becoming best-inclass. Using this method, different benchmarks can be selected from various categories, each of which belongs to a different hierarchy. For example, benchmarks can be based on local-class, regional-class, and world-class categories. When measuring customer satisfaction, customers are likely to be more satisfied with products or services provided by world-class than local class companies.

By using hierarchical benchmarks in customer satisfaction benchmarking, one company can easily locate its corresponding position in terms of customer satisfaction performance, e.g. local-class, regional-class, or world-class. It can also help identify a company's strengths and weaknesses compared to competitors in each hierarchy; that is, the company can have a clear idea on the customer satisfaction gap between its own and local-class, regional-class, or world-class. Furthermore, being able to reach one target class and set another higher class as its next goal can help the company gain more confidence that it is moving correctly towards world-class performance. Hence, this method should help the company identify areas for improvement from both short-term and long-run perspectives and provide a road map to world-class performance.

Under different circumstances, a company will focus more on certain benchmarks from various hierarchies for customer satisfaction benchmarking. That is, the weights given to different hierarchical benchmarks will be different. For example, if customers perceive one company's product somewhere between local-class and regional-class, then it may consider regional-class as the most important benchmark. However, when it performs worse than local-class in terms of customer satisfaction, it may focus more on the local-class benchmark. Here suppose that the weights of each hierarchy are determined. Let Wl, Wr, and Ww denote the weights given to local-class, regional-class, and world-class respectively, and Sown, Sl, Sr, and Sw represent the customer satisfaction levels to the product provided by the company itself, local-class, regional-class, and world-class respectively (see Table 5.3).

TABLE 5.3 HIERARCHICAL BENCHMARKS

	Local	Class Regional	World
Weightage	Wl	Wr	Ww
Customer satisfaction performance	Sl	Sr	Sw

5.4.1 Types of Hierarchical Benchmarks

Two methods can be adopted for utilizing benchmarking information based on hierarchical benchmarks, namely

1.Aggregate benchmark

2.Principal benchmark.

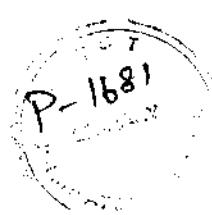
When using aggregate benchmark method, all the information from different hierarchies will be taken into consideration. For target setting, decision-makers should consider both customer satisfaction degrees to the company's product Sown and the overall customer satisfaction performance, which can be computed as

Sagg = SlWl + SrWr + SwWw. This is provided that sufficient resources are given, as customer satisfaction performance in each hierarchy needs to be evaluated. Under principal benchmark method, decision makers usually only consider the competitor in a particular hierarchy which receives the highest weight age, i.e.

Spri = max{Sl Sr Sw}. For example, if the company decides to focus more on regional-class benchmarks, that is Wr is much greater than Wl and Ww, only Sown and Sr should be obtained from customer satisfaction survey. They will be taken into consideration when setting the future customer satisfaction performance. The first method will provide more information, but the second one requires less time and effort.

TABLE 5.4 PRINCIPAL BENCHMARK.

	Our company	Competitor I
Small size	4	5
Light weight	4	5
Reasonable cost	3	4
Indication: 1. Auto/Manual 2. Power ON & Healthy	5	0
Mounting	4	2
Types: 1. For Motor 2. For Compressor	5	5
Heat Dissipation	4	0
Fault Identification Time (sec)	5	4
ON Delay Time for Restart (Min)	4	4
Surge & inrush current protection	4	4
Serviceability	4	3



CUSTOMER QUESTIONNAIRE FORM

(NB: Please tick the relevant box Product: Auto Switch)

1. What is the operating voltage do you required?

   ☐ 110V ☐ 230V ☐ 440V

2. What is the preferable weight of a product when you are going to buy?

   ☐ 250 –300 g ☐ 300 –350 g ☐ 350 – 400 g

3. What are the indications do you required for easy visibility of a error occurrences?

   ☐ Trip Indication ☐ Power ON Indication ☐ Both

4. Which types of timer do you use in your application?

   ☐ ON Delay ☐ OFF Delay

5. What will be your ambient temperature range of your product?

   ☐ -20 to 70 ☐ -45 to 55

6. What type of mounting do you need?

   ☐ Screw ☐ Din rail ☐ Both

7. For what type of applications this product is suitable?

   ☐ for Motor ☐ for Compressor ☐ Both

8. What will be the range of amount do you spend for this product?

   ☐ Rs 300 – 350 ☐ Rs 350 – 400 ☐ Rs 400 – 450

9. In which mode heat dissipation can be overcome?

   ☐ Air circulation holes ☐ Fan provision

10. How the timer setting can be performed?

    ☐ Manual setting ☐ Auto setting ☐ Company

11. What will be the Guarantee period for the product?

    ☐ 3 Months ☐ 6 Months ☐ 1 Year

12. For how many days do you wait for servicing the product?

    ☐ 2 days ☐ 5 days ☐ 10 days

6.4 CUSTOMER SATISFACTION BENCHMARKING IN QFD

To a large extent, the quality of product or service is ultimately judged in terms of customer satisfaction. There are direct linkage between providing customer satisfaction and a superior financial and competitive position. Understanding and meeting customer satisfaction is one of the pillars of achieving speed-to-market for manufacturers. The cost of customer dissatisfaction could be very high. Thus, customer satisfaction is considered as an important goal of an organization, and the satisfied customer is one of its key assets.

Customer satisfaction level is one of the critical success factors that are candidates for benchmarking. QFD can incorporate benchmarking information by extending the traditional matrix (Shen et al 2000). It utilizes benchmarking information primarily in the form of customer satisfaction benchmarking in the planning matrix and technical performance benchmarking in the technical matrix. It is clear that comparison with the competition can identify opportunities for improvement. Based on the customer satisfaction degree to both the company and competitor's products, a goal is to be decided to show the target for meeting each customer attribute.

Customer satisfaction benchmarking is a continuous process of evaluating current performance, setting goals for the future, and identifying areas for improvement. The customer satisfaction benchmarking process in QFD is shown in figure. It should be particularly noted that customer satisfaction benchmarking in QFD is a never ending process. Through this never ending benchmarking, continuous quality improvement can be achieved. It is important to determine if performance improvement really happens after implementing customer satisfaction benchmarking. The effectiveness of the benchmarking process in changing customer's perceptions can be measured through customer satisfaction questionnaires. By comparing the difference between customer satisfaction before and after benchmarking is implemented, it is easy to identify whether the target has been achieved.

1. Customer identification
2. Customer needs acquisition
3. Competitor identification
4. Questionnaire design
5. Data collection
6. Data analysis
7. Strategic decision
8. Implementation

continuous Improvement

TABLE 6.1 CUSTOMER SATISFACTION BENCHMARKING

1 – 5 Scale		Importance	Customer Satisfaction Benchmarking			
			Our company	Competitor I	Competitor II	Competitor III
Customer Attributes	Small size	3	4	5	3	3
	Light weight	3	4	5	2	3
	Reasonable cost	5	3	4	5	5
	Indication: 1. Auto/Manual 2. Power ON & Healthy	5 5	5 5	0 0	0 0	0 0
	Mounting	3	4	2	2	2
	Types: 3. For Motor 4. For Compressor	4 4	5 5	5 5	5 5	5 5
	Heat Dissipation	4	4	0	0	0
	Fault Identification Time (sec)	5	5	4	3	2
	ON Delay Time for Restart (Min)	5	4	4	3	3
	Surge & inrush current protection	5	4	4	0	0
	Serviceability	4	4	3	3	3

