

RESEARCH METHODS

3.1 STUDY FRAMEWORK

This chapter discusses the methods and tools, used to study the quality of fluting-paper. The experts (Juran and Gryna, 1993, p3; Deming 1982, p221-234; Taguchi, et al, 1989, p2 and Crosby, 1984, p59-86) concur that quality can be defined as “customer satisfaction”. Therefore the customer is critical when studying quality. There are various tasks that can be used to study the customer; these include customer surveys and customer complaint analysis (Gryna et al, 2007, p306). In addition Griffin and Hauser (1993) suggest QFD.

Customer complaints analysis can be used to determine whether the customers are satisfied and is a great opportunity to gain and keep loyal customers (Sowards, 2007). Customer complaints are an inward look at the product and the weak areas of the company in need of improvement.

Customer surveys are an external look at the product from the view of the customer. Customer surveys have been used successfully to create better quality products, drive end product attributes and determine problems with products at a mill in Cottonton for 12 years (Shaw, 2004). The customer complaint may therefore provide focus areas when analysing and determining the customer needs.

QFD can be used together with customer surveys and Garvin’s (1987, p43) eight dimension of quality to provide and insight into whether the customer needs are

indicated in the technical specifications of the product as suggested by Symons (1991, p87).

Fluting-paper at mills is made according to the technical specifications which are set by the SABS and additional technical specifications are set by the company. Paper not meeting these technical specifications is culled. There are in addition to these technical specification various other reasons for culling paper, viz. cracking, winding, start-up, aesthetics and a general category called “other”. Comparing the technical specifications to these reasons for cull can provide valuable information on whether the company does cull paper for the correct reasons and whether the customer needs are adequately described by the technical specifications of fluting-paper. This could clarify whether the company produces fluting-paper according to technical specifications that are adequate and that meet the customer needs.

3.2 CUSTOMER COMPLAINTS

Customer complaints draw attention to the areas that affect the quality of the product. This study is a statistical comparison of the reasons for customer complaints between the different mills. These comparisons will emphasize whether the qualities of the product at the three mills are the same and will also emphasize the areas that experience the highest number of customer complaints.

3.2.1 Data Collection

Data for customer complaints were obtained from the databases held at each of the mills and populated by the Quality Assurance Superintendent at each mill. A two-year period from September 2004 to August 2006 was studied. Some of the mills did not record customer complaints in the period prior to the two-year period, and therefore a larger period could not be studied.

The categories of reasons for complaints were grouped as financial, technical and logistics as shown in appendix 4.1. Each mill records different sets of data. While mill X records the reason for the complaint and the volume of each complaint, mill Y records the customer details and the reason for complaint but does not record the volume of each of these complaints. Mill Z records the reason for complaint, the volume of the complaint and the monetary value of the complaint. It would have been useful to have the volumes of each complaint and the monetary value of each complaint for all of the mills for comparative purposes in this study. This study is therefore a count of the occurrence of a typical customer complaint or the frequency in which a complaint was received.

Customer complaints are recorded for all of the mills by the Quality Assurance (Q.A.) Department. The complaints recorded by the mills all have monetary claims. The complaint is initially received by a representative of the Marketing Department, the Product Manager, who reports this to the Q.A. Superintendent of the mill for investigation. Various tests (depending on the type of complaint) are performed on the paper, if the complaint is related to the technical performance of the paper, to determine if the complaint is technically and commercially legitimate and proper. Should the claim, be related to financial or logistics, the QA superintendent consults the relevant personnel from these departments to ascertain what the problem was. Should the complaint be valid, the customer is reimbursed for his losses.

3.2.2 Data Analysis

The data for customer complaints is in the form of nominal data; a count of the occurrence of a particular complaint. The analysis of the data can provide insight into the trends of the different categories of customer complaints. The data analysis can also highlight variations between the customer complaints experienced at each of the mills.

