Practical Use of Monte Carlo Simulation for Costing of Yarn in Textile Industry

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ABSTRACT

Now days, the costing of products are very important in any organization. There is a huge competition among the manufacturing companies to sell the products in reasonable price to the customers across the whole world. Every company wants to make high quality products in less price for achieving the targets, expectation and satisfaction of the consumers.

In South Asia, there is big textile industry for making the high quality products from raw cotton to finish garments. Due to large industry of textile in Pakistan, there is also big competition among the companies regarding quality of product at low prize. Cost of product is important factor to market the product successfully across the whole world. Providing the good quality of products at low prize to the customers is the best strategy to capture the textile market and enhance the customer satisfaction.

To achieve the product cost to its reasonable prize, it’s better to highlight the main factors in costing of textile products. Firstly, focused on the factors that can affect more severe on the product costing and took the other factors and so on. For this purpose, make the analysis by some tools or software to forecast the situation on costing of product. It gave the clear picture for better understanding on costing and helpful for future strategy to maintain the costing of products for national and international market.
PREFACE

Actually a dissertation is periodically inconsolable and really onerous task but to travesty a former Swedish Minster of Finance:

Writing dissertation is damn severe,
But now I prized it as far as here.

The aim of the project is to highlight the factors affecting on costing of textile products in textile industry and how to control it by the analysis and understanding the issues. The project is basically the combination of remarkable practical experience in textile industry and project management studies in Kungliga Tekniska Högskolan (KTH).

I would like to thanks my supervisor Alam Zeb working as technical manager in Dewan Farooque Textile Mill who helped me regarding collecting data of product costing and especially thanks to Mr. Roland Langhé who provide me guidance to make the project successfully and highlighted the critical factors to control the best possible price.
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1. Introduction

1.1 Research Background

This project is related to textile industry especially in yarn manufacturing process contain a different sub process from raw material to finished yarn product. Actually it is a very complicated and technical process in which different risks occur that can cause to damage the quality as well as increase the costing of product. The main reason is the raw material that has not good properties like strength, maturity, impurity and variation of length of fibers.

In this project, I will focus on different risks in the process and especially costing of product from raw material to finish goods. There are different parameters used in costing that cause effect on the profit margin of the final product in the company. The main purpose of the project is to identify the critical factors in the process that cause the negative effect on quality, productivity and costing of different products.

1.2 Problem Description

Due to increase competition day by day in textile manufacturing products on cheap price, we need to work on that area where we can reduce the risks of damage of quality, reduce the non confirming products and especially costing of product from raw material to final goods. In yarn manufacturing process, there are different sub process that contributes to make the good quality yarn as well as chances of making bad quality if we are unable to control the variation and critical success factors in each department.

The problem that is going to discuss or try to solve is one of the major “costing of products” in the textile industry by the application of Monte Carlo technique. On the basis of costing, other problems will also identify such as critical factors that cause effect on costing and product which has low risk regarding quality, productivity and market value.
1.3 Problem Formulation

For the problem formulation, first of all define the problem in details and then gather all relevant data of the problem and prepared in a proper format. After that make a mathematical model from given data and select a suitable probability distribution and make a simulation by the use of @ risk software. Now the last step is to take the results from the forecasting and make a decision for the best results on the basis of future predictions.

In addition, @ risk is also generate sensitivity and scenario analysis report which can identify the input distributions that is most critical to the results and the results are best presented in graphically. There are some other graphs like frequency distribution of possible output variables, cumulative probability curves and also the summery graphs which summarize changing risk across a range of output cells.

Figure: 1 The Monte Carlo Technique for problem solving
1.4 Research Question
The question on costing of product creates many questions for the progress of organization in textile industry. Following are the main research question about this project;

- What will be the level of achievements on the basis of this data?
- How much benefit for the company regarding high quality at low price?
- Is it possible to implement successfully to achieve targets?

1.5 Research Objectives
The main objective of this research objective is to investigate the critical factors that can effect severely on costing of product and enhance the knowledge in this area.

In this research study, the approach to achieve the following goals;

- To identify the issues that can cause increase the cost of product and present the reason why these are most important regarding quality and cost.
- To highlight the difficulties and challenges to understand and implemented the way of working on costing in the organization.
- To identify the needs of organization and requirements for the costing of product and why it is important for making the product with high quality at reasonable price.

1.6 Research Scope
Actually the scope of this project is limited to answering the research question and providing the input for achieving the goals and objectives of the research study. The analysis will be based on the quantitative data of costing and interviews from the manager. The research will be conducted in highly advance textile manufacturing plant with good quality products.

The main purpose of the organization where the data will be collected is to produce the export quality product with very low resources. The objectives of this study are to highlight the critical parameters that will be involved in quality and especially costing of yarn product. Due to this approach, it will be helpful for the business development and enhance the customer satisfaction regarding quality and cost.
1.7 Target Groups

- Finance managers especially for involve in the textile product costing
- Middle and top management of technical person in textile plant
- Marketing and outsourcing managers
- Different textile companies especially making the yarn product
- Other companies with the same field of textile manufacturing products

1.8 Expected Results and Usage

This research project would advance my knowledge especially in the textile field and management skills are chosen and will help to give best results and performance in this field. It’s also helpful in future investigation regarding costing issues in textile manufacturing product from yarn to fabric for the organization. I hope after investigation and completed thesis, following results are expected.