CHAPTER 7

QUALITY FUNCTION DEPLOYMENT

7.1 HISTORY OF QFD

TABLE 7.1 HISTORY OF QFD

Year	Contributors/ Organization	QFD-evolution	References
1966	Kiyotaka Oshimi, Bridgestone Tire Company	A process assurance item table was presented to link the Quality Characteristic to the process factors	Oshimi,1966
1972	Yaji Akao	Hinshitsu Tenaki Japanese word It means Quality Deployment	Akao, 1972
	Kobe Shipyards of Mitsubishi Heavy Industry	Parallel works were going on in this industry and quality charts were used for improving quality	Nishimura, 1973 Suzuki, 1972
	Yaji Akao	Quality Function Deployment	Mizuno and Akao, 1978
1975	Formation of Computer Research committee (CRC) headed by Akao	Japanese Society for Quality Control (JSQC) formed this committee to improve the quality	Akao and Mazur,2003
1978	JSQC	CRC had been renamed as QFD Research group	Akao and Mazur,2003
	Mizuno and Akao	Published a book on QFD	Mizuno and Akao,1978
1983	American Society for Quality Control (ASQC)	Akao published an article in ASQC journal and it had been introduced in America	Akao and Mazur 2003
1987	JSQC	A final survey report of QFD application among 80 Japanese companies was published. The various purposes of QFD were mentioned in the report	Akao et al,1987
	Japanese Standards Association	1000 QFD case studies were published	Akao and Mazur,2003
1993	Yaji Akao	Formation of QFD institute	Akao and Mazur,2003 and www.qfdi.org
1994	Japanese Union of Scientists and Engineers	A book on QFD was published	Akao and Mazur, 2003

QFD was conceived in Japan after second world war when the country moved itself to designing the products by originally from copying and modifying the existing products. Yaji Akao's contributions to integrate the customer's need into the product Planning had led to the birth of QFD.

7.2 WHAT IS QFD?

" No matter how effectively a company meet the initial needs of its customers, it must remain constantly alert and responsive to its customer's continuing wants and needs. If the company is not responsive to these changing needs, the passage of time will erode its early advantages"-American Supplier Institute (ASI).

The American Supplier Institute (ASI) teaches an approach based upon the "House of Quality". It is a four-phase approach (See Figure 7.1) in which a QFD team deploys customer requirements into product characteristics, product characteristics into part characteristics, part characteristics into process characteristics, and finally process characteristics into production characteristics.

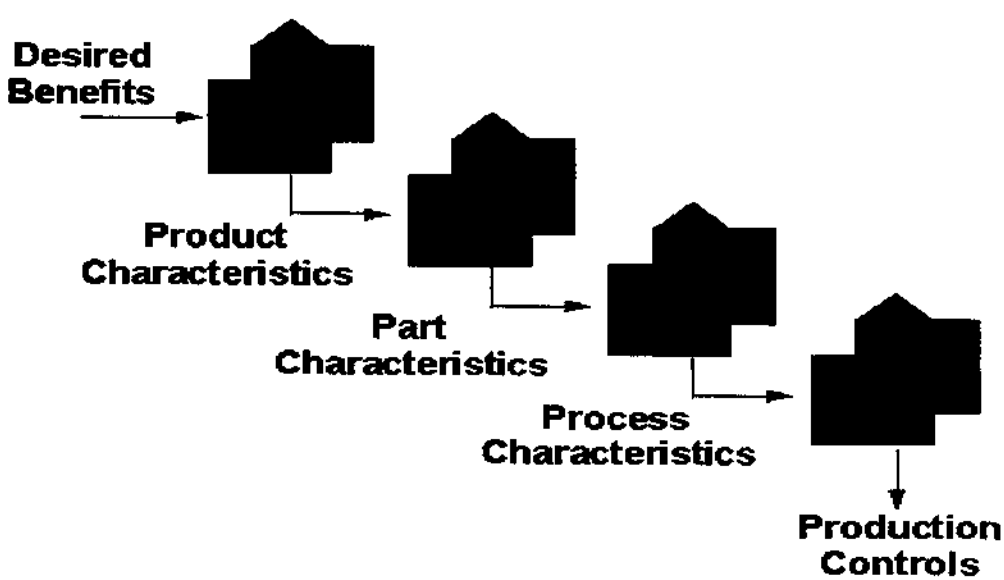


FIGURE 7.1 ASI FOUR PHASE APPROACH

Quality Function Deployment (QFD) is a process – a methodology – for planning products and services. It seats with the voice of the customer; this is the input. The customer's wants and needs become the drivers for the development of requirements for the new or revised products or service. The QFD process requires a number of inputs and decision that are best done through teamwork. Because of this, the process tends to remove many of the functional barriers that develop in large organizations, thereby helping to merge marketing's knowledge of the customer with product engineer's needs to know the customer's requirements. Figure 6.2 shows the benefits of QFD.

The companies that decide to use the QFD method find that they must

- Determine the voice of the customer and
- Examine the company response to this voice through an organized team approach.

In effect, this links the company to its customers. The organization works more cooperatively and the new product or service has increased potential for satisfying its ultimate customers. 25,000 professionals and over 500 companies have realized major improvements in client satisfaction using QFD, achieving:

- A method to "design-in" quality proactively
- Reduced changes in product/process development
- Identified need for changes before making major expenditures
- Reduced product development time
- Fewer start-up problems
- Reduced field problems
- Reduced warranty costs
- Creation of a design knowledge base
- Integrating the "Voice of the client" into the development process

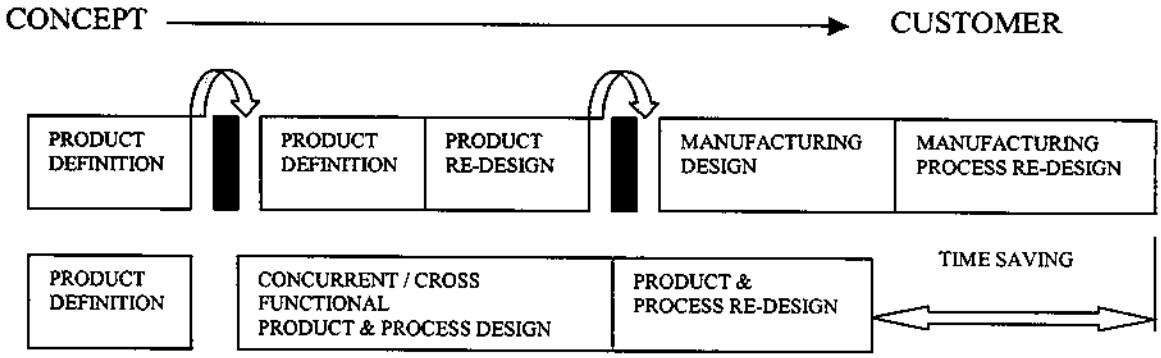


FIGURE 7.2 BENEFITS OF QFD

Before QFD	After QFD
Individual Work	Cross – Functional Teams
Some client Focus	Intense client Focus
"Over the Wall" Development	Supports Simultaneous Engineering
Poor Documentation	Supports Integrated Product Development
Poor Communication	Better Communication / Documentation

Main benefits:

- Improved client Satisfaction
- Reduced Development Time
- Improved Internal Communications
- Better Documentation of key Issues

QFD can be defined as " a system for designing a product or service based on customer demands and involving all members of the product or supplier organization". It enables organizations to be proactive rather than reactive in product design. Through the structured QFD process, the design team is forced to consider what the customer wants, then identify possible ways of achieving that end rather than concentrating on technical aspects of design. There are four phases in a QFD exercise: product planning, component deployment, process planning, production planning. These phases help in channeling design towards customer satisfaction.

" Each phases has a matrix consisting of a vertical column of what's and a horizontal row or how's. What's were the customer requirements; how's are ways of achieving

them. At each stage, the how's that is most important require new technology, or high risk to the organization are carried to the next phase. The result is a better design, shorter product development cycle, better product quality, and lower cost.

7.3 WHY QFD IS CAPTIVATING IN QUALITY ENGINEERING?

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. 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 interview, 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.

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 in quality engineering (QE).

