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STUDY ON THE IMPACT OF RECENT TECHNOLOGICAL CHANGES IN THE KNITTING INDUSTRY AT TIRUPUR

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BONAFIDE CERTIFICATE

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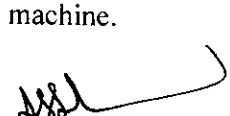
ABSTRACT

The Knitting industry in India is concentrated in Tirupur (Tamilnadu) and Ludhiana (Punjab). Knitted garments account for almost 32 percent of all exported garments from India and Tirupur produces 60 percent of India's total knitwear exports. The considerable investment in capital equipment made by all companies of all sizes has ensured that India has not been left behind. The investment in this sector has seen the industry becoming one of the most creative users of many of the new types of machinery, which is re-enforcing our position in producing different varieties of knitwear and increasing our competitiveness within the global market. This is indeed a significant contribution to the Indian economy by the knitwear industry which has a bright future. So a study was undertaken to review the technologies adopted by the industries and the technological impact with special reference to productivity, quality and cost reduction factors on the growth of the cluster at Tirupur and the survey was conducted at 43 knitting units possessing two different brands of machinery with a self administered questionnaire. The study reveals the fact that technology has influenced the industry to a larger extent in terms of the three chosen factors. Productivity is increased to a higher extent when compared to the older technologies. Quality of the product adopting newer technologies show a great variation and makes us competent with other countries. Cost reduction factor of technology has both positive and negative impacts. With the advent of technology, intensive training is essential for the labourers and the requirement for skilled labour arises. Maintenance of the machineries acquire higher cost with the infrastructural facilities required for the operation of the machine.



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CHAPTER 1

INTRODUCTION

Textiles are so much a part of Indian culture that Gandhiji wanted a spinning wheel put on the national flag, Rough guides (2003). India is known world over for its ancient and rich textile trade and industry. It is believed that India was the first country to manufacture cotton, remarks Dantyagi (2004). Among the finds at Mohenjodaro are a few scraps of cotton sticking to the sides of a silver vase. This at least shows that cotton must have been used in India as far back as the 2nd millennium B.C. Fibres, being the most basic and important input to form any textile, may have been considered adequate to fulfill the needs of mankind, viz, the clothing necessary for covering the body from the adverse effects of the Nature.

Man has never stopped at being contented with whatever he possessed and that little brain of his, with full of ideas for better living, went on inventing newer and newer products, opportunities – meeting challenges all throughout the generations. Thus, a simple crudely woven handmade cloth was just sufficient to cater to his basic requirements. However, as in all walks of life, in clothing also tremendous improvements have been made, more fascinating being the fabrication, the knitting of yarns.

Textile industry is one of the main pillars supporting the Indian economy. It constitutes about 14% of industrial production, 20% of total export earnings, 4% of GDP and provides direct employment to an estimated 35 million people. In spite of these, India's entire share in world textiles trade is still struggling at around 3%. About 45% of Indian garment exports are in the form of knitwear, and in this, **Tirupur** plays a pivotal role, generating as much as 90% of the knitted garment exports, in other words, about 4% of India's total export trade.

Knitting industry in Tirupur has emerged as a premier supplier of value added items earning high foreign exchange. For the past 10 years, there was a phenomenal change in technology and large number of sophisticated computerized

knitting machines, full-fledged processing units, individual machines, compacting machines and other machinery required in knitwear manufacturing have been imported. Moreover exporters have started concentrating on value added products and high unit value realisation. Knitwear industry has clearly identified the definition of fashion meaning thereby combination of many things put together and corresponds to feeling of something. Fashion is mainly dependable on industry and society in a probationary manner. Creation of hi-style and value added knitted garments are instrumental in driving out the value-hidden stuff of the knitwear exporters with a motive that it reaches the intending onlookers who believe in right choice of selection.

With the advancement of the knitting technology, the use of knitted fabrics is expanding rapidly all over the world. The Knitwear sector and its markets are constantly evolving worldwide. This segment of the garment industry has experienced many changes in recent years. With improved technology, the limitations like shrinkage and torque in knitted fabrics or garments have been reduced to a great extent and this has opened more opportunities. Many global players are eyeing the Indian Market with great interest as one of leading markets in the Post Quota Scenario. The Knitwear Exporters from all over India like from Delhi, Mumbai, Bangalore, Chennai and Tirupur have already been equipped with making new designs and collections which complements with the current fashion trend and to meet with International Buyers' requirements. Tirupur is one of the few Indian towns that took advantage of globalization and economic reforms, along with export-led growth. The export of knitwear products from Tirupur is always on the rise every year and the industry continues to show rapid growth.

Computer-Aided Design (CAD) and Computer-Aided Manufacturing (CAM) have revolutionized the knitting industry. The 1970's saw the introduction of CAD/CAM systems. Designers used the CAD system to create product designs and these were transferred to CAM machines to manufacture the final product.

CAD/CAM technology replaced the mechanical patterning and shaping devices on machines with electronic controls. These systems enabled companies to respond quickly to changes in demand. New designs could be set up using CAD and quickly produced on the CAM machine.

Technology can be most broadly defined as the entities, both material and immaterial, created by the application of mental and physical effort in order to achieve some value. In this usage, technology refers to tools and machines that may be used to solve real-world problems. Tools and machines need not be material; virtual technology, such as computer software and business methods, fall under this definition of technology. The word "technology" can also be used to refer to a collection of techniques. In this context, it is the current state of humanity's knowledge of how to combine resources to produce desired products, to solve problems, fulfill needs, or satisfy wants; it includes technical methods, skills, processes, techniques, tools and raw materials. "State-of-the-art technology" refers to the high technology available to humanity in any field. Technology can be viewed as an activity that forms or changes culture. Additionally, technology is the application of math, science, and the arts for the benefit of life as it is known. A modern example is the rise of communication technology, which has lessened barriers to human interaction and, as a result, has helped spawn new subcultures; the rise of cyber culture has, at its basis, the development of the Internet and the computer.

NEED FOR THE STUDY

Knitting industries in Tirupur are facing a tough competition with other countries due to the globalised marketplace. So a study is undertaken to review the technologies adopted by the industries and the technological impact on the growth of the cluster at Tirupur, the **KNIT CITY** of India.

OBJECTIVES

- To identify the different technologies adopted in knitting industry and analyse the lifecycle of each.
- To study the impact of the technological changes that has led to the growth of the sector with special reference to productivity, quality and cost reduction factors.
- To compare the quality output of the adopted technologies and their cost effectiveness.
- To analyse the innovations in the industry from the current past and its usefulness for the cluster.

SCOPE

The study is intended to be presented to the knitted cloth manufacturers in Tirupur about the impact that technology has brought out for their advantage. By analysing the innovations, it is possible to view the growth of the industry from its origin in the 1970's and the advantages of the same.

DELIVERABLES

The study on the impact of recent technological changes in the knitting industry is intended to deliver the following aspects:

- General evaluation of the industry with the implications of technology aided benefits.
- Impact of technology in increasing the productivity of the firm
- Impact of technology in improving the quality of the products manufactured with minimisation of defects.
- Impact of technology in reducing the manufacturing expenses of the product thus leading to a maximum profit.

CHAPTER 2

LITERATURE SURVEY

2.1 REVIEW OF LITERATURE

The literatures pertaining to the study are reviewed under the following headings.

2.1.1. The role and importance of technology

2.1.2. Technology and society

2.1.3. Technology and its development in India.

2.1.4. Knitwear sector in Tirupur.

2.1.5. Impact of technology on the knitting industry.

2.1.6. Technology planning and sourcing for the knitting industry.

2.1.7. Choice of technology

2.1.8. Barriers or obstacles for growth

2.1.9. Managing the technological changes

2.1.1. THE ROLE AND IMPORTANCE OF TECHNOLOGY

The term technology holds a very vast meaning and concept, which varies according to the use it is being put to. It involves the usage of tools which affects and controls the environment, and the ability to adapt to it. Today's modern technology is the direct consequence of the emerging science and engineering in the world. Technology originates from the Greek work "technologia" — "*techne*",("craft") and "*logia*",("saying"). Technology is so widespread, and its use is so vast that we cannot restrict it to any one particular field and its association in the improvement and development of any specific sector. Starting from the sciences, to the sports, peace and historical research technology has been the source of constant development and built up of the modern world. Technology has greatly influenced the society and its lifestyle, it has not only been a source of ease and development of the world's economy due to latest advancements but it has also given way to the rise of a leisure class in this world.

The use of technology in various fields has been so successful and beneficial for us to reach the standards we have in this modern world that it is difficult to summarize the importance of technology, which is never ending. The importance of technology is seen and enjoyed in every phase of our life these days. When we talk on the phone, or internet, it feels very normal to us because we are in a situation where the blessings of technology are overwhelming. Communication was never so easy, and on our finger tips ever. The printing press, telephone, internet are all some of the latest technologies which have lessened the barrier of location for people in different parts of the world. Its importance is so widespread not only in our daily lives but also the major world issues that technology should be the most encouraged scientific education in the coming years. The major advancement in technology is because of the increased scientific research these days. Science has been the pillar of technology and therefore it is considered to be the most looked upon subject in the modern world due to its technological success. Therefore it is also a major benefit for the upcoming generations to continue with the hold of the most developed technological field going on these days.

In many ways, technology simplifies life.

- The rise of a leisure class
- A more informed society, which can make quicker responses to events and trends
- Sets the stage for more complex learning tasks
- Increases multi-tasking (although this may not be simplifying)
- Global networking
- Creates denser social circles
- Cheaper prices
- Greater specialization in jobs

2.2. TECHNOLOGY AND SOCIETY

Technology has such immense benefits in every phase of our lives, that it has not only made our life easier but also has raised the standard of living of every individual. One such department of everyday life related to the business sector is economy. Technology has made the economy of the world climb its highest peaks,

which would have been completely disoriented with increasing population and work load over the time. There have been some extraordinary productivity gains in various nations due to the increase in the use of technology underscoring the importance of economy and how not only the businesses as a whole but also the individuals have been successful. It is worth mentioning that due to the use of latest technologies, everything in a working environment is handled very efficiently.

Management of the employees to the inventories everything is very systematically handled. The most important advantage of technology which helps in boosting the economy of the world is that technology makes everything go in ease. Technology eliminates the unnecessary tedious, production processes done manually, which speeds up the delivery of the goods to the market. This has many advantages in itself to the company. It keeps the prices of the goods low which also enables the companies to meet their individual customer's demands very well. May it be any country's profile and past record it is very evident that the implementation of the technology has magnificently shot up the opportunities for individuals and also the economic levels in general.

2.3. TECHNOLOGY AND ITS DEVELOPMENT IN INDIA

Like other colonized nations, India was dragged into the industrial era on terms that were not of its own choosing and many of the technological developments that have since taken place in India have been geared more towards the export market than bringing about all-round improvements in the quality of life for the Indian masses. For that reason, it cannot yet be said that India has fully entered the modern industrial era. Only when India is able to harness the power of technology and modern industry towards improving the quality of life for the vast majority of its people will that be the case. That will require not only major advances in the Indian education system but radical social changes that have yet to take place in a systematic way. Above all, the forces of religious fundamentalism, religious obscurantism and social backwardness will have to be pushed back and defeated.

2.4. KNITWEAR SECTOR IN TIRUPUR

The knitting industry in India is concentrated in Tirupur (Tamilnadu) and Ludhiana (Punjab). Tirupur produces 60 percent of India's total knitwear exports. Knitted garments account for almost 32 percent of all exported garments from India. Tirupur is basically a traditional centre for cotton ginning and it exports many textile and clothing items. This city accounts for 90 % of India 's cotton knitwear exports to all over the world.

Today, knitting is a complex industry with two main areas, each of which has its subdivisions of specializations. The two main areas of the knitting industry are as follows:

- One area produces knitted goods for apparel manufacturers, for sewing centers, for consumers and others.
- The other area manufactures completed garments like sweaters, hosiery and underwear.

