CHAPTER II
CONCEPTUAL FRAMEWORK AND REVIEW OF LITERATURE

2.1 INTRODUCTION

Review of literature is a significant piece of research. It avails the researcher to bear out their research in diverse proportions. The review of previous studies related to a relevant area in which research is planned to be carried on, the researcher came across the various ways, in which the research was started and the research reached its destination. Hence this study was started from the earlier studies related to technology automation and labour skill development which were found in various international and national journals and magazines. Future the review of earlier studies has helped this research to have a good shape in analytical terms.

2.2 INTRODUCTION TO TECHNOLOGY

At present, the technology dominates all the industries in the globe. It is impossible to imagine a world without technology and it has become the part and parcel of the human spirit. The technology remains as a major factor determining the success of any sector. Machines that could produce more efficiently were developed that replaced human labour. Mass production of goods was made possible by machines. The development of technology brought changes in the economic, social and political systems. Mass production of goods, industrial capitalism, increased standard of living, expansion of international trade etc., Are some of the economic changes brought by technology. It has a greater impact on the socio economic conditions of any country. The importance of technology is only expected to grow further in the days to come.
2.3 DEFINITION AND NATURE OF TECHNOLOGY

Technology can be defined as the knowledge and systems employed for the production of goods and services, using processes, methods, tools and techniques. In elementary terms, the technology is the means by which affairs are getting exercised. Knowledge is practically implemented to produce new things or extend some new services.

The word ‘Technology’ is derived from the Greek word *techno-logia*. *Techno* means *Skill* and *Logia* means *Science*. Therefore, technology refers to the application of scientific knowledge for virtual uses. The word technology is knowledge of the practical or industrial arts, or the knowledge of how craft or industry is wrought.

According to Abramovitz\(^2\) review, Technology is a major input requirement for economic development. Adam Smith was one of the first to examine manufacturing technology systematically in 1776. Powerful evidence or substantiation of the impact of technological change in the economic system.

Arrow\(^3\) pointed out the concepts of applied science as “information that holds technology, is generally applicable, easy to reproduce and reuse and that firms can innovations mainly by dipping freely into a general stock or pool of technological knowledge”.


2.4 MEANING OF TECHNOLOGY AUTOMATION

*Automation* or *automatic control*, is the use of various control systems for operating equipment such as machinery, processes in factories, boilers and heat treating ovens, switching in telephone networks, steering and stabilization of ships, aircraft and other applications with minimal or reduced human intervention. Some processes have been completely automated. The biggest benefit of automation is that it saves labour, however, it is also used to save energy and materials and to improve quality, accuracy and precision.

The primary advantages of automation are:

- Increased throughput or productivity.
- Improved quality or increased predictability of quality.
- Improved robustness (consistency) of processes or product.
- Increased consistency of production.
- Reduced direct human labour costs and disbursements.

The following methods are frequently used to better productivity, quality or validity.

- Set up automation in operations to shorten cycle time.
- Install automation where a high level of accuracy is wanted.
- Replacing human operators in tasks that involve heavy physical or monotonous work.
- Replacing humans in tasks that are done in dangerous environments (i.e. Fire, space, volcanoes, nuclear facilities, underwater, etc.)
- Performing tasks that are beyond human capabilities of size, weight, speed, endurance, etc.
Economic Improvement: Automation may improve in economy of enterprises, society or most of humanity. For example, when an enterprise invests in automation, technology recovers its investment; or when a state or country increases its income due to automation like Germany or Japan in the 20th Century.

- Reduces operating time and work handling time significantly.
- Frees up workers to take on other functions.
- Provides higher level jobs in the development, deployment, maintenance and functioning of the automated processes.

The primary disadvantages of automation are:

- Security Threats/Vulnerability: An automated system may receive a modified degree of intelligence, and is thus more susceptible to committing errors outside of its immediate range of knowledge (e.g., it is typically unable to enforce the patterns of simple logic to general suggestions).

- Unpredictable/Excessive Development Costs: The research and development cost of automating a process may exceed the cost saved by the automation itself.

- High Initial Cost: The automation of a new product or plant typically requires a very large initial investment in comparison with the unit cost of the product, although the cost of automation may be spread among the many products and over time.

- In manufacturing, the purpose of automation has shifted to issues broader than productivity, price, and time.
2.5 ROLE OF TECHNOLOGY IN TEXTILE INDUSTRY

The growth of textiles has given rise to the economic growth of our country. As the fabric manufacture is a labour intensive, the industry's development is much dependent on the labourers' better performance and the level of adoption of engineering science. In this technological world, all the industries are much dependent on automation technology.

Origins of Industrial Growth

The human resource is one of the key ingredients of industrial development. India’s workforce will move up more quickly due to rapid industrialization. The changing age structure of the population, higher education prospectus, greater association with higher technology and knowledge will improve the involvement to the growth of human resources.

The sources of industrial growth are⁴:

- Human resources
- Capital
- Technology
- Productivity
- Management organisation
- Government polices

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2.6 THE ROLE OF AUTOMATION AND INNOVATION

2.6.1 The purposes of automation

In a little noticed speech delivered in 1984, David Pearl, then the president of Gerber Garment Technology Inc., suggested that the proper purpose of automation in the apparel industry is not the mere replacement of human labour, but rather the accomplishing of three things:

1. Improvement of the marketing of the product to ensure the selling of more units, and thus the generation of more income.
2. Improvement of the production efficiency, thus reducing unit costs while supplying the increased demand: and
3. Allowing optimal management control of both marketing and manufacturing, thus thereby balancing income and expense to allow maximum profitability.

2.6.2 Characteristics of automation

The proper automation ought to possess one or more of the following characteristics:

- It should improve manufacturing efficiency, either in terms of output, quality, or the ability to use new processes that, themselves, will enhance output and / or quality.
- It should improve product quality, both in terms of the customer’s quality requirement and providing ways to controlling the production process to ensure consistent and reproducible quality.
- It should provide a firm with the capability to practice either static flexibility-the ability to move easily within a product mix in response to changing market
conditions or, better, dynamic flexibility— the continuing ability to bring new products to market in a timely and effective manner.

➢ It should contribute to the ability of management to exert control on the entire range of the firm’s activities, encompassing product design, manufacturing, and marketing. In a timely and effective manner.

Historically, technological change in the textile industry could be classified by the effect it had on the industry. Evolutionary change had the effect of replacing humans with machines, or human power with machine power, so that production efficiency was improved the new technology often performed better, sometime produced a better quality product, and even eliminated some process steps. However, the key concept is that the task being performed is little different than was being performed before.

These kinds of inventions are often associated with measures of automation and/or modernization. Revolutionary change ought to be recognized by the major changes that it forces on entire industries. The factory system was made possible only after the invention of the fly-shuttle loom, the spinning jenny, and power transmission devices necessary to operate them. It is not really the computer that has revolutionized the industry, but rather it is the ability through software to apply the computer skills to an entire spectrum of technical and managerial problems, with a response time that could not be imagined 50 years ago, that has completely transformed the way we operate an industry\(^5\).

2.7 AUTOMATION IN TEXTILE INDUSTRY

In the primary textile industry, tentative applications of robotics have now a fairly long history, although with relatively few commercial successes. Starting with the 1983 ITMA in Milan, a number of robots have been shown, at first doing only very simple jobs. However, vendors have learned that robotics are more applicable to textile processes when they are combined with other forms of automation to form a system.

Typical uses of robots are in the material handling areas. Just as with extrusion, the trend toward the linking of processes actually simplifies material handling issues. Thus, systems for handling yarn packages at the output of spinning systems, or at the input to dyeing systems are quite commonly available. Other notable uses of robotic automation are the class of Automatic Guided Vehicles (AGV’s) in use in some US textile mills. When coupled with appropriate trailers, these systems move yarn, fabrics and other materials throughout a plant on a Just in Time basis. Since the entire system is computer-controlled, integration of a plant’s process becomes much easier.

Process linkage is an extremely important form of automation. It can be observed in the offerings of most spinning system manufactures, in most nonwovens lines, and in many dyeing and finishing systems. In spinning systems, the typical system features automated material transfer from point in the system – with appropriate provision for balancing the system as yarn counts change. Computer monitoring of the system allows tracking of material throughout the entire process and the early warnings of problems in operation.\(^6\)

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Automation is one of the key elements providing significant thrust to manufacturing process. It helps to improve the quality and cost competitiveness. The technology automation is one of the major causes of the success of the Indian textile sector. It is mainly used in the textile industry to cut the manpower and increase the production level and to meet the targets of production. Automation involves all the performance of manufacturing viz., Cotton picking, ginning, spinning, weaving, garment manufacturing and etc.

2.7.1 Automation in Yarn Manufacturing / Spinning

At present, automation technology has gained much prominence across all sectors. During the former time the cotton picking process was manually done and straight off the spinning mills undertake those activities very efficiently. And today, the HVI systems are employed for examining the cotton fibers. This operation was achieved through stable innovation and modernized automation in the plant capacities.

**Yarn Forming:** This process is practiced much in advance and the innovation of automation by using newer methods of spinning apart from ring spinning viz., open ended spinning, air jet spinning and Murata Vortex System (MVS).

**Cotton Mixing:** It is the blow room process, cotton from bales are taken out and mixed jointly, forming a more homogeneous mixing of cotton, thus reducing batch to batch variation in cotton spun yarn lots.

**Carding Machines** chute feed systems are applied and also auto levellers are used for enhancement in quality, productivity and reducing handling have helped in increasing evenness in the thread.

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**Autoconers Splicing and Yarn** fault detection has been formulated to obtain yarns with lower unevenness and better tone. The yarn remains intact during the procedure.

**The Ring Spindle** speeds have moved upward to 20,000 and high-speed rotors upto 1, 00,000 RPM. Today, spinning machines were 20 times faster compared to twenty years ago. The speed of the motors is unmatchable and it’s highly efficient.

### 2.7.2 Automation in Weaving / Fabric Manufacturing

In weaving, automatic shuttle looms and automatic shuttle-less looms are used for higher productivity, and quality. Shuttle-less looms are much sought as it process weaving process faster. Weaving and knitting machinery’s have been applying the computer textile manufacturing for many years and have created new designs using CAD, bi-directional communication and artificial intelligence. With the accessibility of electronic dobby and jacquard heads, automatic pick findings and needle selection, etc., and these machines are more easily integrated into computer networks of any production cars.