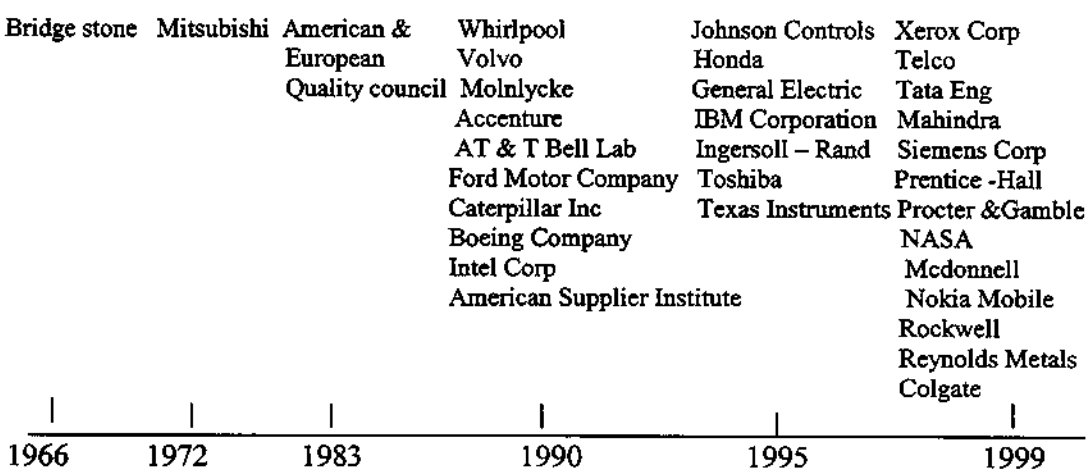


FIGURE 7.3 GLOBALLY WELL KNOWN QFD COMPANIES

7.4 CACHET OF QFD IN INDUSTRIES

Speaking to a media report on Nov 6, 2002. R. Gopalakrishnan Executive Director, Tata Sons said as follows "Promote multi-functional customer contact on a systematic basis", it is so common to see salespeople as being functionally responsible for customer contact and markets. Based on their feedback, design and development teams would deal with customer problems. Wrong all the way.

Sales people have their own limitations and biases – and anyway, customer contact is not their exclusive preserve. Let me share the Telco experience, when the company went through a life-threatening loss situation during the last two years. Telco was that many engineering monoliths tend to be –engineer- dominated, not always savvy to the customer, operating in silos seeking functional excellence, and proud.

Today, Telco is a vastly different organization –listening to customers, operating its sales force to market segments. During the last 18 months, the Panthers, a team of over 250 plant engineers, have worked in the marketplace during 3-6 months projects few even made career shifts. As part of a customer – driven New Products Process, the company's new Quality Functional Deployment (QFD) teams included thirty engineers from plant and Engineering Research. The company even deployed 500 plant engineer's man weeks to assist in a augmentation of the dealer network! That is, in my view, a great example of making everybody's business.

QFD was introduced at Volvo Care Corporation in 1988 and since then they have carried out more than 50 projects. Volvo projects are classified in three categories: product improvement, minor innovation, and innovative (Ekdahl and Guestafsson, 1997). Most of the QFD projects at Volvo belong to the product improvement category. The objective of these projects is generally to improve the existing products; one example of the use of QFD for product improvement at Volvo was the enhancement of the transmission system in 1993 for Volvo 850. The QFD project resulted in several changes being introduced in 1996 and the effect on customer satisfaction was almost immediate. The number of customer complaints related to the manual gearbox was reduced by more than 50%. Another example is the improvement of seat belts. An example of a minor innovation project was the introduction of a three point belt in the middle, instead of the traditional belt around the waist. An innovative project was the example of the environmental concept car. The mission of the project was to develop a vehicle that would fulfill California's strictest environmental laws while meeting Volvo's corporate and customer

requirements and expectation. The result of the project was the development of a four-seated vehicle with two different power suppliers, one electrical and one hybrid.

Whirlpool Sweden started to apply QFD in the end of the 1980's with ten full scale QFD projects. Only the house of quality matrix is used at Whirlpool. After experiencing, few products were conducted on a subsystem level, a large project was developed. The largest project was the development of the VIP 34 microwave oven. Whirlpool wanted to develop a completely new microwave oven with large oven capacity and small outer dimensions. The project was divided into 10 subprojects. Each subproject team was responsible for developing a house of quality for a specific attribute of the oven such as safety, microwave system or oven door. Later on, the results from the different teams were combined into one large house of quality with about 30 customer needs and over 70 quality characteristics. Due to the extent and complexity of the application, a number of difficulties have emerged from the VIP 34 projects. So, the company decided to use QFD for smaller projects.

The main advantage of QFD at Whirlpool were the systematization and structure in the product development process. Another aspect was the improved documentation of the development projects. Further, the practitioners at whirlpool emphasized that the results benefit from having a constant focus on the customer during product development. The drawbacks were related to the amount of time needed to complete the house of quality. Other problem experienced at the company regards communication of results to people who were not familiar with the QFD method and how the information should be interpreted.

Molnlycke introduced the method QFD within product development process in 1990. The primary purpose at the company was to create a common platform for understanding the customer throughout the entire company. The method has been used for several different products in a wide range of markets. Some example of products where Molnlycke used QFD in the development activities are baby diapers and feminine towels. The company has only used the house of quality. For

Molnlycke, the most important benefit of QFD has been the possibility of creating a shared understanding in the entire company of who the customers are and what their expectations will be. Another important advantage of QFD experienced at Molnlycke is the possibility of reusing results from prior projects in the early phases of new product development projects. One of the difficulties is related with obstacle of reaching beyond the first matrix. The company considered as the main reason for this the lack of suitable methods for evaluating the engineering characteristics specific for Molnlycke different products. Although the company frequently stated the reuse of results from early projects, it should take care when using the house of quality for many years since customer requirements are not constants and they vary with time as pointed out by, AKAO (1996). Finally, the company has also come to realize that even though QFD can contribute substantially to the product development process, other tools are also necessary to be truly successful.

North Press Metal (NPM) is a 42-Year-old Pennsylvania-based powdered metal products manufacturer. NPM manufactures and markets gears, bearings, housing, frames and various other special purpose mechanical parts. Their customer base is entirely including first and foremost the big auto firms, as well as major appliance manufacturers and most US machine tool makers. US and German powdered metal firms which are very similar to NPM and the encroachment of nylon and thermoplastic substitute products. NPM overcome the competitive by adopting the systematic way to translate strategic objectives into specific manufacturing actions plans by using QFD methodology. The gap between manufacturing and corporate strategy was bridged through the use of QFD.

In this one of the QFD differences between the companies in Japan and in the USA was that the American companies were more apt to use the phases of quality deployment popularized by the American Supplier Institute (ASI). Comprehensive QFD that originated with AKAO (1996) was more often used by Japanese companies; another issue is concerning the QFD teamwork. In 83 % of American QFD users use cross functional teams which involves, in about 55% of companies, members from

more than five different company functional areas. Surprisingly, Japanese companies which have tradition of working in teams, have lower levels of using cross functional companies which have tradition of working in teams, have lower levels of using cross functional teams (in a bit more than 53% of users) compared with the American companies. Additionally, more than five members were present in the teams in nearly 30 % of users.

7.5 QFD AND THE PRODUCT DEVELOPMENT PROCESS

Quality Function Deployment is a powerful tool to plan products and their specific characteristics and required manufacturing processes. It starts with capturing the voice of the customer (VOC) and next performs competitive analysis as a basis for planning specific technical characteristic of a product to maximize customer value. In addition to provide a rigorous approach to planning, QFD facilitates product team communication and collaboration. QFD uses a series of matrices to document information collected and developed and represent the team's plan for a product. The QFD methodology is based on a system engineering approach consisting of the following general steps.