Indian Knitting industry is a growing industry which is emerged as a premier supplier of value added items. Knitted garments are very popular in the modern fashion scene and are no longer confined to lingerie, underwear and stockings. The revolution in knitwear has brought a range of styles that can be handmade or purchased and is constantly expanding. It is a known fact that knitted garments are popular with kids since time immemorial. But times have changed today and it has become popular for all-men, women and kids.

The development of Tirupur, one has heard so much of knit wear boom in the press over the past few years. However, none of the explanations in the press have been able to explain why and how this little town in Tamil Nadu has come to be the centre of India's local hosiery and export cotton knitwear industry. The industry works through a web of small to mid-sized units, with fabrication here, processing elsewhere and stitching somewhere else. These networks of firms operate through job working, contracting and sourcing arrangements. The business families set up "sister concern"

rather than large fully integrated factories. The considerable investment in capital equipment made by all companies of all sizes has ensured that India has not been left behind. The investment in this sector has seen the industry becoming one of the most creative users of many of the new types of machinery, which is re-enforcing our position in producing different varieties of knitwear and increasing our competitiveness within the global market. This is indeed a significant contribution to the Indian economy by the knitwear industry which has a bright future.

2.5. IMPACT OF TECHNOLOGY ON THE KNITTING INDUSTRY

With the advancement of the knitting technology, the use of knitted fabrics is expanding rapidly all over the world. The Knitwear sector and its markets are constantly evolving worldwide. This segment of the garment industry has experienced many changes in recent years. With improved technology, the limitations like shrinkage and torque in knitted fabrics or garments have been reduced to a great extent and this has opened more opportunities. Many global players are eyeing the Indian Market with great interest as one of leading markets in the Post Quota Scenario. The Knitwear Exporters from all over India like from Delhi, Mumbai, Bangalore, Chennai and Tirupur have already been equipped with making new designs and collections which complements with the current fashion trend and to meet with International Buyers' requirements. Tirupur is one of the few Indian towns that took advantage of globalization and economic reforms, along with export-led growth. The export of knitwear products from Tirupur is always on the rise every year and the industry continues to show rapid growth.

There are many reasons for the growth of the Indian knit garment industry. These are as follows:

- Compared to the setting up of other fabric producing industries, the capital investment for starting a new knitting unit is relatively small.
- The high productivity of knitting machine is also an important factor for the growth of the industry.
- As the preparatory process for knitting is less than weaving, the time required to get an order completed is less than that required in the case of woven fabrics.

- The setting up of knitting machines to produce a given type of fabric is a fast and simpler operation than the setting up of a loom.
- Knitting is more flexible than weaving in the sense that styles and designs can be changed with unparalleled rapidity. Knit garments are geared to quick turnover in keeping with the rapid fashion changes in the apparel market.
- There are wide varieties of new yams that have brought new standards of performance and new aesthetics into the knit market.
- The knit fabrics are very comfortable and are in tune with the times.
- The present generation demand wrinkle-free, ease-of-care fabrics and knit garment is the perfect solution for this. The recent success of knit garments has been greatly due to their easy-care properties.
- Knitted garments generally require no ironing and are therefore it is cool for travelling persons.
- Knitted fabrics are the most comfortable ones for swimwear and sportswear.
- All problems related with labour organization like wages, benefits to labour etc. are reduced in the knitting industry because knitting units require very less labour.
- The machinery manufacturers with the aim of high productivity and versatility have developed highly innovative machinery which has also led to the boom in the knitting industry.

2.6. TECHNOLOGY PLANNING AND SOURCING FOR THE KNITTING INDUSTRY

Technology planning is important for many reasons. Globally, companies are facing many problems. Products are becoming more complicated and customized. Product time to market is shrinking and the product life is shortening. A short-term focus is on reducing investment funding and because of the increased competition, cut-backs are occurring. These problems require companies to be more focused and better understand both their industry and markets. Better technology planning can help deal with this increasingly competitive environment. It is a specific technique for technology planning, which fits within a more general set of planning activities. As a result of

technology planning, a company or an industry can make better investment decisions because it has better information to:

- Identify critical product needs that will drive technology selection and development decisions.
- Determine the technology alternatives that can satisfy critical product needs.
- Select the appropriate technology alternatives.
- Generate and implement a plan to develop and deploy appropriate technology alternatives.

Planning activities must link three critical elements — customer/market needs, products/services, and technologies. The corporate vision drives the strategic planning effort, which generates high-level business goals and directions. Given a corporate vision, strategic planning involves decisions that identify and link at a high level the customer/market needs a company wants to address and the products and services to satisfy those needs. Given this strategic plan, technology planning involves identifying, selecting, and investing in the technologies to support these product and service requirements. Business development involves planning for and implementing certain aspects of the strategic plan, specifically those involving the development of new products and services and/or new lines of business.

2.7. CHOICE OF TECHNOLOGY

According to Williams and Edge (1996), the construction and shaping of technology includes the concept of choice (and not necessarily conscious choice). Choice is inherent in both the design of individual artifacts and systems, and in the making of those artifacts and systems. The idea here is that a single technology may not emerge from the unfolding of a predetermined logic or a single determinant, technology could be a garden of forking paths, with different paths potentially leading to different technological outcomes. This is a position that has been developed in detail by Judy Wajman Therefore, choices could have differing implications for society and for particular social groups. Society also controls technology through the choices it makes.

These choices not only include consumer demands but also:

- the channels of distribution, how do products go from raw materials to consumption to disposal
- the cultural beliefs regarding style, freedom of choice, consumerism, materialism, etc.
- the economic values we place on the environment, individual wealth, government control, capitalism, etc.

2.8. BARRIERS OR OBSTACLES FOR GROWTH

Most new businesses based on new technology start small and stay small. The lack of growth of these businesses limits the diffusion throughout society of the benefits of new technology, and incurs opportunity losses for inventors, investors, potential employees and other stakeholders. The small percentage of new businesses that exhibit dramatic growth account for almost all of the wealth created by new businesses. If newly formed businesses based on new technology could be encouraged to grow, significant social and economic benefits could result. In order to gain these benefits, we need first to identify barriers that impede growth, so that we might find ways to overcome those obstacles.

The seven principal obstacles to growth are :

- lack of vision for the business,
- objectives and risk preferences of startup teams,
- difficulty of identifying a "right" size for the business,
- inappropriate timing of growth,
- trying to grow too quickly or too slowly,
- inappropriate product-market choices for growth, and
- inability to assemble and deploy intellectual , human and financial resources effectively.

2.9. MANAGING THE TECHNOLOGICAL CHANGES

Most organizations today realize the criticality of managing technology changes. They understand that by merely investing in new technology, without careful

planning and on-going assessment, need not necessarily result in improved business performance. Consequently, before implementing a technology it's crucial for the manager to first find out how it is going to affect the business process that is already in place and benefit the company. Another area is the cost involved for making these changes. Hence, the technical manager should look into all areas which will be affected, and also what type of improvement it will bring in.

Change may occur in the internal process, business model, scale of business and technology. Change management is a big question which all institutions face whenever they go for a technological change - proper planning of the change process is required. The process begins from the moment the need for change arises and continues even after it has been fully introduced in the organization. The specific problem must be analyzed and an effective solution should be implemented and managed.

It's important to note that change management is a completely people-driven process and consists of three important factors - involvement, communication and education. It is an art which is not easy for everyone to master. Convincing people to shift from existing routines to something new is always painful. In some organizations, with more tech-savvy people, it is easier. Once the members of an organization are convinced of the need for change, half the battle is won. What follow next are—relentless follow-ups, monitoring and execution as per schedule. These factors decide the progress and ultimate success of a project. There must be policies and incentives that drive desired behavior. It is important to see transformation as an ongoing process rather than as a one-time initiative. Therefore, metrics created to help stimulate an organization toward change and to measure progress toward that objective must be continually reviewed for relevancy.

Managing technological change is nothing but using human psychology to convince people to accept change and the technical manager must have these skills. A technical manager has to review the fit to the current enterprise architecture and an analysis of cost vis-a-vis benefits accrued from the change. If the new technology does not make a difference as compared to the results obtained with existing systems, then change is not warranted.

CHAPTER 3

METHODOLOGY

The methodology adopted for the study is reviewed under the following headings.

3.1 RESEARCH DESIGN

- 3.1.1. Type of Research – Descriptive Study
- 3.1.2. Target respondents
- 3.1.3 Sources of data
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- 3.1.7 Constraints and Limitations

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- 3.2.1. Questionnaire
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3.3. TOOLS FOR ANALYSIS

- 3.3.1. Percentage Analysis
- 3.3.2. Hypothesis testing - Non-parametric tests
- 3.3.3. Chi square test
- 3.3.4. Spearman's Correlation coefficient
- 3.3.5. Use of SPSS 16.0 for analysis

3.1 RESEARCH DESIGN

3.1.1. TYPE OF RESEARCH - DESCRIPTIVE STUDY

Descriptive research or statistical research provides data about the population or universe being studied. It describes the "who, what, when, where and how" of a

situation, not what caused it. Therefore, descriptive research was used for the study as the objective is to provide a systematic description of the impact of technology that is as factual and accurate as possible. It provides the frequency of certain criterion, and lends itself to statistical calculations. The two most commonly types of descriptive research designs are:

1. Observation and
2. Surveys

3.1.2. TARGET RESPONDENTS

Any time a researcher or decision-maker needs to gain greater insight into a particular problem, he or she is likely to question knowledgeable individuals about it. This is usually done through an informal, free-flowing conversation with anyone who is believed to be able to shed light on the question both within the organization and outside it. Such an approach is referred to as an experience survey. It is only meant to help formulate the problem and clarify concepts, not develop conclusive evidence.

An Experience Survey was conducted to identify the various knitting machineries associations functioning in Tirupur city. The two major associations are:

1. **KNITcMA** – Knit Cloth Manufacturers Association
2. **SIIMKA** – South India Imported Machine Knitters Association

KNITcMA

One of the vibrant associations at Tirupur and registered with Tamilnadu Societies Registration Act 1977. They render services to the hosiery industry for its developments and representing to remove the bottleneck problems as and when they arise in the industry.

SIIMKA

Started in 1998, the association has nearly 200 members and is being guided by the needs and expectations of the knitting industries in Tirupur.

The secondary data about the different knitting industries were collected from these associations. The brands of the machineries available in around 350 knitting units was studied and the result is tabulated in Table.3.1

TABLE 3.1. BRANDS OF KNITTING MACHINES AVAILABLE IN TIRUPUR

S.No	Brands of the Machinery	Manufacturer
1	Fukuhara	Japan
2	Shimmer	Taiwan
3	Vignoni	Italy
4	Ssang Yong	Korea
5	Orizio	Italy
6	Jumberca	France
7	Marchisio	Turkey
8	Monarch	UK
9	Camber	Hongkong
10	Keum Young	Korea
11	Falmac	Singapore
12	Terrot	Germany
13	**Pailung**	**Taiwan**
14	Wellknit	Taiwan
15	Year china	Taiwan
16	Smart Machines	Taiwan
17	**Mayer & Cie**	**Germany**
18	Lisky	Taiwan

So the target respondents are the different knitting units in and around Tirupur possessing the two different brand of machines

1. BRAND A - **Mayer & Cie**
2. BRAND B - **Pailung**

3.1.3 SOURCES OF DATA

3.1.3.1. PRIMARY DATA

Primary data was to be collected from the target respondents with a questionnaire through the self administered survey.

3.1.3.2 SECONDARY DATA

Secondary research refers to reviewing literature and data sources, collected for some other purpose than the study at hand. Secondary data from the knitting associations and through the publications, text books and journals. The websites also served to be an important source.

