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AUTOMATION AND ITS IMPACT ON EMPLOYMENT IN THE APPAREL SECTOR OF SOUTH ASIA

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ABSTRACT

Kavindya Sulakshini: Automation and its impact on employment in the apparel sector of South Asia
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South Asia has become world´s one of the emerging markets for apparel because of their cheap labor and raw materials. Therefore, South Asia is one of the potential global apparel manufacturing and exporting centers. Since the apparel industry is highly labor-intensive, this industry provides millions of job opportunities for people who live in countries such as India, Bangladesh, Pakistan, and Sri Lanka. The recent innovations in the apparel industry, such as automating production processes, sewbots, and introducing new machines, have increased the risk of technology-induced job displacement in this region. Therefore, this paper aims to evaluate the threat of automation to employment, focusing on the South Asian apparel industry.

This study uses a qualitative approach complemented by secondary qualitative data. Based on the economic theories and secondary data, this research finds that automation technology in the apparel industry has not led to the significant displacement of jobs in this region. However, the employees who obtained low–skilled employment, such as cutting and sewing machine operating, risk losing their jobs in the industry. The employees who perform jobs that require cognitive skills, such as managerial jobs and executive jobs, are difficult to substitute with technology.

Moreover, technology in this industry is complementary to increasing labor productivity, and it supports increasing the demand for apparel products and improving exporting opportunities. At the same time, it also enables the creation of new job opportunities in this sector by expanding, demanding products, and exporting them. However, the lack of economic feasibility to invest in implementing technology in the industry makes this region quite far behind the other developed countries globally.

Keywords: Automation, Technological Unemployment, Apparel Industry, South Asia

PREFACE

I am very grateful for the encouragement and support of many individuals before and during my study, which enabled me to attempt and subsequently complete this challenging task. However, there are a few in particular whom I would like to name as a gesture of my heartfelt gratitude and appreciation.

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I dedicate this research to my parents Wasantha and Deepa, and my beloved husband, Gehan, who always supports and encourages me to accomplish more in my life. I thank my loving sister Malindi who is always there by my side whenever I need her. Finally, I would like to thank all of my friends in Sri Lanka and Finland, who supported me throughout this academic journey.

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Kavindya Sulakshini

CONTENTS

1. INTRODUCTION

In the past few decades, the apparel industry has significantly changed to new technologies. As a result, many developed countries, including Europe, China, and the United States, have changed their traditional apparel manufacturing systems to modern manufacturing systems. Since these countries have financial capabilities and required knowledge and political support to change their production processes to a modern technology-based production process, they have become more successful in the industry.

However, the apparel industry is mainly based in developing countries because these countries have the comparative advantage of producing apparel for the world market. The reason is that developing countries own labor-intensive economies with low labor costs and low material costs. Therefore, well-known apparels brand names are outsourced and reshore their production process from developing countries.

Apparel is the largest labor-intensive manufacturing industry in the South Asian region. India, Bangladesh, Pakistan, and Sri Lanka are the leading apparel exporters in South Asia. This industry already shares apparel workers in a total of 4.3% and includes the highest number of apparel employees worldwide. However, this region has a growing fear regarding displacement and increasing apparel industry unemployment due to automation technology.

Since the apparel industry is highly labor-intensive in this region, manufacturing employees predict that they will be losing their jobs soon. On the other hand, this region lacks empirical studies regarding this scenario. Therefore, this thesis aims to evaluate the current and future impacts of automation on the employment of the apparel industry, using industry base evidence from the abovementioned four countries in South Asia.

In this study, I evaluate how automation has impacted employment opportunities in the apparel industry and how it affects to wage distribution of the employees.

By critically evaluating existing literature, theories, and related evidence regarding the topic, I will forecast/ predict the impact of automation on employment in the apparel industry in the South Asian region.

1.1 Research Objectives and Research Questions

Due to these new technological changes in the apparel industry, labor-intensive countries in the South Asian region risk losing their labor-intensive jobs. However, seeing many recent studies relevant to technological unemployment, the South Asian apparel industry lacks relevant empirical studies. Therefore, this study aims to understand the technological unemployment of the apparel industry with special reference to the South Asian region. In order to achieve this aim, the study has been divided into smaller, more concrete objectives, which are:

Understand and analyze the labor market changes in the South Asian region with special reference to the apparel Industry.

These objectives lead to the study´s research questions, which are as follows:

RQ1: Which job skill level will remove from the job market? High skill level or low skill level?

RQ 2: What happens to the labor supply and demand of the job market?

1.2 Research Methodology

The purpose of the research is to analyze automation and its impact on employment in the apparel industry of South Asia. To analyze this, the first method I use in this research is to describe the research's background and then discuss the existing literature relating to the topic. Then in chapter four, I use existing economic theory to discuss the topic further. I extended an economic model with related theories and knowledge, which helped analyze the topic further. Then I use empirical data to check the discussed model. The data collection process is based on secondary resources. Annual reports, policy reports, and journal papers were helpful for me in collecting the secondary data for the thesis. Chapter six in the research discusses the research findings with relevant theories and empirical data.

1.3 Structure of the study

This study includes seven chapters. The flow of the relevancy of chapters introduces in the following description.

- *Chapter one:* Chapter one is the introduction to the research. This chapter contains the research background, objectives, research questions, and the research gap.
- *Chapter two:* This chapter explores the background information regarding the selected topic.
- *Chapter three:* Chapter three presents the theoretical background of the research. Further, this section describes the previous studies relating to the topic and related theoretical literature for the research.
- *Chapter four:* Chapter four presents the research methodology and develops further economic models that can be used to analyze the selected topic.
- *Chapter five:* This chapter shows the empirical data relating to the topic.
- *Chapter six:* Discusses relevant models and empirical data while aligning them with the theoretical background explained in chapter four. Moreover, this chapter includes further recommendations for the industry.
- *Chapter seven:* This is the last chapter of the thesis. This chapter includes the conclusion and limitations of the research. Moreover, the limitation section includes further research topics for students who are willing to explore further in this topic.

2. RESEARCH BACKGROUND

2.1 Technology and Technological Unemployment

All the past and present technology has been developed by people's creativity, ability, and imagination. They used their creativity and imagination skills to find a new solution for an existing problem in the world. Today, technology is developing in a very fast phase. Developed countries have already succeeded in adapting to the global technological changes, yet other developing countries struggle to adapt to some technological changes. Even though some countries struggle to adapt to technical changes, all countries accept that technological progress has been the key driver of economic progress. Therefore, all the countries in the world somehow try to adapt to the technology and technological progress in the world.

Over the years, technology has supported the development and enhanced human productivity, and increased people's living standards. Since the great industrial revolution, technological advancement has significantly affected people's employment changes. However, this affected the reduction of the workplace demand for labor. Therefore, since the Great Industrial Revolution, people have feared technological unemployment. The current changes in the technological world (Information and communication–based technological progress) also instilled the fear of mass unemployment. After all, many industries have predicted that they will substitute technology for most labor activities and reduce labor consumption in the future. After all, with all the past experiences of three major industrial revolutions, the world will also endure the mass unemployment of labor in various economic sectors of the world (Pankaj and Nisha, 2019, p. 5).

Unemployment is an economic phenomenon discussed by both economists and sociologists. Many economists and sociologists have defined unemployment using various aspects. Economists distinguish unemployment between frictional unemployment, structural unemployment, and cyclical unemployment. According to Riccardo Campa (2018, p. 58), frictional unemployment happens due to individual mobility of workers between jobs, and structural unemployment results from the decline of particular sectors or occupations. Besides, cyclical unemployment happens due to general but temporary falls in economic activities.

Moreover, another one can add to this. It is technological unemployment. According to the Oxford Dictionary of Economics, technological unemployment happens due to technical progress. Moreover, the dictionary defines technological unemployment as "particular types of workers whose skills are made redundant because of changes in the production method, usually by substituting machines for their services" (Black John, Hashimzade Nigar, 2013, p. 405). However, technological unemployment happens at different levels of society. At the individual level, the employee can lose their job because the employer purchases a new machine or technology to help the job done by the employee previously. Likewise, in the various layers of society, such as at the company level, country level, and global economic level, employers can substitute their laborers with new machines and technologies (Campa, 2018, p. 58).

2.2 Technical progress and innovation through history

Previous waves of automation and technological developments significantly impacted present society and the economy. In the past centuries, societies and economies worldwide transformed from agriculture to manufacturing jobs and service sectors. The impact of this previous technological Development has raised two important facts to consider in the future. The first fact is the massive displacement of employees in some sectors. The second factor is that policymakers have to take action to handle the situation proactively. For instance, if there is massive unemployment among factory workers due to technology, policymakers should have some policies to support them in adapting to the situation or train them to find a new job in another sector. (Servoz, n.d., p. 11).

2.2.1 Beginning of the industrial revolution

During the late 18th and 19th centuries, there were considerable changes in the economy and society. These changes shape the living standard of people and support people to move from human and animal labor to technology and machinery. Moreover, this transition enhanced the efficiency of people and made people come from their villages to industrial cities where they could find a job in a factory. This scenario is a vast process, and history calls this as Industrial Revolution (Industrial revolution 1.0). During the industrial revolution period, many innovations were coming into the world. The invention of a steam engine by an English

blacksmith, Thomas Newcomen (1664 – 1729), harnessed the massive amount of coal-powered energy very economically. Moreover, this invention made a path for other enormous inventions and revolutions in different fields such as textile, mines, railroads, steel production, and many other industries. However, various industries have been developed during the period of the industrial revolution (Mohajan, Kumar, 2019, p. 377).

The first industrial revolution, which started in Great Britain, impacted the textile industry. Between 1770 and 1870 cotton industry was prevalent in England, and by 1990 they produced 40% of the entire world's output of cotton. Some materials from the textile industry, such as silk, wool, and linen, were imported from colonized countries in the Indian ocean. John Kay (1792 – 1865), a Scottish inventor, invented and developed the flying shuttle, the new waving machine. These new inventions sped up yarn threads back and forth when the weaver pulled a handle on the loom. This machine had four spinners to keep up one cotton loom and ten people to prepare the yarn for one weaver machine.

James Hargreaves was a weaver, carpenter, and inventor who lived between 1720 – 1778. He got the patent for spinning jenny in 1770. It supported running eight spindles instead of one by a single worker. Moreover, Sir Richard Arkwright invented a water frame in 1769, which supported waterpower from rapid streams to drive spinning wheels. The importance of this machine was that it helped to increase the industry's productivity by strengthening the threads used in the textile industry. Later in 1779, Samuel Crompton combined both feathers of a spinning jenny and a water frame to produce the spinning mule that made thread stronger and more consistent. The innovations in the textile industry led to increased employment opportunities in this industry. In 1820, there were 12 150 power looms in England and, year by year, popular in the textile industry. In the mid-18th century, about 800 000 people got opportunities to work in the wool industry. Leeds and Manchester in England dominated the cotton industry globally by making England the leading cotton producer globally (Mohajan, Kumar, 2019, p. 379).

These new inventions made an enormous impact on societies' economic and social development. The industrial revolution enhances the possibilities of getting jobs in factories and moving from villages to cities. Women and children also

started to work in factories, which supported increased employment opportunities for them. Moreover, the development of the textile industry played a significant role in the industrial evaluation of technical progress in Great Britain. Between 1770 and 1870 cotton industry was very popular in England, and by 1990 they produced 40% of the entire world's output cotton. Some materials from the textile industry, such as silk, wool, and linen, were imported from colonized countries in the Indian ocean. John Kay (1792 – 1865), a Scottish inventor, invented and developed the flying shuttle, the new weaving machine, to help improve the productivity of the waving industry. These new inventions sped up yarn threads back and forth when the weaver pulled a handle on the loom. This machine had four spinners of the spinning jenny and a water frame to produce the spinning mule, making a thread stronger and more consistent.