The chi-squared test is defined as the squared difference between the observed and expected frequencies, divided by the expected frequency in each cell of the table, summed over all cells of the table (Levine et al, 2001, p 435). Chi-square has been used in a study conducted by Ngai et al (2007, p1375) to successfully compare different categories of customer complaint behaviour. In a marketing study, Lynn (1999) uses chi-square to identify significant relationships in activities such as managing customer complaints. A similar approach may be taken in this study.

The observed values or frequencies of occurrence of a complaint are the values that were collected from each of the mill's databases. The expected values are calculated. To determine whether there exist significant differences the observed and expected data are compared. The outcome of the chi-squared test is the chi-squared value. Should this value be large, then significant differences do exist. The chi-square value is compared to a critical value, based on the degrees of freedom and accuracy desired, from literature. Should the chi-square value be larger than the critical value, then differences exist.

The chi-square test therefore gives an indication of whether the customer complaints experienced by all of the mills are the same in each category. Should the one mill experience customer complaints higher than the expected frequency of the chi-square test, this would indicate that the particular mill is performing poorer than the other mills. An expected frequency that is higher than the observed value in a particular category signifies that this particular category is a problem area that needs to be improved.

The six steps as suggested by Goodman and Newman (2003, p42) provide a framework to understand and analyse customer complaints in a meaningful way to determine focus areas in need of improvement. They suggest six steps as indicated in Chapter 2. The first step which involves the evaluation of the severity of the problem is carried out at the mills by the QA superintendant. The second step which suggests extrapolating the complaint reports to the marketplace

is not relevant in this market which is limited to a few corrugators, five of which used in this study account for eighty percent of the market. The revenue impact of not solving the problem would have been a very useful to understand the financial losses incurred by the mills for customer complaints, but this data was not readily available at all mills for this study. A step that is very valuable is the comparison of customer complaints with internal measures to estimate the severity of the problem. This can be done by comparison of the reasons for customer complaints to the technical specifications for fluting-paper and the reasons for which paper is culled. These comparisons may also allure to the last two steps which entail determining the cause and solution to the customer complaint or problems areas identified by the complaints. This is further explained in section 3.4.

3.3 CUSTOMER SURVEY AND QFD

The customers, the corrugators that convert fluting-paper into containerboard and eventually boxes are intermediate users of fluting-paper. Refer to Figure 3.1 for the value chain of fluting-paper. Boxes manufactured by the Corrugators are sold to the end-user, who uses the boxes as packaging. This packaging can be used for anything from containing fruits to wine bottles and television sets. The majority of customers studied here are supplying boxes to the agricultural sector for the packaging of fruit such as bananas, oranges, and avocados.