3.1.4. SAMPLING METHODS

Non-Probability sampling methods were chosen for the study which included

1. **Judgment sampling** – Choice of two different brands of machinery which were predominantly accepted by the various knitting industries in Tirupur.

BRAND A – Mayer & Cie from Germany

BRAND B – Pailung from Taiwan

On the choice of two different machinery brands, the knitting industries were identified and they were reported to be 83 in number, which included 33 industries owning Brand A type of machinery, 37 industries owning Brand B type of machinery and 13 industries owning both Brand A and Brand B.

2. **Convenience Sampling** – With preference to the nearness of location of the industries, 10 of them were selected for Brand A and 10 industries for Brand B and 13 industries owning both machineries of Brand A and B.

3.1.5 SAMPLE SIZE

Identified population – 83 knitting units

Sample size – 43 units.

The list of addresses of the industries are given in Appendix 2

3.1.6 ASSUMPTIONS

The majority users of a particular brand would have the impact of technology on their productivity, quality and cost reduction factors.

3.1.7 CONSTRAINTS AND LIMITATIONS

All the different brands may not be chosen due to the time and cost factor. The impact of technology on the users of a particular brand of machinery may not remain the same on others as the other brands may be introduced in recent years with highly upgraded technology.

3.2. DATA COLLECTION

3.2.1. QUESTIONNAIRE

The questionnaire was drafted with the objectives in mind and it was very simple with 20 questions which are in the order as below.

1. General evaluation of the industry
2. Impact of technology on productivity
3. Impact of technology on product quality
4. Impact of technology on cost reduction

The questions were all closed – ended and contained **nominal, ordinal** and **interval** scales of measurement. Closed questions are much easier to interpret since they are standardized and therefore can be analyzed statistically. They are also quicker to complete for the respondent, but they are more difficult to write since the answers must be anticipated in advance. Ultimately, the respondent is being asked to choose the answer that is closest to their own viewpoints, but not necessarily their point of view.

Likert scale, also called as summative scale, with five points running from one extreme to another, through a neutral central position, ranging from 'Strongly Agree' to 'Strongly Disagree' was preferred for the survey.

3.2.2. SELF ADMINISTERED SURVEY

Any survey technique that requires the respondent to complete the questionnaire him/herself is referred to as a self-administered survey. The most common ways of distributing these surveys are through the use of mail, fax, newspapers/magazines, and increasingly the internet, or through the place of purchase of a good or service They can also be distributed in person, for instance as part of an intercept survey.

3.3. TOOLS FOR ANALYSIS

3.3.1. PERCENTAGE ANALYSIS

The data collected from the survey were classified and tabulated according to the three different groups of industries, which includes the industries owning Brand A type of machine, industries owning Brand B type of machine and the industries that own both. The tabulated data were converted into percentages and the results were inferred.

3.3.2. HYPOTHESIS TESTING – NON-PARAMETRIC TESTS

The purpose of hypothesis testing is to determine the accuracy of the hypotheses framed due to the fact that the data is collected from sample and not from the entire population. The accuracy of hypotheses is evaluated by determining the statistical likelihood that the data reveal true differences and not the random sampling error.

Non-parametric methods are widely used for studying populations that take on a ranked order. The use of non-parametric methods may be necessary when data has a ranking but no clear numerical interpretation, such as when assessing preferences, in terms of levels of measurement, for data on an *ordinal scale*.

3.3.3. CHI SQUARE TEST

Chi-square test is the most widely used non-parametric test of significance and hence the significant differences between the observed distribution of data among categories and the expected distribution are tested on the null hypothesis.

3.3.4. SPEARMAN'S CORRELATION COEFFICIENT

Spearman's rank correlation coefficient or **Spearman's rho**, named after Charles Spearman and often denoted by the Greek letter ρ (rho), is a non-parametric measure of correlation – that is, it assesses how well an arbitrary monotonic function could describe the relationship between two variables, without making any other assumptions about the particular nature of the relationship between the variables.

3.3.5. USE OF SPSS 16.0 FOR ANALYSIS

The above mentioned tests were carried out with the aid of SPSS 16.0.2 package released in April 2008 and the results were interpreted.

CHAPTER 4

DATA ANALYSIS AND INTERPRETATION

The data collected from the respondents are analysed using the various statistical tools and their inference is discussed with diagrammatic representations. The analysis of the study is reported under the following heads.

4.1. GENERAL EVALUATION OF THE INDUSTRY

4.1.1 Establishment and functioning of the industry

4.1.2. Number of machines initially owned by the industry

4.1.3. Basis of preference for machines during the start-up

4.1.4. Preference for the same brand of machines during expansion

4.1.5. Choice of machines for technological improvement

4.1.6. Solution to the technical difficulties through upgradation

4.2. TECHNOLOGY VERSUS PRODUCTIVITY

4.2.1. Increase in productivity by the adoption of new technologies

4.2.2. Rate of increase in productivity

4.2.3. Decrease in machine stoppages due to the better technology

4.2.4. Rate of reduction in fabric wastages

4.2.5. Beneficial data storage and retrieval systems

4.3. TECHNOLOGY VERSUS PRODUCT QUALITY

4.3.1. Impact of technology on the quality of the product

4.3.2. Occurrence of defects in products using the latest technologies

4.3.3. Difference in quality of the products

4.4. TECHNOLOGY VERSUS COST REDUCTION

4.4.1. Impact of space reduction on the profit of the industry

4.4.2. Decrease in labour due to the advanced machineries

4.4.3 Need for intensive training to the workers

4.4.4. Reduced energy consumption due to the advancements

4.4.5. Expensive maintenance of the machineries

4.1. GENERAL EVALUATION OF THE INDUSTRY

The origin, machines owned during the initial start up of the industry and the investor's preference for the choice of machines are evaluated in this section from the collected data.

4.1.1. ESTABLISHMENT AND FUNCTIONING OF THE INDUSTRY

The results for the establishment and functioning of the industry is presented in Table 4.1 and represented in Figure 4.1

TABLE 4.1. YEAR OF ESTABLISHMENT OF THE INDUSTRY

S.No	No. of Years	Number of Industries				%
		Brand A	Brand B	Both A & B	Total	
1.	More than 20	1	1	1	3	6
2.	15 - 20	2	2	1	5	12
3.	10 - 15	3	4	3	10	24
4.	5 – 10	8	4	2	14	32
5.	Less than 5	1	4	6	11	26
	Total	15	15	13	**43**	100

From the above table it is evident that 32 % of the industries were established within five to ten years and 26 % of them in the recent five years.

The industries which are existing for the past 20 years and more constitute only 6 % and double its number within the fifteen to twenty years from the current year.

Almost one quarter of the selected industries were established about ten to fifteen years back which indicates the flourishing of the industry in those years.

4.1.2. NUMBER OF MACHINES INITIALLY OWNED BY THE INDUSTRY

Table 4.2. indicates the number of machines initially owned during the start-up of the industry and the results are discussed below. The diagrammatic representation of the table is given in Figure 4.2.

TABLE 4.2. NUMBER OF MACHINES INITIALLY OWNED

S.No	No. of Machines	Number of Industries				%
		Brand A	Brand B	Both A & B	Total	
1.	5 or more	1	1	2	4	9
2.	4	1	1	3	5	12
3.	3	8	5	5	18	42
4.	2	4	7	2	13	29
5.	1	1	1	1	3	8
	Total	15	15	13	**43**	100

During the initial start-up of the industry, 42 % of the industries report to have acquired three machines and 29 % of them began to function with two machines.

Almost 10 % of the industries have acquired four machines and the same percentage prevails for industries who opted for more than five machines, which indicates that they start with a small number and expand their units later on.

Only 8 % of the selected industries have started functioning with one single machine.

Figure 4.1

YEAR OF ESTABLISHMENT OF THE INDUSTRIES

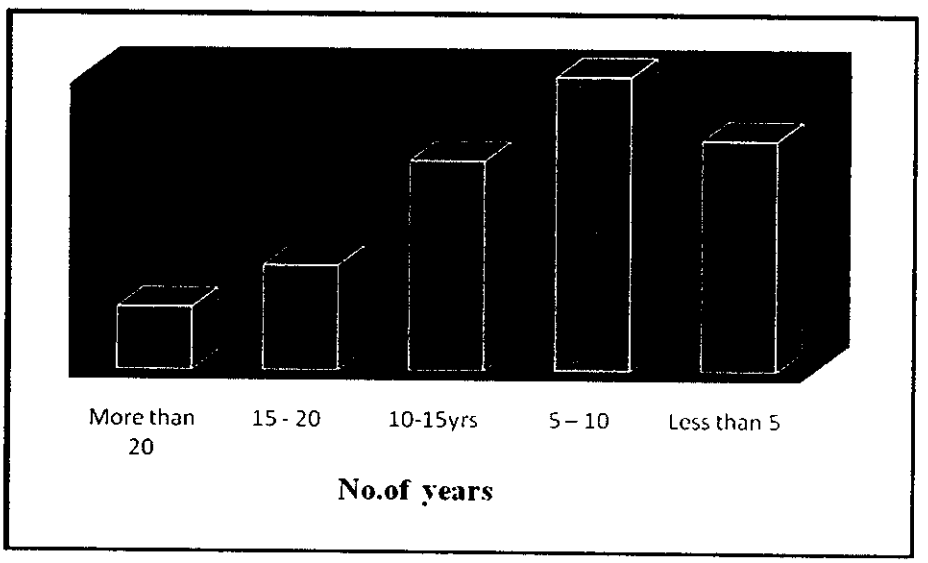
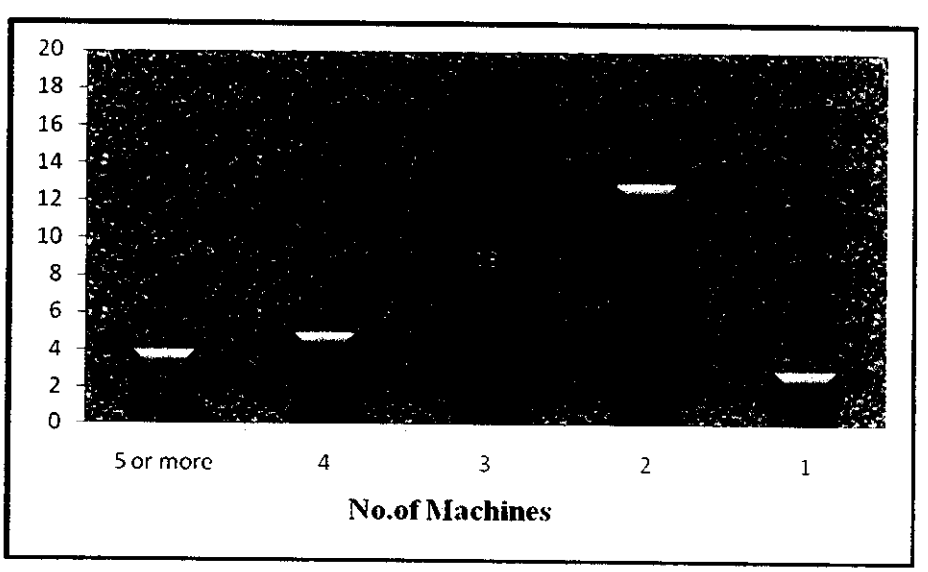


Figure 4.2

NUMBER OF MACHINES INITIALLY OWNED



4.1.3. BASIS OF PREFERENCE FOR MACHINES DURING THE START-UP

The choice for new machineries by the industry may be based on technology, cost of the machine, service provided by the dealers or even the productivity of the machine during the initial start-up. The preference is ranked in ascending order and the results are discussed in Table 4.3.

TABLE 4.3 BASIS OF PREFERENCE FOR THE NEW MACHINERIES

S.No	Preference	Rank Order			
		I	II	III	IV
1.	Technology	5	6	12	**19**
2.	Cost	**25**	13	3	2
3.	Service	4	7	**19**	14
4.	Productivity	9	**17**	9	8
	Total	43	43	43	43

Considering the four important factors in the preference for the new machineries during the initial start-up of an industry, the maximum ranking is given to the **cost** factor by about 25 of the 43 knitting units.