These new inventions throughout the industrial revolutions supported to development of many industries in the world. Further, there were many technological changes at that time. However, sometimes, technological changes and the living standard of people made quite controversial during these periods. There were some problems with employees' working hours, wages, and unemployment. Moreover, some factory owners hired women and children for low pay and badly punished them. The formation of trade unions was prohibited until 1825. Therefore, employees lost ways to fight for their employee rights. However, the industrial revolution worked another way for the production of goods. It increased the production and living standards of the middle class and upper-class people.

Moreover, this provided a sound education system, good housing facilities, advanced health facilities, and mass apparel production. Most importantly, this helped women find employment opportunities outside their homes and villages. Even though the Industrial Revolution negatively impacted employees, it helped change many human development aspects. Further, at the end of the first Industrial Development, it created a new era in human history.

The second part of the industrial revolution (Industrial revolution 2.0) began around the 1923 s, spreading throughout the whole European continent. This started from Henry Ford's assembly line paradigm, which changed the history of the manufacturing process. Moreover, this supported the production of less expensive cars. The third industrial revolution (Industrial revolution 3.0) started with

computer technology evaluation. This technology supported increasing people's digital awareness and human power. The third industrial revolution introduced the first programmable logic controller. Moreover, it introduced electronics and IT for higher production automation, and it significantly helped increase production through computer systems (Teker and Koc, 2019, p. 305).

The fourth industrial revolution started in 2014, and now it is speedily emerging in many industries such as transportation, healthcare, textile, and manufacturing. Klaus Schwab introduced the word "fourth industrial revolution," the founder and executive chairman of the World Economic Forum(Xu *et al.*, 2018, p. 90). As Klaus Schwab mentioned, the fourth industrial revolution will build the widespread availability of digital technologies mainly driven by the convergence of digital, biological, and physical innovations. However, the fourth industrial revolution will affect the industries and job market differently. The basic approach of the fourth industrial revolution is to maximize computerization in manufacturing industries by using technological equipment and lessen the human labor in these industries. Further, according to Teker and Koc (2019), there are five primary goals for this period,

- The reduction in the number of human laborers in the production, thus human mistake rate diminishes automatically at the same parallel.
- To obtain maximum flexibility in the production line to produce exceptional products when requested by the customer.
- Accelerated the production process.
- Increase communication channels between producers and customers.
- To create tracking capability on the waiting period of the order process.

The manufacturing industries significantly change the production structure and job structure due to the fourth industrial revolution. The above points depict that influence of the fourth industrial revolution will change the entire manufacturing process of computing industries, mobile computing industries, machine to machine, optical technologies, nanotechnology, etc. However, history has proved that previous industrial revolutions have gained new world capabilities. Therefore,

this ongoing process of the fourth industrial revolution will also change the people's production standards and living standards.

2.3 Apparel Industry

2.3.1 How technology is changing the apparel industry

The apparel and textile industry is considered one of the oldest and fast-moving industries globally. Most the countries in the world, including Europe and developing countries, use the apparel and textile industry as one of the key driving factors in the economic development of their countries. However, most developed countries outsource their manufacturing process from developing countries like India, Bangladesh, and Cambodia due to their lower labor costs. Since the apparel industry is a highly labor-intensive industry, most developed countries are changing from labor to automation to reduce their cost of manufacturing. However, less developed countries are not yet entirely ready to adopt automation technologies for their apparel manufacturing process.

According to reliable statistics regarding the apparel industry, it employs more than 300 million people worldwide. Moreover, the apparel industry has invested 1.3 trillion dollars in this business. Along with these mass labor forces and investments, the apparel industry operates in a highly competitive and dynamic market environment (Gazzola *et al.*, 2020, p. 1). One of the changes apparel industries faced in the last few years is the automation of their manufacturing process and other production functions. This technological progress in the industry has been the key driver of many countries' economic progress, including less developed countries in the world. However, technological progress in the apparel industry, including digitalization and automation, has increased the fear of mass unemployment in this sector**.** Moreover, scholars argue that soon employers will be able to substitute their labor tasks with machine tasks. Therefore, there will be mass unemployment in many industries, including the apparel Industry (Pankaj and Nisha, 2019, p. 1).

Since the 18th century, the world has witnessed three industrial revolutions. Nevertheless, none of these industrial revolutions has affected the structural unemployment in the world. Instead, these three industrial revolutions have eliminated

a few traditional jobs in many industries and enhanced the labor demand in specific jobs dealing with new technologies. This fact can relate to the apparel industry as well. In this industry, 80 percent of jobs are highly routinized. Therefore, this industry can easily be automated. Recent innovations such as using robots and Computer Numeric Controls have entered the apparel industry, and these innovations have increased the potential to automate the manufacturing processes in this industry. For instance, Tianyuan garments in China already invested US$ 20 Million to build a fully automated garment manufacturing facility in Arkansas. They hope to reduce 33 cents of unit labor cost with this technology by producing a T-shirt for the USA market. Other than that, few garment factories already use "sewbots" for their sewing processes. However, if these experiments become successful soon, many jobs in the apparel industry will be reduced or substituted by new technologies (Pankaj and Nisha, 2019, p. 2).

Much of the discussions regarding technological progress and unemployment are focused on the world's less developed countries. Most developing countries have low labor costs and product costs. Therefore, due to the competitive advantage based on lower labor costs and product costs, developed countries tend to work with less developed countries, especially in the apparel sector. These developing countries have a higher share of routine-based jobs than developed countries. As a result, many garment factories in these countries tend to work with sewbots and automated machines. Therefore, within the next few years, less developed countries will also shift into automated manufacturing processes, which may affect many changes in the labor market of these countries(Kucera and Mattos, de, 2020, p. 101).

2.4 Apparel Trade in South Asia

The South Asian apparel industry is highly labor-intensive, allowing more women to enter the workforce. India, Bangladesh, Pakistan, Sri Lanka, Afghanistan, Bhutan, Maldives, and Nepal include the South Asian region, and some of these countries provide more facilities for reshoring garment products. However, India, Bangladesh, Pakistan, and Sri Lanka are the biggest apparel producers and exporters in this region. According to the available statistics, apparel represents

83% of Bangladesh exports, 45% % of Sri Lankan exports, 19% of Pakistani exports, and 5% of Indian exports (Lopez-Acevedo and Robertson, 2016a, p. 2). The apparel sector in this continent facilitates more people to find a living especially unskilled women from low educational backgrounds can join this sector to find a living.

However, this industry dominates these countries' exports, while laborers face some challenges inside the industry. One of the main challenges this industry face is technological changes that happen in the manufacturing process. As mentioned in the above section, due to these technological changes, many routinizations' jobs will be disappeared or substitute soon. As a result, many employees in this sector will be unemployed or have to enhance their skills in a specific field with a higher demand for labor. Despite these obstacles and arguments regarding the technology, South Asia already has implemented these changes in its business. For instance, Pacific Jeans of Bangladesh and MAS Holdings of Sri Lanka developed their new products with the partnership of the United States, the Europe Union, and Japan. These partnerships offered them to develop new technologies and methodologies in these organizations, making them innovative and productive.

The simple meaning of the word "technology" is machines and manufacturing devices used in production and manufacturing(Islam., 2017, p. 4). Compared to the European Union and other developed countries globally, South Asia is still far behind in the technological field. However, the apparel industry is making some progressive changes to make the manufacturing lines less labor consumed and more productive. For instance, India, Sri Lanka, Bangladesh, and Pakistan are now using new advanced machines and computer-aided productions for their manufacturing process. In the 1990s, computer technologies in the apparel sector used computer-based CAD and CAM facilities to speed up manufacturing functions such as grading, making, and cutting patterns and fabrics. Further, this technology supported integrating with other processes in the industry, such as accounting, payroll, and management information systems. Implementing this technology with other sections of the production process enhanced the job security, job satisfaction, and work-life balance of the employees in the apparel sector (Islam., 2017, p. 4).

2.5 Automation in the Apparel industry

Considering the new changes in the apparel industry, the cutting part is one of the most critical parts of this production process. However, the cutting operations are fully automated using Knife systems, lasers and water, and plasma jets. Moreover, the laser technology process is mainly used for the apparel industry's fault detection process. In addition, automation of manufacturing processes such as spinning, weaving, garments, and dyeing have made more efficient and significant changes in the apparel industry.

Spinning is the most critical manufacturing process, including other sub-processes such as picking and ginning. Before the automation of the manufacturing process, these sub-processes were entirely done manually, and it demanded a higher amount of labor power and cost. After introducing the High-Volume Instrument (HVI), cotton fiber tests can be done within a few seconds, which took many hours before. To ease the yarn's quality development process, automation has been introduced, and it helped to increase the production of yarn and get the uniform yarn quality. Moreover, automation has supported separating the contamination of any color, size, and nature of the fiber. Transport automation has been done using robots, and it helped to carry out heavy tasks and packages that employees previously did in the factory (Agrawal and Choubey, S, 2016, p. 31).

During the last three decades, the weaving section has improved by using technology and automation for its process. The significant development regarding this process is using automatic shuttle and shuttles loom to produce fault-free cloth more efficiently and elegantly. This development has been done according to three basic picking principles, i.e., rapier, projectile, air-jet, and water–jet. Further, microprocessors have come to the industry, and they support monitoring, controlling, and regulating the critical aspects of the weaving machines. In addition to the aforementioned tasks, the dyeing process also uses automation for its processes. The dyeing process includes many tasks such as desizing, scouring, bleaching, printing, and finishing, which were manually done before. However, after automation invades the apparel industry, these tasks can be quickly and precisely controlled by using robots. Moreover, robots help pick and transport yarn bobbins and carry them to the dyeing machines. Apart from the processes above, automation supports handling devices with artificial intelligence, intelligent

transportation system, manufacturability prediction, virtual Tryon and 3D garment design, etc. (Agrawal and Choubey, S, 2016, p. 31).

Automation brings many advantages to the apparel industry while reducing the demand for labor. Even though automation reduces the labor tasks in the production process, it supports enhancing productivity in the apparel sector. However, reducing human resources in this sector is cost-saving, leading to massive unemployment. Since the apparel industry in South Asia is labor-intensive, automation will threaten employment in this sector.

2.6 Impact of Technology change on Apparel Employees

Automation is a collection of software or hardware that can complete tasks without human interaction. Although, automation led to decreased human labor in the production process and positively impacted the production process, such as increasing organization productivity and decreasing labor costs. However, these technologies have threatened to displace many traditional jobs in the manufacturing sector. Therefore, this will threaten traditional labor jobs in South Asia's apparel industry.

In addition to the apparel industry, many other prominent organizations, such as Toyota and Tesla, already use automation for their assembly–line work instead of human labor. Moreover, some cutting-edge organizations have even used "light–out" factories because it is unnecessary to use lights and heating facilities without any human worker on the factory floor. Similarly, in Cambodia, where the apparel industry dominates the manufacturing sector, the country has faced nearly half a million job losses due to the technology and automation of sewing machine operators. Apart from the apparel industry, 27%, 30% of employees who work in food and beverage products in Thailand and Indonesia risk displacing their jobs due to automation. All of these employees were from rural areas, and they have average skills in education and more limited skills in other areas such as technology. Therefore, most employees in developing countries are from rural areas, and they risk losing their jobs due to technological changes in their workplaces (The Asia Foundation, 2020, p. 11).