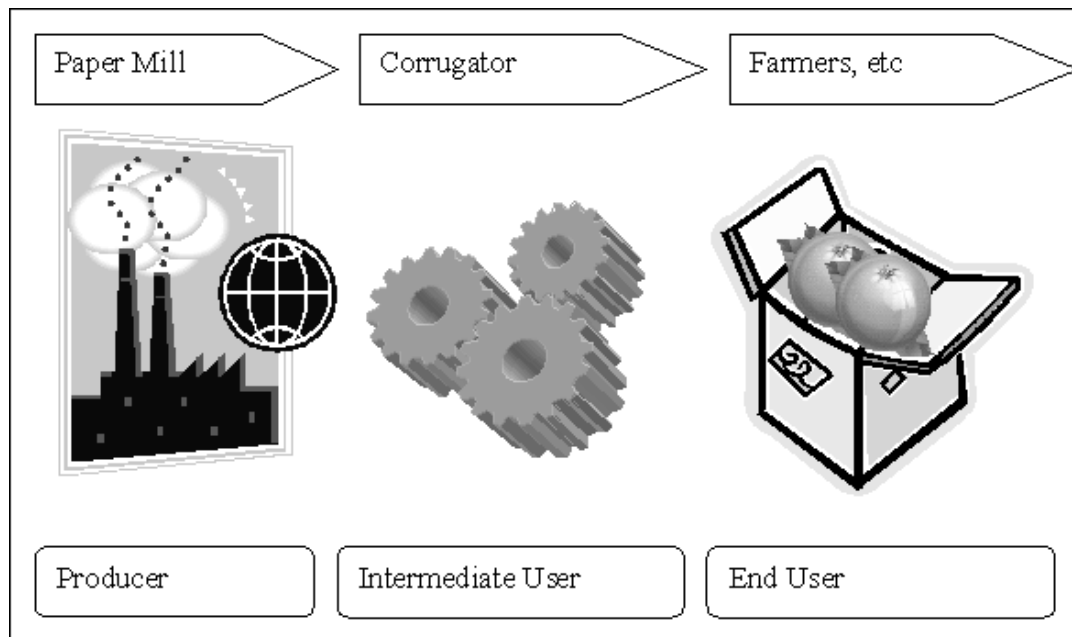


Figure 3.1: Value Chain of Fluting-paper

3.3.1 Data collection

Sample Size

Forty-six customers purchase fluting-paper from the company. The customers are all Corrugators. The five largest customers that account for more than seventy five percent of the sales volumes from the company of this study are chosen as the sample for this study. These customers account for more than eighty percent (Pearson and Henning, 2007, p23) of the total sales (from this company and competitors) of corrugated containers in the South African market.

Griffin and Hauser (1993, p1) have conducted extensive studies into the number of customers to study for QFD development. They indicate that on average; more than ninety percent of customer needs can be identified by twenty to thirty customers from a sample of two-hundred to three hundred customers. This is an average sample proportion of ten percent. These five customers studied here account for approximately eleven percent of the total number of customers

purchasing fluting-paper. Refer to Appendix 3.1 for the percentage of sales that each of these customers contribute. These are the company's most important customers that are critical to the continued existence of the company.

Survey Method

Collis and Hussey (2003, p66) explain that a survey is a method where information is obtained on a population by drawing a sample from the population and making inferences of the population. This study uses the survey method of obtaining information on the customer needs. Surveys can be either analytical or descriptive. A descriptive survey identifies and counts the frequency of a population while an analytical survey explores relationships between different variables (Collis and Hussey, 2003, p66). This study uses an analytical survey as data, which are descriptive of customer needs, are desired from the survey.

There are various approaches used to conduct surveys, each with strengths and weaknesses. People are more responsive to the face to face interview that is self administered (Ross, 1999, p250). This type of interview also eliminates the possibility of cheating and bias but is more expensive. This survey was conducted in the form of form of face-to-face interviews with the customers.

The aim of the survey was to obtain ratings required to populate the QFD matrix that is developed to relate the customer needs to the process characteristics. The customer needs are determined from literature. These customer needs from literature form the original set of customer needs also indicated in Table 2.2. This original set of customer needs was subjected to the pilot study before forming the set of customer needs after the pilot study that was posed to the customer. The customer was first questioned if they had additional needs to those that were posed to him/her. The customer was then requested to provide ratings for each of the customer needs, and for the new needs if any. The ratings requested of the customer are indicated in Table 3.1.

The pilot study was conducted prior to conducting the survey with the customers. The marketing personnel were chosen as the target audience for the pilot study as these persons have the closest relationships with the customer. A set of customer needs obtained from literature were prepared for the pilot study, as shown in Table 2.2. This set of customer needs was sent to persons in the marketing department of the company to obtain comments on whether the customer need was relevant and important to the customer. The pilot study was also to ensure there were no needs that were sensitive to customers and to determine if there were other significant criteria that needed to be included. These comments were used to adjust the set of customer needs which were to be used in the customer survey.

Interviews were arranged with customers either telephonically or via e-mail. The marketing person that was responsible for each customer assisted with making contact with the customer. The customers were interviewed at their manufacturing facility, except one customer, that did not respond to the interview request and provided responses to the ratings via email.

The person interviewed was the person responsible for the quality assurance of the incoming material, i.e. fluting-paper to their facility. This was the quality manager in most facilities and the general manager for those that did not have a quality manager.

Ratings Used for Survey

There are three ratings that were obtained during the survey. The ratings are those suggested by Akoa (1990. p22). The first rating indicates the importance of each of the customer needs, on a scale of one to five. A score of one indicates the need is not important, two is less important, three indicates the customer is neutral toward this need, while four and five indicate the need is important and very important respectively.