Automated processing includes control on the slashed and the weaving functions of

1) Automatic Pick Repair

2) Automated Warp Breakage Locator

3) Computerized Machine Control

The manual workers are needed for this beam replacement and repair of warp breaks.
2.7.3 Automation in Dyeing and Printing

Automation in dyeing and printing process is very much in need. Since it involves a lot of minute parameters and this dyeing process requires the milligrams variation of a recipe can change the shade of the fabric. In this dyeing process, the temperature, pressure, water level, water flow, circulation and time of treatment need to be maintained throughout the process. The automation process will improve the productivity by holding in the above parameters very accurately.

2.8 IMPORTANCE OF TECHNOLOGY IN TEXTILE INDUSTRY

Technology acts as a pivotal part in the achiever of all occupations in the creation. In textile industry advance machineries are to be installed and controlled so as to compete in worldwide marketplaces. Textile technology is the order of the day. The crux of the concern lies in validation of skilled workforce relating to engineering.

The following ways the technology helps to the production unit:

- To acquire competitive advantage in terms of technology
- To increase the production within a minimal time frame.
- This will also help to reduce production cost
- To bring innovations in products
- To gain greater market share by virtue of superior technology and lower cost, thereby improving the profitability
- To help sustain business, overcoming the threat of obsolescence

In a competitive environment only those textile units that deliver a cost advantages over its challengers have a better chance and pull through. Cost reduction can be made possible exclusively through technology.
Technology plays a major role in improving productivity. The textile units are run by human beings, they make use of technology in some form or the other to conduct out their operations.

Since the productivity depends to a large extent on technology, the survival of an organization depends on technology. Therefore, it is the only technology that makes an organization competitive advantage. Hence, no organization can ignore technology. Technology is important for the survival and growth of an organization.

2.9 BENEFITS OF TECHNOLOGY

Technology aids all business firms. Both production oriented firms and service oriented firms derive benefits from the use of technology. The production oriented firm stand to gain a lot from technology. Since technology leaves a greater scope for the improvement / modification of products and for the creation of new products.

Some of the benefits that technology offers are as below:

- Technology helps a firm to make optimum use of available resources and thus to bring down the cost of production.
- Technology helps a firm to bring out new products/ new services to satisfy customer expectations. This, in turn, will help the firm to retain its market share and improve it further.
- Technology comes to help for extending the product life cycle.
- Technology helps a firm to exploit the benefits of economies of scale. With mass production, the production cost per unit gets reduced sustainability due to economies of scale.

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Technology helps a firm in its long term survival.

Technology helps a firm to gain competitive business advantage, to sustain for long, to improve profits and to become a market leader in the domain in which the firm operates.

In a globalized environment, a firm that produces quality products can compete in the world market where there is good scope for getting premium price and high volume sales.

A firm that has developed and perfected a technology that is sound, robust and cost-effective can also explore the scope for earning through technology transfer arrangements.

2.10 SKILL DEVELOPMENT - MEANING AND FOCUS

The objective of Skill Development is to create a workforce empowered with the necessary and continuously upgraded skills, knowledge and internationally recognized qualifications to gain access to decent employment and ensure India’s competitiveness in the dynamic global market. It aims at increasing the productivity and employability of the workforce (wage and self-employed) both in the organized and the unorganized sectors. It seeks increased participation of youth, women, disabled and other disadvantaged sections and to synergize efforts of various sectors and reform the present system with the enhanced capability to adapt to changing technologies and labour market demands.

According to the International Labour Organization (ILO) “Skill development is of key importance in stimulating a sustainable development process

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and can make a contribution in facilitating the transition from an informal to the formal economy. It is also essential to address the opportunities and challenges to meet new demands of changing economies and new technologies in the context of globalization”. Skills development can help build a “virtuous circle” in which the quality and relevance of education and training for women and men fuels the innovation, investment, technological change, enterprise development, economic diversification and competitiveness that economies need to accelerate the creation of more jobs10.

2.11 MEANING AND DEFINITION OF TRAINING AND DEVELOPMENT

A training program is an effort by the employer to provide opportunities for the employees to acquire job related skills, attitude and knowledge. The training and development focus on changing or improving the knowledge, skills and attitude of individuals. Training typically involves providing employees the knowledge and skills needed to do a particular task or job, though attitude change may also be attempted.

Developmental activities, in contrast, have a longer-term focus on preparing for future work responsibilities while also increasing the capacities of employees to perform their current jobs11.

2.11.1 DEFINITION OF TRAINING

Training is the process of acquiring the skills necessary to do the job.

- Robert N.Lussier: 2002

The working definition of training is “Training is the transfer of defined and measurable knowledge or skills”.

10 www.skilldevelopment.gov.in/focus accessed on 14.08.2013 at 6.30 am.

2.12 NATURE OF TRAINING AND DEVELOPMENT

Training\textsuperscript{12} is an act of increasing knowledge, skill and attitude of an employee for improving his performance on the job. Training is concerned with imparting specific skill for doing a particular job.

Development has a broader meaning. Its aim is to grow or improve the overall personality of an individual. It is a continuous process and is on the initiative from the individual. Development is to meet an individual’s future needs.

2.12.1 Training involves certain issues as noted below:

Identification of training needs and the setting of training objectives is pivotal to the success of any training programme. Identification and selection of right training and development methods is key to its effectiveness. Evaluation of the training and development programme is necessary for its continuity. All the training and development programmes must be linked to the business strategy of an organization. The common contents of training are:

- Improving basic work skills
- Closing gaps in skills and competencies
- Upgrading technological skills
- Improving group membership skills
- Teaching leadership/ supervisory skills
- Developing managerial skills
- Enhancing self- management and self- directed learning skills

2.13 IMPORTANCE OF TRAINING AND DEVELOPMENT

- Training is required for improving the performance of labourers in the current job.
- It is important and essential to keep speed with technological advances.

➢ To adjust with the changing culture of modern environment and to face the heavy competition in the working place.
➢ The training aids in achieving the industry’s growth and efficiency of labour’s performance.
➢ It will help to reduce workload and create a aware about the latest technology
➢ It helps to sustain in their job in the present competitive world
➢ It gives better knowledge about the new technology and work environment\textsuperscript{13}.

2.14 PURPOSE OF TRAINING

The major purpose of Training is listed below:

1. The training facilitates achievement of industries objectives and goals.

2. The programmes are derived from the industries overall performance objectives and specific job requirements.

3. Training supports to the enlarging of employee’s skills and permitting them.

4. The training activities are collaborative and experimental and it includes regular opportunities in integrating the knowledge and skills to give knowledge for solving problems.

5. The training is established based upon an assessment of the target employee’s knowledge, skills, and abilities.

6. It meets individual skill development requirements as reflected in an individualized development plan. It is based on each trainee’s own skill level and training goals.

7. It also builds operative’s understanding that training forms an essential part of successful job performance\textsuperscript{14}.


### 2.15 SKILL REQUIREMENT AND SKILL GAPS IN TEXTILE INDUSTRY

**TABLE NO: 2.1**

The skill requirements and skill gaps in the textile sector are detailed below

<table>
<thead>
<tr>
<th>Function</th>
<th>Level</th>
<th>Skill Required</th>
<th>Skill Gaps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spinning</td>
<td>Operator</td>
<td>• Operating knowledge of the spinning machines.</td>
<td>• Knowledge/ skill confined to single or few machines</td>
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<td></td>
<td></td>
<td>• Ability to ensure that machine stoppage time in minimal</td>
<td>• Lack of knowledge of compliance to quality</td>
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<td></td>
<td></td>
<td>• Monitor spinning operation as regards the availability of sliver/bundles/lap</td>
<td>• Inadequate ability to multi-task between types of machines.</td>
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<tr>
<td></td>
<td></td>
<td>as input to respective stages of the spindling operation</td>
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<td></td>
<td></td>
<td>• Should be able to read gauges, dials, or other indicators to make sure a</td>
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<tr>
<td></td>
<td></td>
<td>machine is working properly</td>
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<tr>
<td></td>
<td></td>
<td>• Ability to work on different machines. For e.g. a spinning operator</td>
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<tr>
<td></td>
<td></td>
<td>should be able to work on carding, roving and spinning machines.</td>
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<td></td>
<td></td>
<td>• Discipline at shop floor, punctuality and regular attendance at workplace.</td>
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<td></td>
<td></td>
<td>• Adherence to cleaning and machine maintenance schedule.</td>
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<td></td>
<td></td>
<td>Understanding of support to be provided for maintenance of various textile</td>
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<tr>
<td></td>
<td></td>
<td>machines.</td>
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<td></td>
<td></td>
<td>• Ability to comply with quality norms.</td>
<td></td>
</tr>
<tr>
<td>Function</td>
<td>Level</td>
<td>Skill Required</td>
<td>Skill Gaps</td>
</tr>
<tr>
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<td>-------------------------------------------------------------------------------------------------</td>
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<tr>
<td>Weaving</td>
<td>Operator</td>
<td>• Operating knowledge of relevant type of looms.</td>
<td>• Insufficient knowledge of looms especially shuttle less type of looms.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Examine looms to determine causes of looms stoppage, such as warp filling, harness breaks, or mechanical defects.</td>
<td>• Inadequate ability to multi-task between different types of machines.</td>
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<tr>
<td></td>
<td></td>
<td>• Observe woven cloth to detect weaving defects.</td>
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<tr>
<td></td>
<td></td>
<td>• Discipline at shop floor, punctuality and regular attendance at workplace</td>
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<tr>
<td></td>
<td></td>
<td>• Adherence to cleaning and machine maintenance schedule- understanding of support to be provided for maintenance of various textile machines</td>
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</tr>
<tr>
<td>Production</td>
<td>Production manager/shift in charge/supervisor</td>
<td>• Technical competence-very strong understanding of both fabric and chemicals.</td>
<td>• Inadequate knowledge of both textile manufacturing and chemistry in combination</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Process improvement skills-waste control, finding solutions to maintenance and engineering related problems as most of the units do not have a dedicated R&amp;D for process improvement.</td>
<td>• Inadequate of cross-functional knowledge especially knowledge of effluent treatment processes.</td>
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<tr>
<td></td>
<td></td>
<td>• Need for understanding quality requirements of customers.</td>
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<td></td>
<td></td>
<td>• Problem solving skills, good communication skills to manage shop floor workers who are mostly minimally educated.</td>
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<tr>
<td>Function</td>
<td>Level</td>
<td>Skill Required</td>
<td>Skill Gaps</td>
</tr>
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</tbody>
</table>
| Fabric processing | Operator    | • Operating knowledge of bleaching and colouring, jet dyeing machines, jiggers, soft flow dyeing machines etc.  
• Knowledge of various type of chemicals used in processing.  
• Ability to identify and differentiate colours.  
• Need for certification of skills- The operators working on boilers need to have certification.  
• Understanding of waste treatment operations. | • Insufficient availability of personnel who can work in boiler operations.  
• Inadequate knowledge of various machines and chemicals.  
• Insufficient knowledge of effluent treatment processes  
• Inadequate knowledge of CNC machines |
| Garments          | Operator    | • Good machine control-knowledge of threading of sewing machine, stitching on different shapes, seaming garment components together in various fabrics to specified quality and quality standard  
• Knowledge of machine maintenance procedures  
• Knowledge of pattern making, Grading and Draping.  
• Knowledge of CAD for pattern Development  
• Ability to sew complete garment. | • Lack of proper knowledge of sewing machine operations, and different types of seams and stitches  
• Ability to work across different machines is missing  
• Ability to stitch the complete garment is missing (In case of units which do not follow line systems of production) |