1. Derive top-level product requirements or technical characteristics from customer needs (Product planning Matrix)
2. Develop product concepts to satisfy these requirements.
3. Evaluate product concepts to select most optimum (Concept Selection Matrix)
4. Partition system concept or architecture into subsystem or assemblies and flow-down higher –level requirements or technical characteristics to these subsystems or assemblies.
5. Derive lower –level product requirements (assembly or part characteristic) and specifications from subsystem/assembly requirements (Assembly/Part Deployment Matrix)
6. For critical assemblies or parts, flow-down lower-level product requirements (assembly or part characteristic) to process planning.

indicator of future needs. Plan who will perform the data collection activities and when these activities can take place. Schedule activities such as meetings, focus groups, surveys, etc.

2. Prepare for collection of customer needs. Identify required information. Prepare agendas, list of questions, survey forms, focus group/user meeting presentations.

3. Determine customer needs or requirements using the mechanisms described in step 1. Document these needs. Consider recording any meetings. During customer meetings or focus groups, ask "why" to understand needs and determine root needs. Consider spoken needs and unspoken needs. Extract statements of needs from documents. Summarize surveys and other data. Use technical such as ranking, rating, paired comparisons, or conjoint analysis to determine importance of customer needs. Gather customer needs from other sources such as customer requirement documents, customer meetings/interviews, focus groups, product clinics, surveys, observation, suggestions, and feedback from the field.

4. Use affinity diagrams to organize customer needs. Consolidate similar needs and restate. Organize needs into categories. Breakdown general customer needs into more specific needs by probing what is needed. Maintain dictionary of original meanings to avoid misinterpretation. Use function analysis to identify key unspoken, but expected needs.

5. Once needs are summarized, consider whether to get further customer feedback on priorities. Undertake meetings, surveys, focus groups, etc. to get customer priorities. State customer priorities using a 1 to 5 ratings. Use ranking techniques and paired comparisons to develop priorities.

7.7.3 Technical Information Portion

1.Organize customer needs in the product planning matrix. Group under logical categories as determined with affinity diagramming.

2. Establish critical internal customer needs or management control requirements; industry, national or international standards; and regulatory requirements. If standards or regulatory requirements are commonly understood, they should not be included in order to minimize the information that needs to be addressed.

3. State customer priorities. Use a 1 to 5 rating. Critical internal customer needs or management control requirements; industry, national or international standards; and regulatory requirements, if important enough to include, are normally given a rating of "3".

4. Develop competitive evaluation of current company products and competitive products. Use surveys, customer meetings or focus groups/clinics to obtain feedback. Rate the company's and the competitor's products on a 1 to 5 scale with "5" indicating that the product fully satisfies the customer's needs. Include competitor's customer input to get a balanced perspective.

5. Review the competitive evaluation strength and weaknesses relative to the customer priorities. Determine the improvement goals and the general strategy for responding to each customer needs. The improvement factor is "1" if there are no planned improvements to the competitive evaluation level. Add a factor of .1 for every planned step of improvement in the competitive rating, (e.g., a planned improvement of going from a rating of "2" to "4" would result in an improvement factor of "1.2". Identify warranty, service, or reliability problems & customer complaints to help identify areas of improvement.

6. Identify the sales points that marketing will emphasize in its message about the product. There should be no more than three major or primary sales points or two major sales points and two minor or secondary sales points in order to keep the marketing message focused. Major sales points are assigned a weighting factor of 1.3 and minor sales points are assigned a weighting factor of 1.1. Maddux (1986)

7. The process of setting improvement goals and sales points implicitly develops a product strategy. Formally describe that strategy in a narrative form. What is to be emphasized with the new product? What are its competitive strengths? What will distinguish it in the marketplace? How will it be positioned relative to other products? In other words, describe the value proposition behind this product. The key is to focus development resources on those areas that will provide the greatest value to the customer. This strategy brief is typically one page and is used to gain initial focus within the team as well as communicate and gain concurrence from management.

8. Establish product requirements or technical characteristics to respond to customer needs and organize into logical categories. Categories may be related to functional aspects of the product or may be grouped by the likely subsystems to primarily address that characteristic. Characteristics should be meaningful (actionable by Engineering), measurable, practical (can be determined without extensive data collection or testing) and global. By being global, characteristic should be stated in a way to avoid implying a particular technical solution so as not to constrain designers. This will allow a wide range of alternatives to be considered in an effort to better meet customer needs. Identify the direction of the objective for each characteristic (target value or range, maximize or minimize).

9. Develop relationship between customer needs and product requirements or technical characteristics. These relationships define the degree to which as product requirement or technical characteristic satisfies the customer needs. It does NOT show a potential negative impact on meeting a customer need --this will be addressed later in the interaction matrix. Consider the goal associated with the characteristic in determining whether the characteristic satisfies the customer need. Use weights (we recommend using 5-3-1 weighing factors) to indicate the strength of the relationship-strong, medium and weak. Be sparing with the strong relationship to discriminate the really strong relationships.

10. Perform a technical evaluation of current products and competitive products. Sources of information include: Competitor website, industry publications, customer interviews, published specifications, catalogs and brochures, trade shows, purchasing and benchmarking competitor's products, patent information, articles and technical papers, published benchmarks, third-party service & support organizations, and former employees. Perform this evaluation based on the defined product requirements or technical characteristics. Obtain other relevant data such as warranty or service repair occurrences and costs.

11. Develop preliminary target values for product requirements or technical characteristics. Consider data gathered during the technical evaluation in setting target values. Do not get too aggressive with target values in areas that are not determined to be the primary area of focus with this development effort.

12. 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 product requirements or technical characteristic. Focus on negative interactions – consider product concepts or technology to overcome these potential trade-offs or consider the trade-off's in establishing target values.

13. Calculate importance ratings. Multiply the customer priority rating by the improvement factor, the sales point factor and the weighting factor associated with the relationship in each box of the matrix and add the resulting products in each column.

14. Identify a difficulty rating (1 to 5 point scale, five being very difficult and risky) for each product requirement or technical characteristic. Consider technology maturity, personnel technical qualifications, resource availability, technical risk, manufacturing capability, supply chain capability, and schedule. Develop a composite rating or breakdown into individual assessments by category.

15. Analyze the matrix and finalize the product plan. Determine required actions and areas of focus.

16. Finalize target values. Consider the product strategy objectives, importance of the various technical characteristics, the trade-offs that need to be made based on the interaction matrix, the technical difficulty ratings, and technology solutions and maturity,

17. Maintain the matrix as customer needs or conditions change.

7.8 REVIEWING MATRIX FOR PRIORITY ITEMS

7.8.1 Concept Development

1. Develop concept alternatives for the product. Consider not only the current approach and technology, but other alternative concept approaches and technology. Use brainstorming. Conduct literature, technology, and patent searches. Use product benchmarking to identify different product concepts. Develop derivative ideas.

Perform sufficient definition and development of each concept to evaluate against the decision criteria determined in the next step.

2. Evaluate the concept alternatives using the Concept Selection Matrix. List product requirements or technical characteristics from the Product Planning Matrix down the left side of the Concept Selection Matrix. Also add other requirements or decision criteria such as key unstated but expected customer needs or requirements, manufacturability requirements, environmental requirements, standards and regulatory requirements, maintainability / serviceability requirements, support requirements, testability requirements, test schedule and resources, technical risk, business risk, supply chain capability, development resources, development budget, and development schedule.

3. Carry forward the target values for the product requirements or technical characteristics from the Product Planning Matrix. Add target values as appropriate for the other evaluation criteria added in the previous step. Also bring forward the importance ratings and difficulty ratings associated with each product requirement or technical characteristic from the Product Planning Matrix. Normalize the importance rating by dividing the largest value by a factor that will yield "5" and post this value to the "Priority" column. Review these priorities and consider any changes appropriate since these are the weighting factors for the decision criteria. Determine the priorities for the additional evaluation criteria added in the prior step. List concepts across the top of the matrix.

4. Perform engineering analysis and trade studies. Rate each concept alternative against the criteria using a "1" to "5" scale with "5" being the highest rating for satisfying the criteria.

5. For each rating, multiply the rating by the "Priority" value in that row. Summarize these values in each column in the bottom row. The preferred concept alternative(s) will be the one(s) with the highest total.