1.8.1 Results

- A better understanding of costing from raw material to final product of yarn
- Better understanding about the critical parameters and their affects on process for costing
- A clear picture of key performance indicators (KPI’s) for costing of yarn in the process

1.8.2 Usage

- The results from this research project might be helpful for the managers and top management for the clear picture of cost management in the process and marketing managers to selling the product with best price and according to customer needs and expectations.
- It can also be used to forecasting the situation in future about costing of yarn to fabric manufacturing in the organization.
1.11 Outline of the Thesis

Chapter 1 (Introduction):
In this chapter of introduction, there is briefly description about research background, problem description & formulation, research question, research objectives, research scope, target groups and expected results from this project.

Chapter 2 (Review of literature):
It shows the depth study about the Monte Carlo Simulation technique and how it works with different distributions and especially its application in project management.

Chapter 3 (Research methodology):
This chapter presents how the study of this thesis designed and conducted including explanation and approach to collecting data from the process. Furthermore, it also explains in details with the practical experience of industry and interviews with technical managers.

Chapter 4 (Implementation of Monte Carlo Technique):
This chapter shows how to implement Monte Carlo Technique on quantitative data, describe the process layout, justification for the selection of this project and analysis of data about costing of product, make the mathematical model & simulation and finally identify the risk for the product.
Chapter 5 (Finding & Discussion Results):

It shows the final results and key findings from the analysis of product data and with the help of practical experience of the technical persons. These results obtained from the project help to work on costing of product with highlight the critical factors.

Chapter 6 (Conclusion & Recommendation):

The conclusion of the research and recommendation will explain in the final chapter of this project. With the help of this conclusion & recommendation, the reader will be able to give the answered for about the research question and purpose of this project. Recommendation will also help the readers to give the better suggestion to make the product at low price in the textile market.
Chapter 2

2. Review of Literature

2.1 Theories of Monte Carlo Technique:

Monte Carlo is a mathematically computerizes technique that people use to calculate the risks in quantitative analysis and decision making on the basis of output data. The professional of different fields use this technique in lot of disparate fields as finance, manufacturing, engineering, research & development, energy, transportation, environment and especially in project management [1].

Monte Carlo simulation actually furnishes the decision maker with the better choice of possible outcomes and the probability that may occur in any choice of action. First time, this technique was used by scientist in atom bomb and it was name for Monte Carlo, one of the resorts and its name is Monaco resort town renowned for its casinos. Since its introduction in World War II and has been used to model a different verities of conceptual and physical systems.

2.2 How Monte Carlo simulation works?

In practical life, Monte Carlo simulation used to perform the risk analysis by the building models of possible results with the substituting a range of values, a probability distribution for any factor that has uncertainty. In Monte Carlo simulation, a random value selects for each of task base on the estimate and calculates the model on the base of random value. Then record the result of the model again the process is repeated. After that, it calculates the model hundreds or thousands of times in running simulation and each time should be used different randomly selected values.

When the simulation is complete, we have a large number of results from the simulation model and each result base on the random input values. Then we can use these results to describe the
probability of reaching the various results in the simulation model. Variables can have different probability of different outcomes by using probability distribution and these are more realistic way to describe the uncertainty in variables of risk analysis. There are some common probabilities distributions in short details are given below;

**Normal** – The user describes the simply mean or expected value and standard deviation to describe the variation about the mean. Examples of variables described by the normal distribution include the energy prices and inflation rate.

**Uniform** – The user simply defines the maximum and minimum values and all values have equal chance of occurring. Examples of variables by uniform distributed include manufacturing cost and sales revenue for making a new product.

**Triangular** – User defines the minimum, most likely and maximum values and around to most likely values is more chances of occurring. Variables that could be described by triangular distribution include inventory levels and past sales history per unit of time [1].

**Pert** – The user also simply defines the minimum, most likely and minimum values and just like the triangular distribution in which the values around the most likely are more likely to happen. The values between most likely and maximum are more likely to occur than the triangular that are not emphasized on extremes. Example of using pert distribution is to describe the duration of different tasks in project management model.

**Discrete** – The user describe the most specific values that may more chances of occurring and likelihood of each. Example of discrete distribution is the result of lawsuit, 30% chances of positive verdict, 20 % chance of negative verdict, 30% chance of settlement and 20% chance of mistrial.
2.3 Application of Monte Carlo Simulation in Project Management

With regarding to project management, Monte Carlo simulation is;

“A technique that computes or iterates the project cost or schedule many times using input values selected at random from probability distributions of possible costs or durations, to calculate a distribution of possible total project cost or completion dates”.

(Project Management Institute, 2004)

In project management literature, Monte Carlo technique is generally mentioned under the topic of risk management and it can also be seen in the areas of cost management (budgeting) and time management (scheduling).