Productivity factor, which denotes the maximum utilisation of the machine is ranked second by about 17 industries.

Service facilities provided by the manufacturers is in the third ranking preferred by about 19 out of the 43 units.

Technology is in the last grade which indicates that least preference is given as the beginners are most considerate about cost and functioning of the machine rather than the technological factor.

4.1.4. PREFERENCE FOR THE SAME BRAND OF MACHINES DURING EXPANSION

The brand reputation plays an important role in the purchase of any product and the choice of the industries for the same brand for expansion is analysed and discussed in the following Table 4.4.

TABLE 4.4 PREFERENCE FOR THE SAME BRAND OF MACHINE

S.No	Preference	Number of Industries				%
		Brand A	Brand B	Both A & B	Total	
1.	Same brand	14	14	1	29	68
2.	Different brand	1	1	12	14	32
	Total	15	15	13	**43**	100

68% of the knitting units prefer to purchase the same brand of machinery in contrast to only 32% of them going in for different brands.

This may be due to the fact that usage of a particular brand of machinery with its technology seem to be more user-friendly even when there is an upgradation in the technological factors.

4.1.5. CHOICE OF MACHINES FOR TECHNOLOGICAL IMPROVEMENT

During the expansion of the industry, the choice for the machineries may be based on the technological improvements developed in the machine and the data for acceptance is given in Table 4.5 and represented in Figure 4.3.

TABLE 4.5 CHOICE OF MACHINES FOR TECHNICAL IMPROVEMENTS

S.No	Options	Number of Industries				%	χ^2
		Brand A	Brand B	Both A & B	Total		
1.	Strongly Agree	1	1	2	4	8	12*
2.	Agree	5	4	7	16	38	
3.	Neutral	2	1	1	4	10	
4.	Disagree	3	6	2	11	26	d.f
5.	Strongly Disagree	4	3	1	8	18	4
	Total	15	15	13	**43**	100	

***significant at 1% level** $\{\alpha = 7.78\}$

Around 46 percent of the industries agree and strongly agree to the fact that the choice of the machineries is for their technological improvements in contrast to 44 % of the industries in all disagree to the statement. 10 % of the units neither agree nor disagree.

The value of the χ^2 test of independence to determine the association of attributes is significant at 1 % level of significance with a computed value of 12.00 with 4 degrees of freedom.

4.1.6. SOLUTION TO THE TECHNICAL DIFFICULTIES THROUGH UPGRADATION

The problems and difficulties faced by the users of the knitting machineries are taken into consideration by the manufacturers with the latest technology that replaces the older ones. Table 4.6 presents the opinion of the knitting units which is diagrammatically represented in figure 4.4.

TABLE 4.6. SOLUTION THROUGH TECHNOLOGICAL UPGRADATION

S.No	Options	Number of Industries				%	χ^2
		Brand A	Brand B	Both A & B	Total		
1.	Yes	5	4	3	12	27	29.9*
2.	Yes, to some extent	7	7	7	21	48	
3.	Neutral	1	1	2	4	10	d.f
4.	No, to some extent	1	3	1	5	12	
5.	No	1	0	0	1	3	4
	Total	15	15	13	**43**	100	

*** significant at 1% level** $\{\alpha = 7.78\}$

From the above table, it is noted that around 75 % of the selected industries agree to the fact that technological upgradation in machineries solves the previous difficulties faced by the consumers, which proves the positive impact of technology.

The value of the χ^2 test of independence to determine the association of attributes is significant at 1 % level of significance with a computed value of 29.9 with 4 degrees of freedom.

Figure 4.3

CHOICE OF MACHINES IS FOR THEIR TECHNOLOGICAL IMPROVEMENTS

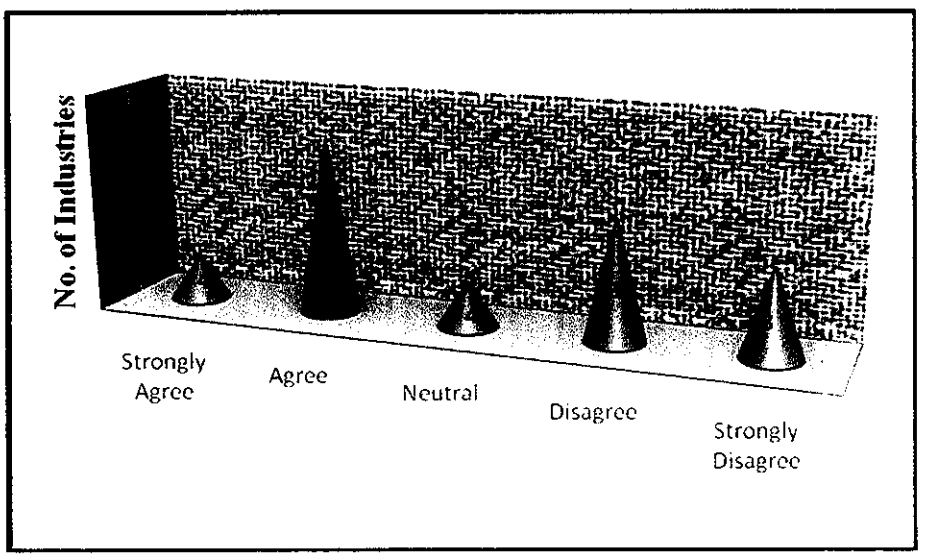


Figure 4.4

TECHNOLOGY UPGRADATION PROVIDES SOLUTION FOR THE TECHNICAL PROBLEMS

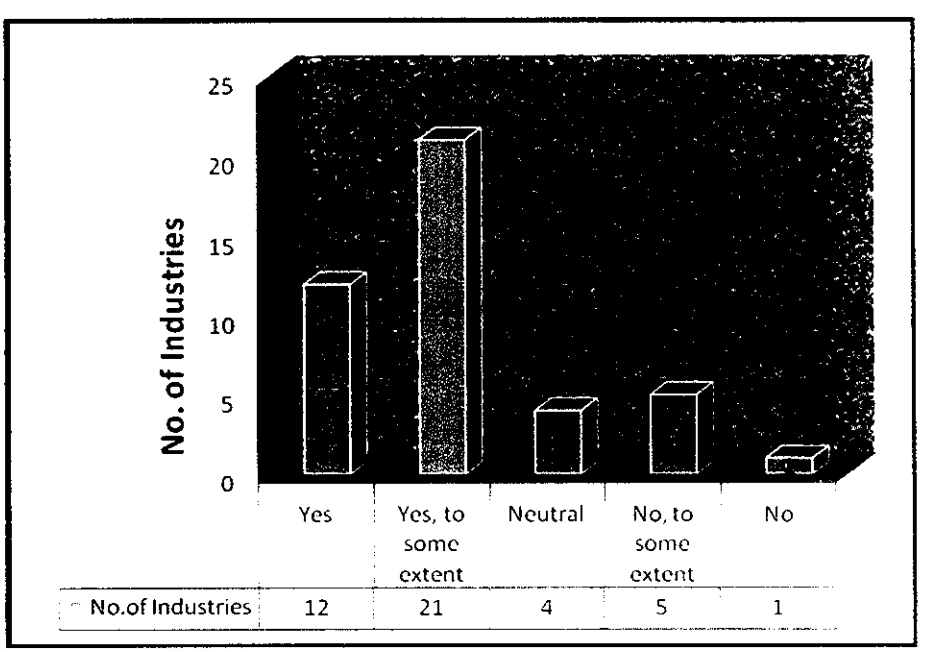


TABLE 4.7

CORRELATION BETWEEN CHOICE OF MACHINES FOR TECHNICAL IMPROVEMENTS AND SOLUTION TO THE PROBLEMS

SPEARMAN'S CORRELATION COEFFICIENT ρ			
		TECHNICAL IMPORTANCE	**SOLUTION TO PROBLEMS**
TECHNICAL IMPORTANCE	**Correlation Coefficient**	1	**0.835****
	Sig. (2-tailed)		0
	N	43	43
SOLUTION TO PROBLEMS	**Correlation Coefficient**	**0.835****	1
	Sig. (2-tailed)	0	
	N	43	43
****Correlation is significant at the 0.01 level (2-tailed)**			

From the above table, it is evident that there exists a **positive** correlation between the two factors, choice of the machines for technological improvements with a consideration that they can provide solution to the technical difficulties faced by the knitting industries in Tirupur.

Spearman's Correlation Coefficient ρ = **0.835** at 1% level of significance.

4.2. TECHNOLOGY VERSUS PRODUCTIVITY

Productivity refers to the ratio between input and output which denotes the rate of maximum utilisation of the resources. To prove the fact that technology has an impact on productivity, the following statements were opined by the knitting units.

4.2.1. INCREASE IN PRODUCTIVITY BY THE ADOPTION OF NEW TECHNOLOGIES

When new technology is adopted, it has to give a rise in the productivity factor for the financial returns of the company. Table 4.8 presents the data in this regard and diagrammatically represented in Figure 4.5.

TABLE 4.8. INCREASE IN PRODUCTIVITY BY THE ADOPTION OF NEW TECHNOLOGIES

S.No	Options	Number of Industries				%	χ^2
		Brand A	Brand B	Both A & B	Total		
1.	Strongly Agree	3	3	1	7	17	68.9*
2.	Agree	10	10	10	30	69	
3.	Neutral	1	1	1	3	6	
4.	Disagree	0	1	1	2	5	d.f
5.	Strongly Disagree	1	0	0	1	3	4
	Total	15	15	13	**43**	100	

*** significant at 1% level** $\{\alpha = 7.78\}$

Around 86% of the industries agree and strongly agree to the increase in productivity due to the adoption of new technologies whereas only 8% of them deny and 6% of them neither agreed nor disagreed.

The value of the χ^2 test of independence to determine the association of attributes is significant at 1 % level of significance with a greater computed value of 68.9 with 4 degrees of freedom.

4.2.2. RATE OF INCREASE IN PRODUCTIVITY

The rate of increase in productivity in an interval scale is presented in the following table 4.9 and represented in Figure 4.6.

TABLE 4.9 RATE OF INCREASE IN PRODUCTIVITY

S.No	Options	Number of Industries				%
		Brand A	Brand B	Both A & B	Total	
1.	More than 10 times	2	2	1	5	12
2.	5-10 times	9	7	1	17	38
3.	2-5 times	3	6	11	20	47
4.	Slight improvement	1	0	0	1	3
	Total	15	15	13	**43**	100

From the above table it is evident that the industries accept for the rate of increase in productivity to a maximum extent, more than 10 times by about 12% of the industries.

The major acceptance rate is 2-5 times been accepted by nearly half of the population. The rate of increase in productivity more than five times from the previous machineries is opined by around 38% of the industries.

12% industries account for more than 10 times rise in productivity ratio, which clearly states the production capacity per machine in the industry, showing that maximum yield is possible if technological changes are implemented in the industries.