Technology upgrading in developing countries such as India, Pakistan, Sri Lanka, and Bangladesh are potentially subject to severe changes in their economy and

employment structures. These changes will bring positive impacts on these economies and negative impacts. If we discuss the positive changes, these computerized technologies and automation have changed the manufacturing systems of these countries towards capital–intensive technology. Moreover, to complete their higher demand for products from international markets, this technology modifies current manufacturing processes concerned with cutting, material handling, fusing, sewing, pressing, and finishing. This helps reduce the labor task in these processes and speed up their manufacturing process, making them fulfill their customer demand within a given time frame. Moreover, technology enhances reliability, adaptability, divisibility, speed of operation, and low production process energy consumption (Islam., 2017, p. 4).

However, technology changes the employment structure of these countries as well. Due to the changes in the manufacturing process, labor-intensive jobs have become riskier and more insecure. Job insecurity makes employees dissatisfied with their jobs and stresses their future career opportunities. The south Asian apparel industry consists more of female employees. Therefore, females have a higher risk regarding their job than male employees. However, automation does not affect all the jobs available in the apparel sector. According to Fernando *et al.* (2020), work is generally classified as cognitive (tasks that require more knowledge and skills) or manual (tasks that require more physical skills) and further divided into routine and non–routine work. Their jobs can be categorized according to cognitive and manual tasks in the apparel industry.

Work classification	By task	Type of work - General	Type of work – Apparel
Cognitive	Routine	Measuring, Controlling, Quality assurance	Cutting machine operations; Quality control; Merchandising and purchasing
	Non – Routine	Engineering, Advising, Research, Information gathering, supervising, Teaching	Supply chain managers; Designers; Marketing and brand managers; Pattern Makers

Manual	Routine	Assembling, Driving, Fabrication, Warehousing, Shipping, Maintenance	Sewing machine operators; Garment pressers; Marker makers
	Non - Routine	Guarding, Serving, Repairing, Care work	Line leaders; Tailors; Custom sewers

Table 1. *Classification of type of work (Fernando et al., 2020, p. 13).*

Automation and technology will significantly impact routine and manual tasks performed in the apparel sector. In this sector, employees who work in non–technical repetitive tasks that use simple task-specific machines are at risk of being substituted by automation. Next, automation will replace employees who have manual and routine tasks requiring specific training and technical skills. However, the situation will change if labor-intensive tasks are cheaper than capital-intensive ones. In this situation, automation will be less attractive than labor-intensive tasks. For example, Japan has heavily automated factories and advanced technologies to produce garments, but they outsource human labor from South Asian countries such as India and Bangladesh because labor is relatively cheaper than capital (Fernando *et al.*, 2020, p. 13).

However, the increasing demand for automation and technology in the apparel sector does not mean that all employees in the manufacturing section will lose their jobs in the future. Even if all the departments in the factory are automated in the future, there will be jobs that require human labor. For example, design, monitoring, and quality evaluations still need human labor to perform their tasks. Therefore, repetitive, unskilled, purely physical manufacturing and routine tasks have a higher risk of automating. However, even though these tasks are fully automated, new opportunities will open up for people who require higher cognitive skills to perform the job. (The Asia Foundation, 2020, p. 12).

Automation is widening the wage gap between technical and manual workers. According to Lan (2020), when the apparel sector moved from industry 2.0 to 3.0, manual employees did not experience a pay cut. However, newly recruited employees to perform newly added technological tasks had higher payments than other employees in the sector. Technology in the industry changes the demand

for new skills, knowledge, and abilities to perform work. Therefore, industries require different workers with different abilities for their organizations. This works the same for the apparel industry as well. However, lower-skill people cannot adapt to the newer skills quickly. Therefore, they have to make two choices: either adapt to the new technology with new skills or leave the industry. The skills and knowledge gap between employees in the organization always widen the wage gap between employees. Therefore, if employees need to retain in the industry, they have to upgrade their skills, knowledge, and abilities according to their requirements (Islam., 2017, p. 6).

Technological changes have a more significant impact on South Asian apparel industry women. Apparel work is highly female intensive in this region, and women in this industry share many employment opportunities for them in this region. Moreover, female employees in this industry share a higher percentage of the national workforce in the region (Lopez-Acevedo and Robertson, 2016a, p. 2). However, women in developing countries face numerous challenges due to social and economic constraints. Low-skilled women in these industries have less education and less training than in other industries. Therefore, female employees cannot quickly absorb the technological changes.

People concerning that automation will cause to displace their jobs in the future. However, this issue matters to the South Asian region because it highly depends on the apparel industry to increase its employment opportunities and export income. Therefore, this is a sensitive situation for all four countries (India, Pakistan, Bangladesh, and Sri Lanka) to handle in the near future

3. LITERATURE REVIEW

This chapter will focus on the literature regarding technological unemployment in the apparel industry and the theoretical background for labor demand-supply and wage distribution. This includes relevant literature on the selected topic without regional barriers but mainly focused on the available literature for the Apparel industry in the South Asian region.

3.1 Technological Unemployment?

"Men have become the tools of their tools" – Henry David Thoreau (1854)

According to (Hillier and Hanson (2018), "unemployment is a common and complex phenomenon studied by sociologists and economists. Therefore, economists divide unemployment into frictional, structural, and cyclical unemployment". Frictional unemployment relates to the individual mobility of workers between jobs, and structural unemployment happens to result from the decline of a sector or occupation. Then cyclical unemployment occurs due to temporal falls in economic activity. Further, technological unemployment also could be added to this list. Considering the definition regarding technological unemployment, the Oxford Dictionary of Economics defines technological unemployment as follows,

"Technological unemployment is unemployment due to technical progress. This applies to workers whose skills are made redundant because of changes in production methods, usually by substituting machines for their services. Technical progress does not necessarily lead to a rise in overall unemployment (Hillier and Hanson, 2018, p. 58)".

The above definition indicates that technological changes do not necessarily result in reduced job opportunities in the job market. However, some economists predict that the transition from human labor to technologies may affect the job market's flow.

Accelerating technological unemployment will be one of the world's crucial issues in the next few years. The 2015 world summit on "technological unemployment" held in New York discussed the consequences of technological unemployment.

At this world summit, some speakers highlighted the labor market issues, worldwide unemployment, and economic structure. The keynote speakers include Noble Prize-winning economist Joe Stiglitz, World Technology Network founder Jim Clark, humanoid roboticist David Hanson, *etc.* According to the world summit,

“Accelerating technological unemployment will likely be one of the most challenging societal issues in the twenty-first century. Never in history are so many industries being simultaneously upended by new technologies. Though `creative destruction, in which lost jobs are replaced with new ones, will be a factor, our newest technologies have the clear potential to eliminate many more jobs than we create (Peters, 2017, p. 1)”.

This statement regarding technological unemployment highlights that even technologies reduce human participation in the job market to increase productivity through technology, negatively affecting potential candidates' employment opportunities. Moreover, similar confusion and emotive exist regarding automation in the job market. However, this confusion is not a newly arises issue. From the beginning of the economic profession, scholars discussed the transformations in the labor market. Further, in 1821, in his last edition of "The principles of Political Economy and Taxation," reputed economist Ricardo added a new chapter entitled "On machinery." This chapter analyzed the impacts on the economy after introducing machinery to the employment market. With regards to wage – earners, Ricardo clears his thinking is as follows:

"I am convinced that the opinion entertained by the laboring class, that employment of machinery is frequently detrimental to their interests, is not founded on prejudice and error, but is conformable to correct principles of political economy."(Pol and Reveley, 2017, p. 172).”

After two centuries of the above words, the machinery questions are back on the agenda. However, there is a specific definition of technological unemployment in the literature. Therefore, Danaher (2017) indicated two types of version in technological unemployment: short and long–term technological unemployment. This concept is very contested because it is explicit that new technologies displace workers faster than the economy can find jobs for them. The economist John

Meynard Keynes, with evidence of his works clear idea of technological unemployment as follows:

"We are being affected with a new disease of which some readers may not have yet heard the name, but of which they will hear a great deal in the years to come – namely, technological unemployment. This means unemployment due to our discovery of means of economizing labor use outrunning the pace at which we can find new uses for labor".

According to Keynes, technological unemployment uses technology more than human labor in work. Moreover, this means that using machines in the workplace will be higher in the future, and human power in the workplace will be less relative to the machines. However, does that mean technologies will ever reduce jobs in the market? (Pol and Reveley, 2017, p. 172).

Madhavan. *et al.* (2018) indicate that from the 19th century, after introducing the first machines into the world, turnover of excess employees is a common practice. The introduction of the power loom in the United Kingdom during the Industrial Revolution led to competition between skilled weavers and machines that could weave better and faster. This caused the wage reduction of employees in the weaving industry and the displacement of unskilled employees. Due to these reasons, desperate weavers started campaigning against their owners. These fighters who objected to the increased use of mechanized looms and knitting frames are called Luddites in history. However, owners' reactions to this situation were harsh. Owners hanged these seventeenth Luddites, and many other employees were imprisoned. However, after this harsh reaction from factory owners, the movement was quickly dispelled.

According to McClure (2017), after the Luddite rebellion in England, the great depression started, and during this period, John Maynard Keynes first introduced the term "technological unemployment." Then, economists were thinking about technological unemployment and were concerned about the relationship between employment and technological advancements. Since then, technological unemployment has been happening in various industries, and it has caused a change in the economic and social patterns of many countries. However, in labor-intensive economies called the global south, such as South Asia, South Africa would

make considerable differences in their countries due to automation and technology. These emerging technologies would make gaps between skilled and unskilled labor in these countries. Therefore, this is a very time-sensitive problem for developing countries, and they should take careful reactions to this timely problem (Madhavan *et al.*, 2018, p. 127).

3.2 Forecasting the future impact of automation on employment

As the apparel industry becomes increasingly globalized, Many developed countries that produce apparel have shifted to low-wage and labor-intensive Asian countries. Considering the lower manufacturing costs, labor costs, and considerable numbers of the labor force in these countries, developed countries tend to reshore their manufacturing processes to these countries.

According to Islam (2017), numerous changes happened in manufacturing processes in the South Asian Apparel industry due to automation. The traditional manufacturing processes have upgraded to a technology-based modern system, making the manufacturing process more productive and less labor-intensive. As a result of these changes, job structure**,** economic structure, and educational systems also have to face significant changes. Labour supply and demand process in these countries, wage structures, and the gap between skilled and unskilled labor jobs are visible, and these factors make changes in the social pattern of these countries.

In their paper, Pankaj and Nisha (2019) indicate that the advancement of automation and digital technology has caused the fear of mass unemployment among employees in the apparel industry. Further, the paper argues that if digital innovations and robotics continue at the current pace, industries will be able to substitute human labor for machines soon. However, this paper further indicates that, even though technology eliminates human labor at some point in the industry, it also supports creating new employment opportunities in the field while increasing demand for them. Adaption to new technology does not entirely reduce the jobs in the sector, but according to the past evidence of industrial revolutions, it creates winners and losers in the industry. That means there would be various structural changes in the labor market, but employees who successfully adapt to the changes will remain in the industry, and others will lose their position.

3.2.1 Job destruction and job creation

The main objective of automation and technology is to increase the productivity of the apparel sector. Moreover, this supports reducing the demand for human labor in the industry. As the (United Nations Department of Economic & Social Affairs, 2017)indicates, new technologies substitute workers in specific jobs, but that does not mean that technology would eliminate entire occupations. For instance, the bookkeeping job recently replaced computers with special software, but operating the computer still needs humans. Therefore, the organization still needs people with specialized skill sets to operate the special software for the job mentioned above.