6. For the preferred concept alternatives(s), work to improve the concept by synthesizing a new concept that overcomes its weaknesses. Focus attention on the criteria with the lowest ratings for the concept ("1's" and "2's"). What changes can be made to the design or formulation of the preferred concept(s) to improve these low

ratings with the product concept? Compare the preferred concept(s) to the other concepts that have higher ratings for that particular requirement. Are there ways to modify the preferred concept to incorporate the advantage of another concept?

7.8.2 Subsystem/Subassembly/Part Deployment Matrix

1. Using the selected concept as a basis, develop a design layout, block diagram and/or a preliminary parts list. Determine critical subsystems, subassemblies or parts. Consider impact of subsystems, subassemblies or parts on product performance or with respect to development goals. What parts, assemblies or subsystems present major challenges or are critical to the success and operation of the product? What critical characteristics have a major effect on performance? Consider performing failure mode and effect analysis (FEMA); failure mode, effects and criticality analysis (FMECA); or fault tree analysis (FTA) to help pinpoint critical items and their critical characteristics from a reliability/quality perspective.

2. If there will be multiple Subsystem/Subassembly/Part Deployment Matrices prepared, deploy the technical characteristics and their target values to the appropriate matrices. Carry forward the important or critical product requirements or technical characteristics from Product Planning Matrix (based on importance ratings and team decision) to the Subsystem/Subassembly/Part Deployment Matrix. These "Product needs" become the "what's" for this next level matrix. Where appropriate, allocate target values (e.g., target manufacturing cost, mean time between failures, etc.) to the Subsystem/ Subassembly /Part Deployment Matrices. Organise these product requirements or technical characteristics by assemblies or part(s) to be addressed on a particular deployment matrix. Include any additional customer needs or requirements to address more detailed customer needs or general requirements. Normalise the importance Ratings from the Product Planning Matrix and bring them forward as the Priority ratings. Review these priority ratings and make appropriate changes for the subsystems, subassemblies or parts being addressed. Determine the Priority for any needs that were added.

3. Considering product requirements or technical characteristics identify the critical part, subassembly or subsystem characteristics. State the characteristics in a

measurable way. For higher-level subsystems or subassemblies, state the characteristic in a global manner to avoid constraining concept selection at this next level.

4 Develop relationships between product needs (Product-level technical characteristics) and the subsystem /subassembly /part technical characteristics. Use 5-3-1 relationship weights for strong, medium and weak relationships. Be sparing with the strong relationships.

5. Develop preliminary target values for subsystem / subassembly / part characteristics.

6. Determine potential positive and negative interactions between the technical part characteristics using symbols for strong or medium, positive or negative relationships. Too many positive interactions suggest potential redundancy in critical part characteristics. Focus on negative interactions – consider different subsystem /subassembly / part concepts, different technologies, tooling concepts, material technology, and process technology to overcome the potential trade –off or consider the trade-off in establishing target values.

7. Calculate importance ratings. Assign a weighting factor to the relationships (5-3-1). Multiply the customer importance ratings by the improvement factor (if any), the sales point factor (if any) and the relationship factor in each cell of the relationship matrix and add the resulting products in each column.

8. Identify a difficulty rating (1 to 5 point scale, five being very different and risky) for each Subsystem / Subassembly / part requirement or technical characteristic. Consider technology maturity, personnel technical qualifications, business risk, manufacturing capability, supplier capability, and schedule. Develop a composite rating or breakdown into individual assessments by category. Determine if overall risk is acceptable and if individual risks based on target or specification values are acceptable. Adjust target or specification values accordingly.

9. Analysis the matrix and finalize the subsystem/subassembly/part deployment matrix. Determine required actions and areas of focus.

10. Finalize target values. Consider interactions, importance ratings and difficulty ratings.

CHAPTER 8

HOUSE OF QUALITY

8.1 PRIORITIZED CUSTOMER REQUIREMENTS

Customer satisfaction is the main objective of any service industry. The prioritized customer requirements make up a block of columns corresponding to each customer requirement in the house of quality on the right side of the customer competitive assessment. These prioritized customer requirements contain columns for importance to customer, target value, scale-up factor, sales point, and an absolute weight.

8.1.1 Importance to Customer

Assigning it a rating ranks customer requirements. Number 1 to 5 are listed in the importance of customer column to indicate a rating of 1 for least and 5 for very important. In other words, the more important the customer requirement, the higher the rating.

8.1.2 Target value

The target value column is on the same scale as the customer competitive assessment (1 for worst, 5 for best). This column decides whether to keep the product unchanged, improve the product, or make the product better than the competition.

8.1.3 Scale-up factor

The scale up factor is the ration of the target value to, the product rating given in the customer competitive assessment. The important consideration is the level is the level where the product is now and what the target rating is and deciding whether the difference is within reason.

Scale up factor = target value /product rating

8.1.4 Sales point

The sales point tells how well a customer requirement will sell. The objective here is to promote the best customer requirement and any remaining customer requirements that will help the sale of the product.

8.1.5 Absolute weight

The absolute weight is calculated by multiplying the importance to customer, scale-up factor, and sales point.

Absolute weight = (Importance to customer) (scale-up factor) (sales point)

8.2 PRIORITIZED TECHNICAL DESCRIPTORS

The prioritized technical descriptors make up a block of rows corresponding to each technical descriptor in the house of quality below the technical competitive assessment.

8.2.1 Degree of Difficulty

The degree of technical difficulty helps to evaluate the ability to implement certain quality improvements. It is determined by rating each technical descriptor from 1 (Easy) to 5 (difficult).

8.2.2 Target value

A target value is an objective measure that defines values that must be obtained to achieve technical descriptor. How much it takes to meet or exceed the customer's expectations is answered by evaluating all the information entered into the house of quality and selecting the target values.

8.2.3 Absolute weight

The absolute weight for the j^{th} technical descriptor is given by

$$aj = \sum_{i=1}^{n} Rij\ ci$$

Where

aj= row vector of absolute weights for the technical descriptors (I= 1….m)

Rij= weights assigned to the relationship matrix (I=1…. n, j=1….m)

ci= column vector of importance to customer for the customer requirements (I=1….n)

m= number of technical descriptors

n= number of customer requirements

8.2.4 Relative weight

The relative weight for the j^{th} technical descriptors is then given by replacing the degree of importance for the customer requirements with the absolute weight for customer requirements. It is

$$bj = \sum_{i=1}^{n} Rij\ di$$

Where

Bj= row vector of relative weight for the technical descriptors (j=1…m)

Di= column vector of absolute weight for the customer requirements (I=1 ….n)

$$aj = \sum_{i=1}^{n} Rij\ ci$$

Where

aj= row vector of absolute weights for the technical descriptors (I= 1....m)

Rij= weights assigned to the relationship matrix (I=1.... n, j=1....m)

ci= column vector of importance to customer for the customer requirements (I=1....n)

m= number of technical descriptors

n= number of customer requirements

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Where

Bj= row vector of relative weight for the technical descriptors (j=1...m)

Di= column vector of absolute weight for the customer requirements (I=1 ....n)

CHAPTER 9

CAUSE AND EFFECT ANALYSIS

9.1 CAUSE AND EFFECT ANALYSIS FOR COST REDUCTION

9.1.1 Engineering Helped

Three Engineering techniques have been suggested for achieving this target cost reduction objective: Value Engineering (VE), Quality Function Deployment (QFD), and design for manufacture and assembly . They are mainly employed by product and process engineers. In the spirit of TQM and KAIZEN, everyone in an organization should be involved in improvement activities, including target – cost reductions. Unfortunately, not everyone is familiar with these engineering techniques. So in an effort to facilitate target costing, we present the cause and effect analysis, an easy - to - understand and easy – to – use method that can be employed by nonengineers.