For the risk management of projects, a standard approach is outlined in Project Management Institute 2004, in which six processes includes such as Risk Identification, Risk Qualification, Risk Management Planning, Risk Quantification, Risk Response Planning and Risk Monitoring and Controlling. For these processes, Monte Carlo simulation is usually used as a method to analyze the Risk Quantification Process to quantify the risk better for the project budgeting and scheduling. With the help of this method, the project manager is able justify the clear picture of budget reserve or schedule reserve or both to deal with the issues that might be severe effect on the performance of the project.

In project management, Monte Carlo simulation is not yet widely used and should be some exposure through some project management practices. This exposure is primarily in the certain areas like cost management and time management to quantify the risk levels on the project cost or time schedule for completing the project. Williams (2003) outlined the approach about how to use the Monte Carlo simulation in project management and how to help the project manager in answering the question such as “what is the expected cost of the whole project, “what is the probability of completion of the project within due date and what is (say) 90 % confident for the project duration.

In time management, Monte Carlo simulation can be applied to project schedule to improve the confidence about the target completion date or duration of the project. For this purpose, Project manager and experts assigns a probability distribution function for the duration of activity of each task or group of tasks to get better estimates in the project network. To simplify the
practice, a three point estimate is mostly used where the project manager or experts supplies the three condition like worst case, most likely and best case of durations for each or group of tasks. The project manager then fit these three estimates of duration in a suitable probability distribution such as triangular, beta and normal distribution for the task. As the simulation is complete, the project is able to report the probability of completion of the project in any particular date and project manager can easily make a decision to set a schedule reserve for the project. All these above procedure can be completed with the help of project management software like Microsoft Project or Primavera and with Monte Carlo simulation like @Risk.

In cost management, Monte Carlo can also be used by Project manager to get a better understanding project budget and estimation of final budget for the completion of project. Instead of assign the probability distribution for the task duration, the Project manager assigns the distribution and estimates to the project cost by the project expert and take a suitable probability distribution for the total project cost. Project manager then use it for the better decision about the budget reserve for the project even if contingency plans are necessary to respond any risk in the project.
Chapter 3

3. Research Methodology/Approach

The methodology will give a clear picture about how to problem is approached in better way, what should be the strategy for case study and which type of data is necessary and important tools, models and method to be used.

3.1 Research strategy

The project is to find the conclusion on how the costing of product is calculated and how to choose the parameters for major contribution in costing so that actions can b taken to identify the best product with respect to profit per pound in the manufacturing process.

Following are the different main strategies towards the conclusion;

**Inductive approach**: in this approach, the conclusions are made from the data collection and empirical findings. In this conclusion are drawn by the developing of new theories and study the theories.

**Deductive approach**: this approach is basically on logic and accepted if the conclusion have directly link with the logic. In this conclusions are drawn and based on existing theories.

**Hypothetic-deductive approach**: the conclusions are drawn from the hypothesis of existing theories. For checking the validity of conclusions, these hypotheses are tested in real life.

3.1.1 Research strategy used in this project

In this current project, deductive approach is used where the logic is applied on the basis of analysis to draw the conclusion. The data is collected from the process and the empirical findings are used to draw the conclusions of how the cost of product is incurred in the company on different process and find out the important parameters that can affect on costing of product in
the company. Thereby taking further steps to enhance the knowledge of costing measures and find the best product which is preferable in the company.

### 3.2 Research technique

Regarding the study techniques, it depends on the quantity of knowledge of the trouble and which kind of knowledge that is easily available and more helpful in this regard. The techniques are categorized into explorative, descriptive and hypothetically testing (Patel & Davidson, 2003).

**Explorative techniques:** It is used when there are some gaps in the knowledge of problem area, that means more knowledge need to be collected to understand the actual problem. Gathering knowledge in the form of qualitative and quantitative data is used to get the as much data as possible for future studies.

**Descriptive techniques:** It can be used when most of the knowledge about the problem is known and start to systemize the data into models for the detail description of figures. Its focus on some chosen aspects of the problem and will give a more detailed view of the aspect. The method used in these techniques is usually quantitative like values [2].

**Hypothetically challenge:** When knowledge is very high and many theories exists, then this study can be used. When this technique is used, it is very important to have the more knowledge about the problematic area. Both quantitative and qualitative method can be used to collect the information & facts needed to connect the hypotheses, theory & reality (Patel & Davidson, 2003)

### 3.2.1 Research technique used in this project

The project will be made in descriptive way and explained existing theories of Monte Carlo techniques on product costing and will connected with existing knowledge of company process and costing data of product. After that gather the information by colleting the data and described the method by making the probability distribution and noted the results and then made the conclusion about which the product give more profit and has market value.
3.3 Data collection techniques

Data collection techniques are mainly two types; one is Quantitative and the other one is Qualitative.

**Quantitative data collection:** this type of data is comes from process measurement and analytical values and useful for the statistical analysis and investigation. During this collection of data, some are important questions used like “how many”, “how often” and “how significant” (Patel & Davidson, 2003).

**Qualitative data collection:** this method provides the data through analysis, interviews, written test and other verbal orders method. It gives more information as compared to quantitative data and people describe their own situation, beliefs and motivation. During this type of data collection, “what”, “why” and “how” are important questions (Patel & Davidson, 2003).