Apart from the job destruction in various industries, automation and technology support create new employment opportunities in the industry. Therefore, job creation effects will counter job destruction at the workplace. The following table indicates the automation's job destruction and job creation process.

Job destruction	Job creation
Reduces labor required to perform tasks.	Automation complements specific job tasks.
Automation of tasks; some occupations eliminated.	Creation of new industries and products.
Technology alters the tasks an occupation requires.	An increase in productivity lowers costs and prices.
	Higher growth and income, thus boosting demand.

Table 2. Job destruction and creation (United Nations Department of Economic & Social Affairs, 2017, p. 18)

As mentioned in the above table job destruction and job creation process is almost similar to the process in the apparel industry. According to Lan (2020), industrial revolutions three and four create skill polarization between highly skilled employees and low-skilled employees in the industry. Most of the time, these low-skilled employees worked as manual workers, and until the third industrial revolution, they did not require specific skills to perform their jobs. However, once these production lines became automated, these manual workers also needed specific skills (to operate machines) to perform their job. These manual workers

do not require the specific knowledge to perform work with automation. Because most of the time, these people would be substitutes with automation and have to quit their jobs. Therefore, workers with no qualifications, no specific computer skills, no knowledge regarding the garment sector, and no capability to acquire new knowledge or skills related to control and managing automation chains will be at risk in the future.

Pankaj and Nisha (2019) explain that since the garment industry is highly routinization, it can displace many jobs in the future. This paper is based on the Indian garment industry, and further, this paper indicates that according to the secondary data in the Indian garment industry, 80 percent of garment sector jobs in the country are routine jobs. Therefore, 80 percent of jobs can be technically automated. However, as mentioned in the paper, due to the overall labor cost of the country, full automation of garment industry jobs is not feasible. Therefore, automation in India is restricted to a few garments, specific jobs, and selected production processes. Moreover, the paper argues that, despite labor-saving technology and reducing labor-related jobs, the country's apparel industry will introduce millions of additional jobs in the future because of the increase in domestic demand for apparel in the country.

Parschau and Hauge (2020), in their paper, present some recent figures regarding technological-related jobs. According to the Asian Development Bank, new technologies (not specifically automation technologies) positively impacted employment from 2005 – to 2015. Further, the paper mentioned that, between 2005 – 2015, there were 101 million jobs displaced, but 134 million jobs were created. Moreover, the authors argue that adaptation of AI-driven automation technologies in developing countries can increase the productivity of specific industries more than increase employment growth. When productivity increases, the employment opportunity increases; therefore, employees have more opportunities to find jobs in the labor market.

3.2.2 Impact of technological innovation on jobs and wages

Islam (2017), in his paper, indicates that new technology demands new skills, abilities, and higher workability for the manufacturing process in the apparel industry. Therefore, different skills demand different workers who possess these skills. However, lower-skilled workers cannot quickly adapt to the new technologies. Frequent failure of employee adaptability makes them uncertain and unsatisfied with their job. Therefore, they either have to learn and develop new skills required for the new jobs available in the job market or completely get away from the job market.

Bennett (2016), in his paper, explains skill-specific unemployment risk. According to the article, technological progress in organizations leads to changing the productivity levels of high-skilled and low-skilled labor. Moreover, according to the paper, technological progress led to a change in the employment structure within the specific organization. Moreover, the paper discusses that "if a certain threshold is reached, it becomes more beneficial for employers to create jobs targeted specifically at highly qualified workers: this also results in higher returns in education."

Thus, the manufacturing and non – manufacturing industries that work using computers have a higher demand for skilled labor. Moreover, these highly skilled laborers have competition with other high skilled laborers who work in similar industries, and therefore, they tend to increase their skills to work in companies that have positive wage effects for their skills. Further, this positive wage effect can increase productivity in organizations that employ highly skilled workers. However, some repetitive tasks done by white-collar employees can easily substitute by computerization and technologies. That means that while clerical and other middle-class jobs are displaced, managerial and professional jobs would be benefitted from technological advancement in the job market.

According to Lopez-Acevedo and Robertson (2016), the apparel industry is highly labor-intensive, and more female workers are employed in the industry than male employees. Especially in the South Asian region, most employees in this industry are women. Due to the social constraint**,** low education level, and lack of opportunities to develop their professional skills, these women face many disadvanta-

geous situations, even in society and the workplace. The following table represents the proportion of female workers among full-time production workers in South Asia.

Sri Lanka	Bangla-desh	India	Pakistan
31 %	21	11	1 %

Table 3. *The proportion of female workers among full-time production workers (Lopez-Acevedo and Robertson, 2016b, p. 19).*

The above table represents that the South Asian apparel industry employed many female employees in their factories, except for Pakistan. However, most of these employees do not have quality education or skills, leading to higher salaries in the labor market. Therefore, these women employees cannot command high prices for their work. Even though they gain a lower wage rate in the industry, these women are still ready to supply their labor bearing the lower cost. However, this leads to a surplus in the labor market, and this situation will be worse when these employees substitute with automation and technologies in the future.

According to Chuah *et al. (*2018), directly replacing labor with technology affects the employees' wages and income in any industry. However, even the technology negatively affects the wage and employment of employees, it has a positive impact on complementary tasks and the organization's productivity. For instance, 40 years ago, banks in the United States introduced teller machines, making the service more productive and information oriented. Introducing a teller machine to the customers reduced the queues at the banks. Moreover, people used to withdraw and deposit money by themselves. This helped reduce the workloads of the employers who work in the banks. Moreover, the productivity effect supports creating new opportunities and demand for other jobs such as programmers and data controllers.

Moreover, it creates a gap between employees who performed cognitive and non–cognitive tasks. People who work as technical employees would increase their demand in the future, and manual workers most probably substitute with technical workers. Because of this reason, the wage gap between manual workers and technical workers would be increased in the future. Other than that, peo-

ple with cognitive abilities would have more opportunities in the industry. Therefore, their jobs would be secure in the future, but people who do not have cognitive skills would have to stay long to find a job.

3.3 Skill Biased Technological Change

Technological unemployment has affected the productivity of employees in the labor market. The skill-biased technology implies that the development of technology and availability of the technology in the labor market increases the overall economic output. However, it decreases certain types of labor (depending on the skill level) in the labor market (Autor *et al.*, 2003, p. 31). Further, according to the SBTC literature, skilled workers are more likely to adapt to the changes happening in the labor market (technology-related changes) and are less likely to replace them with technology. On the other hand, low-skill workers are less likely to adapt to the technology changes and have fewer chances of adapting to the technology. Therefore, according to (Hemous and Olsen, 2013), this theory considers high-skill labor and capital as complementary but low–skilled labor and capital as substitutes. Due to that, low-skilled – labor become less competitive relative to the high–skilled labor in the labor market.

3.4 Routine / Task biased technical change (technical or technological?)

In their paper, Acemoglu and Autor (2011) imply the routineness of job tasks in the labor market. Further, Autor *et al.* (2003) explain that technologies are more likely to substitute with the limited, straightforward, and well–defined tasks, both cognitive and manual. Moreover, these tasks can complete while aligning to the explicit rules. Moreover, they explained that technology could complement the tasks requiring more creative skills. However, these tasks are challenging to do using technology relative to the price of labor.

David Autor and Daron Acemoglu propose a category for analyzing the routine biased technical change in the labor market. As they proposed, we can categorize occupations into five categories according to the nature of their occupations,

- Routine cognitive (e.g., Accounting
- Routine manual (e.g., Manufacturing)

- Non-routine cognitive analytical (e.g., Sales, Medical)
- Non-routine manual (e.g., Janitor services)
- Non-routine cognitive interpersonal (e.g., Managerial)

Further, this paper argues that routine tasks are easy to substitute with machine technology, saving more time and human labor in the labor market. In addition, technology enhances the comparative advantage of occupations that demand more creative and analytical skills to perform specific tasks. Further, the paper proposes that academics focus more on developing creative and analytical skills because these skills have more demand in the future job market (Acemoglu and Autor, 2011, p. 1077).

3.5 Previous studies

Parschau and Hauge (2020), in their paper, explain how automation is stealing manufacturing jobs in South Africa based on data from the apparel industry. The objective of that paper is to analyze the threat that will occur due to automation in the apparel industry and how it affects the employment opportunities in this industry. Since South Africa is among the few developing countries adopting automation technologies in the apparel industry, many scholars' debate that this region will suffer a massive job loss due to automation. The paper draws evidence from 26 interviews with factory managers from the apparel industry. Finally, the research found that the overall impact of automation in the apparel industry is very low and will continue to be very low in the future. Moreover, research proves that automation would impact firms' productivity and is directly related to increasing employment opportunities in the given industry.

In their paper, Pankaj and Nisha (2019) raised concerns about future job opportunities in the garment sector. Their paper highlighted the risk of adapting to "sewbots" and other automation manufacturing processes in the apparel industry and how it affects displacing human labor in this industry. This paper is only based on the Indian apparel industry, which has a huge internal demand for jobs in the apparel industry. The paper is based on secondary data and key informant interviews from the employees in the industry. However, the paper argues that though

automation technology would displace employees, it does not affect mass unemployment in the Indian apparel industry. The reason is that automation technology opens up new employees such as data analysts and virtual experience designers. Moreover, this paper represents that except few production processes in the Indian apparel industry, other production processes would have healthy employment growth while increasing their productivity in the industry.

Kucera and Mattos de (2020) discuss the impacts of automation and reshoring on developing countries' apparel and electronic industries. These two industries are highly labor-intensive industries in developing countries. The paper emphasizes that new automation technology may affect job losses in the apparel industry and impact the demand and wage of employees in this industry. Moreover, this paper highlights an example from Wall Street Journal published in 2018. According to the Wall Street Journal, one of the union leaders in Bangladesh has stated that factory owners in this country threatened their employees that they would be ready to replace their employees with automated technology if they would not agree to management's plan. After all, this scenario suggested the view of top management in developing countries regarding automated technologies. In such a scenario, even the employees ready to adapt to new technologies would have to face many consequences regarding employment laws and policies in the industry.

Lan (2020), in his discussion paper, indicates the survey results regarding automation and employment opportunities in the Vietnam apparel industry. Vietnam is a southeast Asian country that is just shifting into automation technology. According to the survey responses of the paper, employees in the Vietnam apparel industry risk losing their employees due to the automation technology in this industry. Among all employees in this industry, the riskiest employee category is manual workers because they cannot adapt to the changes in the industry. Finally, the author concludes their paper with a few recommendations for trade unions and employers in the industry and how government should secure employees' right to be employed in the upcoming digital era.

Fernando *et al.* (2020) conclude in their paper how automation impacts labor, particularly low–skilled workers working in the apparel industry in Sri Lanka. This study uses a qualitative approach, using secondary quantitative data. The main

finding of this paper is that automation does not lead the apparel industry to significant employee displacement in the low–skilled employee category, but high-skilled employees get more benefits from automation than the lower-skilled. Further, this paper emphasizes the consequences faced by female employees who perform routine manual work in this industry.

Oberdabernig (2016) paper reviews the “theoretical impacts of innovation and technological upgrading on employment, skills and the life spans of jobs.” This paper pays special concern to developing countries and provides overall conceptual evidence regarding the selected topic. The paper implies that the growth of technological innovations in developing countries caused an increase in demand for skilled labor while improving their wages relative to less skilled labor. Furthermore, the paper indicates that technological innovations affect developed countries and developing countries differently. This paper also distinguishes the impacts of technological innovation on different skill levels, especially on high-skilled and low-skilled labor.