Cause & Effect analysis was developed initially to investigate the causes of quality problems. The technique also is used for analyzing other problems. We have also used cause and effect analysis to work with companies in creating cost savings. It is a practical tool for cost analysis and cost reduction that complements engineering techniques to enhance target costing. Ironically, despite its versatility and ease of use. Cause and Effect analysi . often isn't noticed because it looks so simple. One cannot really appreciate its value and the beauty of its simplicity until it is put into actual use. Although cause and effect analysis many be potentially powerful application for cost analysis, there is a dearth of reports regarding its use.

Cause and effect analysis was developed by Professor Kaoru Ishikawa of Japan's Wasda University, around 1950. The Ishikawa diagram, or fishbone diagram, is a pictorial representation of the relationship between an effect and its potential causes. The effect or symptom of a problem is written at the head of an arrow. The branches going into the main arrow represent potential causes. Each cause can be further broken down into sub causes. Theoretically, one can trace the "root causes" of a

problem by repeatedly analyzing or breaking down sub causes and get as detailed as desired.

Cause and Effect analysis starts with a whole and breaks the body down into detailed "cell". One can grasp the big picture by examining the complete cause and effect diagram. More important, CEA serves not only as a tool for tackling problems but also as a motivation for proactively detecting or searching for potential problems.

Figure 9.1 demonstrates a simple application of Cause and Effect analysis. A product's cost is broken down into material cost, labor cost, over head, power supply board cost and equipment cost (Richard C Chen et al, 2000). Material costs are analyzed according to the product's major components and parts, and each item's purchasing or transfer price and usage quantity are reviewed. Typical questions asked includes: Is the price reasonable? Can the price be slashed? Can we negotiate with vendors for further discount? Can the usage quantity be reduced or eliminated without hurting the product quality? Although labor as a percent of total manufacturing costs has decreased significantly during the past two decades, labor costs are still subject to review and improvement. Indeed, no improvement is too small in the drive to reduce costs.

Labor costs can be reviewed in a fashion similar to those of material costs. Unit labor cost and the usage quantity of labor at each stage of production may be reduced. The overhead category usually provides ample opportunities for cost saving. Quite often, people hide waste under the name "overhead." For example, in a manufacturing setting, many of the indirect charges to manufacturing overhead include the time spent dealing with delays and problems that add lead-time. Lengthened lead times contribute to the increase in inventory costs; this lengthening can drive up product costs substantially.

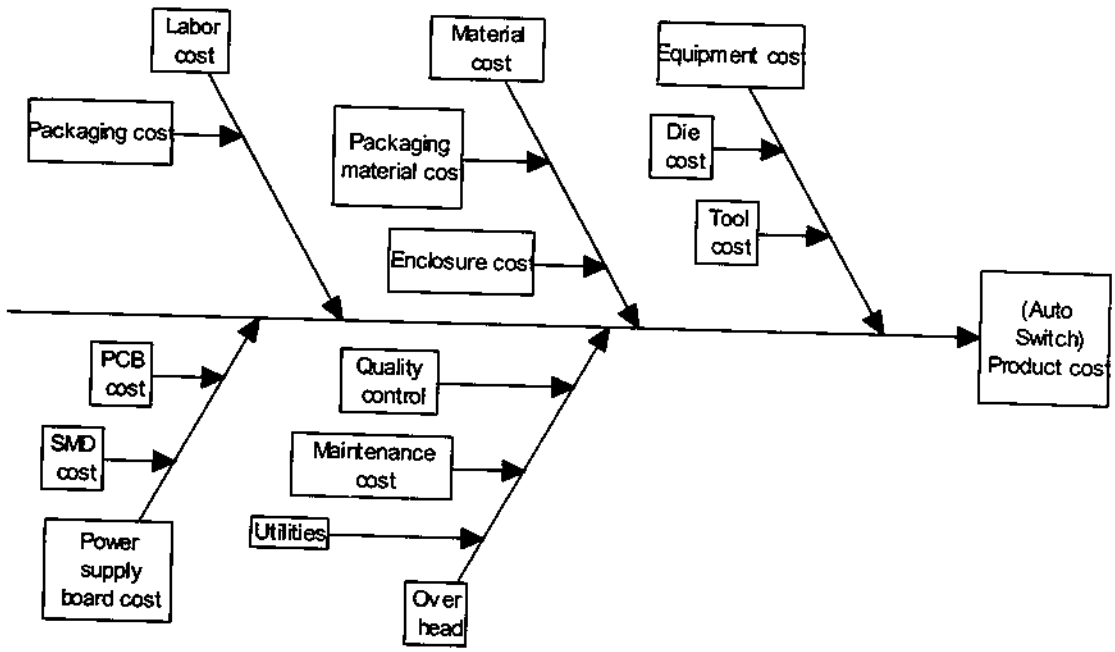


FIGURE 9.1 CAUSE & EFFECT DIAGRAM FOR COST ANALYSIS

The pursuit of reduction in both material and labor costs usually involves a critical review of a firm's product and process designs. The notation of producibility or manufacturability as a design principle used in DFM/DFA is very helpful for the effective application of Cause and Effect analysis. The objective of producibility is to design a product as well as the process of making the product, in such a way that the product is easy to make. This procedure can be accomplished through product/ process simplification. Any component or part that does not value to the final product or to the customer is a waste and should be eliminated. This method is referred to as a value-added concept. Simplified products often lead to simplified process. Certainly, reengineering of the processes is possible without changing the product designs. With unnecessary components, parts, and processing eliminated, the material and labor costs can be reduced. Furthermore, with products and processes simplified, the production processes and easier to control. This leads to better quality. With fewer defects, less scrap, and fewer rejects, the quality – related costs can be reduced.

The use of Cause and Effect analysis for cost reduction – and the improvements triggered by target costing – are not limited to firm's product/process designs. These enhancements may also involve the review and reengineering of other aspects of the firm's complete supply chains. Figure 9.2 shows a firm's business activities represented as two value chains: horizontal and vertical.

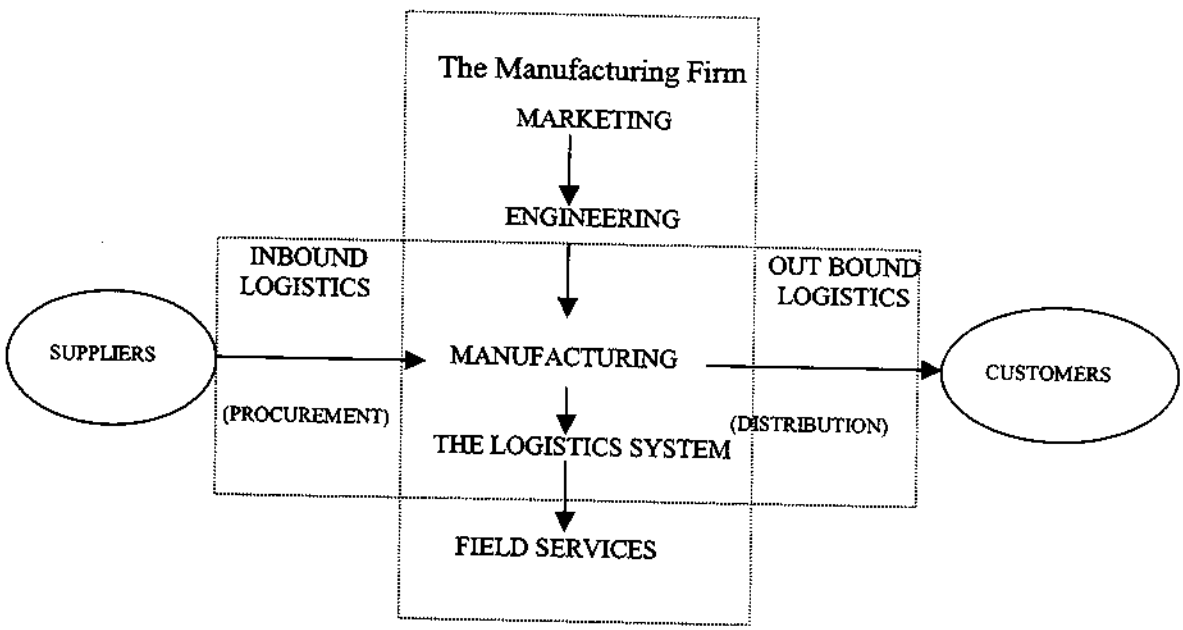


FIGURE 9.2 VALUE CHAIN OF A MANUFACTURING FIRM

The horizontal value chain represents the firm's logistics system. Operations in manufacturing systems involve the physical transformation of materials, components, or subassemblies into a higher – level component or assembly. These conversion activities are usually coupled with a process involving material flows. The material flows entail movement of materials from suppliers to the manufacturing firm. This movement is from one location or department to another within the firm, as well as from the manufacturing firm to customers. At each stage of this flow process, values are added to the product. This flow is the value chain. The vertical value chain connects the firm's product/process design with its manufacturing and field service activities. Again, values are added to the products at each stage of the process, from the conception to the manufacturing to the after – sale services.