Figure 4.5

INCREASE IN PRODUCTIVITY DUE TO TECHNOLOGY ADOPTION

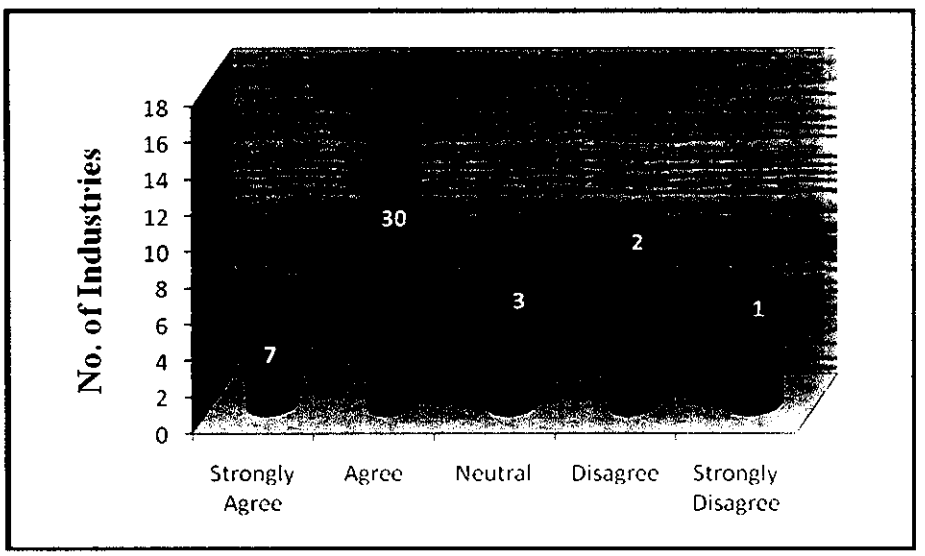
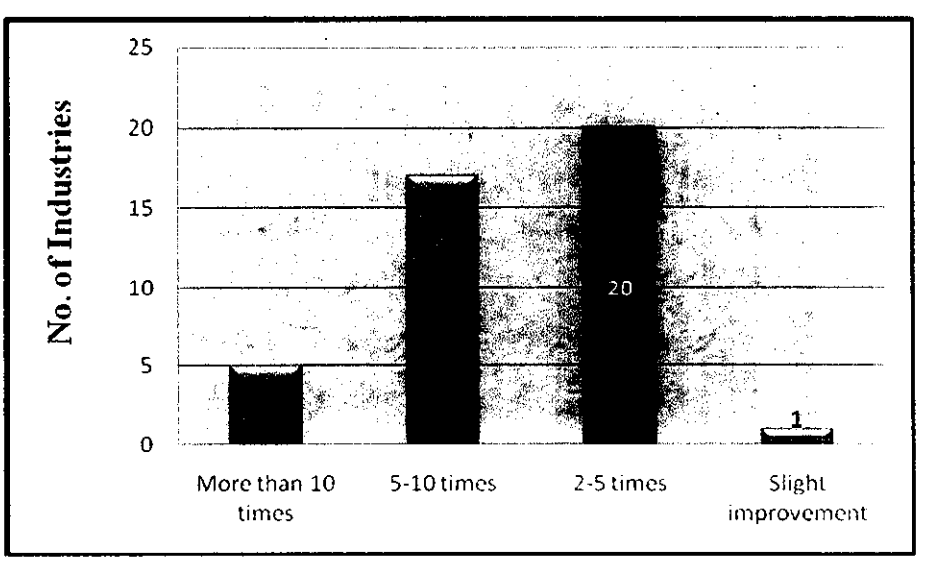


Figure 4.6

RATE OF INCREASE IN PRODUCTIVITY



4.2.3. DECREASE IN MACHINE STOPPAGES DUE TO IMPROVED TECHNOLOGY

The machine stoppages due to some recurring faults in the yarn feed or other disturbances seem to lower the rate of productivity. The following table 4.10 presents the data on the opinion of the knitting units that technological impact has lowered the frequency of machine stoppages and represented in Figure 4.7.

TABLE 4.10. DECREASE IN MACHINE STOPPAGES DUE TO IMPROVED TECHNOLOGY

S.No	Options	Number of Industries				%	χ^2
		Brand A	Brand B	Both A & B	Total		
1.	Strongly Agree	7	6	4	17	39	16.9*
2.	Agree	5	4	3	12	27	
3.	Neutral	1	1	1	3	8	
4.	Disagree	1	4	3	8	19	d.f
5.	Strongly Disagree	1	0	2	3	7	4
	Total	15	15	13	**43**	100	

*** significant at 1% level** $\{\alpha = 7.78\}$

More than 65% of the knitting units agree and strongly agree to the fact that the frequency of machine stoppages have been reduced to a considerable extent. Only 26% disagree, which includes 7 percent of the units who strongly disagree to the statement.

The value of the χ^2 test of independence to determine the association of attributes is significant at 1 % level of significance with a computed value of 16.9 with 4 degrees of freedom.

4.2.4. RATE OF REDUCTION IN FABRIC WASTAGES

Increase in productivity can be brought about by the fullest utilisation of resources which is the other form of reduced wastages. Table 4.11 and figure 4.8 represents the rate of reduction in fabric wastages.

TABLE 4.11 RATE OF REDUCTION IN FABRIC WASTAGES

S.No	Options	Number of Industries				%
		Brand A	Brand B	Both A & B	Total	
1.	5 % or less	1	0	0	1	2
2.	5 – 10 %	1	1	1	3	6
3.	10 – 15 %	12	13	10	35	82
4.	15 % or more	1	1	2	4	10
	Total	15	15	13	**43**	100

The inference from the above table clearly shows that 82% of the knitting units have accepted a 10-15% rate of reduction in fabric wastages.

8% units in all opine lesser value and the rest 10% feels a higher rate more than 15% reduction.

So, from the percentage analysis of the above fact, it is evident that the rate of reduction is higher which increases the value of productivity.

Figure 4.7

DECREASE IN MACHINE STOPPAGES

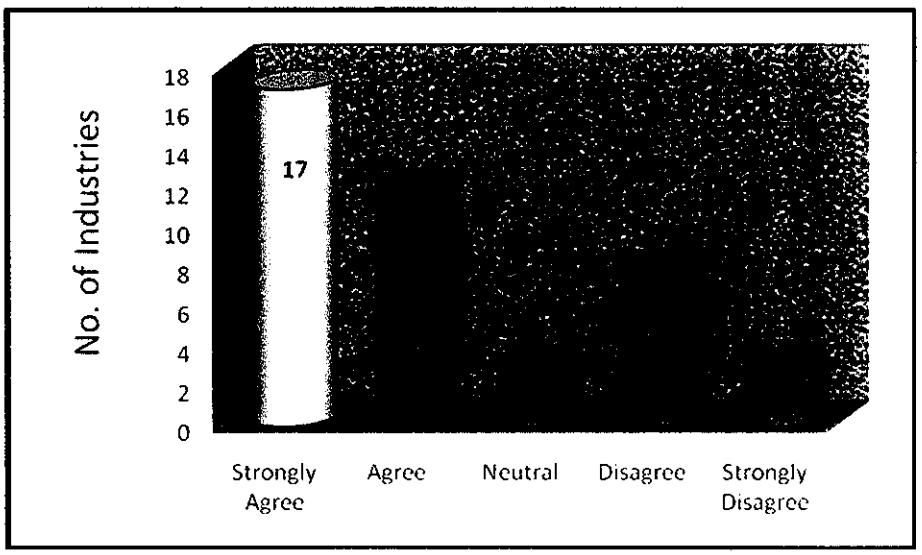
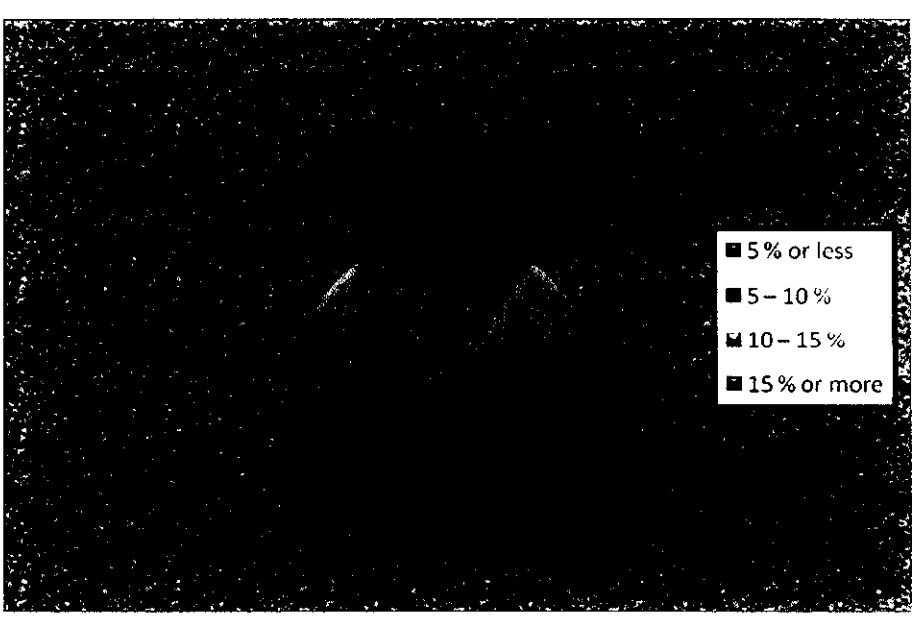


Figure 4.8

RATE OF REDUCTION IN FABRIC WASTAGES



4.2.5. BENEFICIAL DATA STORAGE AND RETRIEVAL SYSTEMS

With the advent of technology, data storage and retrieval systems have been made better in every different field it is applied. The analysis for the benefits of the data storage and retrieval system in knitting industries is presented in Table 4.12.

TABLE 4.12 BENEFITS OF DATA STORAGE AND RETRIEVAL SYSTEMS

S.No	Options	Number of Industries				%	χ^2
		Brand A	Brand B	Both A & B	Total		
1.	Yes	5	6	0	11	26	2.67*
2.	Yes, to some extent	7	7	1	15	34	
3.	Neutral	1	1	7	9	21	
4.	No, to some extent	2	1	5	8	19	d.f
5.	No	0	0	0	0	0	3
	Total	15	15	13	**43**	100	

*** not significant at 1 % { $\alpha = 6.25$ }**

From the above table, it is noted that around 60 % of the selected industries agree to the fact that data storage and retrieval systems in machineries is beneficial to the consumers, as it minimizes the preparatory processes for the manufacture of a previously produced product.

The value of the χ^2 test of independence to determine the association of attributes is not significant at 1 % level of significance with a computed value of 2.67 with 3 degrees of freedom.

TABLE 4.13

CORRELATION BETWEEN THE VARIOUS FACTORS THAT INCREASE PRODUCTIVITY

SPEARMAN'S CORRELATION COEFFICIENT ρ				
		INCREASE IN PRODUCTIVITY	DEC IN MACHINE STOPPAGE	DATA STORAGE & RETRIEVAL
INCREASE IN PRODUCTIVITY	**Correlation Coefficient**	1	0.718	**1.000****
	Sig. (2-tailed)	.	0.172	.
	N	5	5	5
DECREASE IN MACHINE STOPPAGE	**Correlation Coefficient**	0.718	1	0.718
	Sig. (2-tailed)	0.172	.	0.172
	N	5	5	5
DATA STORAGE & RETRIEVAL	**Correlation Coefficient**	**1.000****	0.718	1
	Sig. (2-tailed)	.	0.172	.
	N	5	5	5
	****Correlation is significant at the 0.01 level (2-tailed)**			

From the above table, it is evident that a **strong positive** Correlation exists between increase in productivity due to the adoption of new technology and data storage and retrieval systems. Thus, the data storage and retrieval systems act as a factor of technology to increase productivity.

Spearman's Correlation Coefficient $\rho = 1$ at 1% level of significance.

4.3. TECHNOLOGY VERSUS PRODUCT QUALITY

As with the higher ends of technology, quality of the product may be improved and the data collected and analysed to prove the relationship between technology and product quality is presented in the following tables and figures.

4.3.1. IMPACT OF TECHNOLOGY ON THE QUALITY OF THE PRODUCT

The opinions from the knitting industries on the impact of technology on the product quality is presented in Table 4.14 and Figure 4.9.