4. RESEARCH MODEL

Before moving into the empirical studies, this chapter will present a simple model to clarify the basic arguments of employee displacement and wages in the sector. Before developing the model, we assumed that low-skilled workers are much easier to substitute with automation technology than high-skilled workers in the industry. Later with empirical studies, I will discuss how much these countries will invest in adapting to automation in their countries. Before moving to the model, we need to understand why the apparel industry uses automation technology to perform its manufacturing process.

4.1 Why do organizations use Technology?

Industries tend to use technologies to increase productivity while saving their labor in industries. The final goal of industries is to increase their output with the same input to maximize their profit. In terms of economic productivity, an organization´s productivity is measured by output per unit of input, such as labor, capital, or any other resources. The objectives of productivity measurement include technology, efficiency, real cost-saving, benchmarking production process, and living standards.

According to the mentioned productivity objectives, the technology of an organization plays a vital role in increasing the organization's productivity. Therefore, organizations tend to increase their productivity while introducing new technologies for their organizations. If the organization understands that the return on investment on new technologies is higher than the rate of return on investment on traditional technologies, then organizations will invest in new technologies and vice versa.

4.2 The simple theory of the Canonical Model

Acemoglu and Autor(2011) introduced the Canonical model in their book Handbook of Labour economics. According to this model labor market has two specific labor levels. Those are high-skilled labor and low-skilled labor. The employees

who are considered high performers (employees who obtain high skill labor) obtain college degrees or education qualifications equal to it. The low-skill labor only obtains primary education or less educational level relative to the high performers. This is the central idea of the canonical model; the elasticity of substitution between these two types of skills supports to decide on which skill level employees' organizations prefer to keep.

4.2.1 The change in labor

I will begin with the skilled employees (H) and unskilled employees (L). According to their skill level, high-skilled employees have high educational qualifications, but unskilled employees have low levels of educational qualifications. According to Acemoglu and Autor (2011), the fact that highly skilled and low skilled workers are imperfect substitutes in production is important to the two worker paradigm. Because if these two skills are perfectly substituted for each other, industries will tend to recruit low-skill level employees to perform every task in the industry for a minimum wage. However, to understand how changes in relative supplies in two labor affect the skill premia, we should understand the elasticity of substitution between high skill and low skilled workers.

As mentioned by (Federici and Saltari (2014), the Elasticity of substitution is an index that measures the pace at which marginal returns fall as one element is raised in relation to another. If the elasticity of substitution of labor and capital is more than one, for example, lowering the relative price of capital will result in a greater than a proportional shift away from labor. The elasticity of substitution between the employees can measure as follows,

$\sigma = \infty$ Perfect substitution

$\sigma = 1$ Cobb Douglas

$\sigma = 0$ Leontieff

$\sigma > 1$ gross substitution

$\sigma < 1$ gross complements

Adapting from Acemoglu and Autor (2011, p. 1103), the above measures give the elasticity of substitution between the two labor types. If the elasticity of substitution is $\sigma = \infty$, then the two labor types are a perfect substitution for each other.

That means if the industry decides to reduce the high skill labor, low skill employees can substitute for the task performed by the high skill employees perfectly. If the elasticity of substitution is $\sigma = \infty$, it is called Cobb Douglas. Cobb Douglas means both high skill employees and low skill employees gain a fixed share of the wage for each other. If the constant elasticity of substitution is $\sigma = 0$, then this situation is called Leontief. The meaning of that is output can only be produced using skilled and unskilled workers in a fixed proportion. If the constant elasticity of substitution is $\sigma > 1$, then it is called gross substitution, and in this case, an increase in one labor type can increase the demand for the other labor type as well. The last one is $\sigma < 1$and this depicts that increase in one labor type caused to decrease in demand for the other labor. For instance, if the industry demands high-skill labor only, then demand for low-skill labor will continuously decrease.

According to Acemoglu and Autor (2011), every employee in the world owns a unique skill set of their own. If he or she is a highly skilled employee, he owned I € L has l_i efficiency unit, and if he or she is a highly skilled employee, he owns by i € H h_i unit of skill level respectively. Further mentioned in by the authors, since the two types of skills are performed quite similar tasks, the factor augmented technology can complement high skilled workers to low skilled workers and vice versa. Because if these skill level does not have a difference between them, then the employer decides to recruit any of the employees who are ready to supply their labor at a low wage. However, due to this fact labor market is vulnerable to skill-biased demand shifts. If not, high-skill employees will be disadvantageous in every situation because they cannot get an equilibrium wage for their qualifications. On the other hand, the low-skilled employee can get benefits from this by supplying their labor for a high salary. Since all workers supply their labor inelastically in the labor market, their total labor supply can be shown as follows,

$$L = \int_{i \in L} l_i \, di \text{ and } H = \int_{i \in L} h_i \, di$$

In the Canonical model, the basic idea is to interpret the elasticity of substitution between high-skilled and low-skilled labor. Therefore, we can use the following production function to evaluate the constant elasticity of substitution (CES) form by using the following formula adapted from the (Acemoglu and Autor, 2011, p. 1103),

$$Y = \left[(A_L L)^{\frac{\sigma-1}{\sigma}} + (A_H H^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma-1}{\sigma}}$$

As Acemoglu and Autor (2011) mentioned, A_h and A_l considers the factor of augmented technology in this production function, and the elasticity between high skill and low skill labor is σ € (0 ∞) further, as mentioned previously in this section if the high skilled labor and low skilled labor are gross substitutes for each other then σ > one if these skill types are gross complementary for each other then σ < 1.

By using this as a foundation, we can derive three situations from the above function. The first situation is we can assume that there is no substitution between high skill and low skill labor in the industry, and output can only produce by using all these skills in a fixed proportion. For example, if we produce apparel for the market, we need both high-skill labor and low-skill labor. We need low-skill labor for cutting apparel and sewing these apparel to make it good to sell. Then we need high skill labor to decide the price for these apparel and search for a suitable market to sell these apparel. This means that the industry values both skill levels equally, and therefore, the industry puts both skill levels proportionately to produce the products. In this situation, the elasticity of the substitution between two skills is zero.

In the second situation, two skill types are perfectly substituted for each other, and the elasticity of substitution is infinite. Moreover, in this situation, there is only one skill possessed by employees in different quantities. The third situation is Cobb – the Douglas form and where elasticity is substitution is equal to 1, and each factor is paid a fixed share of overall income. This means that even if some employees performed better, they only receive a fixed share of the wage for themselves(Acemoglu and Autor, 2011, p. 1104). I will use this theoretical foundation to analyze more information about the model in the following sections of this chapter.

Based on the theoretical foundation regarding the Canonical model in the previous section in this chapter, we need to understand whether technology support decreasing the labor jobs in the industry or not. To analyze this, I will take an apparel firm that owned two inputs which are labor and automation technology adapted from (Acemoglu, 2002, p. 5),

$$Y = \left[\gamma(A_L L)^{\frac{\sigma-1}{\sigma}} + (1-\gamma)(A_Z Z)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma-1}{\sigma}}$$

In the above function, L indicates the labor in the industry, both high-skilled and low-skilled labor. Z determines the new technologies (automation, sewbots etc) in the industry. Moreover, A is the technology index. Deriving from the above formula, I will construct another formula to understand whether technology is H-biased or L-biased. To check this, I will calculate the marginal product of the labor and technology adapted from the (Acemoglu 2002, p. 6),

$$\frac{MP_Z}{MP_L} = \frac{1-\gamma}{\gamma}\left(\frac{A_Z}{A_L}\right)^{\frac{\sigma-1}{\sigma}}\left(\frac{Z}{L}\right)^{\frac{\sigma-1}{\sigma}}$$

According to the above formula, “A” refers to the technological progress of the industry. AZ/AL depicts relative marginal products of labor and technology. σ-1/ σ support measures the elasticity of substitution between the two factors. The relative marginal product of Z is decreasing due to the Z, Z/L. This can be considered a usual substitution effect. Generally, the substitution effect leads to a downward sloping relative demand curve. The reason for that is once the demand for the technology decreases, then the demand for the labor also decreases because the industry needs labor to operate technology such as automation machines, etc. The effect of the A_Z is dependent on the elasticity of substitution.

Further, if the $\sigma > 1$, an increase in A_Z relative to the A_L increases the relative marginal product of Technology (Z) in the industry. Resulting from that, if the industry increases the technology more than the labor, it supports to increase in the productivity of the industry. This means that if the industry is $\sigma > 1$then the industry benefited from technology.

If the $\sigma < 1$, an increase in A_Z causes a reduction in the relative marginal product for Z. The reason for that is technology supports to increase in the productivity of the industry by itself with less help from the labor. Therefore, the demand for human labor will be less relative to the technology. Following that intuition, when the two factors are the gross substitution for each other, Z augmenting changes in the industry is Z biased because when technology support increases, the productivity, the industry prefers to invest in technology more and more. Therefore, if the changes happen in the industry are Z (Technology) augmenting, then

the industry will invest in increasing Z further. And when two factors are gross complementary, then the Z augmenting technical changes are L biased in the industry. Because if Z and L are gross complements for each other, an increase of one factor (labor or technology) support increase the demand for other factor as well. If we are in Cobb Douglas case, neither L nor Z changes are working in the industry (Acemoglu and Autor, 2011, p. 1103).

Following that intuition again, we need to understand why $\sigma < 1$, Z augmenting technical changes in L biased. The reason behind that is that when the industry is gross complementary, an increase in productivity of Z increases the demand for L as well. Because when an industry uses more technology, the same industry needs skilled employees to work with this technology. However, as a result of that, an increase in demand for technology makes the excess demand for labor as well. However, this means that even if the industry invests in technology instead of improving the labor in the industry still industry has a demand for the labor. We will discuss this further with the empirical data in this industry (Chapter 6).

Autor *et al.* (2003) state in their paper that technological changes can substitute only for the tasks which are cognitively routinized. The non-routine tasks which do not include repetitive tasks, such as managerial decision-making tasks, cannot substitute with new technologies. According to that idea, it is clear that factor augmenting tasks are easily replaced by repetitive tasks, which are mostly done by the low-skilled workers. Therefore, we can conclude that the factor augmenting technological changes benefits more to the high-skilled workers relatively more than the low-skilled workers in the industry.

According to Acemoglu and Autor (2011), " there is no explicitly skill replacing technologies" we can understand that skill cannot be replaced by automation technology or any other existing technology. However, due to the fact that technology can enhance labor productivity and the labor demand for some skill levels, we can come to the following conclusion.

Due to the fact that technology only replaces cognitively routinized tasks, we can assume that high skilled jobs will be safe in the industry. However, according to Autor *et al.* (2003), the technology always substitutes the employees who have

been working on the routine tasks, which are more programmable. Moreover, it describes that non–routine tasks which demand flexibility, creativity, and problem-solving skills to perform their jobs have fewer chances to substitute with automation and new technologies. Therefore, we can clearly understand employees who perform tasks that are considered as high skilled tasks will be secure in during the technological wave.

Since the high skilled jobs have a more comparative advantage in the apparel job market, there will be more demand for these jobs. But due to the shortage of the required skills, wages for these employees will be high in the short term. If we consider the long term, the situation will be changed since we are considering the South Asian labor market: if the market can produce more talented and skilled labor for the industry, the industry can occupy more highly skilled labor. Then the wage for high-skill labor will be reduced relative to the low-skill labor.

5. EMPIRICAL DATA

In this chapter 4, the objective is to find the real-world application of the proposed methodology illustrated above. For this purpose, I explained the available data and information based on the industry. In this aspect, I would analyze the country-specific data and information and analyze them accordingly.