3.3.1 Brainstorming

It is such activity that performed in a group and makes a large number of ideas for the solution of the problem and this method was popularized by Alex Faickney Osborn in 1953 and in a book called Applied Imagination [3]. Osborn proposed that through the brainstorming, groups can get double creative output for searching the solution of given problem. Every person shall have a equal chance to express their own feelings and ideas to give the better solution. It is important to describe the actual problem before the brainstorming session and problem should be clear and not so big. In case of big, breakdown the problem into smaller components and include in the session one by one with their own questions (Anderson & Schwencke 1998).

3.3.2 Study of theory

It is also best way to search the information in systematic way during the writing of the project. It contains collection of data, processing of data and previous methods and will help for deep understanding of investigation (Nyberg, 2000). But in this project, there are different approaches used to enhance the knowledge about the Monte Carlo simulation such as study of practical statistics theory and compendium by the using of lab, assignments given during the whole course study, practical statistics lectures, study of different reports and articles [4].
3.3.3 Internet research

This is also easy way of research to finding the required data which creates the contact between the researcher and the given information through electronic means like research in database, downloading files, web pages, journals and different articles from the internet. Actually it is the practice of using the internet especially in the World Wide Web (www) for research. This is the combined with the information and communication technology that is easy way to spread the information and communication to each other by some new technical tools (Nyberg, 2000). The same practice has done in this project to found the required data about the research studies regarding different files, articles and links [4].

3.3.4 Data collection techniques used in this project

On the basis of study process and used the helping channels for making the results and conclusion, it is essential to gaining the knowledge about the costing and Monte Carlo Simulation study. For this purpose, both qualitative and quantitative data are used in this project.

The qualitative data comes from the study of literatures, articles, journals and internet searching and also through the interviews and observation from the technical persons. Sometimes I will get important information by work experience regarding costing and manufacturing process.

The quantitative data measurements made by the company from the process and make the spreadsheet for analysis the data. The data consists of different products with different costs from raw material to finish packing in the process. I will use the long range data for getting the clear picture of the results and able to make decision for future forecasting on the basis of Monte Carlo simulation model.

3.4 Validity & Reliability

Validity can be defined as “the degree to which they accomplish the purpose for which they are being used” (Worthen et al., 1993)[5].

Reliability can be defined as “the degree of consistency between two measures of the same things” (Mehrens and Lehman, 1987)
For the projects of involving information and data collection, it is really important to measure the right things or by the right way especially when using the quantitative data in the project. The meaning of “Validity” is to measure the right things and “Reliability” means to measure them in a right way.

3.4.1 Validity and Reliability of the current project

On the basis of actual data and practical knowledge about the products for costing, this study case is very reliable for costing of product point of view in textile industry. In Textile industry, there is critical issue to analysis the cost of running product and which product is feasible, profitable and risk free with respect to market situation. In addition, it is very helpful for planning of making the profitable and reasonable product in future within the constraint budget.

In financial point of view of any textile company, its validity is more accountable to measure the check points from raw material to finish goods cost coming from different suppliers in the market. It identify the critical factors which can be effect on product costing and also analysis the risk involved to increase the overall budget of the company. On the basis of output results, costing manager with the help of process manager can be achieve the financial goal for the specific product and make it more profitable in the market.

Its validity is also more trustable because author has to remarkable experience in textile industry with advance practical statistics and especially supervisor with great and real knowledge of process and in costing of products in textiles. In this case, there is real and actual data, good and value able experience and knowledge instead of expert judgment, propose data and unaware about the textile knowledge.
4. Implementation of Monte Carlo Technique

On the basis of quantitative data of costing of textile products, I have applied the Monte Carlo simulation for identify the risks that can occur in the process to increase the manufacturing cost of product. For this purpose, it is necessary to explain and understand the process and cost of different factors involve in the whole process from the material to final products. For better understanding and clear picture in forecasting situation, first of all need to explain the different process involve in the costing of products.

4.1 Introduction of textile processes

There are different manufacturing processes used in making the yarn product from raw material to finish yarn. Following are the main processes in textile plant;

- Blow room process
- Carding process
- Drawing process
- Combing process
- Roving process
- Ring spinning process
- Winding process
- Packing process

These are the major sub departments in textile plant for making yarn product. All these process play very active role on the costing of products and affect on the overall budget of the textile plant. Due to some rejected materials in every department, overall yield %age is effected and thus increase the manufacturing cost of products.
<table>
<thead>
<tr>
<th>Head office</th>
<th>Logistics</th>
<th>Inspection</th>
<th>Manufacturing process</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Start</strong></td>
<td><strong>Purchase cotton</strong></td>
<td><strong>Cotton arrival &amp; storage</strong></td>
<td><strong>Cotton bales indent</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Specification from Suppliers</strong></td>
<td><strong>Lab testing of Cotton</strong></td>
<td><strong>Blow room section</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Rejected</strong></td>
<td><strong>Carding section</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Drawing section</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Combing section</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Roving section</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Ring spun yarn section</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Winding section</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Packing section</strong></td>
</tr>
<tr>
<td><strong>B-Grade storage</strong></td>
<td><strong>Rejected</strong></td>
<td><strong>Final yarn inspection</strong></td>
<td><strong>Delivery order</strong></td>
</tr>
<tr>
<td><strong>A-Grade yarn storage</strong></td>
<td><strong>Rejected</strong></td>
<td><strong>Dispatch to customer</strong></td>
<td><strong>Final yarn inspection</strong></td>
</tr>
</tbody>
</table>