Source: NSDS Report – 2022
2.16 THE REQUIREMENTS FOR AUTOMATION IN TODAY’S TEXTILE MANUFACTURING ENVIRONMENT

Today’s manufacturing environment is characterized by rapidly changing, fragmented markets with world-wide competition and higher customer expectations in the areas of quality, reliability and responsiveness. This requires a more strategic approach to the business that emphasizes long range, broad based goals that will make the company responsive to change. It is no longer enough to be the low cost producer; it is necessary to differentiate yourself by other means, such as quality, reliability or responsiveness.

Today’s environment has a direct effect on automation efforts, to improve quality, reliability and responsiveness, it is necessary to consider projects which will bring processes closer together. The non-value adding steps in the manufacturing process must be reduced by streamlining project flow, eliminating inventory and cutting out material handling. It is not sufficient to automate material handling just to reduce labour costs. It is now more important to reduce lead time by eliminating material handling all together and automating the flow of information between processes, between plants and between customers and suppliers.

Automation has a much broader scope now, encompassing the automation of information flow as well as product flow. The group must be heavily involved in implementing the latest manufacturing and management techniques including Just in Time (JIT), Computer Integrated Manufacturing (CIM), Total Quality Control (TQC), Electronic Data Interchange (EDI), and Quick Response (QR).
Specific automation projects should start with a process flow study. This should identify the product routing, processing time, inventory levels, lead times and any other factors which give an indication of how this process affects the overall responsiveness, quality and reliability of this product.

An overall guideline to adhere to is ‘simplify first, automate next, and integrate last’. If this is utilized, it will avoid automating a mess and instead will lead to streamlined product flows, reduced material handling and shorter lead times.

The new manufacturing environment will not wait for those of us who resist change and are reluctant to take risks on investing in new technology. It is an ever changing environment and once you get behind, it will take quick, bold actions on the part of forward thinking managers to get back that competitive edge.\textsuperscript{15}

\textbf{2.17 TRAINING FOR AN AUTOMATED TEXTILE INDUSTRY}

The technological revolution now underway in the textile industry is forcing changes in the areas of capital investment, management and labour, automation and robotization. This will imply a lower number of workers, but higher skill levels need and this of course implies radically different training requirements.

Some organizations have already found in that of training to decide whether to train completely new employees on the newer, more automated equipment or to retrain older employees one of the big problems that has to be addressed here is that ‘un-learning’ time must be added to the time necessary to learn the new technology, and it appears that the longer people have performed with the old technology, the

longer it takes them to unlearn that behaviour before they can start learning to perform well in the new behaviour. According to several mill managers interviewed as the basic research foundation for this paper, the amount of time it took to unlearn the old technology appeared to be highly correlated with the amount of time the person had been working at the old technology so that older workers were more likely to have much more difficulty in this kind of retraining. On the other hand, older workers who had been running machinery that was not completely different from the new machinery, but perhaps one generation removed rather than three and four generations removed were said to have a much easier time in retraining for the new technology.

Now that textile machinery has gotten very complicated, very automated, and full of electronic components, it seems that textile machinery manufacturers will also have to provide a good deal of training for their new equipment. A financial burden on mills that equipment since the workers will have to be transported to the training sites, fed and housed at company expense while undergoing the training. It appears that many textile operations recognize that this kind of training must be undertaken because the workers are not going to be trained on just how to operate the machinery but that quality training is combined with operations.

Automations have certainly changed the lifestyle of workers in some plants. In some cases this is done with great reluctance on the part of the workers and is accompanied by continued resentment. In other cases, especially where employee input is sought and compromises are worked out between management and labour, there has been much better success.
In past decades, mill electricians were generally concerned with getting power from one place to another safely, but now the emphasis is on being able to repair the complicated electronics that go with the new equipment.

Many of the textile mills in the south are in small towns at some distance from large metropolitan areas, and if electronics technicians are not able to repair the circuit boards it can cause delays in getting a new expensive inventory of replacement boards.

The lack of knowledge about the new equipment, coupled with fundamental resistance to change, makes it very easy for one or two employees to start an active campaign against a new technology before management has even completed its evaluation of this machinery and certainly before any purchase decision has been made. In more highly capital intensive configuration of the textile industry, the supervisors are spending less and less time managing people and more and more time monitoring quality and evaluating machinery. Many of the current cadre of first line supervisors in the textile industry in the united states received a great deal of training on managing large groups of people, but have received very little training in the areas of monitoring quality and evaluating machinery.

Fairly short training times can be expected for the operators, but long-term and expensive training times for the upper level maintenance and electronic specialist are anticipated. The use of interactive video for training as well as for troubleshooting will certainly be needed in this new configuration.

In the past, the ‘hands-on’, on the-job training was the most important part of the training. Larger mills might have had a fairly small training room with one or
two major pieces of equipment used for training. But in the future, the textile industry expects to see more formal classroom instruction and interactive video training coming along.

In the past, the training cost per person was fairly low, but the high turnover rate in textile employees made total training cost is very high. Most training was done on the basis of teaching people how to operate machinery whereas in the future, the training must be oriented towards how to produce a high quality product\textsuperscript{16}.

\textbf{2.18 FUTURE CHALLENGES FOR THE TEXTILE INDUSTRY}

The world population has just passed 7 billion and is estimated to increase by a further 4 billion by the year 2050. This means that there will be a steady increase in the demand of fiber consumption to cover market needs worldwide. A number of alternative sources are available to cover the future needs. The \textbf{first} is natural fibers, such as cotton and wool. These fibers will form an important source for fabric production, but their share of the total virgin fiber production is estimated to decrease significantly due to the revised priorities of the usage of land areas worldwide.

The \textbf{second source} is oil-based synthetic fibers. It is difficult to predict exactly how long the world’s oil supplies will last. Synthetic fibers have a great advantage over other types of fiber because they not only satisfy the requirement of traditional textiles, but also open up new uses for fibers in technical and industrial applications.

The **third source** is man-made cellulosic fibers produced from renewable resources originating from forest products, which means that sustainable development is possible.

The **fourth source** is recycled, natural, synthetic and cellulosic fibers. Recycling is gaining ground because of environmental issue. However, it will fulfill its potential, when industrial solutions are found for chemical recycling of man-made fibers.

The **fifth source** is biopolymers (e.g., Corn-starch-based fibres). This is an exciting new field and at present, development and commercialization of these types of fibers is in full progress. In future these fibers will be the viable substitutes for synthetic fibers in many applications.

It is not generally expected that there will be a strong need for new generic fibers. The main challenges that the textile industry faces are as follows:

- To be highly innovative.
- To use environmentally friendly materials and processes.
- To be highly efficient with high productivity.
- To have a leading-edge Research & Development agenda.
- To exploit new technological frontiers.
- To produce highly functional and high performance products.
- To produce highly designed products.
- To have strategic partnerships with many non-traditional industrial sectors.
According to Du Pont, in the coming decades the emphasis to textile
developments is expected to be in the fields of:

1. Safety and protection.
2. Electronics and communication technology.
4. Coating technology.

Much development work remains still to be done in the fields of technical
textiles and high-functional textiles. There is a strong need to establish close
partnership between textile companies and the textile research community in order
to maximize the benefits of these partnerships in terms of innovation and growth.
Fiber and textile technology has tremendous potential for caring synergies with
other industrial sectors - for example, biotechnology, communication, space
technology, optics and other high-tech materials – thereby contributing towards new fiber-based materials for the twenty-first century17.

2.19 LABOUR SKILL REQUIREMENTS IN TEXTILE INDUSTRY

India has gained global appreciation as an attractive outsourcing destination mainly due to its abundant availability of labour force. The Indian textile industry is one of the biggest sectors in magnitude, and the second largest in terms of employment generation. The industry has several sectors employing nearly 4 million workers, providing a significant contribution to the national economy. Skills of Indian textile labourers are ingrained in them for generations. Earlier it was hand technology and currently, power technology. Textiles and apparel constitute major exports for India generate $14 billion revenue. Termination of the decade old export quotas will make for a drastic alteration in the sector. India enjoys several advantages comparatively over other lands such as abundant labour force, vertical integration of the complete production process and material resources18.

The Confederation of Indian Textile Industry has seen the increase of total material and clothing market at USD 100 billion in 2015 against USD 55 million at present. These estimates will see phenomenal growth in the manufacturing, processing and garmenting sectors of the textile industry, which in turn will drop up the need for an approximated 25 million new businesses. The technological modernization being the key to high industrial growth, project intensive industries

like textile, will not only require skilled hands, but also massive vocational training for skill upgradation of the existing workforce, engaged in the organized as well as unorganized sectors. The breeding is the most vital and essential elements in empowering people with skills and knowledge and grant them access to productive work.