The second rating was a comparison of the company to the competitor in fulfilling the particular customer need. The company and competitor were each rated on a scale of one to three. A rating of 3 is used to show that the customer views the company as performing better in satisfying the particular customer need, while a rating of 1 is used to show a worse performance. A rating of 2 indicates that the customer views the company and competitor as equal in satisfying the particular customer need.

The third rating is used to determine if there would be any change in their sales volumes if there were changes in the product for each of the customer needs. This is referred to as the sales point. The customer would use 1.0 to show no sales increase, 1.2 for some sales increase and 1.5 for significant sales increase.

To measure the central tendency of the data, the mean, median and mode are often used. The advantages and disadvantages of each are provided by Collis and Hussey (2003, p212). The median is the middle value of a dataset, it can only be roughly estimated and when the distribution is irregular (as it may be for this small dataset) the median may not be characteristic of the distribution. The mode which is the most frequently occurring value in a dataset is unaffected by outliers, but is not so easy to obtain when there are two or more numbers occurring at the same frequency. The mean which is the arithmetic average has the advantage that it can be calculated exactly and makes use of all the data points. Using the mean to assess the data from the survey, may provide a better description of the central tendency of the customer's preferences, which are used in the QFD matrix development. The mean for the customer rate of importance is calculated and is rounded off to the nearest whole number. The mean for the sales point is a weighted mean, using the ratings as the weights.

Table 3.1: Summary of the Ratings for the Customer Needs

RATING 1		RATING 2		RATING 3	
Customer Rate Of Importance For Each Customer Need		Rating of Own Performance and Competitor Performance		Rating of Sales Point	
1	Not important	1	Worse	1.0	No sales increase
2	Less important	2	Equal	1.2	Some sales increase
3	Neutral	3	Better	1.5	Significant sales increase
4	Important				
5	Very important				

3.3.2 Data Analysis

The QFD Matrix

Figure 3.2 presents the general format of the QFD matrix. In the matrix, the overall customer needs on the left hand side of the matrix are correlated to the technical characteristics in the relationship matrix in the centre or heart of the QFD matrix. The planning matrix is on the right hand side, and consists of several columns containing the ratings of importance of each customer need and the performance of competitors and the company in question.

The relationship matrix shows associations between the customer needs and each technical characteristic. Three symbols or numerical ratings (Slack et al, 2007, p134) are used in the relationship matrix to show the correlations. These are ? (9) to show strong correlation, ? (3) to show average correlation and ? (1) to show some correlation.

The technical matrix is below the relationship matrix and is a technical assessment of the product. Technical assessments suggested by Bicheno (2002, p89) are feature score sums, benchmarks, own performance and feature targets. Slack et al (2007, p134) suggest more workable technical assessment categories of absolute importance, relative importance and technical which are appropriate and relevant to this work.

The absolute importance (for each technical characteristic), is the sum of the product of the rating for the relationship between the customer need and the technical characteristic and, the importance of each customer need. The absolute importance for each technical characteristic is determined by the equation below:

$\text{Absolute Importance} = \sum (\text{correlation rating} \times \text{customer rate of importance})$

The relative importance, in the technical assessment matrix, translates the absolute importance into a ranked relative importance while technical difficulty is the degree of difficulty it would take to improve the technical characteristic. The degree of difficulty can be rated on a scale of 1 to 5, where 1 is easy, and 5 is difficult with the ratings between 1 and 5 show increasing levels of difficulty. Technical experts perform this rating on the technical difficulty.

The roof of the house is the technical interaction matrix, showing the relationships between the different technical characteristics with each other. This study does not consider the technical interaction matrix or the roof as these are not the focus of this study.