5.1 Apparel industry employee estimates and trends

The south Asian apparel industry employs nearly one million employees, including women in this region. Export-oriented apparel production of this industry has been the key industry in this region which has the potential to generate job opportunities in the formal sector. Therefore, this industry mostly acts as one of the industries that help reduce poverty among employees who obtain low-skilled labor. This industry mainly employs more than 43 million employees in this region. Alone in India, the apparel industry occupies 16.8 million workers in the sector, and Bangladesh and Pakistan exceed over 4 million employees in the same sector. Figure 1 depicts the employee distribution in the apparel industry among Asia's different regions.

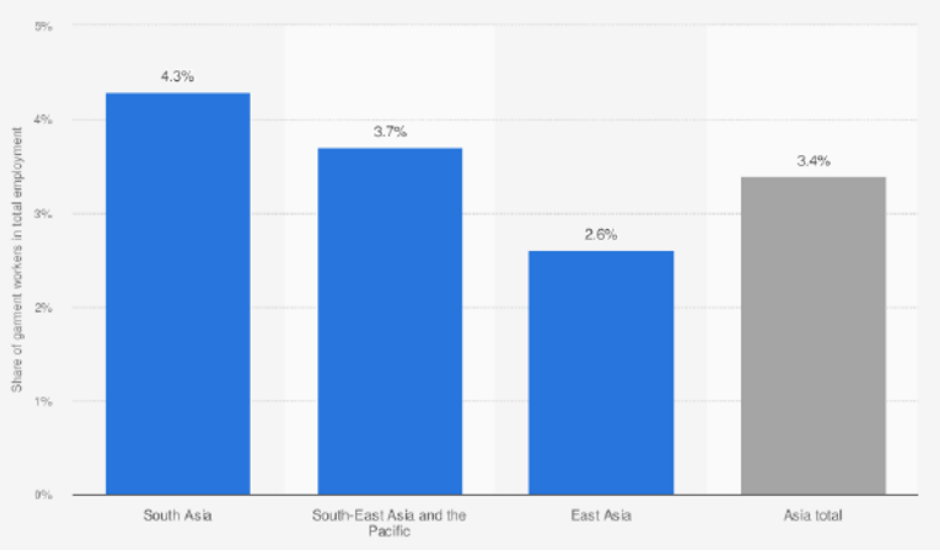

Figure 1. *Share of garment workers in total employment in Asia in 2019, by region* (Statista, 2020, p. 1).

The above diagram shows the apparel industry employees' distribution in the Asian region. The above diagram, it is clearly showing that South Asia has

become the largest apparel producing region among all other regions in Asia, creating a higher number of garment occupations in the continent. However, this industry occupied more female employees than male employees in the region. The following diagram depicts the total employment by sex in the region.

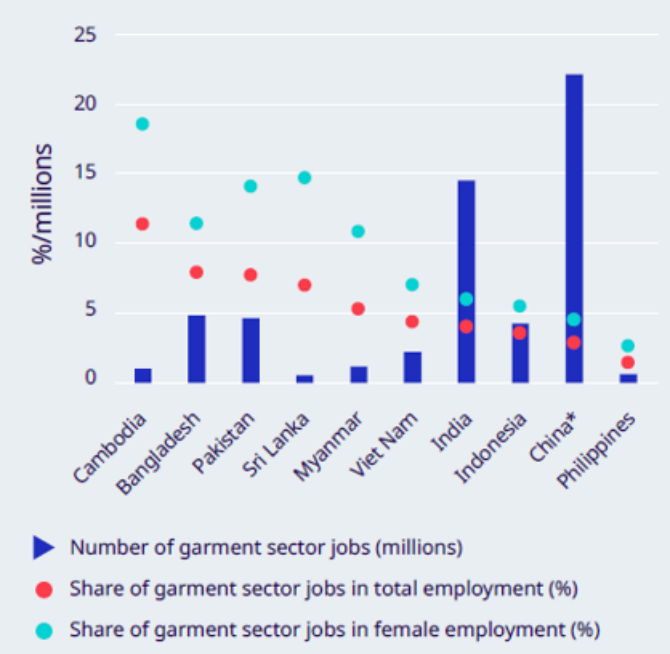

Figure 2. *Millions of workers are employed in the garment sector: The majority are women* (International Labour Organization, 2020, p. 3).

Source: (International Labour Organization, 2020, p. 3)

The above diagram clearly shows that male employee engagement is relatively low compared to female employee engagement. The reason behind that is, that most of these factories are located in the rural areas of these countries, and therefore, women who have low educational levels tend to join these factories seeking jobs in the formal sector. Further, the governments of these countries facilitate them to make progress in life and economic empowerment of the country.

5.2 Wage estimates and trends

In developing South Asia, employment tends to be very informal due to a lack of stable wage rates. The following diagram will depict the wage differences between the different regions on the continent.

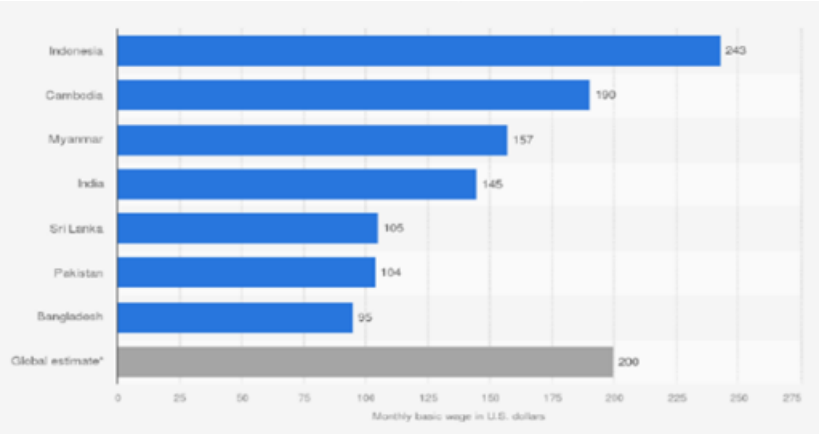

Figure 3. *Average monthly basic wage of garment workers in selected Asian countries between March 2020 to March 2021* (Statista, 2020, p. 1).

Wages in the South Asian region (India, Bangladesh, Pakistan, Sri Lanka) are well below relative to other countries in this continent. However, most foreign off-shore apparel companies tend to relocate to this region due to low wage rates and low production costs. Moreover, these factory workers in this industry are often paid in line with the country's minimum wage rate. Unfortunately, this is not enough for them to lead a quality life, and in most cases, even if the wage increases, it is lower than inflation and the cost of living.

While women employee accounts for the highest shares of job opportunities in this industry, they continue to face considerable wage discrimination. In all four countries, we analyze the South Asian region; the average monthly wage rate is higher for men than for female employees.

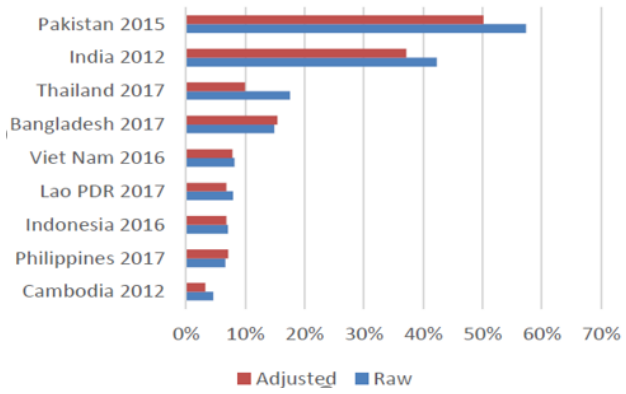

Figure 4. *Gender pay gap, latest year, raw and unadjusted* (Pillay., 2018, p. 3).

The above diagram depicts the regional wage disparity among male and female employees. According to the above diagram, Pakistan has the highest wage gap

(66.5%), followed by the other three South Asian economies. By contrast, Bangladesh has the lowest wage disparities (1.1%) among the other three economies. Likewise, India (36.3%) shares a moderate wage gap between male and female employees. The women employees who enter this industry generally want to find a job as either a production worker or a helper. These jobs attract more female employees because they require low skill levels and more minor educational qualifications to perform the job.

However, developed countries tend to offshore their factories due to low labor and material costs. Mostly these developing countries get a comparative advantage from the low cost and low material cost of these countries. The following table describes the cost of producing one apparel item in a few Asian countries, including India, Bangladesh, Pakistan, and Sri Lanka.

Export Rank/Indicator/ country	World Unit Values (Based on Numbers of Items (2013)						World Export Rank, by Product Category, by Value (2013)					
	Trousers	Sweaters/ Sweatshirts	Knit shirts	Coats	Woven Shirts	Dresses and shirts	Trousers	Sweaters/ Sweatshirts	Knit shirts	Coats	Woven Shirts	Dresses and shirts
China	$6.5	$7.7	$4.1	$17.4	$7.2	$8.5	1	1	1	1	1	1
Bangladesh	$6.3	$6.2	$2.9	$13.3	$6.2	$5.0	3	3	3	4	4	9
India	$6.9	$5.2	$3.8	$16.0	$7.8	$8.6	11	8	5	13	3	3
Pakistan	$8.2	$4.8	$2.8	$7.8	$6.7	$6.1	9	11	14	14	29	33
Sri Lanka	$7.5	$6.3	$4.6	$16.7	$9.2	$8.4	13	17	15	24	10	12
Vietnam	$7.0	$4.6	$4.6	$20.5	$7.2	$6.8	5	4	6	3	7	5
Cambodia	$6.3	$5.5	$3.9	$10.9	$6.2	$5.3	7	6	9	8	11	10
Indonesia	$6.0	$4.6	$4.2	$16.9	$7.6	$6.9	6	7	8	5	6	6
World	$7.8	$7.0	$3.9	$19.8	$8.3	$9.7	_	_	_	_	_	_

Table 4. *World unit value cost comparison (Lopez-Acevedo and Robertson, 2016b, p. 8).*

The above comparison between a few Asian countries gives a clear understanding of the product cost of various apparel items. China is the first country mentioned in the list, and the country has been considered the world´s largest apparel manufacturer and exporter for more than a decade. However, China has a higher cost for manufacturing apparel items compared to the other countries. Therefore, most apparel companies tend to open their factories in low-cost countries like India, Bangladesh, Pakistan*, etc*. Even though wages in the South Asian apparel industry are lower than in China's, the industry's productivity level is much greater than in China.

Why do they prefer to open their factories in these countries instead of developed countries? The answer to this question already exists in the above paragraph. The low labor cost and low manufacturing cost compared to the other region of

the world is one answer to that question. However, still, there are many other unrevealed reasons behind that.

As mentioned above, low labor and material costs are the main reason for attracting foreign factories and foreign investment to the South Asian apparel industry. Besides that, working conditions, working hours, laws regarding the industry, and gender perspective play a vital role in this region. Before discussing these facts further, the following diagram will show how many factories and employees occupy this region's apparel industry.

	Sri Lanka	India	Pakistan	Bangladesh
Estimated number of exporting factories (2014/16)	800	1,200	5,000	5,000
Share of manufacturing (%) (2014)	43.5	5.5	20.2	80.9
Firm ownership	80% Joint ventures and locally owned	Majority local	Less than 2% of Foreign-owned	90% Local
Role of FDI	Historically high	Low	Low	Low

Table 5. *The number of employees occupies the apparel industry in South Asia (International Labour Organization, 2017, p. 7).*

The above diagram depicts that many employees are occupied in this sector, and the apparel industry plays a central role in creating more job opportunities in the formal sector. Especially, female employees enter this industry looking for low-skill and low-wage jobs. However, even though these jobs exist in the formal sector, the industry provides long working hours, low salaries, and uncomfortable conditions. Moreover, most of these countries do not have active labor laws to protect employees. Therefore, South Asia is the best place for developed countries to establish their business while enjoying the comparative advantage of low-cost labor and other mentioned reasons.