TABLE 4.14. IMPACT OF TECHNOLOGY ON THE QUALITY OF THE PRODUCT

S.No	Options	Number of Industries				%	χ^2
		Brand A	Brand B	Both A & B	Total		
1.	Yes	5	5	3	13	30	7.58*
2.	Yes, to some extent	4	4	3	11	26	
3.	Neutral	1	1	1	3	6	
4.	No, to some extent	2	2	2	6	15	d.f
5.	No	3	3	4	10	23	4
	Total	15	15	13	**43**	100	

*** not significant at 1 % { $\alpha = 7.78$ }**

Around 56% percent of the industries opine to the fact that the technological improvements in machines have an positive impact on quality of the product in contrast to 38% of the industries in all disagreeing the statement. 6% of the units remain neutral.

The value of the χ^2 test of independence to determine the association of attributes is not significant at 1 % level of significance with a computed value of 7.58 with 4 degrees of freedom.

4.3.2. OCCURRENCE OF DEFECTS IN PRODUCTS USING THE LATEST TECHNOLOGIES

Minimization of defects adds to the quality of the product and the analysed data from the opinion of the industries is presented in Table 4.15 and schematically represented in Figure 4.10

TABLE 4.15 DEFECTS ARE MINIMIZED COMPARED TO THE OLDER TECHNOLOGIES

S.No	Options	Number of Industries				%	χ^2
		Brand A	Brand B	Both A & B	Total		
1.	Strongly Agree	4	3	2	9	22	12.23*
2.	Agree	5	6	3	14	33	
3.	Neutral	1	0	1	2	5	
4.	Disagree	3	4	6	13	29	d.f
5.	Strongly Disagree	2	2	1	5	11	4
	Total	15	15	13	**43**	100	

*** significant at 1 % { $\alpha = 7.78$ }**

Around 55% of the knitting units agree and strongly agree to the fact that the defects in products have been minimised to a considerable extent. But 40% units disagree, which includes 11 percent of the units who strongly disagree to the statement and the rest remain undecided.

The value of the χ^2 test of independence to determine the association of attributes is significant at 1 % level of significance with a computed value of 12.23 with 4 degrees of freedom.

4.3.3. DIFFERENCE IN QUALITY OF THE PRODUCTS

When the same raw material is fed, difference in technology can bring changes in the product quality and the acceptance by the knitting units on this statement is presented in Table 4.16 and Figure 4.11.

TABLE 4.16. QUALITY OF THE PRODUCT DIFFERS WITH TECHNOLOGICALLY IMPROVED MACHINES

S.No	Options	Number of Industries				%	χ^2
		Brand A	Brand B	Both A & B	Total		
1.	Yes	7	8	5	20	46	16.25*
2.	Yes, to some extent	5	6	2	13	29	
3.	Neutral	0	0	0	0	0	
4.	No, to some extent	1	1	6	8	19	d.f
5.	No	2	0	0	2	6	3
	Total	15	15	13	**43**	100	

*** significant at 1 % { $\alpha = 6.25$ }**

From the above table, it is noted that around 75 % of the selected industries agree to the fact that there exists a variation in quality of the product adopting newer technologies and the remaining 25% of them disagree to the statement.

The value of the χ^2 test of independence to determine the association of attributes is significant at 1 % level of significance with a computed value of 16.25 with 3 degrees of freedom.

Figure 4.9

IMPACT OF TECHNOLOGY ON THE QUALITY OF THE PRODUCT

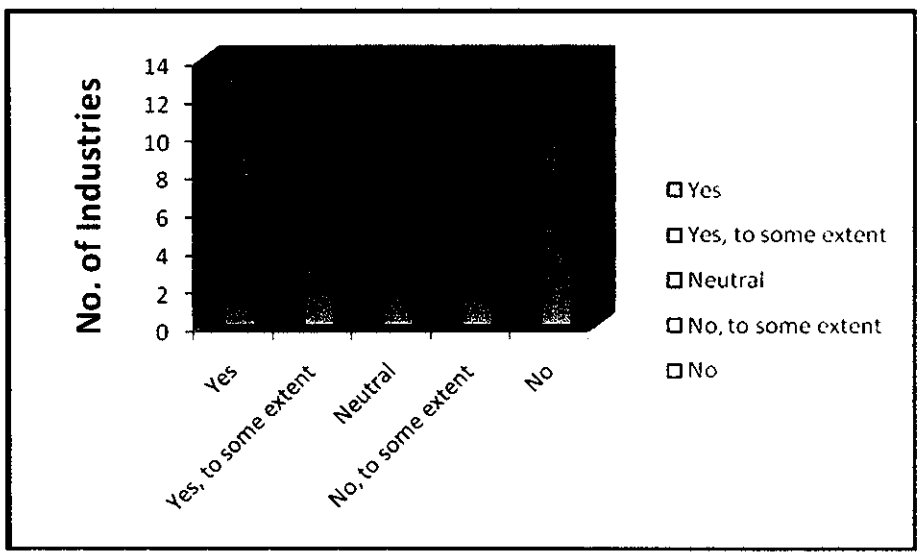


Figure 4.10

MINIMUM DEFECTS DUE TO THE IMPROVED TECHNOLOGIES

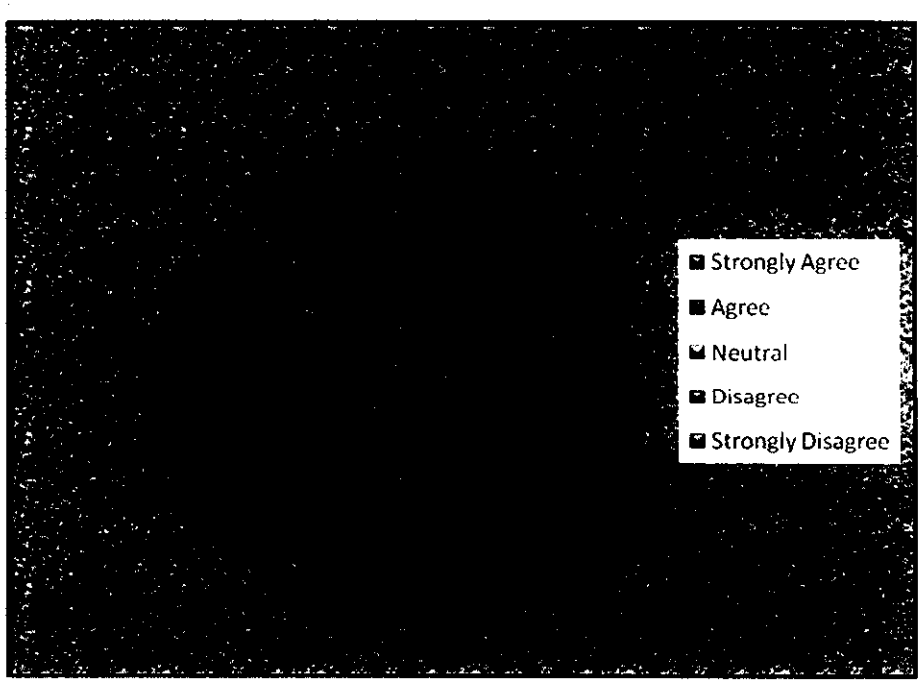


TABLE 4.17

CORRELATION BETWEEN THE VARIOUS FACTORS THAT IMPROVE QUALITY DUE TO TECHNOLOGY

SPEARMAN'S CORRELATION COEFFICIENT ρ				
		IMPACT	DEFECTS	DIFFERENCE
IMPACT	**Correlation Coefficient**	1	**-.572****	**.986****
	Sig. (2-tailed)	.	0	0
	N	43	43	43
DEFECTS	**Correlation Coefficient**	**-.572****	1	**-.502****
	Sig. (2-tailed)	0	.	0.001
	N	43	43	43
DIFFERENCE	**Correlation Coefficient**	**.986****	**-.502****	1
	Sig. (2-tailed)	0	0.001	.
	N	43	43	43
	****Correlation is significant at the 0.01 level (2-tailed)**			

From the above table, it is evident that **positive** correlation exists between impact of technology on the quality of the product and the difference in quality when recent technologies are adopted.

Spearman's Correlation Coefficient ρ = **0.986** at 1% level of significance between impact and difference in quality.

Negative correlations exist between the impact and defects at ρ = - **0.572** and defects and difference in quality at ρ = - **0.502** at 1 % level of significance.

4.4. TECHNOLOGY VERSUS COST REDUCTION

Huge investments in machineries ultimately anticipate higher profit for the firm, which includes the cost reduction factor in production. The following tables and figures account for the impact of technology in reducing the cost of the product manufactured, which are concerned with space reduction, decrease in labour and reduced energy consumption. The drawbacks of this factor associated with technology may be the requirement for intensive training given to the workers and the maintenance cost of the machineries and their parts.

4.4.1. IMPACT OF SPACE REDUCTION ON THE PROFIT OF THE INDUSTRY

When technology advances, the compactness of the machineries becomes evident as the handling of smaller devices becomes easier. The compact machines may occupy lesser space than the huge machineries and hence more machines may be accommodated in the industry leading to profit. Table 4.18 clearly shows the above mentioned fact.

TABLE 4.18. SPACE REDUCTION DUE TO THE COMPACT MACHINES PROVIDES PROFIT TO THE FIRM

S.No	Options	Number of Industries				%	χ^2
		Brand A	Brand B	Both A & B	Total		
1.	Strongly Agree	2	3	0	5	12	11.5*
2.	Agree	7	8	2	17	39	
3.	Neutral	1	1	5	7	16	
4.	Disagree	3	3	3	9	22	d.f
5.	Strongly Disagree	2	0	3	5	11	4
	Total	15	15	13	**43**	100	

*** significant at 1 % { $\alpha = 7.78$ }**

The inference from table 4.15 is that almost half of the population agree and strongly agree that space reduction by the machines adds up to the profit of the firm. 33% of the industries in all disagree to this opinion and 16% remain neutral.

The value of the χ^2 test of independence to determine the association of attributes is significant at 1 % level of significance with a computed value of 11.5 with 3 degrees of freedom.

4.4.2. DECREASE IN LABOUR DUE TO THE ADVANCED MACHINERIES

Automation has been a major phenomenon in all industries where huge machineries are used and hence reduces the labour required for operation. Table 4.19 and Figure 4.12 presents the opinion of the industries in this regard.

TABLE 4.19 LABOUR IS DECREASED DUE TO THE ADVANCED MACHINERIES

S.No	Options	Number of Industries				%	χ^2
		Brand A	Brand B	Both A & B	Total		
1.	Strongly Agree	5	4	3	12	27	22.2*
2.	Agree	7	8	4	19	45	
3.	Neutral	1	1	2	4	9	
4.	Disagree	0	1	1	2	6	d.f
5.	Strongly Disagree	2	1	3	6	13	4
	Total	15	15	13	**43**	100	

*** significant at 1 % { $\alpha = 7.78$ }**

From the above table, it is noted that around 72 % of the selected industries agree to the fact that there exists a decrease in labour requirements when newer technologies are adopted whereas about 19% of them disagree and strongly disagree to the statement. The rest of the industries constituting 9% neither agree nor disagree.

The value of the χ^2 test of independence to determine the association of attributes is significant at 1 % level of significance with a computed value of 22.2 with 4 degrees of freedom.