Figure: 2 Process flow chart of Dewan Farooque Textile Mill
4.2 Justification of selection

During production of different process, there are lots of elements that cause the increase the production cost of the product. There are some losses in the form of waste in every department to make the cost more on product. My aim is to identify the issues and problems regarding cost in different products of the department. Now days, reduction of cost is necessary for making the better financial condition of the company.

4.3 Understanding of costing of product

The costing of yarn is little bit complicated as compared to other textile product because of involvement of different parameters major in cotton rates and bank interest, packing cost, local and ocean freight and especially different wastes from different departments. All these parameters severely impact on the yarn costing and can be reduce to gain the more yield and production or reduce wastes.

Another method we can use is the per spindle cost i-e how mush cost of running one spindle to make the yarn in one day. In per spindle cost, basically us the general procedure and calculate the costing of all yarn products in the same respective. But in other way of costing, all parameters change significantly according to different yarn products and raw material.

4.4 Study of Quantitative Data

For the purpose of analysis of costing, took a process data in the manufacturing of textile product. The main factors that can affect on cost of product are yield, cottons rate, comber noil (fine waste), yarn sale rate per pound and yarn cost in the market. The overall effects of these factors resulted on profits per pound increase or decrease of different product. All these data collected from the process for last one year and compared the data of different products regarding profit margin for the company. With the helping and study of these factors, cost of product can be decreased significantly as well as increased the value of product by maintaining the quality. Following are the comparisons of different data from different products in the tables with the different month in 2011.

According to given data, we have calculated maximum and minimum values and used the uniform distribution to make the analysis for costing of products.
The product is 40/cm weaving made on the production machine named as G33 ring frame and the calculation is given below;

<table>
<thead>
<tr>
<th>Parameters/Month</th>
<th>Jan.</th>
<th>Feb.</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton (Rs/40kg)</td>
<td>4650</td>
<td>5500</td>
<td>5500</td>
<td>6025</td>
<td>6230</td>
<td>6250</td>
<td>4650</td>
<td>6250</td>
</tr>
<tr>
<td>Yield (%)</td>
<td>67.86</td>
<td>76.03</td>
<td>88.24</td>
<td>74.56</td>
<td>74.49</td>
<td>73.21</td>
<td>67.86</td>
<td>88.24</td>
</tr>
<tr>
<td>Noil (%)</td>
<td>16%</td>
<td>15%</td>
<td>15%</td>
<td>16%</td>
<td>17%</td>
<td>14%</td>
<td>14%</td>
<td>17%</td>
</tr>
<tr>
<td>Yarn sale (Rs/lb)</td>
<td>141.5</td>
<td>160</td>
<td>145</td>
<td>154.4</td>
<td>168</td>
<td>158.65</td>
<td>142</td>
<td>168</td>
</tr>
<tr>
<td>Conv.</td>
<td>65.47</td>
<td>58.16</td>
<td>53.39</td>
<td>52.79</td>
<td>53.64</td>
<td>51.18</td>
<td>51.18</td>
<td>65.47</td>
</tr>
<tr>
<td>Cotton Intrest</td>
<td>4.48</td>
<td>4.97</td>
<td>4.48</td>
<td>5.51</td>
<td>5.70</td>
<td>5.78</td>
<td>4.48</td>
<td>5.78</td>
</tr>
<tr>
<td>Packing (Rs/lb)</td>
<td>1.70</td>
<td>1.70</td>
<td>1.70</td>
<td>1.70</td>
<td>1.70</td>
<td>1.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yarn Cost (Rs/lb)</td>
<td>139.04</td>
<td>141.03</td>
<td>127.82</td>
<td>145.00</td>
<td>148.67</td>
<td>148.12</td>
<td>128</td>
<td>149</td>
</tr>
<tr>
<td>Profit/ lbs (Rs/lb)</td>
<td>2.46</td>
<td>18.97</td>
<td>17.18</td>
<td>9.40</td>
<td>19.33</td>
<td>10.53</td>
<td>2.46</td>
<td>19.33</td>
</tr>
</tbody>
</table>

Table: 1 Costing data for the product of 40/CM weaving non-compact

There are different important parameters include in the above table that can effect on costing of products such as; cotton rates, yield %age, noil %age, yarn cost, yarn sale rates in the market and resulted parameter is profit per pound of product.

The cotton price varies and depends on the market situation, if price is high, then chances of getting more profit but in case of high price, the margin is low. In the case of yield %age, it depends upon raw material (cotton quality) and final product quality. If yield is more, then profit margin is more and vice versa. Noil %age is also important factor in the costing of yarn product and it is basically short fibers %age removed from the long fibers in the combing machine.