5.3 The economic viability of technology upgrades and automation

From a developing country's point of view, technology upgrading always depends on the assimilation level of foreign technologies into the country. Moreover, the country's labor force, employees´ ability to acquire new technology, and the educational level of the employees in the country have a significant impact on

deciding on technology assimilation. Most importantly, government policies that encourage new investment in the technological field have a great effect on deciding the automation and technology upgrading of a specific industry or a specific country.

5.3.1 India

The textile and apparel industry in India acts as the leading source of foreign exchange earnings. Further, this industry contributes 4% of the gross domestic product (GDP), 20% of industrial output, and slightly more than 30% of the country's export earnings. Especially this country benefits from the comparative advantage in terms of skilled human resources and in cost of production relative to major textile producers in the world. Further, India is among the top 15 apparel exporters globally.

India is still a labor-intensive country, and the apparel industry provides 45 million direct employment opportunities and 60 million indirect job opportunities for people in the country. However, the most important advantage this industry gains from technology is reducing labor costs and improving the industry's speed, quality, and efficiency. Therefore, the Indian government has supported infusing new technologies into the apparel sector over the past few years. Beginning from the year, 1999 government released $6 billion in funds for the industry to cover their technological needs, especially in the weaving and processing. Moreover, few commercial banks in India, such as the Industrial Development Bank of India (IDBI) and the Small Industries Development Bank of India (SIDBI), have lowered their interest rate by less than 5 percent to offer industrial loans for factories. This supported industry in acquiring new technical facilities for their industry in 2000 (Foundation, 2021, p. 5).

Industry	Applied			Sanctioned		
Sector	Number of loans	Project cost	Loan amount	Number of loans	Loan amount	Amount disbursed
	Million Rupees			Million Rupees		
Spinning	84	10,800	7,077	60	4,422	1,067
Viscose filament yarn	2	241	118	2	118	61
Synthetic filament yarn (Texturing, twisting)	17	1,120	719	5	336	157
Weaving	23	2,481	1,490	14	1,113	237
Composite mills	44	25,226	11,836	27	6,728	1,538
Knitting	21	276	192	13	103	25
Made – ups manufacturing	3	84	48	1	8	7
Garment manufacturing	35	1,642	880	24	665	232
Processing	57	7,211	4,186	42	2,964	1,657
Ginning and pressing	8	288	140	8	109	18
All other	10	390	254	5	123	15
Total (Rs)	304	49,759	26,940	201	16,689	5014
Total (Million dollors)		1,160	630		385	115

Table 6. *Utilization of technology up-gradation fund by the textile and apparel industry sector (Simpson., 2001, p. 37).*

The above diagram shows how much the industry has invested in acquiring new technologies for different sections of the production process. However, the above diagram does not depict how much this industry has invested in automation technology. Since automation technology is relatively new to this region in the 2000 s, the industry does not pay attention to automating the manufacturing processes.

Further, the industry is growing fast and receiving valuable investment opportunities from the government, foreign investors, and various institutions to increase technological aspects in the industry. The following list will describe the recent initiatives the Indian government and different bodies have taken to improve the technological facilities in the industry.

- Amended Technology up-gradation Fund Scheme: The Indian government allocated Rs.17,822 crore (US$ 2.38 billion) for technology up-gradation. This fund scheme expects to boost the Indian apparel industry and enable ease of doing business.
- FDI - Foreign direct investment (FDI) of up to 100% is allowed in the textile sector through the automatic route.
- R & D: Defence Research, Development Organization (DRDO) and IIT Delhi, and South India Textile Research Association have facilitated innovation in the textile industry through new technologies.
- In April 2021, India´s ministry of textiles announced that the National Institute of Fashion Technology (NIFT) would work toward introducing technical textiles as an academic subject in the near future.
- Ahmedabad (Gujarat) – based Zedex Clothing Pvt. Ltd. Factory has already invested in automation technology, and they are planning to be the pioneer of textile automation technology. (Varshney Nitish, 2021)

It is clear that the Indian government is concerned about the apparel industry and investing in it to develop technological facilities. As we know, automation is also essential to enhance productivity and reduce the industry's costs. However, there is still no accurate information regarding how much they have invested in automation technology alone in the industry. However, Since India is one of the leading apparel exporters to the international market, this industry will enhance the global competitiveness by assimilating the automation technology near future.

5.3.2 Bangladesh

Apparel is the primary export industry in Bangladesh, and it accounts for 83% of the country's total export earnings. Since the independence of Bangladesh in 1971, the garment industry in this country has been expanded through export-

oriented government policies. Bangladesh´s government continues to help the garment industry by lowering interest rates on long and short-term loans and rationalizing tariffs and taxes on capital, raw materials, dyes, and chemicals. Like the other countries in the South Asian region, Bangladesh's apparel industry also operates as a high labor-intensive and low–skilled manufacturing sector. However, this industry now plays an important role in implementing new strategies and technologies to increase the industry's effectiveness, productivity, and competitiveness to compete with other countries in this region.

In order to accelerate technological progress in the apparel industry, the Bangladesh government and foreign investors have invested in multiple ways in the industry. The country is now ready to enter industry 4.0, and the apparel sector is also looking for different ways to adapt to the new technologies in the world. The following list will describe the recent initiatives the Bangladeshi government and different bodies have taken to improve the technological facilities in the industry.

- In 2012, Bangladesh received a $1.13 billion FDI inflow to the country. This is their first-ever experience of receiving satisfactory FDI to the country and the second time Bangladesh´s FDI exceeded the billion-dollar mark in a single year. After that, the country has received FDI continuously multiple times. This foreign investment makes a positive impact on the country´s apparel industry, and it supports the function of the industry very well and the country itself.
- The country's government has formulated a National Science and Technology Policy that supports education and support Technology research and a workforce of the country.
- Since the industry is highly dependent on exports and the international market, it is necessary to adopt new technology to increase the industry's productivity. Therefore, to train skilled labor, the government has established a specialized institute named the National Institute of Fashion Technology (NIFT) (Yunus and Yamagata, 2012, p. 21).

Since the country is still a low tech and labor incentive country, investing in technology is very low. The country is highly dependent on foreign investment, and the government facilitates attracting foreign investors by implementing various

policy responses. Therefore, it is hard to disclose accurately how much governments and other parties have spent on upgrading technology and automation in the industry. However, later in this chapter, I hope to explain actions taken by the factory owners to develop the productivity of the industry through technology and automation.

5.3.3 Pakistan

Pakistan is categorized as the 8th largest exporter of textile products in Asia. This sector employs 40% of the overall labor force and accounts for 46% of the total manufacturing sector. Moreover, this industry contributes 8.5% of the country's Gross Domestic Product (GDP). Pakistan operates as the eighth largest exporter of textile products in Asia in the world market. This industry provides employment opportunities for many employees in the country with low capital investment. In Pakistan, 46% of employees occupy the manufacturing sector, and out of that 40% of employees occupy the apparel industry. During the last five years, this industry-supported increasing the country's per capita income by 23%, and policymakers believe that if they have better management practices, they can improve the sector's productivity by 20%.

Recently Pakistan government has implemented multiple policies to improve the technological abilities of the industry. They believe that better management practices, skilled labor, and advanced technologies will support improving the industry's productivity and efficiency. Therefore, the following action has been taken by the government and policymakers of the country towards advancing the technological capabilities of the industry.

- The country's government has facilitated an additional investment of $5 billion in machinery and technology.
- The federal government may reimburse 50% of markup up to a maximum of 5% per year (whichever is less) as part of the “technology up-gradation fund support scheme as well as provide up to 20% investment support to SMEs and 5% to non-SMEs for the importance of new plant and machinery up to Rs. 10 million, through loans or their resources.
- The country's subsidized credit scheme supports increasing the import of new machinery to the industry.

- The government has facilitated the promotion of online business platforms (E-commerce), and now it has reported 16.6 million online users.
- Pakistan receives fewer FDI facilities compared to other South Asian countries. Overall, the total FDI received by the Pakistan government is less than 2% of investment in the country (Ministry of Commerce, 2020, p. 10).

The following graph shows the total foreign investments received by the Pakistan apparel industry between 2007 and 2016.

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Textile and Apparel (US$ Million)	30.1	36.9	27.8	25.3	29.8	10	-0,2	43.9	20	15.5
Total FDI (US$ Million)	5,409	3,719	2,150	1,634	820	1,456	1,698	987	2,305	2,746
T and A share of total	0.60 %	1.00 %	1.30 %	1.50 %	3.60 %	0.70 %	0 %	4.40 %	0.90 %	0.60 %

Table 7. *FDI inflows to Pakistani Textile and Apparel Industry (Frederick and Daly, 2019, p. 26).*

The above graph reveals that the apparel sector in this country operates under a minimal share of foreign investments. However, the industry is still facing several challenges in developing automation and newer technologies in the country. Lack of skilled labor in the country, lack of research and development regarding the technology, and lack of foreign investment make it less innovative than other apparel-producing countries.

5.3.4 Sri Lanka

The apparel export sector in Sri Lanka acts as the most important and active contributor to the country´s economy. Over the past four decades, this industry has grown tremendously, and now it has become the leading foreign exchange earner of the country, accounting for 40% of total export and 52% of industrial product exports. This industry is wholly owned by the country's private sector and has effectively capitalized on foreign market prospects.

Since the 1970 s, the apparel industry in Sri Lanka has been considered a high value-added industry to the country's economy. Moreover, the country´s economy is moving toward a knowledge-based economy through automation technology and communication technology. While the country´s apparel industry remains a labor-intensive process, some sections have been progressively automated. To develop the technological facilities, FDI and the various joint ventures with local firms invest in the industry and support continuing the development of the industry's technological field. The following diagram will describe export in apparel (LKR Mil) compared to total investments, foreign investments (LKR Mil), and workers.

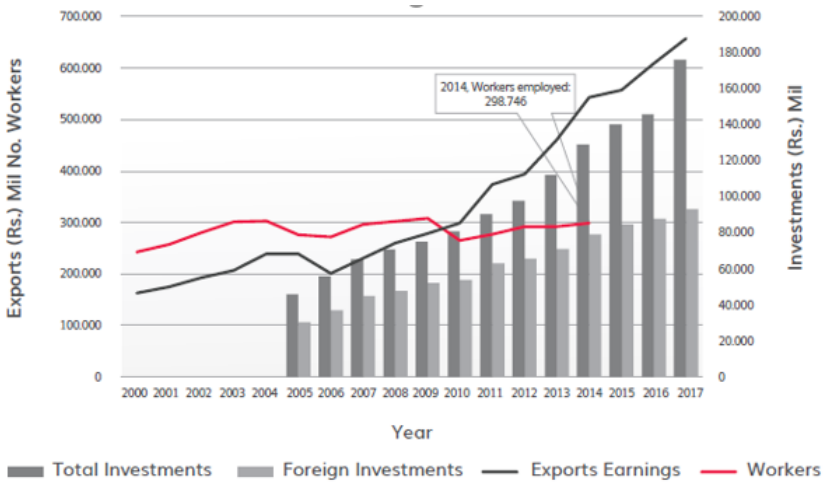

Figure 5. *Exports in apparels (LKR Mil) compared to total investments, foreign investments(LKR Mil), and workers, Sri Lanka)*(Brandix, 2020, p. 42).