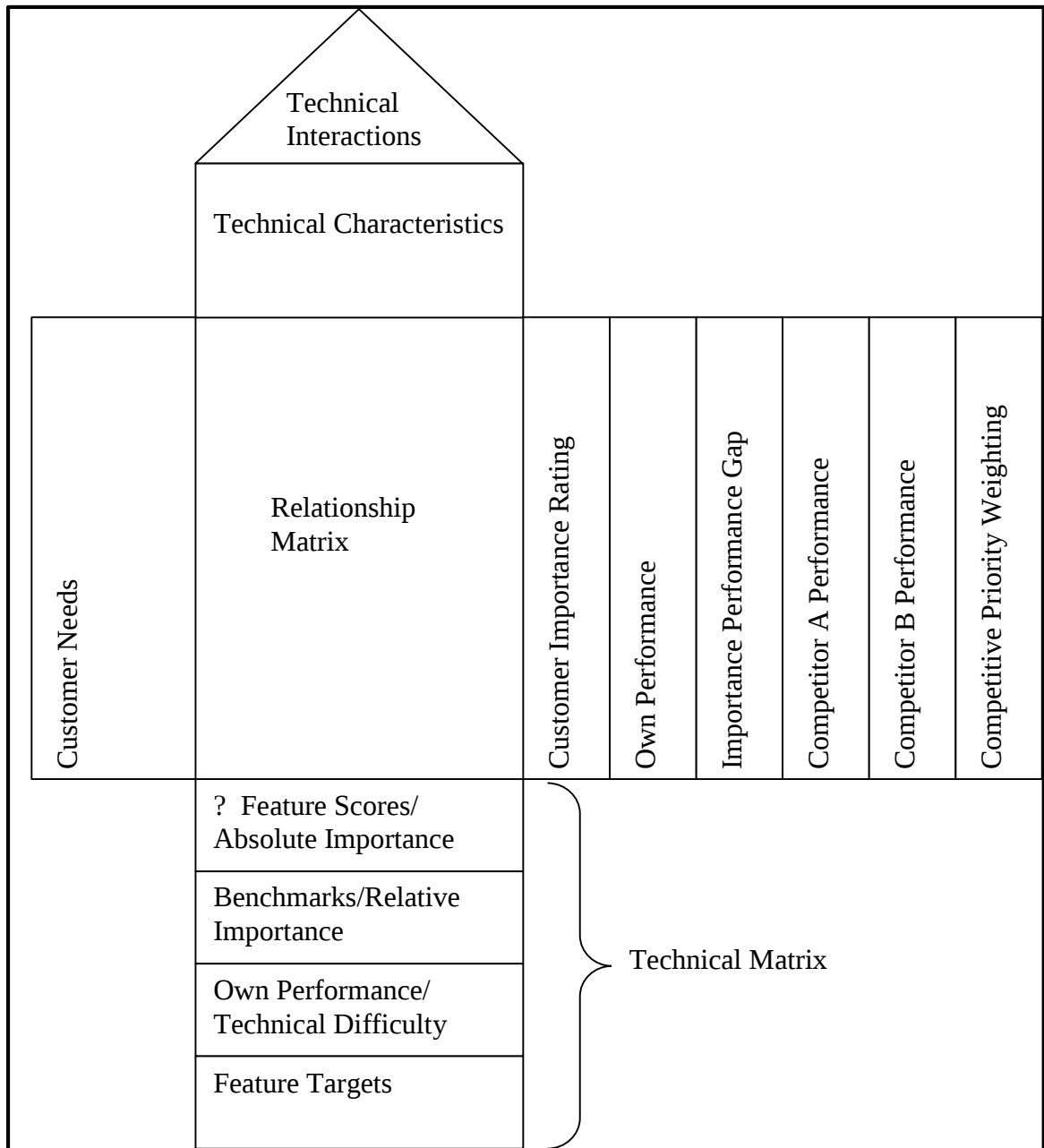


Figure 3.2: Quality Function Deployment Matrix (Bicheno, 2002, p89 and Slack, 2007, p134)

Pilot Study and Ratings by Technical Experts

To construct a quality function deployment matrix requires knowledgeable technical people or technical experts in the field of fluting-paper manufacture to provide certain ratings and measurable variables to the customer needs, technical characteristics and process characteristics. Symons (1991, p87) supports this approach of using a team of technical experts for developing the QFD matrix. These were three people from the company's technical department that conduct research and development into paper, have experience in projects relating to fluting-paper development and trouble shooting fluting-paper related problems. All three people have more than five years of experience in the field of paper manufacture.