The resulted profit/lbs is actually the difference of product sale rate and product cost per pound of the company. The yarn sale rate per pound is also direct effect on costing of product and it varies on market situation and sometimes can get good price on the basis of quality of product. On the other hand, cost of product mostly depend upon our process efficiency, waste in the process, yield %age and lead time of the product.
The above graph is made from the parameters that are most important and can affect on costing. You can see here that 19.33 values is high & the main reason is high sale rate as compared to others due to high quality of product and near value of 18.97, due to less cotton rate and also yarn cost rate.

Following is the table of yarn 40/cm weaving made the production machine name as; K44 ring frame and calculation is given below;

<table>
<thead>
<tr>
<th>Parameters/Month</th>
<th>Jan.</th>
<th>Feb.</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton (Rs/40kg)</td>
<td>5500</td>
<td>5500</td>
<td>5146</td>
<td>5610</td>
<td>6025</td>
<td>6150</td>
<td>5146</td>
<td>6150</td>
</tr>
<tr>
<td>Yield (%)</td>
<td>76.03</td>
<td>88.24</td>
<td>64.01</td>
<td>74.56</td>
<td>74.56</td>
<td>76.21</td>
<td>64.01</td>
<td>88.24</td>
</tr>
<tr>
<td>Noil (%)</td>
<td>15%</td>
<td>15%</td>
<td>18%</td>
<td>16%</td>
<td>16%</td>
<td>15%</td>
<td>15%</td>
<td>18%</td>
</tr>
<tr>
<td>Yarn sale (Rs/lb)</td>
<td>170</td>
<td>150</td>
<td>145.24</td>
<td>148.22</td>
<td>156</td>
<td>164.5</td>
<td>145</td>
<td>170</td>
</tr>
<tr>
<td>Conv.</td>
<td>57.17</td>
<td>52.20</td>
<td>56.08</td>
<td>50.30</td>
<td>50.09</td>
<td>50.96</td>
<td>50.09</td>
<td>57.17</td>
</tr>
<tr>
<td>Cotton Intrest</td>
<td>4.97</td>
<td>4.48</td>
<td>5.10</td>
<td>5.13</td>
<td>5.51</td>
<td>5.55</td>
<td>4.48</td>
<td>5.55</td>
</tr>
<tr>
<td>Packing (Rs/lb)</td>
<td>1.70</td>
<td>1.70</td>
<td>1.70</td>
<td>1.70</td>
<td>1.70</td>
<td>1.70</td>
<td>1.70</td>
<td>1.70</td>
</tr>
<tr>
<td>Yarn Cost (Rs/lb)</td>
<td>140.25</td>
<td>126.63</td>
<td>139.81</td>
<td>135.81</td>
<td>142.30</td>
<td>144.08</td>
<td>127</td>
<td>144</td>
</tr>
<tr>
<td>Profit/ lbs (Rs/lb)</td>
<td>29.75</td>
<td>23.37</td>
<td>5.43</td>
<td>12.41</td>
<td>13.70</td>
<td>20.42</td>
<td>5.43</td>
<td>29.75</td>
</tr>
</tbody>
</table>

Table: 2 Costing data for the product of 40/CM weaving compact
The product made from this machine has high quality yarn as compared to other machines due to very less variation and high strength of yarn. These products have high sale rate due to good quality also the profit per lb increased. In the above table, highlighted the most significant factors that can cause increased or decreased the cost of product accordingly.

![Profit/ lbs]

In the above table, the profit/lb is increased in January due to high yield %age with high sale rate. But in March, the profit is decreased due to very low yield %age & increased comber noil from the raw material and also very low sale rate of final product.
In the table of 60/CM on machine K44, the details of parameters are given below;

<table>
<thead>
<tr>
<th>Parameters/Month</th>
<th>Jan.</th>
<th>Feb.</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton (Rs/40kg)</td>
<td>8960</td>
<td>8255</td>
<td>9010</td>
<td>6825</td>
<td>8900</td>
<td>11000</td>
<td>6825</td>
<td>11000</td>
</tr>
<tr>
<td>Yield (%)</td>
<td>77.13</td>
<td>78.05</td>
<td>75.28</td>
<td>76.28</td>
<td>75.06</td>
<td>76.03</td>
<td>75.06</td>
<td>78.05</td>
</tr>
<tr>
<td>Noil (%)</td>
<td>13%</td>
<td>13%</td>
<td>15%</td>
<td>15%</td>
<td>15%</td>
<td>13%</td>
<td>15%</td>
<td>15%</td>
</tr>
<tr>
<td>Yarn sale (Rs/lb)</td>
<td>249</td>
<td>230</td>
<td>255</td>
<td>208</td>
<td>265</td>
<td>270</td>
<td>208</td>
<td>270</td>
</tr>
<tr>
<td>Conv.</td>
<td>93.76</td>
<td>83.12</td>
<td>79.00</td>
<td>92.65</td>
<td>78.13</td>
<td>73.25</td>
<td>73.25</td>
<td>93.76</td>
</tr>
<tr>
<td>Cotton Interest</td>
<td>8.03</td>
<td>7.34</td>
<td>8.19</td>
<td>6.16</td>
<td>8.11</td>
<td>9.94</td>
<td>6.16</td>
<td>9.94</td>
</tr>
<tr>
<td>Packing (Rs/lb)</td>
<td>1.70</td>
<td>1.70</td>
<td>1.70</td>
<td>1.70</td>
<td>1.70</td>
<td>1.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yarn Cost (Rs/lb)</td>
<td>231</td>
<td>209</td>
<td>219</td>
<td>196</td>
<td>216</td>
<td>245</td>
<td>196</td>
<td>245</td>
</tr>
<tr>
<td>Profit/ lbs (Rs/lb)</td>
<td>17.28</td>
<td>21.36</td>
<td>36.07</td>
<td>11.10</td>
<td>48.85</td>
<td>24.99</td>
<td>11.10</td>
<td>48.85</td>
</tr>
</tbody>
</table>