National Skill Development Corporation (NSDC) report, the overall employment in the Textile & Clothing sector would increase from approximately 33 to 35 million in 2008 to approximately 60 to 62 million by 2022. This would interpret into an incremental human resource requirement of approximately 25 million individuals of this the Mainstream Textiles & Clothing sector has the potential to utilize some 17 million persons incrementally till 2022. It means that by the end of the XII Plan (2016 - 17), which is roughly close to 2018, the textile sector's incremental human resource requirement would be around 17.8 million, of which 11 million human resources would be demanded in the Mainstream Textiles & Clothing sector.

2.20 EMERGING TRENDS IN HUMAN RESOURCE REQUIREMENTS

The modifications in the technology would significantly move the profile of people required. As observed earlier, the share of shuttleless looms in the Indian textile industry is only 2-3 % as against a world average of 16.9 %, thereby suggesting a low level of modernization in the Indian weaving industry. Although the Indian spinning sector is relatively more modernized, just about 60 % of installed spindles. In the apparel sector, India has much lower investment is special purpose machines, which perform specific social occasions and add value to the merchandise. Very few export establishments have invested in cutting or furnishing
machines. The lower level of technology and government incentives like TUFS would drive modernization in the industry where as the high power cost would be detrimental.

The technological upgradation would necessitate resource to be trained in modern machinery and also greater in house spending on training. The shortage of labour and increasing wage rate would further induce greater automation, which will lead to higher productivity.

The modern machinery would require skilled maintenance people who have the requisite knowledge of the same. Proper maintenance would be crucial as machine down time and costly spare parts would significantly affect the performance of the industry\textsuperscript{19}.

**2.21 REVIEWS RELATED TO TEXTILES**

Sergio Mariotti (1986)\textsuperscript{20} investigated the structural evolution of the textile clothing industry. It is mainly due to organizational innovations to economize on transaction costs and increase the dynamic efficiency of Kovai textiles. The rise of managerial hierarchies in the coordination of diversified activities, the drop in the number of vertical hierarchical arrangements and the diffusion of intermediate governance structures are the main changes in industrial organization. There is evidence from the Italian industry, which supports this trend.


Subramanian (1992)\textsuperscript{21} examined the partial and total factor productivity growth of labour and capital, nature of returns to scale and estimation of the elasticity of substitution between capital and labour in the cotton textile industry in Tamil Nadu during the period 1975-86. It was found that partial factor productivity has increased by 2.42 percent. The real wage of labour has also increased at the rate of 1.36 percent level and the capital intensity substantially declined by 24.50 percent per annum in the partial production of capital. The total factor productivity has also gone down in the absence of technological progress on the cotton textile manufacture. The study suggested improvement in the quality of textile labour, massive investment in textile machinery, healthy industrial relations and use of appropriate technology for the best performance of textile industry in Tamil Nadu.

Nauro Compos et al., (2007)\textsuperscript{22} has attempted to study the main barriers to firm entry and exit in developing countries and how do they differ from barriers to firm operation and growth. Their importance in the institutional and regulatory framework. This study examines the evidence from the Brazilian textiles and electronics industries. It is found that not only these institutional barriers are higher in Brazil but, also that they seem to have risen since the early 1990s, and that their effects vary across sectors. The evidence from a survey that was carried out in 2005 suggests that institutions are more important as barriers to entry than as barriers to firm operation and growth.


Bheda Rajesh (2002)\textsuperscript{23} this paper argued the productivity level in apparel manufacturing in India, the factors related with productivity in the Indian garment industry and the scope of development. It concludes that apparel productivity level in India is considerably lower than the western industry. The study has established almost 100 \% productivity improvement potential for average Indian garment factory. It turns clear after review that most of factors are of the techno-managerial nature and apparel manufacturers can improve the productivity, performance substantially by implementing best practices in the field of operations and management training, industrial technology, production preparation and scheduling industrial relations and productivity linked incentive schemes.

Belay Seyoum (2007)\textsuperscript{24} has asserted that trade liberalization has exposed Indian textiles and apparel industries to fierce competition from a growing number of international suppliers. Many traditional suppliers are also vulnerable to strong competition from China since they no longer enjoy preferential access to the Indian market. After discussing overall trade liberalization in the industry, including the recent phase out of quotas, the range of strategic changes being adopted by Indian companies to remain competitive are discussed. It also assesses some of the important developments in the textiles and apparel industry, including the increasing role of China as a dominant supplier to the market.


Srinivasan (2010)\textsuperscript{25} has found that the usage of finer and softer textile yarns will improve the aesthetics of fabrics and will be useful in producing highly fashionable materials. The methods of engineering finer and softer textile yarns including raw material requirements, fiber to yarn conversion systems such as siro spinning, solo spinning, compact spinning, jet ring, jet wind, core, cover and wrap spinning, vortex spinning, twist less spinning, self-twist spinning and air-jet texturing. Further, the details of structure including fiber distribution and packing density, aesthetic, comfort and other properties of these yarns, their applications and their future trends using bamboo fibers and micro-fibers are discussed.

Muralidharan et al., (2011)\textsuperscript{26} have found that commercially polyester/cotton blended fabrics are dyed by two-bath or one-bath-two step dyeing method employing suitable dyes and chemicals for each fiber. The two bath dyeing methods are relatively long and complicated and the one bath-two step dyeing procedure is shorter as compared to two bath method but the dye ability is poor. To address this issue, the present investigation focused to formulate a new method in which the polyester/cotton blends can be dyed at lower temperature with an improved dye uptake and fastness properties using disperse and reactive dyes. Polyester/cotton blended fabric and yarns were subjected to pre-treatment using two different azeotropic solvent mixtures and then dyed using disperse and reactive dyes. The dye ability of the pre-treated samples


were found to increase tremendously while the fastness properties get slightly improved.

**Das et al., (2011)** has analysed the breaking strength of spun yarn and it is accepted as one of the most important parameters for assessment of yarn quality and one basic way to increase profits and quality in textile process is to hold yarn breakage to a minimum level. The mechanism of yarn failure under tensile loading decides the strength of staple yarns. This study presents the critical review of various theoretical and experimental works pursued on static failure mechanism of ring, rotor, air-jet and friction spun staple yarns. The reported failure mechanisms of slivers and roving’s and yarns in woven fabrics are also summarized. The arterial, spinning and testing parameters influencing the static failure mechanisms various mm are discussed.

**Marion Tobler-Rohr (2011)** has concluded that marketing forces are imposing decisions on the textile value-added chain for economic reasons and thereby are setting the consequences for a sustainable development. The push strategy coming from the value-added chain has almost disappeared in favour of a pull strategy from product development and marketing, establishing new rules by working in a global environment. Comparisons are drawn between the American perspectives of the large merchants and the EU and Swiss economic structure with small and medium-sized companies, also including consumer behaviour in the textile markets.

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Monjo Carrio et al., (2011)\textsuperscript{29} in their study have summarized the main aspects of tensile structures made with specific fabric materials. They have reviewed the historical antecedents and the technical and formal typology for this type of structure in architecture. The construction conditions as well as the different materials and finishing’s necessary to build and maintain the textile structures and membrane covers are briefly discussed.

Venkatesan Baskaran et al., (2012)\textsuperscript{30} have concluded that textile supply chains consist of multinational garment retailers (customers), garment manufacturers (suppliers), and ancillary suppliers (suppliers to manufacturers). Suppliers’ within the Indian textile and clothing industry (both garment manufacturers and ancillary suppliers) are evaluated using sustainability criteria. Sixty-three suppliers are examined using six sustainability criteria (i.e. Discrimination, abuse of human right, child labour, long working hours, unfair competition, and pollution), suppliers are categorized into the three categories of ‘good performer’, ‘moderate performer’, and ‘performance not up to expectation’. Since all the criteria are potentially subjective, employed the grey approach was employed for analysis. The results indicate that the criterion of long working hours is a critical one for both categories of suppliers; in the case of garment manufacturers, we found that pollution and unfair competition were the most important criteria. In addition, employing child labour was found to be a critical criterion in the case of ancillary suppliers.


Muzyczek (2012)\textsuperscript{31} has found that natural fibers are very important and very useful fibers which compete and coexist together with man-made fibers, particularly in the areas of quality, sustainability and economy and production. Natural fibers are mostly used for the production of underwear and apparel, especially for higher level products. Cotton, wool, flax and silk are the main natural fibers used in the clothing industry with cotton being the most widely produced. The potential for further growth in production of cotton is limited; therefore, many stakeholders are optimistic about the market for fibers from crops such as flax and hemp. This study presents a review of the types of flax and hemp fibers used in the production of textiles. The linen and hemp manufacturing process is complicated and requires great skill at each stage of production. Hemp and flax textile processing technologies are very similar, because the textile properties of hemp are very close to those of flax. Also considers the financial and economic value of flax and hemp fibers are studied and presents statistics of flax production, including locations and tonnage of production. To meet the demands of a new industrial market, fiber flax must preserve its image as a high quality natural product, grown traditionally.

Kothari (2013)\textsuperscript{32} concluded that a weaving unit must have a satisfactory system of process control that focuses on loom production, quality monitoring and the cost of fabric production in order to achieve quality and production targets at the lowest possible cost. The factors that affect loom productivity and efficiency


and what needs to be done to optimize these factors to produce the fabric of required quality at the lowest cost are elaborated. Online quality and process control in weaving are discussed and factors affecting the weaving cost are analysed.

Murat Atlay et al., (2013) concluded that innovation is widely regarded as one of the most important sources of sustainable competitive advantage in an increasingly changing environment, because it leads to product and process improvements, makes continuous advances that helps firms to survive, allows firms to grow more quickly, be more efficient, and ultimately be more profitable than non-innovators. The main purpose of this study was to examine the relationships between innovation and firm performance. The survey of this study is conducted on top level managers of 113 firms operating in the automotive textiles industry which is one of the most innovative industries in Turkey, as of the year 2011. The obtained data from the questionnaires are analysed through the SPSS statistical package program. Analysis results demonstrated that technological innovation (product and process innovation) has a significant and positive impact on firm performance, but no evidence was found for a significant and positive relationship between non-technological innovation (organizational and marketing innovation) and firm performance in Tirupur textile industry.