The improvements in product/process designs are usually direct and quick results of target costing and the cause and effect analysis for cost reduction. In the long run, the firm will reengineer its horizontal value chain to achieve break throughs and further cost reductions. Improvements along the horizontal reduction in over heads.

Cause & Effect analysis for target costing is not a one-time project. In fact, Cause and Effect analysis represents a dynamic process of continuous improvements in operations by continuously driving down costs to improve a firm's competitiveness.

9.1.2 Cost – Plus Approach

A commonly used pricing method for either new or existing products is a cost – plus approach. Using this approach, firms set their products prices by adding a certain amount of profit margin to the product costs. These costs are usually estimated by engineers, based on design expenses. An implicit assumption behind this practice is that product costs are relatively fixed – at least in the short run. The desired profit margin usually consists of the amount necessary to satisfy the firm's stakeholders and the need to fund the research and development of future products. While setting the selling price by adding the profit margin to the product cost is logical, this method often results in a product price that is not competitive with the market. In contrast, target costing is a market – driven approach. Cooper and Kaplan describe this approach as a simple syllogism:

1. Let the market place determine the selling price of the future product.
2. Subtract from this price the profit margin the company wants to achieve.
3. This yields the target cost at which the product must be manufactured.

The selling price is not really determined by the market passively. Instead, a company sets the selling price at the level that it believes would gain the most competitive advantage, often measured by a target market share. Many times, the target costs are well below the currently achievable costs based on the standards established by product/process engineers.

9.2 INTEGRATION OF TARGET PRICING/TARGET COSTING WITH OPERATION MAGEMENT

Figure 8.3, which briefly summarizes such an integration process, suggests two important implications for management accounting.

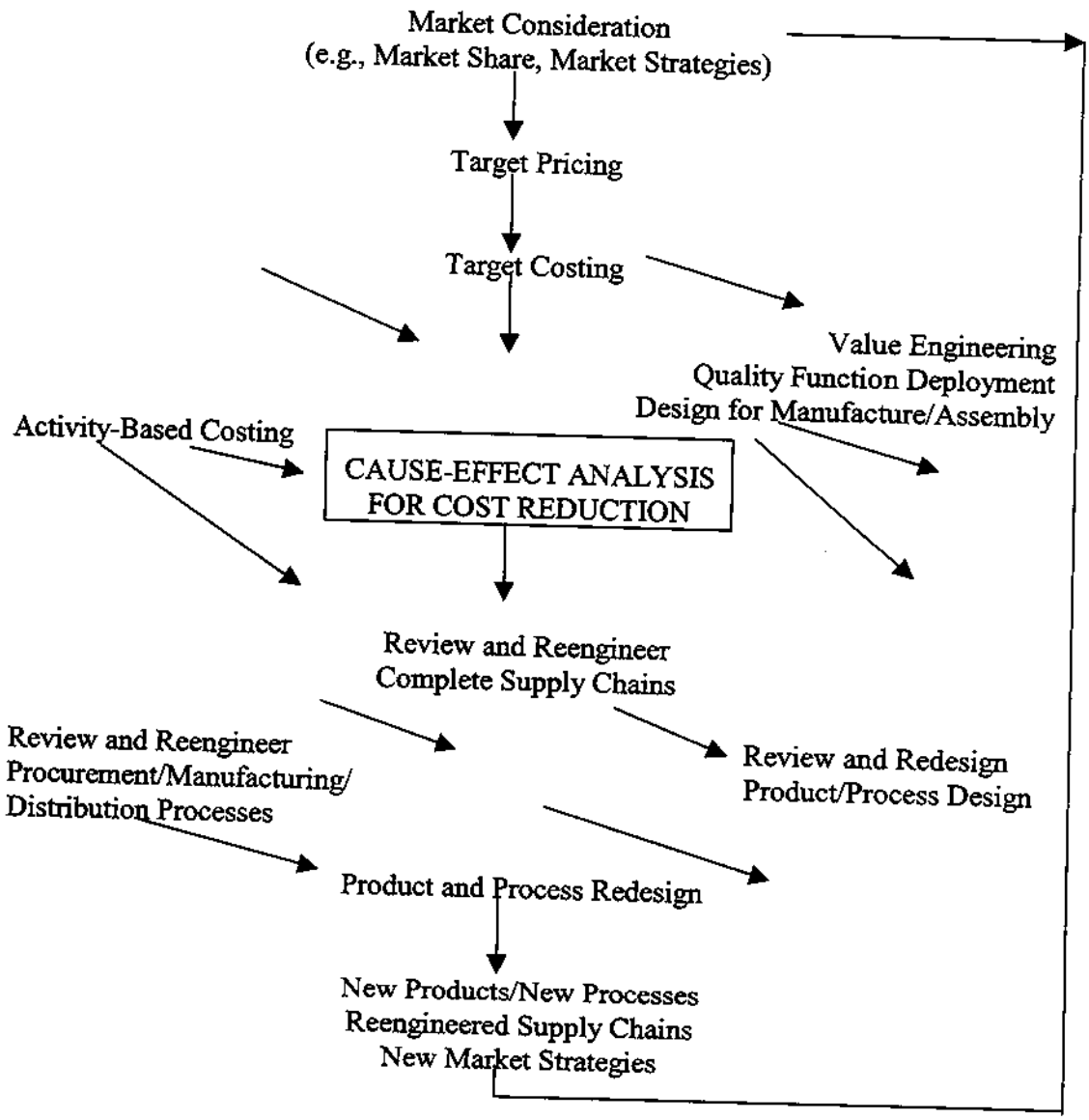


FIGURE 9.3 INTEGRATION PROCESS

Target costing is a market –driven strategy. Under this scheme, a firm's product is priced based on the levels that give it the best competitive advantage. Target costs are derived from the target prices. Then a certain amount of desired profit is subtracted from the prices. The resulting target costs are often well below the currently achievable costs, which are based on the standards established by product/process engineers. The target costs thus become both the benchmarks and the driving force for the company's (cost) improvement activities.

First, it is highly recommended that cause and effect analysis for cost reduction be incorporated with and/or supported by activity-based costing (ABC). For ABC to work well, the activities, the costs, and the relationship between the two must be identified. Cause and Effect analysis does just that. It helps identify cost drivers- the activities that cause the incurred costs.

The second implication is that the applicability of target pricing/target costing is not limited to external markets. It works well for internal customers, too. The later stages of a manufacturing process are the customers to the earlier stages. Functional departments within a company can also be perceived as mutual customers. With or without a formal establishment of profit centers, target pricing/target costing can be applied to two units that have a transfer-pricing relationship. The dynamic process depicted in figure 9.3 can be incorporated into such between – unit interfaces. Consequently, transfer prices are reviewed and revised according to the "continuous improvement" process.

Target costing is also applicable to other areas of the business besides target-pricing strategy. For example, a firm may want to work closely with its suppliers to drive down the material costs. Because it is easy to understand and easy to use. Cause and Effect analysis would be a particularly effective communication medium for such a target-costing effort. Future research should be directed to the integration of cause and effect analysis –based target costing with a firm's activity –based costing, as well as its strategic decision –support systems.