Table: 3 Costing data for the product of 60/CM weaving compact

The most significant parameters are highlighted here to make the clear comparison against the profit per lb. For made the product of high quality, mostly used the USA and Egyptian cotton on these machines (K44). These are used to eliminate hairiness on the surface of yarn and results are smooth, even and high strength of final product of yarn.

Figure: 5 Bar Graph of profit/lbs for product of 60/CM weaving compact

For making the product of 60/CM on K44 machine, the profit per pound is increased in the month of May due to good yield %age with high yarn sale rate in the market. But if we see lower value of profit, the cotton rate is less and product sale rate is also less in the market.
In the manufacturing of yarn product of 80/CM on K44 machine, there are also same type scenario here for increasing the profit margin. It depends upon cotton rate, Yield %age, yarn cost rate and sale rate in the market.

<table>
<thead>
<tr>
<th>Parameters/Month</th>
<th>Jan.</th>
<th>Feb.</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton (Rs/40kg)</td>
<td>8960</td>
<td>8255</td>
<td>9010</td>
<td>8900</td>
<td>11000</td>
<td>8255</td>
<td>11000</td>
</tr>
<tr>
<td>Yield (%)</td>
<td>77.13</td>
<td>78.05</td>
<td>75.28</td>
<td>75.06</td>
<td>76.03</td>
<td>75.06</td>
<td>78.05</td>
</tr>
<tr>
<td>Noil (%)</td>
<td>13%</td>
<td>13%</td>
<td>15%</td>
<td>15%</td>
<td>13%</td>
<td>13%</td>
<td>15%</td>
</tr>
<tr>
<td>Yarn sale (Rs/lb)</td>
<td>296.6</td>
<td>294.8</td>
<td>270</td>
<td>300</td>
<td>300</td>
<td>270</td>
<td>300</td>
</tr>
<tr>
<td>Conv.</td>
<td>145.59</td>
<td>128.79</td>
<td>114.34</td>
<td>114.34</td>
<td>114.34</td>
<td>114.34</td>
<td>145.59</td>
</tr>
<tr>
<td>Cotton Intrest</td>
<td>8.03</td>
<td>7.34</td>
<td>8.19</td>
<td>8.11</td>
<td>9.94</td>
<td>7.34</td>
<td>9.94</td>
</tr>
<tr>
<td>Packing (Rs/lb)</td>
<td>1.70</td>
<td>1.70</td>
<td>1.70</td>
<td>1.70</td>
<td>1.70</td>
<td>1.70</td>
<td>1.70</td>
</tr>
<tr>
<td>Yarn Cost (Rs/lb)</td>
<td>283.15</td>
<td>254.31</td>
<td>254.27</td>
<td>251.86</td>
<td>286.10</td>
<td>252</td>
<td>286</td>
</tr>
<tr>
<td>Profit/ lbs (Rs/lb)</td>
<td>13.45</td>
<td>40.49</td>
<td>15.73</td>
<td>48.14</td>
<td>13.90</td>
<td>13.45</td>
<td>48.14</td>
</tr>
</tbody>
</table>

Table: 4 Costing data for the product of 80/CM weaving compact

In the below table, the profit margin in February & April almost near to each other but the only difference is product sale rate and cost rate due to cotton price & Yield %age.

![Profit/lbs Bar Graph](image)

Figure: 6 Bar Graph of profit/lbs for product of 80/CM weaving compact
4.5 Mathematical Model & Simulation

The result of Monte Carlo Simulation @ Risk is the probability distribution in above figure; in the simulation of yarn 40/cm weaving, the minimum figure for profit per pound is 3.3 Rs, but this figure is the bottom line and it will be only achieved, if all negative circumstances occur. That means with the probability of 5%, the profit per pound of product will fall below 3.3 Rs.

In the case of upper limit, the maximum figure for profit per pound of this yarn product is 18.48 Rs and it will only be achieved if all positive circumstances would occur in the process. That means the profit will not exceed 18.48 Rs per pound for the probability of 95%.

Figure: 7 Probability distribution for 40/CM weaving non-compact
In the probability distribution via Monte Carlo Simulation @ Risk shows the figure of simulation of yarn product of 40/CM weaving. At the probability of 5%, the profit will be 6.65 Rs and the figure is bottom line and will be achieved if all negative circumstances occur.