Thomassey (2013) has revealed that competitive environment and the emergence of the mass customization concept; garment design has become a crucial step for clothing companies in Tirupur. Indeed, garments should be designed


quickly under controlled costs and perfectly fitted to consumers. No traditional pattern making in 2D matches these new constraints since it requires the production of expensive and time consuming physical prototypes.

**Petrie (2013)** has reviewed the fundamental principles of all types of adhesive bonding for textiles. Adhesives and adhesion are of fundamental importance to the textile and clothing industries. This study discusses the various theories supporting adhesion, the common types of adhesive used with textiles, and important bonding processes that are employed in the textile industry. It concludes with a review of recent trends in textile adhesives.

**Ammayappan (2013)** wool is a natural fibers mainly used for suiting, shawl, carpet and blankets, however it has distinct demerits like shrinkage due to the presence of cuticle scales on the surface of the fiber. Research works, since 1950 have been carried to resolve those problems by different methods. This review highlights the eco-friendly surface modifications of wool fiber to rectify the problem by improving its functionality.

**Snezana Stankovic (2014)** has analysed the characteristics of folded yarns. Although the characteristics of folded yarns have been the subject of many investigations, there is a serious lack of study concerned with the influence of yarn folding on comfort properties of clothing materials. Therefore, this study focused on the effect of yarn folding on both thermal and technical development comfort of

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plain knitted fabrics. In addition to the structural characteristics of the yarns and knitted fabrics, the transport properties, deformation behaviour and surface properties of the knitted fabrics were investigated. The results obtained indicated that the influence of yarn folding on thermal and tactile comfort properties of clothing materials is mainly positive. These effects were caused by the modification of yarn packing density which further influenced the air volume distribution as well as the fiber and yarn mobility within the fabric.

2.22 TECHNOLOGY MANAGEMENT

Whitley et al., (1982) attempted to quantify some of the compensatory effects on employment which may offset the direct displacement effects of faster technological change. It is argued that technological change will not necessarily increase unemployment levels. There are a number of compensating effects which may reduce and even outweigh any initial displacement effects. The study uses simulation techniques with a detailed model of the Tamil Nadu economy. One conclusion is that, even if the Tamil Nadu does not innovate as fast as its major competitors, a more rapid rate of diffusion of new technology may result in higher employment.

Rada (1983) has examined the different effects of Information Technology (IT) in products, processes, office work and services and some of the implications for the international division of labour and developing countries. The basic argument is that the technological profile of all productive activities is changing and this has far reaching effects in the textile industry (reinvention of the industry) and services

(transportability of services). The effects on LDC is essentially one of increasing obsolescence of their industries, services and development strategies.

Yu H sing (1989)\textsuperscript{40} has concluded that owing to concerns over the secular decline in employment and trade deficits in the U.S. textile industry, this study estimates the variable employment elasticity’s of demand for labour in this sector by applying an expanded version of the Box-Cox Extended Autoregressive (BCEA) model of Savin and White. The major findings suggest that (1) all of the functional forms accept the semilog a form can be rejected in favour of the BCEA model; (2) the elasticity’s of demand for labour are variable; and (3) wage elasticity’s have become more elastic and the textile industry has exhibited constant or slightly decreasing returns to scale in recent years.

2.23 IMPACT OF TECHNOLOGY

Hall (1994)\textsuperscript{41} has analysed the results given of an investigation into the perception and use of information as a technical development and resource for effective business performance and competitive advantage in the Scottish high performance textile industry. Case studies reveal that there are predominant patterns of information usage within the industry. There is a low level of appreciation of information as a strategic resource. The results confirm that there is a strong relationship between information activity and innovative practices. Current information needs of the industry in question are highlighted and recommendations are made on how these might be met.


Nandini Joshi (1977)\textsuperscript{42} asserted that textiles is the only commodity other than food which is universal and is in continuous demand, a primary way to provide and sustain employment on a large scale and continuous basis could be an appropriate technology in the textile industry. Hand-spinning - a rural women's industry, can only survive only with a large and expanding market, which in turn can be achieved only with more application of scientific research leading to lower costs of production and higher quality of the textiles. More R & D in Khadi (i.e. hand-spun and hand-woven textiles) industry, could go a long way. The application of the modern principle of open-end spinning to the hand-spinning instrument can dramatically raise the output per worker, without substantially increasing the cost of the instrument. An experimental hand-spinning instrument, called Dabba - Kataai instrument, has recently been constructed with the application of the open-end-spinning principle. Comparison of output and employment obtainable, for a uniform amount of outlay over a uniform period, from four different spinning technologies - traditional hand-spinning instrument, Dabba - Kataai instrument, ring-spinning machine and open-end spinning machine - shows that, given the prevalent capital and labour resources and corresponding factor costs in India, Dabba - Kataai is most appropriate both in terms of output and employment. In terms of the social and environmental consideration also this technology is most suitable. Application of scientific and technological research can contribute significantly to reducing costs in Khadi industry and should also be directed towards improving the quality of the output.

Simon Teitel (1984) has critically analysed the technological activities of the semi-industrial economies of Latin America that has led to the adaptation of imported technologies as well as the development of new products and processes have been both an involuntary by product of manufacturing activities and the result of deliberate decisions to set up technological research facilities. Technological research reported by Latin American firms have shown to be largely complementary to production and carried out to reap the extra benefits of protection. External effects are thus disregarded since the benefits from industrial production suffice to induce the requisite adaptive research. It focusing on technology as information and engineers as its processors, looking at the learning stages from using imports to the creation of new products, and examining these processes in terms of a progression toward increasing technological complexity.

Allen Scott (2006) in the basic approach to the geographic investigation of low-technology, labour-intensive spinning and textile industries is sketched out by invoking notions of industrial organization, locational agglomeration, and spatial divisions of labour. The distribution of the clothing, footwear, and furniture industries across the contemporary world is described on the basis of detailed published statistics. Special emphasis is accorded to similarities and contrasts in the geography of production between more developed and less developed countries. The level of development, agglomeration tends to be a pervasive (though not universal) feature of these three industries. Global trading patterns in the three industries are subjected to extended investigation.

Lawrence (2010)\textsuperscript{45} has given an historical account on the development of the yarn spinning process, from its initial beginnings as a hand craft, to the mechanization of the process during the Industrial Revolution, and through into the twentieth century when a wide range of different spinning techniques were developed. The basic equations generally applicable to spinning technology are presented and descriptions given of the various techniques currently used commercially, classified according to the fundamental principles of the method on which they are based.

Busgen (2012)\textsuperscript{46} new interior textile of technology development is motivated by an ongoing global shift of supply and competition. Traditional manufacturers actually focus their development on the addition of innovative functions and utility value. The detail systematic procedural methods, which are used for product development of interior textiles. Four case studies associated with this study illustrate successful product development examples for smart floors, acoustic damping tapestries, luminescent curtains and smart automotive cover fabrics. Learning experiences from these and other research projects are explained.

Reed (2014)\textsuperscript{47} introduced the concept of textile dyeing, based on a brief review of various types of dyes and fibres and the interaction between dyes and fibres, and the mode of controlling dyeing processes based on conventional time-temperature profiles as well as those based on controlling the rate of dye exhaustion. The package dyeing process and parameters influencing the adsorption


and diffusion of dyes within packages are then introduced. Various adsorption isotherms are briefly examined and factors that affect the dyeing of fibres are discussed. Different control technical development and strategies based on assessing the amount of dye in the dye bath are then briefly examined.

**Azaza (2014)**48: This work deals with the evaluation of the residual bagged fabric volumes using image analysis technique and development. Indeed, image processing method was applied and compared for denim bagged woven samples. Hence, seven different denim fabrics are evaluated and investigated in order to measure their residual bagging volumes. Different inputs characterizing denim garment specimens are also tested to analyze and evaluate their effects on the bagging volume values. To extract and evaluate residual bagging volume, overall captured images of bagged fabrics based on 3D analysis of intensity images were processed and analyzed. Regarding the findings obtained, the image analysis technique offers good results and helps, in 3D distribution, to evaluate objectively the residual bagging volume of denim samples. Besides, referring to the results, the residual volume which affects negatively bagging appearance can be improved when some influential inputs are widely studied and controlled. Furthermore, based on the influential input parameters contributions, it may be concluded that an increase of weft yarns density (pick/cm) increases the residual bagging volume of denim fabrics. However, when the energy of compression increased, the residual bagging volume decreased. All results given by image analysis method are improved using the regression method and principal component analysis of technology technique.

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2.24 AUTOMATION TECHNOLOGY IN TEXTILE INDUSTRY

Howard Pack (1984)\(^49\) has analysed the past choices of technology and present levels of productivity in the Philippines’ cotton spinning and weaving industries. Detailed engineering and economic information are used to assess the costs of alternative technologies, to estimate levels of productivity relative to international standards of best practice, and to analyse the sources of productivity short-falls. High costs of production are due both to inappropriate technological choices and to low productivity in the use of the technologies chosen. The major sources of low productivity are lack of sufficient firm-level specialization among product varieties and deficient firm-level technological capabilities; inadequate labour skills. The discussion emphasizes the general applicability of the analysis wherever low productivity is likely to be a problem.

Raykun Tan (1995)\(^50\) has concluded that to enhance the productivity and competitiveness of the manufacturing sector, the Taiwan government is establishing technology transfer infrastructure as a strategy for promoting automation. The status of the automation capability, the role of government in shaping the industry from the perspectives of four determinants: textiles strategy and structure, factor creation, demand condition, and related and supporting industries are discussed briefly.

Nicholas Bilalis et al., (1999)\(^51\) have presented an integrated information system proposed for the textile/apparel industries. The main idea is to propose a common communication platform between fabric producer and garment

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manufacturer in order to standardize technical and qualitative fabric definition. The heart of the system is the fabric technical and qualitative chart as well as the quality-cost function formulation procedure that seriously affects trade relationships. The innovative contribution of this system is represented by the fact that the technical and qualitative chart of the piece will now be created by the fabric producer on the basis of the requirements of the Garment Manufacturer so that it can be used directly by the latter's computer system.