These technical experts were consulted on:

1. Evaluating the preliminary set of customer needs that were designed to be posed to the customer for the customer survey. The experts were consulted to ascertain whether all the important customer needs were accounted for and if there were any additional customer needs that could be added to the survey. This formed the pilot study of the questions and ratings posed to the customer during the survey.
2. Confirmation of the technical characteristics to describe each of the customer needs that were needed for the development of the QFD matrix.
3. The experts were also asked to provide ratings for technical interaction matrix that forms the heart of the QFD matrix. These ratings show the relationship between the technical characteristics and the customer needs of fluting-paper.
4. The ratings for technical difficulty, in the QFD matrix, were also needed to be completed by a team of technical experts who have experience in both the technical characteristics of the product (fluting-paper) and the process of manufacturing the product.
5. The reasons for cull are compared to the technical specifications, customer complaints and customer needs using QFD relationship matrix. The relationships were compiled by the technical experts in these matrices.

3.4 PROCESS MEASUREMENT: CULL

The suggestions by Goodman and Newman (2003, p42) to compare customer complaints to internal measures to elucidate problems are useful here. The internal measures suggested by Goodman and Newman (2003, p42) include quality assurance standards, repair and repair rates, system downtime and returns. Gryna et al (2007) also suggest rework as a measure of the manufacturing output. The reasons for cull and technical specifications of fluting-paper are internal measures that are akin to the internal measures suggested above. Thus cull and technical specifications can be compared to the customer complaints and the customer needs to determine if the company is producing fluting-paper that meets the customer needs.

Data for cull was obtained over a two-year period from September 2004 to August 2006 and is the same period as used for the customer complaints analysis. Not all mills measure and record the same parameters at equal intervals. Mill Y and mill Z record and display cull data on a daily basis while mill X records the parameters per batch (i.e. per customer request of grammage). To standardize the data, values for mill X were averaged to obtain daily averages. Data was then averaged per category over the two year period.

The QFD chart can be used here to compare the different customer needs and complaints to the manufacturing measurements. A similar approach was used by Wang and Lin (2007) to compare the quality defects to production processes to construct a defect tracking matrix. Although the approach taken by them was for a different industry and process the similar principles of using quality function deployment and systematic comparisons can be used here. Using these systematic comparisons the data for cull can be compared to the technical specifications, customer complaints and customer needs to determine discrepancies between these measurements of quality.

3.5 SUMMARY OF THE QUALITY OF FLUTING-PAPER

Quality has been defined as customer satisfaction (Juran and Gryna, 1993, p3); therefore it is important to take the customer into consideration when studying the quality of fluting-paper. Customer complaints are promoted by many (Crosby, 1996, Juran 1992, Kaydos, 1991 and Maskell, 1991) as measures of customer satisfaction. The categories of customer complaints are obtained from customer complaint databases held at the mill and can be analysed to indicate whether there are differences between the qualities of fluting-paper at the mills. Statistical analyses of these categories of customer complaints using chi-square tests may also allude to problem areas in the mills. In this way the first objective of investigating the nature of customer complaints of fluting-paper to identify problem areas can be achieved.

The second objective of identifying and relating the customer needs to the technical specification, defined by the company of fluting-paper can be achieved by using the customer survey and quality function deployment. The reasons for cull, which are a measure of the process, are related to the technical specifications, customer needs and customer complaints using QFD principles to execute the third objective of this study.

The last objective is to determine the reasons (if any) for the customers differing perceptions and claims of inconsistent quality. This can be achieved by reviewing the gaps formed during the comparisons of the various measures of customer satisfaction, viz. customer complaints, technical specifications and customer needs to the process measure of poor quality paper, viz. cull in the QFD matrices.

Study of these objectives thus allow the investigations of the relationships between customer needs, technical specifications and the quality of fluting-paper at the mills to allow conclusions to be drawn on the hypothesis, the company's mills produces fluting-paper consistently according to technical specifications that meet the customer needs.