Figure 4.11

DIFFERENCE IN QUALITY BASED ON THE ADOPTED TECHNOLOGY

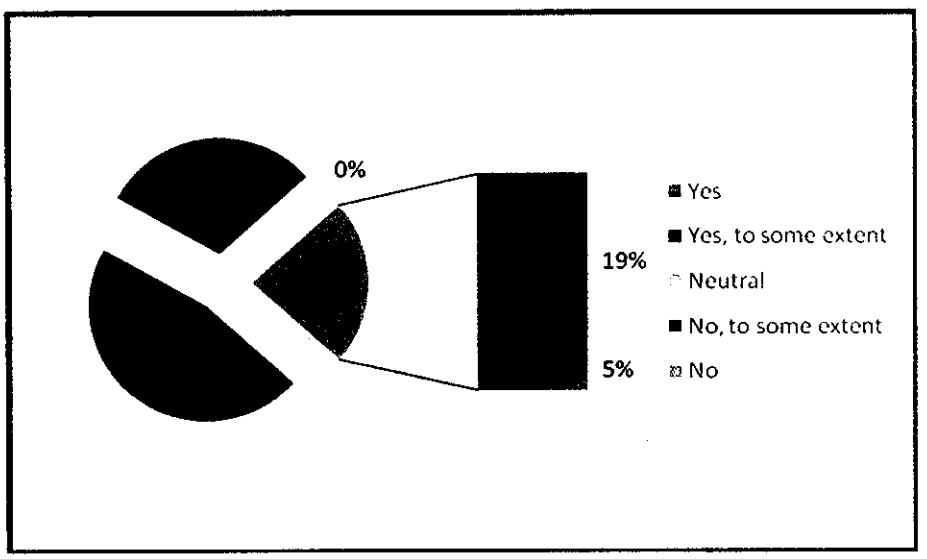
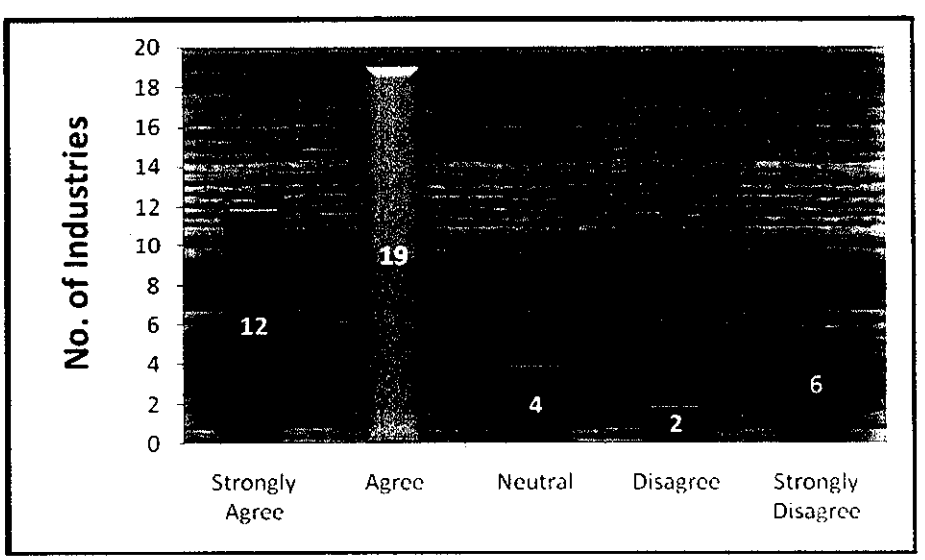


Figure 4.12

DECREASE IN LABOUR DUE TO THE ADVANCED MACHINERIES



4.4.3. NEED FOR INTENSIVE TRAINING TO THE WORKERS

Technological influence on machines have brought about a change in requirements of skilled labour and hence with the advancement in technology, need for intensive training arises which involves the cost and time factor for the industries. The opinion of the industries is presented in table 4.20 and figure 4.13.

TABLE 4.20. INTENSIVE TRAINING IS REQUIRED FOR THE WORKERS

S.No	Options	Number of Industries				%	χ^2
		Brand A	Brand B	Both A & B	Total		
1.	Yes	9	7	4	20	46	12.9*
2.	Yes, to some extent	3	3	5	11	26	
3.	Neutral	0	0	0	0	0	
4.	No, to some extent	3	3	2	8	18	d.f
5.	No	0	2	2	4	10	3
	Total	15	15	13	**43**	100	

***significant at 1 % { $\alpha = 6.25$ }**

About three-fourth of the population in all and strongly agree to the fact that the need for intensive training for machine operation is required in contrast to 28% of the industries who disagree to the statement. When training is essential, it has an effect on the cost and time factor which may show a negative trend to cost reduction with the advent of technology.

The value of the χ^2 test of independence to determine the association of attributes is significant at 1 % level of significance with a computed value of 12.9 with 3 degrees of freedom.

4.4.4. REDUCED ENERGY CONSUMPTION DUE TO THE ADVANCEMENTS

Consumption of fuel and energy may add up to the cost involved in manufacturing a product as the power supply for all the machines will be from a single source and all the machines will be in operating mode when a single machine has to be run. This technical difficulty has been taken into consideration with the advancements in technology and hence the manufacturing cost can be reduced. The opinion of the industries in presented in table 4.21 and figure 4.14.

TABLE 4.21 REDUCTION IN ENERGY AND FUEL CONSUMPTION

S.No	Options	Number of Industries				%	χ^2
		Brand A	Brand B	Both A & B	Total		
1.	Strongly Agree	12	12	10	34	79	40.5*
2.	Agree	3	2	0	5	11	
3.	Neutral	0	0	0	0	0	
4.	Disagree	0	1	3	4	10	d.f
5.	Strongly Disagree	0	0	0	0	0	2
	Total	15	15	13	**43**	100	

*** significant at 1 % { $\alpha = 4.61$ }**

From the above table, it is noted that around 90 % of the selected industries agree to the fact that energy consumption has been reduced to a greater extent with the recent machineries reducing the cost of fuel and energy expenses for the firm. 10% of the industries do not find a change in the energy consumption level.

The value of the χ^2 test of independence to determine the association of attributes is significant at 1 % level of significance with a computed value of 40.5 with 2 degrees of freedom.

4.4.5. EXPENSIVE MAINTENANCE OF THE MACHINERIES

The digital advancements in technology require sophisticated infrastructure for the better functioning of the industries and hence this may be a barring factor to reduce cost. Table 4.22 and figure 4.15 represents the data in this regard stating the opinion of their acceptance.

TABLE 4.22 EXPENSIVE MAINTENANCE OF THE MACHINERIES

S.No	Options	Number of Industries				%	χ^2
		Brand A	Brand B	Both A & B	Total		
1.	Yes	11	11	2	24	56	24.8*
2.	Yes, to some extent	4	3	3	10	22	
3.	Neutral	0	0	0	0	0	
4.	No, to some extent	0	1	6	7	16	d.f
5.	No	0	0	2	2	6	3
	Total	15	15	13	**43**	100	

*** significant at 1 % { $\alpha = 6.25$ }**

Around 78 % percent of the industries agree and strongly agree to the fact that the maintenance cost of the machineries have increased due to the technological impact whereas the rest 22% of industries in all disagree, inclusive of about 6% who strongly disagree to the statement.

The value of the χ^2 test of independence to determine the association of attributes is significant at 1 % level of significance with a computed value of 24.8 with 3 degrees of freedom.

Figure 4.13

NEED FOR INTENSIVE TRAINING

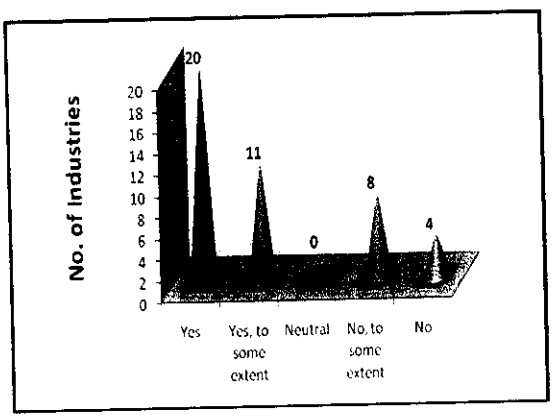


Figure 4.14

REDUCTION IN ENERGY CONSUMPTION

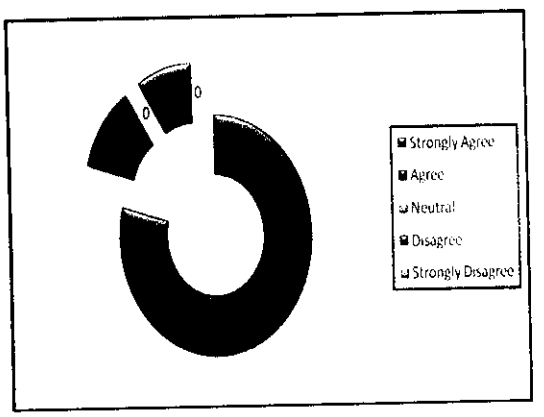
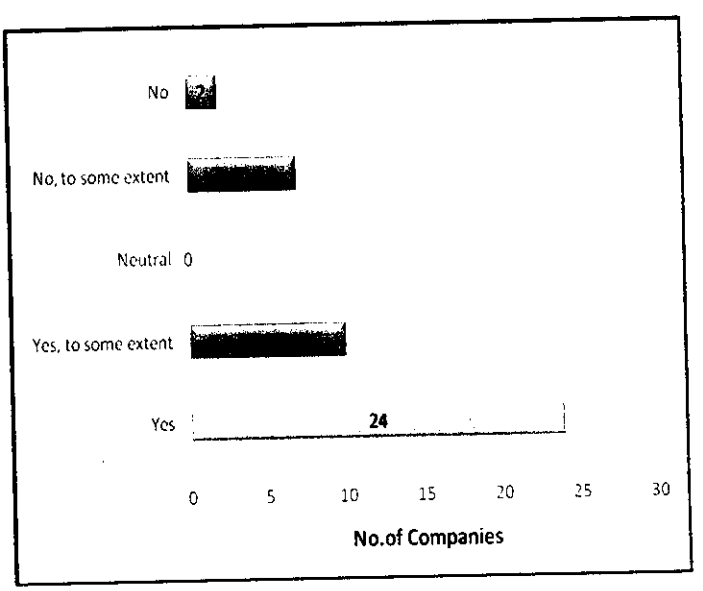


Figure 4.15

EXPENSIVE MAINTENANCE OF THE MACHINES



CHAPTER 5

CONCLUSION

5.1 SUMMARY OF FINDINGS

The findings of the study are as follows:

5.1.1 GENERAL EVALUATION OF THE INDUSTRY

- About 32% of the industries were established within five to ten years and 26 % of them in the recent five years. The industries which are existing for the past 20 years and more constitute only 6 % and double its number within the fifteen to twenty years from the current year. Almost one quarter of the selected industries were established about ten to fifteen years back which indicates the flourishing of the industry in those years.
- During the initial start-up of the industry, 42% of the industries report to have acquired three machines and 29 % of them began to function with two machines.
- The maximum ranking is given to the **cost** factor by about 25 of the 43 knitting units. **Productivity** factor, which denotes the maximum utilisation of the machine is ranked second by about 17 industries. **Service** facilities provided by the manufacturers is in the third ranking preferred by about 19 out of the 43 units. **Technology** is in the last grade which indicates that least preference is given as the beginners are most considerate about cost and functioning of the machine rather than the technological factor.
- 68% of the knitting units prefer to purchase the same brand of machinery in contrast to only 32% of them going in for different brands.
- Around 46 percent of the industries agree and strongly agree to the fact that the choice of the machineries is for their technological improvements in contrast to 44 % of the industries in all disagree to the statement. 10 % of the units neither agree nor disagree.

- 75 % of the selected industries agree to the fact that technological upgradation in machineries solves the previous difficulties faced by the consumers, which proves the positive impact of technology.
- A **positive** correlation between the two factors, choice of the machines for technological improvements with a consideration that they can provide solution to the technical difficulties faced by the knitting industries in Tirupur.

5.1.2 TECHNOLOGY VERSUS PRODUCTIVITY

- Around 86% of the industries agree and strongly agree to the increase in productivity due to the adoption of new technologies whereas only 8% of them deny and 6% of them neither agreed nor disagreed.
- The major acceptance rate of increase in productivity is 2-5 times been accepted by nearly half of the population.
- More than 65% of the knitting units agree and strongly agree to the fact that the frequency of machine stoppages have been reduced to a considerable extent.
- 82% of the knitting units have accepted a 10-15% rate of reduction in fabric wastages.
- Around 60 % of the selected industries agree to the fact that data storage and retrieval systems in machineries is beneficial to the consumers, as it minimizes the preparatory processes for the manufacture of a previously produced product.
- A **strong positive** Correlation exists between increase in productivity due to the adoption of new technology and data storage and retrieval systems. Thus, the data storage and retrieval systems act as a factor of technology to increase productivity.