But if we see the other scenario, the maximum figure of the product is 28.53 Rs per pound and this is the upper limit and it will be achieved in case of all positive circumstances occur. That means with the probability of 95%, the figure for the profit per pound will not exceed 28.53 Rs or in other words: for only with the probability of 5%, the profit per pound for this product will exceed 28.53 Rs to 30 Rs.
In the above figure of probability distribution, here is the minimum value of 12.98 Rs per pound for the probability of 5% and it will only achieved if all the things are negatively happened. The profit will not increase to 12.98 Rs.

In case of maximum level of profit per pound of this product, the 46.95 Rs is high value and it will be achieved if all positive circumstances would be occurred in this scenario. That means with the probability of 95%, the profit will be increased from 12.98 Rs to 46.95 Rs per pound of the product and it will not exceed up to 46.95 Rs. In other word; with only the probability of 5%, the profit will exceed 46.95 Rs.
In the above simulation of this product, there is very little variation of probability distribution and trend of profit per pound from the previous product simulation graph.

If we see the minimum figure of profit per pound, it is 15.18 Rs for the probability of 5% and it’s near to the previous product profit per pound. In case of maximum value of profit per pound, both are approximately same for the maximum profit 46.4 Rs and 46.95 for the 90 % probability. It means the profit will not exceed to 46.4 Rs in both cases.
Chapter 5

5. Finding & Discussion Results

In this case study, analysis the quantitative data regarding costing and what is profit per pound of different textile products in the process. On the basis of actual data, technical experience and through discussion with supervisor for the product of 40/CM weaving non-compact on G33, 40/CM weaving compact on K44, 60/CM weaving compact on K44 and 80/CM weaving compact on K44, found the different scenario regarding increase the profit margin per pound as well as reduce the cost of product. I focused mainly on significant factors (KPI’s) of costing such as cotton rate, yield %age, yarn cost rate & sale rate per pound of the product.

Comparison of two products showed the clear picture of which product is best & valuable for the company and what will the profit margin? Following details will give the clear understanding between two products regarding parameters affect on costing and profit margin per pound;

In case of yarn 40/CM weaving, compared the same product but on made different machines one was non-compact making yarn machine and other compact making yarn machine. Actually the compact making machine produce good quality yarn as compared to non-compact product but only verified which product can give more profit and has market value as compared to other then. From the probability distribution of figure 7 & figure 8, the maximum probability (90%) for gaining the profit per pound was varied for these two products. It was more for made the compact yarn and less for the non-compact yarn.

In the study of 60/CM and 80/CM compact yarn, compared the different product but made on same machine type K44 and both were most usable products for making shirting fabric and summer wearing clothes. From the view of probability distribution of figure 9 & figure 10, there is little difference for achieving the profit margin for the maximum probability (90%). It was more for making the product of 80/CM compact as compared to other one.
From the analysis of 60/CM & 80/CM data, it’s very difficult to decide which product is more profitable due to very less difference in probability distribution? In my point of view and discuss with supervisor, 60/CM yarn is made from high cost rate, high material cost, chances of loss of yield & production to achieve the high quality of this product and profit margin. It is also less consume and use only for making specific fabrics in the market.

But in the other case such as 80/CM product, it is possible to manage the yarn cost rate, material cost, yield %age and production to achieve the high quality of this yarn product as per customer demand. Due to high consumption for the manufacturing of different types of fabrics such as, summer wearing clothes, fashion cloths and garments in the market of all over the world.
6. Conclusion & Recommendation

After finding and results from the analysis of data, it’s easy to describe the conclusion and recommendation for further research and study. For the better understanding of costing of product, took the two types of scenario: 1st was compared the data of same product but on different machines and 2nd compared the different product data on same machine.

From the study of process data, analysis of data and probability distribution, it’s clear that 40/CM weaving compact is more profitable and market value product as compared to the same product on non-compact machines. Due to compact product and high strength, it has good working & smooth running on machines, that’s why production, quality and yield %age increased of this type of yarn product as compared to non-compact product with the chances of loss of production, quality and yield %age. If we see with respect to market value, the consumption of this production is so high for the manufacturing of major in suiting, bed sheeting and upholstery fabrics for all over the world.

On the basis of analysis of costing data, my professional experience and market value: I will recommend for the yarn manufacturing companies, 40/CM weaving compact product should be in manufacturing plan for getting the more profit per pound.

In case of other product for profit per pound from the analysis of data, such as 80/CM compact has slightly more profit as compared to 60/CM weaving compact in the process. Due to high market value, consumption and more profit per pound as described in previous chapter; the 80/CM weaving compact is more preferable product in the textile industry to achieve the customer expectations and profit for the progress of the company.
On the basis of data analysis of costing, my professional experience and detail discussion with technical supervisor, 80/CM weaving compact yarn is more profitable and demanding product as compared to 60/CM weaving compact in the market. That’s I will recommend that product for the yarn manufacturing industries to get the high profit and more sustainable product in the market.
7. References