Margherita Balconi (2002)\textsuperscript{52} investigated the wave of codification of technological knowledge which has occurred over the last two decades due to the availability at low cost of technological automation and measurement instruments. During this process, traditional tacit skills of workers have become largely obsolete and modern operators on the shop floor are mainly process controllers and low-level problem solvers. Alongside this, the acceleration of innovation has made high-level problem solvers increasingly important. Tacit knowledge has thus remained crucial, but it has become complementary to a codified knowledge base and concerns problem solving heuristic, interpretation of data, etc.

Noel (2008)\textsuperscript{53} has explored current trends in the social psychology of clothing, postmodernism, and advancing technologies that suggest a concept of clothing in the future. New technologies in the initial stages of development, such as organic light-emitting devices and polymer light-emitting devices, demonstrate the possibility of a soft, wearable digital screen that would project any type of


image. Such a device could be perfected, the creative uses could expand dramatically to allow for change and personal manipulation of appearance that our postmodern society craves. A future scenario and set of illustrations present a bodysuit that could be controlled by a microcomputer to project multiple images in a matter of seconds, thereby changing appearances depending on the situation.

Suzanne Loker et al., (2008)\textsuperscript{54} has analysed, how digital technology and the Internet are changing practices of dress and appearance in the 21\textsuperscript{st} century. An exploration of the technologically-assisted ways we see and interact with images of self and the clothing we wear is presented. Applications of body scan images for individuals and businesses to improve fit are examined as well as the interactive technologies being developed that allow individuals to view and dress their own body scans for virtual-try-on, virtual-fit, and virtual-reality applications. Although issues surrounding consumer comfort with, availability of, and profitable business models for these technologies still prevent broad-based adoption, we pose questions about the potential advantages and challenges for the digital, interactive third dimension of dress.

Annette Ames (2008)\textsuperscript{55} has used long-term forecasting techniques, to analyse apparel design problems and possible outcomes for a style of fashionable women's clothing in the relatively near future, approximately 10 to 20 years from now. The form of fashion design that exists outside of commercial constraints and is used to create drama on the runway is chosen to provide freedom in aesthetic


response to a projected scenario of the future. The runway showpiece is intended to provide inspiration to its designer for designs of more practical, saleable clothing.

**Gowda (2010)** has asserted that with the advances in yarn spinning technologies, developments in yarn properties and specific applications of various yarns are bound to increase. It also discusses the prominent yarn texturizing technologies, innovations and technical applications of texturized yarns. Finally, it highlights the future trends in yarn spinning technologies.

**Jenkyn-Jones (2011)** described the role of fashion design in the dynamics between the global textile industry and the growing power of retail. The effect and importance of textiles, expressively promoted by designers as carriers of cultural memes, are explored. How and why choices for fabrics are made, how this scenario was established and has changed over the last century through technological progress, education and is further challenged by the progress of communications and CAD/CAM is discussed. Opportunities for closer co-design ventures between suppliers and consumers are predicted. At the same time movements towards sustainability and consumer and corporate conscience provokes implications and repercussions for future perspectives and changes in longstanding cultural habits and education are envisaged.

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Lamar (2011)\textsuperscript{58} examined the role of digital technology in enabling a design and development process, integrating the functions of both textile and apparel creation. First, digitally enabled processes integrating design of textile and design of apparel simultaneously are discussed, including examples of garments developed through integrated processes. The focus of the study, shifts specifically to the role of technology automation design and visualization technologies in enabling an integrated digital process, and concludes with discussion of future directions.

Witkowska (2011)\textsuperscript{59} has concluded that the study of textile material strength measurement, especially tear strength, has its roots in the work of a textile designer for the US army. Since then, research has continued in the area of technical textiles, and finally has been adopted in industries manufacturing textiles for daily use. Now, static tear strength is one of the most important criteria for assessing the strength parameters of textiles designed for use in protective and work clothing, everyday clothing and sport and recreational clothing, as well as in textiles for technical purposes and interiors, upholstery and so on. This study presents the existing models of fabric tearing, as well as a new model for the tearing of a fabric sample from a wing-shaped specimen. Traditional models of fabric tearing are based on the distribution of mechanical forces. Additionally, the model of predicting the tearing of a wing-shaped sample by use of an Artificial Neural Network (ANN) is presented.


Tyler (2011)\(^60\) has explained the operation of Triaxial weaving which is used to manufacture woven fabrics with three sets of parallel fibres. It covers a range of weaving and braiding techniques that produce fabrics with a range of weights and properties. The history and possible future of the weaving technique are discussed, and the associated applications and manufacturing techniques are surveyed.

Noor- Evans et al., (2012)\(^61\) has concluded that the process of ‘de-maturity’ of the European textile industry, moving away from its traditional roots is an attempt to revive the fortunes of this mature industry, through the adoption of novel technologies, such as nanotechnology, microelectronics and/or biotechnology. The process requires a paradigm shift involving every aspect of the firm that includes its technical capabilities, research and development (R&D) and business strategy. A discusses a new product development strategy that permits the incorporation of the novel technologies into current business activities, which is consistent with the Open Innovation paradigm are briefly discussed.

Jaime Gomez et al., (2012)\(^62\) has analysed the determinants of the use of advanced manufacturing technologies in manufacturing textiles. More traditional approaches and consider the role of complementarities in technology adoption at two levels. First, Teece's (1986) framework was adopted to study the incentives to use new technology that stems from investments in R&D, human capital and

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advertising. Secondly, technology use by a system effect that arises from the use of related technologies was analysed.

**Veit (2012)**

Veit (2012) in his paper has analysed the simulation of textile machines and increasing importance as trials of machines are often time consuming and expensive. In addition, many customers today demand quick production of small lots which in turn requires an optimized machine setting within a very short period of time. A wide range of methods, covering processes from yarn production and processing through fabric manufacturing to finishing.

**Tyler et al., (2012)**

Tyler et al., (2012) has concluded that developments in clothing production technologies have been rapid and significant in two areas. The first concerns sew-free technologies, primarily adhesive bonding of seams. The technology innovations have affected many markets, but primarily lingerie and sportswear. This study considers the drivers for adoption of these technologies and the machinery used to achieve welded seams. The other area concerns three-dimensional (3D) body scanning and the potential for integrating scan data with 3D CAD and work on the fit of garments.

**Langereis et al., (2013)**

Langereis et al., (2013) has explained in his study, the electronic systems with sensors and actuators are enablers for increasing the protection level of textile appliances. Apparel and many other textiles are close to the human body and are part of numerous professional and home routines and tasks. This means that textiles

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are positioned in our daily life in locations where they can act extremely well for protective purposes by means of monitoring and being responsive. Intelligence created by electronics starts with sensors and actuators integrated into the textile to make it responsive. In addition, a power system, interconnect and processing logic are needed. Some characteristic problems encountered with sensing human parameters can be solved by smart topologies and sensor arrangements.

Parnia Zakikhani et al., (2014) have found that natural plant fiber composites have been developed for the production of a variety of industrial products, with benefits including biodegradability and environmental protection. Bamboo fiber materials have attracted broad attention as reinforcement polymer composites due to their environmental sustainability, mechanical properties, and recyclability, and they can be compared with glass fibers. This study describes the various procedures that have been developed to extract fibres from the raw bamboo culm. There are three main types of procedures: mechanical, chemical and combined mechanical and chemical extraction. Composite preparation from extracted bamboo fibers and various thermal analysis methods are also classified and analysed. Many parameters affect the mechanical properties and composite characteristics of bamboo fibers and bamboo composites, including fiber extraction methods, fiber length, fiber size, resin application, temperature, moisture content and composite preparation techniques. Mechanical extraction methods are more eco-friendly than chemical methods, and steam explosion and chemical methods significantly affect the microstructure of bamboo fibers.

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**Grace Carswell et al., (2013)**: This study analyses the recognition that labourers have received less than the fair share of empirical and analytical attention in scholarship on global production networks. Little is known about how jobs for export markets fit into workers’ wider livelihood strategies, or how workers react to new employment opportunities available to them. Based on evidence from the Tirupur garment cluster in Tamil Nadu, South India, the study takes labourers, their livelihoods and their social reproduction as its starting point. It reviews the relevant labour geography and GPN literature, and suggests that the labour agency has been almost solely conceptualized in terms of collective forms of organized worker resistance. The study also draws on material from South India to examine how people enter garment work as well as the multiple and everyday forms of agency they engage in ‘horizontal’ approach that accounts for gender, age, caste and regional connections in the making and constraining of agency are followed. Such an approach has revealed how labour agency is not merely fashioned by vertically linked production networks, but as much by social relations and livelihood strategies that are themselves embedded in a wider regional economy and cultural environment.

**Maamoun (2014)**: A polyester/cotton blended fabric of 2 blending ratios is printed with a single class of dye (nano disperse dye) via 2 burn-out techniques. Burn-out effect is accomplished in the present work through using 2 acids separately: Nitric and sulfuric acids. The first technique development involves printing the substrates with a paste that contains the nano disperse dye refluxed in nitric acid. In the second

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technique, the fabric is printed with a burn-out agent (sulfuric acid) followed by overprinting with the milled disperse dye treated with ultrasound waves. All parameters found to affect the K/S values as well as percentage of weight loss of the printed blended substrates are investigated in detail. Results show that the use of a single class of dye nanoparticles enormously improves the colour depth of the prints also best burn-out effect can be obtained using sulfuric acid (with reasonable weight reduction).

2.25 IMPACT OF TECHNOLOGY AUTOMATION IN TEXTILE INDUSTRY

Giorgio Barba Navaretti et al., (2004)\textsuperscript{69} has examined the link between imported technologies and a country’s export performance, as measured by product quality. The analysis is set in the background of the process of regional integration between the European Union (EU) and its neighbouring developing countries. The underlying question is whether trade integration fosters or dampens learning and technological upgrading. It is found that unit values of exports from these countries to the EU rose steadily between 1988 and 1996, relative to the unit values of world exports to Europe. If increases in unit values satisfactorily proxy increases in product quality, then trade integration has fostered product upgrading and technological learning in the sample countries.

Gordanacolovic (2011)\textsuperscript{70} has revealed that industrial mode of production of clothing requires thorough preparation of the production process, because several factors are to be connected: people, time, machines, production


facilities, organization and material in a coordinated and rational system. The technological system of production of clothing must provide the required product quality, the production volume needed, the delivery of finished garments within the stipulated time and the maximum utilization of capacities with minimal costs.