5.1.3 TECHNOLOGY VERSUS PRODUCT QUALITY

- Around 56% percent of the industries opine to the fact that the technological improvements in machines have an positive impact on quality of the product in contrast to 38% of the industries in all disagreeing the statement. 6% of the units remain neutral.

- Around 55% of the knitting units agree and strongly agree to the fact that the defects in products have been minimised to a considerable extent. But 40% units disagree, which includes 11 percent of the units who strongly disagree to the statement and the rest remain undecided.
- 75 % of the selected industries agree to the fact that there exists a variation in quality of the product adopting newer technologies and the remaining 25% of them disagree to the statement.
- **Positive** correlation exists between impact of technology on the quality of the product and the difference in quality when recent technologies are adopted.
- Negative correlations exist between the impact and defects and defects and difference in quality at $\rho = -0.502$ at 1 % level of significance.

5.1.4 TECHNOLOGY VERSUS COST REDUCTION

- Almost half of the population agree and strongly agree that space reduction by the machines adds up to the profit of the firm. 33% of the industries in all disagree to this opinion and 16% remain neutral.
- 72 % of the selected industries agree to the fact that there exists a decrease in labour requirements when newer technologies are adopted whereas about 19% of them disagree and strongly disagree to the statement. The rest of the industries constituting 9% neither agree nor disagree.
- About three-fourth of the population in all and strongly agree to the fact that the need for intensive training for machine operation is required in contrast to 28% of the industries who disagree to the statement. When training is essential, it has an effect on the cost and time factor which may show a negative trend to cost reduction with the advent of technology.
- Around 90 % of the selected industries agree to the fact that energy consumption has been reduced to a greater extent with the recent machineries reducing the cost of fuel and energy expenses for the firm. 10% of the industries do not find a change in the energy consumption level.

- 78 % percent of the industries agree and strongly agree to the fact that the maintenance cost of the machineries have increased due to the technological impact whereas the rest 22% of industries in all disagree, inclusive of about 6% who strongly disagree to the statement.

5.2 CONCLUSION, SUGGESTIONS & RECOMMENDATIONS

- Thus the technological impact on the knitting industries is studied with reference to three different factors constituting productivity, quality and cost reduction based on the survey conducted at 43 units possessing two different brands of machinery.
- The study reveals the fact that technology has influenced the industry to a larger extent in terms of productivity, quality and cost reduction factors.
- Productivity is increased to a higher extent when compared to the older technologies.
- Quality of the product adopting newer technologies show a great variation and makes us competent with other countries.
- Cost reduction factor of technology has both positive and negative impacts.
    - With the advent of technology, intensive training is essential for the labourers and the requirement for skilled labour arises.
    - Maintenance of the machineries acquire higher cost with the infrastructural facilities required for the operation of the machine.

5.3 DIRECTIONS FOR FUTURE RESEARCH

Further studies can be carried out taking into consideration the aspects of managing the change in technology and planning for the adoption of the best suited technology catering to the needs of the industry as some features of the machine with the recent technology are not being used by the industries.

APPENDIX – 1

Questionnaire devised to study the Impact of recent Technological changes in the Knitting industry at Tirupur.

Respected Sir/Madam,

Technology has profoundly influenced the course of human civilization and the scientific revolutions of the 20th century have led to many technologies in all different arenas. Knitting industry in Tirupur has flourished to a greater extent and it brings laurels based on the different technologies adopted by the exporters.

As a part of the curriculum I, Ms.S.Sudha pursuing the final year post graduation in Business Administration from Anna University – Chennai would like to learn the impact of the technological changes in the industry for my project activity.
I feel grateful to you for sharing your knowledge through this questionnaire.

1. The industry was set up and functioning for the past

   ☐ More than 20 yrs ☐ 15-20 yrs ☐ 10-15 yrs ☐ 5-10 yrs ☐ less than 5 yrs

2. No. of machines owned by the industry during the initial set-up

   ☐ 5 or more ☐ 4 ☐ 3 ☐ 2 ☐ 1

3. On what basis were the machines preferred during the start-up? Rank the answers giving 1 for the preference.

   ☐ Technology ☐ cost ☐ service ☐ productivity

4. List the different brands of machines available in your industry

   ---

   ---

5. Do you prefer the same brand of machines during the expansion of the industry?

   ◯ Yes ◯ No

6. In the recent past, choice of the machines for the industrial expansion is for their technological improvement.

☐ Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly disagree

7. Technological upgradation in machines brings a solution for some of the problems faced by the industry.

☐ Yes ☐ Yes, to some extent ☐ Neutral ☐ No, to some extent ☐ No

8. Productivity of the industry has been increased due to the adoption of new technologies.

☐ Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly disagree

9. Due to the industrial expansion using upgraded technological machines, what is the increase in productivity per day?

☐ More than 10 times ☐ 5-10 times ☐ 2-5 times ☐ Slight improvement

10. Machine stoppages have been decreased to a larger extent.

☐ Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly disagree

11. To what extent have the fabric wastages been reduced?

☐ 5% or less ☐ 5 – 10% ☐ 10-15 % ☐ 15% or more

12. Data storage and retrieval systems are the predominant features to save time

◯ Yes ◯ No

13. Impact of technology is to improve the quality of the product.

☐ Yes ☐ Yes, to some extent ☐ Neutral ☐ No, to some extent ☐ No

14. Minimum defects occur in the fabrics compared to the older technologies.

☐ Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly disagree

15. Finer processed fabrics are obtained from the same quality of yarns using different machines.

☐ Yes ☐ Yes, to some extent ☐ Neutral ☐ No, to some extent ☐ No

16. Reduction of space by the smaller machines has led to profit for the industry

☐ Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly disagree

17. Technology upgradation in machines brings decrease in labour.

☐ Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly disagree

18. Advanced technologies require intensive training for the workers.

☐ Yes ☐ Yes, to some extent ☐ Neutral ☐ No, to some extent ☐ No

19. Energy consumption is reduced increasing the profit for the firm.

☐ Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly disagree

20. Maintenance of the machine has become expensive

☐ Yes ☐ Yes, to some extent ☐ Neutral ☐ No, to some extent ☐ No

Impact of technology has brought a boom in the knitwear sector.

Comment your views.

****

Gratitude is mine to express heartfelt thanks for spending your valuable time.

APPENDIX – 2

LIST OF ADDRESS

COMPANIES WITH BRAND - A MACHINERY

1. AAR GEE EXPORTS
54/3 Sadayappan Koil Street,
Tirupur-641601

2. AATHITHYAA CREATIONS
No.8 A SIDCO Industrial Estate,
Perumanallur.641 666.

3. AHILL KNITTING MILLS
197, KPN Nagar,
Tirupur -01.

4. AJANTHA KNIT FABBS
M.A.Knitting Building,440.
Palladam Road, Tirupur

5. AVIRAM KNITTERS
No 7,,SIDCO,
P.N.Road.Tirupur-641666

6. G.L.INTERNATIONAL
628/5,Veerapandi,
Palladam Road,
Tirupur

7. GAARLANDS
77-D Periya Thottam
15-Velampalayam Road
Tirupur -651652

8. GEETHANJALI KNITTING
5,T.S.R.Lay Out,2nd Street,
Kongu Main Road,Tirupur-641607

9. IDUMBAN KNITTERS
S.f 440,443 S.B.I colony
Gandhinagar (po)
Tirupur - 641603

10. J.K.FABRICES
No.23,Tahdco Industrail Estate,
Mudalipalayam,
Tirupur-641606

11. PREMNATH KNITTERS
146, Union Mill Road,
Tirupur.1

12. QUALITY KNITS
Shed No , 90, Thadco,
Industrial Estate, Mudalipalayam,
Tirupur 641606

13. RANKAPUR KNITTING MILLS
14-A, Railway Station Road,
K.K.Nagar,
Uttukuli.638751

14. SARANDEV KNITS
17, COLLEGE ROAD,
5th Cross Street,
Tirupur 641602

15. SARGAN HOSIERIES
65,Lakshmi Nagar,
50 Feet Road, Tirupur-641602

COMPANIES WITH BRAND - B MACHINERY

1. AAR AAR KNITWEAR

89,THADCO Industial Estate,
Mudalipalayam,
Tirupur-641606.

2. BHARANI EXPORTS

45, THADCO Industial Estate,
Mudalipalayam,
Tirupur-641606.

3. CASIO FABRIC

39a.B Nagar,Gandhinagar (PO)
Tirupur

4. CORAL KNITTING COMPANY

4/81,Kulathu Palayam Road,
Near Lakshmi Kalyana mandapam,
Tirupur

5. D.S.FABRICS

31,Elangonagar, P.N.Road,
Tirupur-641602

6. G.R.KNITTERS

51 THADCO Industial Estate,
Mudalipalayam,
Tirupur-641606.

7. G.V.S.KNITTING MILLS

32 THADCO Industial Estate,
Mudalipalayam,
Tirupur-641606.

8. JAI FABRICES

131,APR Building,
Govindraj Spinning Millscompound,
Veerapandi,Tirupur-5

9. JAYAPRABHA HOSIERIES

95, THADCO Industial Estate,
Mudalipalayam,
Tirupur-641606.

10. K.S.T.KNITTING COMPANY

153,Dharapuram Road ,
Tirupur-641604

11. SARAN GARMENTS

8/649 , Arulpuram
Palladam Road,
Karai Pudur
Veerapandi Via
Tirupur - 5

12. PACIFIC TEXTILES

Shed No. 14,
THADCO Industial Estate,
Mudalipalayam,
Tirupur-641606.

13. PETAL SHAMROCK PVT LTD

S.F.No.335/341, New Colony
15,Velampalayam,
Anuparpalayam PO,
Tirupur.641652

14. PRADHAK EXIM

Shed No. 82,
THADCO Industial Estate,
Mudalipalayam,Tirupur-641606.

15. SAMRAJYAM KNIT FABRICS

8,Lakshmi Puram,
Tirupur 641606

COMPANIES WITH BRAND – A & B MACHINERY

1. PSR GARMENTS

37, SIDCO,
Harvey Road,
Tirupur

2. RASHI KNITS

Shed No. 1,
SIDCO Industrial Estate,
Ganapathipalayam,
Palladam

3. SRI RANGA KNITS

98/2, Stallion Garments Backside,
Periyapallayam
Tirupur

4. ANUSAM KNITTERS PVT LTD

2/798, N.S.K.Compound,
Mahalakshmi Nagar,
Tirupur

5. CLASSIC CLOTHING COMPANY

S.F.No : 77,
Classic Compound,
Nathakadu Thottam,
Periyandipalayam,
Tirupur.

6. CHENNIYAPPA TEXTILES

4B SIDCO INDL ESTATE,
Harvey Road, Tirupur-641602

7. JV TEXTILES

711, Nithya Ginning Factory Compound,
Karuppagoudam Palayam,
Tirupur - 641 604.

8. S & G APPARELS (P) LTD

42/2, Pazhankarai ,
Kuppandampalayam (P.O),
Tirupur.

9. S. G. S . INTERKNITS (P) LTD

Shed .No. 54 , TEKIC SIDCO ,
Mudalipalayam ,
Tirupur.

10. SASURI ARTS

178 & 179 , TEKIC SIDCO ,
Mudalipalayam ,
Tirupur

11. SCM TEXTILE MILLS

862 / 2 , Suryan Nagar ,
ABT Road New Extn,
Karuvampalayam ,
Tirupur-4.

12. SOWMIYA FASHIONS

10, Thiruneelakandapuram North,
Kongu Main Road,
Tirupur-7

13. LEO GEM FABS

RM & Bros COMPLEX
Palladam Road
Tirupur

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