TABLE 9.1 PARTS AND COST ANALYSIS

No	Cost details	Rupees
1	Power supply board cost	272.70
2	Labor cost	21.00
3	Over head cost	32.03
4	Profit margin	52.88
5	Inventory cost	14.25
6	Retailing marketing cost	20.26
7	Interest on receivables	12.76
8	Enclosure cost	14.12

9.3 RELATIVE RANKING

Estimated costs of the items, parts or sub-systems are ranked from the highest to the lowest in terms of money value per unit of the product and total amount for the product. Generally, potential value improvement is the greatest on those items ranked with the highest total costs.

9.3.1 Pareto's Law

Ranking can be done by applying Pareto's law. From Parts and Costs analysis tabulation, a relative ranking tabulation, Table 9.2 , can be generated. A graph can also be drawn as shown in Figure 9.1.

TABLE 9.2 RELATIVE COST RANKING

No	Cost details	Rupees	%	Cumulative %
1	Power supply board cost	272.70	62	62
2	Profit margin	52.88	12	74
3	Over head cost	32.03	7	81
4	Labor cost	21.00	5	86
5	Retailing marketing cost	20.26	5	91
6	Inventory cost	14.25	3	94
7	Enclosure cost	14.12	3	97
8	Interest on receivables	12.76	3	100

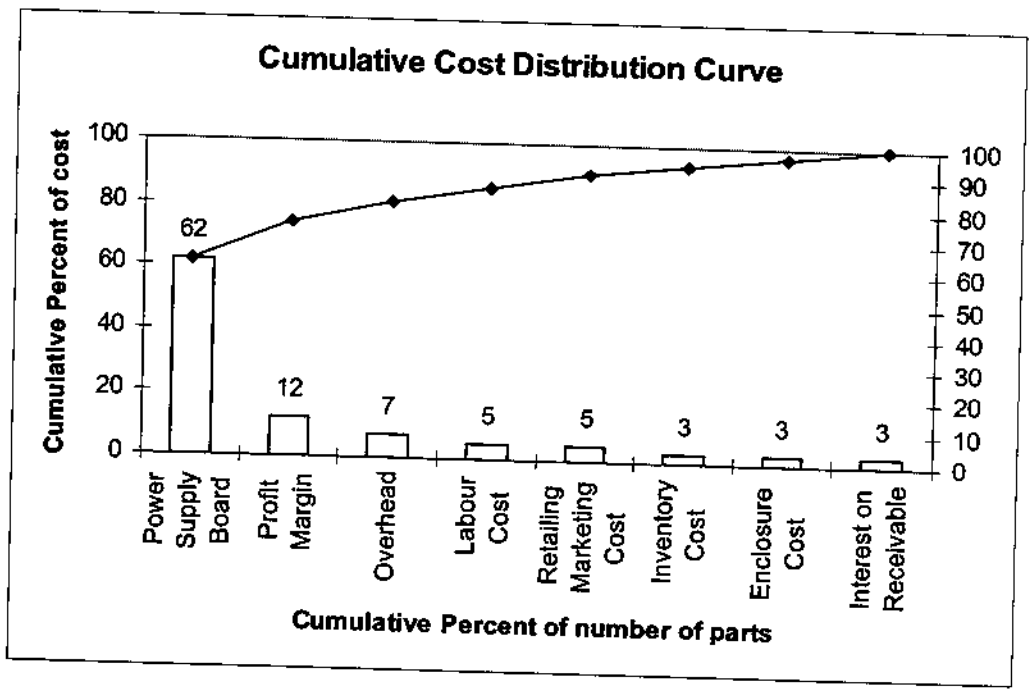


FIGURE 9.4 CUMULATIVE COST DISTRIBUTION CURVE

CHAPTER 10
CONCLUSIONS

Benchmarking is to understand the 'best' with the others and at what level we are working. In this study AUTO SWITCH product of Lakshmi Electrical Control Systems Limited was selected for benchmarking. Benchmarking partner selection is one of the most critical factors like flexibility, price, serviceability, and product feature for successful benchmarking projects. This paper discussed very simple approaches for the identification and selection of benchmarking partners. Lakshmi Electrical Control System is the best organization based on the chosen attributes of AUTO SWITCH.

House of Quality is used to compare the customer requirements and product feature and determine their relationships. It will provide marketing benefits because it stress specific requirements that have been identified by the customer. Most importantly, implementing QFD resulted in a satisfied customer. Cause & Effect diagram is used to analyze, the product cost.

FEATURES

SINGLE PHASING PREVENTION:

As long as the motor is operating on 3 Phase Voltage, the coil of the motor will remain in a healthy condition. If any phase of the 3 Phase supply fails or disconnected due to any reason, the Motor could still continue to run on 2 Phase Voltage. This is dangerous as it results in over current and burden to the coil of the Motor leading to a burnout. LECS Auto Switch will prevent such single phasing within 4 seconds and disconnects the supply to protect the motor. The unit will sense the presence of 3 phase voltages and will not switch on if any of the phases are missing.

REVERSE SEQUENCE:

If the 3 Phase supply is connected in a wrong sequence (YRB, BRY, RBY), reverse voltage would cause the Motor to run in the reverse direction. Accidental happening of such reversal can cause damage to the equipment connected to the motor. LECS Auto Switch senses such a condition and prevents the motor to start and run. It will allow the motor to start only when the Motor is connected with proper sequence (RYB).

UNBALANCE PROTECTION:

This feature protects the motor from Voltage unbalances between the phases (>50V).

AUTO/MANUAL OPERATION:

Auto Mode:

This mode is selected when the motor is required to start automatically when the power fails and resumes without any intervention. A time delay in starting is also provided to avoid possible damage to motor due to erratic Voltage.

Product Selection:

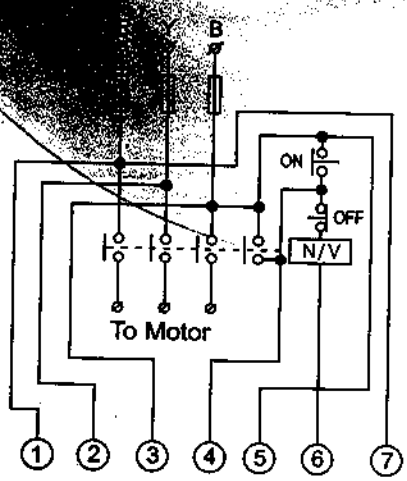
Type AS — FOR MOTORS NEEDING A START TIME OF 1 MINUTE, IN AUTO MODE

Type AS — FOR COMPRESSORS NEEDING A START TIME OF 6 MINUTES, IN AUTO MODE

Manual Mode:

This mode is selected when the Manual intervention (Manual Reset) is required by the user.

WIRING DIAGRAM



TERMINAL DETAILS

R	Y	B	DUMMY
1	2	3	D

4	5	6	7
START PUSH BUTTON		N / V COIL IN SERIES	

NOTE: INTERCHANGE 1 AND 3 IF STARTER DOES NOT HOLD

13. Richard C., and Chen H. (2002), " Cause – Effect Analysis for Target Costing", *Management Accounting Quarterly Winter* 2002, pp 1-9.

14. Day, R.G. (1996), " *Quality Function Deployment linking a company with its customer*", Tata McGraw- Hill Publications, New Delhi.

15. Shen, X.X.,Tan K.C. and Xie M. (2000), "Benchmarking in QFD for quality improvement", *Benchmarking: An International journal*, pp 282-291.

16. Vivianne Bouchereau and Hefin Rawlands.(2000), " Methods and techniques to help quality function deployment (QFD)", *Benchmarking: An International Journal*, pp 8-19.

17. Yunus Kathawala and Jaideep Motwani. (1994) "Implementing Quality function Deployment", *The TQM Magazine*, pp 31-37.