Hergeth (2012)\textsuperscript{71} has asserted that management strategies are driven by changing technologies, and technological change in practically all industries is accelerating. The study addresses how technology management and technological changes impact business models and all aspects of strategic planning. Specific attention is paid to industry technology road-mapping as a tool for technology planning and management, including some examples of applications within the textile industry.

Ossevoort (2013)\textsuperscript{72} has asserted that smart textiles do not necessarily imply a less sustainable option to ordinary textiles, as long as the product does not offers better user value, user attachment and longevity. This study discusses the difference between ordinary sustainable methods based on saving energy and resources and methods that tackle excessive consumption, such as user involved design to enhance product durability. The theoretical model of user involved design through a practical example of the development of a smart lightweight tracking tent and concludes with a set of general guidelines for developing sustainable smart-textile products.


Olaru Sabina et al., (2014)\textsuperscript{73} : Their study proposed an innovative methodology for the clothing design activity, which allows the designer to adapt basic patterns developed for type bodies in the actual body form of a certain subject, using simulation in virtual environment of body-garment fitting. For the application of this innovative technology, it provides theoretical and practical information on development of two methods for morphological assessment of subjects in order to obtain the information required in patterns design for clothing based on concrete body form of potential users. Methodology to adapt basic patterns developed for a body type to the concrete form of subjects, applying simulation technology of body-product fitting in virtual environment.

Mary O Mahony et al., (2008)\textsuperscript{74} provided a unique cross-country comparative perspective on the impact of information and communication technology and automation on the demand for skilled labour. It employs panel data for the US, the UK and France, comprising several skill categories for each country for the 1980s and 1990s. The study considers the issue of whether skill bias is transitory or permanent both by considering changes through time and by dividing the highly skilled into textile industry. The results indicate that the impact of technology on the demand for skilled labour is slowing down, at least in the US, supporting a transitory interpretation.


Nancy Nelson Hodges (2008)\textsuperscript{75} has attempted to explore textile and apparel industry dynamics from the point of view of the news media to understand how such dynamics are presented to the general public. North Carolina, having been home to many jobs in these industries, was used as a case study. Data were a total of 600 articles from two of the state's primary newspapers spanning the period from 1998 to 2003. Content of these articles was analysed via a hermeneutic, interpretative framework to develop a thematic interpretation of the image of the two industries provided by the news media. Several themes were tied together through three broad topical areas—industry changes, strategic, technical development labour skill initiatives, and the impact of loss - and provide a multidimensional view of the industries as presented to the public. Further research is needed to understand the impact this image might have on public perceptions of the future of these industries.

Stefano Elia et al., (2009)\textsuperscript{76} has investigated the effects of outward FDI on the home country employment and skill composition. Considering the “textile” as the unit of the analysis, we capture both direct and indirect effects of foreign production on the textile and its environment. The empirical evidence refers to the internationalization of production by Italian firms throughout the period 1996–2002, and it shows that foreign activities have a negative impact upon the demand for low skilled workers in the parent textiles region.


Ochola et al., (2012)\textsuperscript{77} : Fiber to yarn conversion process has been affected by several factors which include properties of raw material, level of technology, machinery and skill of machine operators. In cotton fibre spinning, the cost of raw material plays an important role, since it accounts for over 50 % of the total cost of the ring spun yarn. Yarn imperfection (neps, thick and thin places) on the other hand is an important yarn parameter which affects yarn and fabric processing, and quality parameter. In this study, the relationship between fiber properties and yarn imperfections has been investigated using statistical and Monte Carlo techniques. The linear regression analysis developed models that generated coefficient of regression (R) value of 0.68, 0.65 and 0.68, respectively for nips, thick and thin places, respectively. The sensitivity analysis for statistical models showed that yarn twist, micronaire value, fiber maturity, trash area, fiber length, fiber strength and fiber yellowness are the influential factors for affecting yarn imperfections. Others factors that included trash grade, fiber uniformity, spinning consistency index, fiber reflectance, yarn linear density, trash content, fiber elongation and short fiber index should also are considered while studying yarn imperfection of cotton ring spun yarns.

Rajeswari (2003)\textsuperscript{78} has studied the conventional theoretical approaches which emphasize economic growth through allocation of substantial resources to textiles manufacturing production. An extension of these approaches is proposed to account for the increasingly important role of the sector in innovation and diffusion of technology. In addition, it is argued that the global diffusion of key value-


added core components and the imperatives of dynamic, information-related economies of scale tend to erode comparative advantages from low labour costs in developing countries.

2.26 SKILL DEVELOPMENT AND LABOUR SKILL REQUIREMENTS IN TEXTILE INDUSTRY

Keith E. Maskus et al., (1994) provided a perspective on labour skill, training development and trade in a North Indian context by calculating the factor contents of global textiles and bilateral import and export with Asian countries. The factors include natural resources, capital, and 73 distinct and highly detailed occupational categories. Occupational employment across the inter industry structure of the economy is an informative proxy for differential labour skills. Rankings are calculated of the factor contents of trade in 1989, and the detailed occupational categories used are assigned to major standard groupings of labour skills. The results demonstrate clearly that both intergroup and intragroup specialization of skills are significant determinants of trade. Several categories of skilled manual workers are highly ranked sources.

Mamoria (1995) has explained that the training is a practical and vital necessity for all peoples in today’s business environment. Because it enables employees to develop and rise within the organization and increase their market value, earning power and job security. The training is also aids to mould employee’s attitude and help them to contribute to their organizations growth.


Cambell (1977)\textsuperscript{81} stated that training refers to instruction in technical and mechanical operations while development refers to philosophical and theoretical education concept. It is designed for non-managers while development involves managerial personnel. Training is for specific job related purpose while development is for general purpose.

James Hoyt (2001)\textsuperscript{82} has found no support for the claim: “Employees with multiple skills enable organizations to thrive in dynamically changing and unpredictable environments.” The study showed that the “Multi-Skilled Worker” (MSW) was a non-significant predictor of financial performance in a statistical analysis of companies that operated in these environments. A sample of companies drawn from three high-technology industries (suppliers to the automotive industry, electronic instrumentation, and textile manufacturers) showed no relationship between employee skill diversity and financial performance. As a result, it appears that the benefits of a multi-skilled workforce may be overstated in terms of its contribution to the organization's financial performance. Or, it may simply suggest that the additional profits generated by responsive, multi-skilled employees are insufficient to offset the additional costs associated with training and hiring them.

Nina Pavcnik (2003)\textsuperscript{83} has concluded that although many developing countries have experienced growing income inequality and an increase in the relative demand for skilled workers during the 1980s, the sources of this trend


remain a puzzle. This study examines whether investment and adoption of skill-biased technology have contributed to within-industry skill upgrading in Chilean plants. Using semi parametric and parametric approaches. The use of imported materials, foreign technical assistance, and patented technology affect the relative demand for skilled workers are skilled.

**Susan Chun Zhu (2005)**\(^{84}\): Since the late 1970s, both developed and developing countries have experienced skill upgrading; that is, a rise in skilled labour's share of employment and payroll. In this study, the extent to which skill upgrading can be explained by product cycles, that is, by U.S. innovation and the subsequent relocation of production to U.S. trading partners. The following conclusions obtain. (i) Product-cycle trade is strongly and positively correlated with skill upgrading in a large panel of production about manufacturing and countries. (ii) No such correlation is apparent for conventional trade measures that do not differentiate between product-cycle goods and non-product-cycle goods. (iii) Product-cycle trade is at least as important as other previously identified domestic sources of skill upgrading such as capital deepening.

**Robert Palmer (2007)**\(^{85}\) has asserted that in the developing countries, labour skills and training development has been neglected. Skills development does not appear in the Millennium Development Goals (MDGs) or in many poverty reduction strategies and has been side-lined in favour of investment in primary education involve in textiles. However, it is hoped that discussion of skills development in the 2005 Global

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Brenton et al., (2007)\(^{86}\) have suggested a number of reasons as why the clothing sector has played such an important role in economic development. The sector absorbs large numbers of unskilled labour, typically drawing them from rural agricultural households to rural locations. Despite relatively low start-up investment costs, expansion of the sector provides a base upon which to build capital for more technologically demanding activities in other sectors. Growth of the sector allows imports of more advanced technologies to be financed through revenues gained from Tirupur garment exports.

Hati (2011)\(^{87}\): Seam pucker is a wrinkled appearance along the seam, which influences the appearance to a considerable degree. The various causes of seam pucker are discussed here. This critical review article basically presents the various methods of evaluation of seam pucker. There are several methods emerged with time to evaluate the seam pucker, however the research is still continuing to find our most accurate and easy methods. The initial methods of seam pucker evaluation were based on subjective assessment, but it suffered from the limitations of higher evaluation time, inconsistency among judges and the need for training and the results are not reliable. The objective assessment of seam pucker is carried out

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by the various methods; photometric instruments, cognitive theory, parallel light,
fractal dimension, artificial neural network, neuro-fuzzy logic, sensory
measurement and structured light projection. The advantages and disadvantages of
various methods of objective assessment are brought out.

**Abd El-Hady (2011)**: This study focuses on the development of rib
jacquard weft knitted designs which used for manufacturing women garment and
then examines the newer designs that have been created considering the aesthetic
appearance of the fabric as well as the desired properties. All the samples were
produced on circular machines with Rib Jacquard (RJ) system which uses revolving
stacks of discuss at each feed selection position. The selected yarns were interlaced in
many different ways to produce various designs. Even with a cursory glance, an
untrained eye could see a visual difference in designs. Much less apparent is that each
design has different performance properties in spite of using the same production
parameters yarn count, yarn type, structure, machine model etc. Based on the results
obtained in this study, it is clear that there is a highly significant effect of the motif
kind on the four studied variable thickness weight, air permeability and bursting
strength values for all produced samples. The results indicated that the performance
properties of the fabrics will vary depending on motif kind.

**Gonul Oguz (2011)** has explored the implications of Turkish labour
migration for the human resources strategies of the European Union (EU). The key
issues in the migration debate centre on globalization and the constant need for

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technological change (innovation), which gradually resulted in fundamental economic transformations. Each of these transformations has fundamental implications for nature of knowledge-driven economies. Impact of knowledge on economic growth is evident and crucial. Under the influence of globalization and information technologies, for most countries it became necessity to be competitive in the world market. This shift has probably increased the importance of human capital in the West, with complex and sometimes contradictory implications for public policy making. The textile revolution has laid the foundation of transformation in term of sectoral structure. As a result, both processes and products have been revolutionized, adjusting the equation between capital and labour. The growth in the service sector has led to major jobs losses in manufacturing. Lack of skills in the face of continuing economic change is a Europe-wide phenomenon.

Abeeha Batool et al., (2012)\(^{90}\) found that the outcome of labours training has been analysed, how it takes competitive advantage to an organization. The labours level of confidence reflects the efficiency and effectiveness of the training which further growth the competitive advantage. At present the new teaching education and training methods are rising due to modern environment revolutionization in the economic, labour and technological world of workforce.

Muhammad khan et al., (2013)\(^{91}\) in their study discussed the skill sets of workers, especially educational attainment and technical and vocational training


capacity and its relationship with wages in district Faisalabad. The study highlights the need to promote technical and vocational skills and education of labour force through greater investment on training programs so that male and female productivity could be increased. Education and vocational training of female needs to be increased in order to increase labour force participation rate of women in the district. Furthermore, education reforms especially in technical and vocational education are necessary which needs to be closely linked to the requirements of the domestic industry, service and agriculture sector in the district.

Elena karpova et al., (2013) has concluded that in-depth interviews, has analysed the fashion industry professionals’ viewpoints, on creativity, focusing on traits of creative people and how creativity can be developed. Four creative, traits were identified, including different thought processes, determination, having an open mind, and, risk taking. About one-third of participants believed that creativity is innate, and therefore, some, people were born creative where as others were not. Another third of participants maintained that, everyone has some creative potential that can be further developed. The remaining fashion, professional’s distinguished artistic creativity from creative problem solving.

Strategies for creativity enhancement and development included (1) practicing creative thinking strategies, (2), formal training, (3) diverse experiences and exposure to the world; and (4) creating a safe, yet, challenging environment have been suggested.

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Sharleen D Souza (2013) in his study, the areas around Mumbai, skilled labourers were paid Rs. 7500-8000 per month, but now, it has crossed or increased Rs. 10,000 per month. For unskilled labour it has increased from Rs. 5000 – 6000 per month to Rs. 7500 – 8000, “Textiles is no longer an employer’s market; it is now an employees’ market.

Grace Carswe et al., (2013) has asserted that with the recognition that labour has received less than its fair share of empirical and analytical attention in scholarship on global production networks. Little is known about how jobs for export markets fit into workers’ wider livelihoods strategies, or how workers react to new employment opportunities available to them. Based on evidence from the Tirupur garment cluster in Tamil Nadu, South India, the article takes labourers, their livelihoods and their social reproduction as its starting point. It reviews relevant labour geography and GPN literature, and suggests that labour agency has been almost solely conceptualized in terms of collective forms of organized worker resistance. The article then draws on material from South India to examine how people enter garment work as well as the multiple and everyday forms of agency they engage in.

John Sargent et al., (1997) examined the contribution to worker skill development made by Transnational Companies (TNCs) in Mexico. Test is to determine if firms that have implemented any or all parts of the integrated manufacturing model (defined as the use of advanced manufacturing technology, just

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in time inventory practices, and total quality management) are more likely to make significant skill development contributions than firms that do not use these practices. Primary finding is that TNC’s with intensive total quality management practices tend to make above average contributions. It was found that no significant statistical relationship between advanced manufacturing technology and skill development.

Mark S. Freel (2005)\textsuperscript{96} investigated the pattern of association found between firm-level innovativeness and a variety of indicators of skills, skill requirements and training activity. In doing so, the study was able to distinguish between types and level of innovation (i.e. product or process, novel or incremental) and between manufacturing and service firms. In broad terms, the key findings serve to underline the importance of intermediate ‘technical’ skills, rather than higher level ‘technology’ skills. However, perhaps the most fundamental observation is the recognition that labour quality has a dynamic component, in addition to the static elements commonly measured.

Geishecker et al., (2005)\textsuperscript{97} argued that owing to globalization and increasing fragmentation of production will lead to reductions in wages for low-skilled workers in developed countries. This claim has been substantiated by empirical research which finds that, on average, fragmentation can reduce the relative wage of low-skilled workers. However, trade theory is not as clear-cut on this issue. It is found that the effect of fragmentation on workers depends not only on the skill group of workers but also on the skill integrity of the industry.


Geoff Mason et al., (2012)\textsuperscript{98} analysed the relationship between human capital and productivity growth using a five-country multi-textile industry dataset together with a measure of human capital which accounts for both certified skills (educational qualifications) and uncertified skills acquired through on-the-job training and experience. Evidence of positive human capital effects on growth in average labour productivity in textile department, particularly when using our composite human capital measure are found.

2.27 LABOUR SHORTAGE IN TEXTILE INDUSTRY

Francis Teal (2000)\textsuperscript{99} has concluded that real wage rates in Ghana have fallen substantially over the last 20 years. In this study survey data for the years 1991–1995 is used to assess the changes which have occurred in the 1990s. It is shown that the real wage rate for the unskilled has continued to fall. Factor share equations for skilled labour and unskilled labour training are estimated, which show the rise in skilled wages leading to substitution to unskilled labour but no rise in the share of skilled labour training. The own price elasticity’s of skilled and unskilled labour are estimated at $-0.44$ and $-0.52$, respectively.

Gonzaga et al., (2006)\textsuperscript{100} has concluded that the skilled labour earnings differentials decreased during the trade liberalization implemented in Brazil from 1988 to 1995. The role of trade liberalization in explaining these relative earnings movements are discussed. Several independent empirical exercises that check the


traditional trade transmission mechanism are using disaggregated data on tariffs, prices, earnings, employment and skill intensity. It was performed found that: i) employment shifted from skilled to unskilled intensive sectors, and each sector increased its relative share of skilled labour; ii) relative prices fell in skill-intensive sectors; iii) tariff changes across sectors were not related to skill intensities, but the pass-through from tariffs to prices was larger in skill-intensive sectors; iv) the decline in skilled earnings differentials mandated by the price variation predicted by trade was even larger than the observed one.

Jens Sudekum (2008)\textsuperscript{101} concluded that there is a considerable variation in the skill composition of employment across cities and regions. The way of skill compositions evolve over time sheds light on the strength of concentration forces for high-skilled workers, such as localized increasing returns to human capital. The study reports, robust evidence that regions with a large initial share of high-skilled workers had higher total training development and employment growth in Asian country (1977–2002), but lower growth of high-skilled jobs. There has been a convergence of local skill compositions over time, on average and even within particular industries.

Davide Antonioli et al., (2011)\textsuperscript{102} has concluded that the shifting of labour demand toward relatively more skilled workers has been a hot issue in the economic field for many years. A consolidated explanation for the upskilling phenomenon is that technological–organizational changes have driven the labour demand with detrimental consequences for less skilled workers. In order to upgrade the skill workforce the firm has at least two main channels at its disposal: the


external labour market strategy, mainly based on hiring and firing mechanisms; the internal labour market strategies, which improve the skill base of the employees through training activities.

**Rawat (2011)**\(^{103}\) the textile and clothing industry will not be able to upgrade technologically quickly and will find difficult to survive in export and domestic markets unless a massive mass skill development programme is launched to bridge the gap of managerial and technical cadre of professions for the fibre to fashion chain of textile, apparel and retail industries. The current workforce in Indian textile and clothing industry is about 35 million and it will increase to 47 million by 2015 including 5 million skilled workers and 2 million technical and other personnel, if the growth projections are to be met.

**Ousama Ben Salha (2013)**\(^{104}\) has assessed the effects of economic globalization on the level and volatility of labour demand for different skill groups in Tunisia. Using a panel dataset covering textile manufacturing industries between 1983 and 2009, three main findings are reported. First, exports and imports exert a positive impact only on the semi-skilled and skilled labour demand while foreign direct investment flows increase the demand for semi-skilled and unskilled workers. Second, the regional analysis suggests that exports to the European Union boost the demand for the semi-skilled and skilled labour.

**Raikumar (2014)**\(^{105}\) has discussed about the Coimbatore textile industry. Coimbatore district is known as the textile hub of the state, faces acute shortage in


skilled employees today. The city has more than 9 institutions offering technical training in textile engineering, but still now the industry difficult to get skilled employees. The city has an install capacity of 7 million a spindles compare to Maharashtra and Gujarat, the textile profession is losing its popularity. In the last ten years, the textile education has come down drastically, the industry has grown significantly during the same period. Thus, there is severe shortage of skilled labourers in Coimbatore.

2.28 CONCLUSION AND RESEARCH GAP

The above reviews aids to find out the research gap. The textile industry is one of the booming industry in India. It directly contributes to the economic growth of our nation. The usage of advanced technologies and skilled labour is the major reason for the growth of this sector in the world. At present, the textile industry is facing lot of problems like power shortage, labour shortage, pollution problems and etc. Textile industry is labour intensive industry. Most of the researchers have concentrated studies about the role played by technology in enhancing labourers performance. Today, the textile industry is facing shortage of skilled labourers, because of adaptation of new technologies. The labourers are not having adequate skills to work with the automated technology. And thus textile sector need to focus on training programmes to suit the technological developments. The previous studies have not focussed on the skill development of textile labourers due to automation particularly in textile units of Coimbatore region. From the above reviews, the researcher found the researcher gap to study “Technology automation and labour skill developments in textile industry”.

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FIGURE NO: 2.2
MODEL FOR TECHNOLOGY AUTOMATION AND LABOUR SKILL DEVELOPMENT

- Impact of Technology automation
  - Positive Effects for Textile Units
  - Positive Effects for Labourers
  - Need for Advanced Training
  - Economic Development of the Nation
- Cost Reduction
- Increased Quality and Productivity
- Wastage Reduction
- High Growth of the Industry
- Reduced Workload
- Improvement in Labour Performance
- Increased Skill & Knowledge
  - Economic Development of the Nation