According to the above diagram, between 2005 and 2017, the total investment in the apparel industry increased from 45,879 LKR million to 175,891 LKR million. On the other hand, between 2000 and 2017, the country's export earnings also increased from 162 533 LKR to 657,347 LKR million. The relationship between capital investment and export of the country is crucial because it depicts the correlation between how the investment of the country supports increasing the efficiency of the industry's production process. Further, this diagram depicts information about the country's labor force as well. Between 2000 and 2014, the workforce in the apparel industry varied from 285,000 to 300,000. The peak point of labor assimilation of the industry is the year 2009, and in the same year, the export yearning of the country increased more than threefold. This revealed that the

country's workforce, investment in technology, and export earnings have interconnection among themselves and they support increasing the productivity and efficiency of the industry (Fernando *et al.*, 2020, p. 23).

Further, after the 2017 budget, the Sri Lanka government has implemented the following initiatives to develop the technology assist apparel industry of the country.

- To facilitate science, technology, and innovation, the Sri Lankan government will increase the allocation of LKR 826 million to LKR 1.3 billion.
- Fashion design and digital technology will be a new subject for school children in the country, and LKR 100 million will be allocated to encourage students to pursue higher studies in this field. (Bachelor of Education in Science, Technology)
- To attract foreign investors to the country, the government provides a 5% grant for investors at the end of their 2nd year. Who invest more than USD 500 million and get a 5-year multiple entry visa. Further, if the investor can generate more than 500 employment opportunities in the sector and if they can maintain it for five years, the government will grant a 100% capital allowance on such business.
- LKR 250 million will be allocated to the Sri Lanka Institute of Technology and LKR 50 million to the Centre of Excellence in Robotics Applications to continue their research on technology and innovation (Deyshappriya and Zylva, 2016, p. 4).

In Sri Lanka, the private sector wholly owns the apparel industry. Three leading apparel manufacturers in Sri Lanka (MAS, Hirdaramani Apparel Brandix Lanka) dominate the industry. I discussed with three employees who work in these companies to get their new updates regarding the tendency and investments toward automation technology.

MAS is one of the largest apparel manufacturing companies in Asia, and it has branches scattered around other Asian countries as well. According to the employee who works in MAS, they have a separate IT department to implement new technologies in the industry. They have already implemented “Uipath” and RPA

with automation at its core to save labor days. He says that once they started the Uipath and RPA, they could save around 1000 labor days per month across the business. Since MAS is a privately owned organization, they do not agree to reveal their investment in this technology.

Brandix is another biggest apparel manufacturing chain based in Sri Lanka while scattering its plants across the Asian region. They use the “TUKA” system initially tested by the Brandix Denim production section. This technology has shown dramatic results in increasing efficiency and reducing human labor in the industry. The employee who works in the Hirdaramani also said that they are also going through innovations, but they cannot reveal their investment to the general public. As I mentioned earlier in this section, all of these apparel factories are privately owned, and they have competition with each other. Therefore, most of the time, they would not like to reveal their financial data to the general in the country.

5.4 Is new automation technology already causing unemployment?

The world is now living in an era where digitalization and technology play a significant role in their life. Most industries need to go in hand with technology to reduce their cost, improve their quality and improve sustainable management practices to develop their industries. However, some people argue that, even though these technologies occur to develop the workplace quality and quality of goods, this leads to displacing millions of employees out of their jobs. We needed a long-term approach to analyzing this because organizations cannot acquire all the technologies overnight. It takes time. Therefore, this should analyze them according to the country's financial stability, economic stability, and how much they invest in developing its human capital and technologies.

5.4.1 Investment in Technology vs. Human capital

The pessimistic view of improving automation and other technologies in the apparel industry displaces human jobs in the sector. Since the South Asian apparel industry is highly dependent on human labor, it is crucial to analyze how many jobs will be displaced due to automation technology. However, manufacturing is one of the labors – intensive and low-skilled jobs, and it mainly demands repetitive tasks. Therefore, it is necessary to analyze how much the apparel industry

invests in developing the labor in the industry and how much they invest in developing the country's automation technology.

To analyze the industry's human capital situation, I would like to present some empirical data regarding the industry. For that, I would like to take two leading apparel manufacturing factories that operate in South Asia and analyze their newest technologies, which help reduce the industry's labor task, employee engagement in the industry, and how much these organizations would like to invest in developing human resources of the industry.

The Brandix Group is one of the leading apparel manufacturers based in South Asia, and it has its main headquarters in Sri Lanka. Brandix has expanded its manufacturing presence to Sri Lanka, India, and Bangladesh and provides over 53,000 employment opportunities for people across the region. However, Brandix recently adapted its management practices into sustainable strategies, and it supports aligning its day-to-day process with continuously investing in developing technologies and the human capital of the organization (Brandix, 2020, p. 4).

Recently the organization has been acquiring new technologies to improve the organization's efficiency. As mentioned in the previous section, the organization adapted " Tuka technology," Which helps double the efficiency in the "Denim" section in the manufacturing process. "Tuka" is a newly installed CAD system. The organization already has invested money in installing the equipment in the organization and trained the employee to operate this system**.** However, the organization never mentions how much they have invested in installing this system in the factory. Further, the organization's management says that they do not focus on the cost of installation but focus on the results and efficiency of the system. Since the private sector owns these organizations, they do not like to reveal their accurate statistics regarding their investment in such technologies.

As mentioned by the management of Brandix, they believe that "Tuka technology has improved the efficiency of the process and save time and money of the organization. Moreover, they state that they would like to introduce this technology to the organization's different departments, such as sales and merchandising. However, the most important fact about tuka technology is that this technology

does not reduce the employee in the organization, but it requires training people to handle the new technology (Brandix, n.d., p. 4).

The apparel industry considers its employees are the most valuable asset in their industry. Brandix also believes that its employees are their greatest asset. Across the region, this organization has employed more than 53 000 employees, and they invest in their employees to improve their skills, abilities, efficiency, and engagement. The following table will depict the number of male and female employees engaged in the organization. (Sri Lanka, India, and Bangladesh)

Number of employees occupied in the Brandix

Sri Lanka

	Male			Female			Total
	Staff	Worker	Executive	Staff	Worker	Executive	
Permanent	620	1,750	1,845	2,470	27,566	708	34,959
Contract	28	57	-	-	-	-	402

Table 8. *The number of employees occupies Brandix, Sri Lanka (Brandix, 2020, p. 37).*

India

	Male			Female			Total
	Staff	Worker	Executive	Staff	Worker	Executive	
Permanent	890	1,043	489	531	11,494	104	14,551
Contract	587	-	-	237	-	-	824

Table 9. *The number of employees occupied in the Brandix, India (Brandix, 2020, p. 37).*

Bangladesh

	Male			Female			Total
	Staff	Worker	Executive	Staff	Worker	Executive	
Permanent	158	324	51	17	1,899	1	2450
Contract	2	33	-	-	53	-	88

Table 10. *The number of employees occupied in Brandix Bangladesh (Brandix, 2020, p. 37).*

The following table shows the total number of employees.

	Male			Female			Total
	Staff	Worker	Executive	Staff	Worker	Executive	
Permanent	1,668	3,117	2,385	3,018	40,959	813	51,960
Contract	617	90	-	263	344	-	1,314

Table 11. *The total number of employees occupied in Brandix, South Asia (Brandix, 2020, p. 37).*

The above tables depict the number of employees (Brandix) in the factories across the South Asian region. The organization spends a significant amount of time and effort to attract prospective employees to the organization and retain them throughout their journey. The organization implements various training and development programs for its executives and non-executive employees.

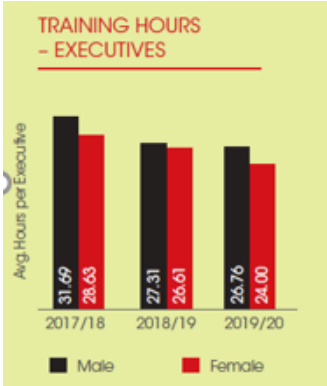

Figure 6. *Training hours – Executives* (Brandix, 2020, p. 42).

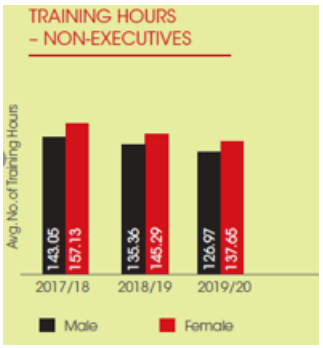

Figure 7. *Training hours – Non-Executives (Brandix, 2020, p. 44).*

The above diagrams indicate hours spent by the organization to provide training and developing opportunities for the executive and non–executive employees. Likewise, The Brandix, and other apparel industries that operate in this region, spend a significant amount of money developing and retaining their employees. For instance, “Teejay Lanka” spends Rs. Forty-four million of investment in training and development of employees per year. Teejay Lanka is also considered one of the largest textile groups that provide Knit Fabric to the South Asian region. This organization provides employment opportunities for more than 2200 Sri Lankan and Indian employees. According to the available data, Teejay, as a company, invested Rs. 3,923,394 million in 2016/17 year, Rs. 1,842,126 million in 2017/18 and Rs. 2,203,755 million in 2018/19 respectively on technology initiations. While investing in technology, this organization also has spent Rs. 44 million of money on training and development programs and spend 41 827 total training hours for training and development (Teejay Lanka Plc., 2019, p. 42).

In addition to that, the number of employees occupied in this factory (Teejay Lanka PLC) has increased relative to the past years. According to the statistics in their annual report in 2018, this factory occupied 2,338 employees, and in 2019 it increased to 2,610 employees. The variance is 11.6% (Teejay Lanka Plc., 2019, p. 9).

Considering the Pakistani labor force situation, they represent more male labor than female labor. The country's apparel sector represents 40% out of 46% of the total manufacturing labor force of the country. However, the problem in Pakistan is that the country has a shortage of skilled labor, and companies do not provide enough financial facilities to invest in training and development programs. Other

than that, male-dominated cultural characteristics and a lower rate of female participation made the industry drag backward in investing in developing the human capital of the country (Frederick and Daly, 2019, p. 26).

6. DISCUSSION

The transition from a labor-intensive economy to a technology-based economy considerably impacts the labor market. Especially in the South Asian region, since employees are mainly in labor-intensive industries, it hugely impacts their occupational career and lifestyle. As the demand for textile and apparel continuously rises, it is necessary to increase production and quality. To meet the rising demand of the industry, the apparel industry is adopting automation technology. In general, South Asia is considered a region with significant poverty, unemployment, inequality, and low career opportunities. Therefore, it is necessary to analyze the impact on this region due to the introduction of automation technologies to the apparel industry.

6.1 Theoretical argument

At the end of chapter four, I gave a foundation for further discussion on the topic. I summarised the topic that labor and technology in this industry act as the gross complementary because we use technology in an industry as a fact that helps to improve the productivity of the industry; however, since the gross complementarity $\sigma < 1$ increase in the productivity of the firm and by increasing demand for technology and labor vice versa.

6.1.1 Technology – skill complementarities

According to Autor *et al.* (2003), computer technology substitutes the employees who perform routine and programmable tasks while complementing workers in executive non-routine jobs that require creative, analytical, and problem-solving skills to perform their jobs. This statement highlights one important fact regarding the apparel industry's technological unemployment. Because this industry is relatively labor-intensive, most laborers are in the manufacturing process. Recently some factories in the apparel industry introduced manufacturing-based automation machines to the industry. The motivation behind using these technologies is to increase the productivity of the manufacturing process by decreasing human efforts.

Since these factories introduce automation technologies to the industry to improve the manufacturing process's productivity, this needs human skills to operate these machines. To operate these machines industry needs to have relevant people who have relevant knowledge. Therefore, either industry needs to recruit people who know or train existing employees. This argument proves that if we use the technology in an industry, we need to recruit more employees to the industry since these are gross complementarity. Therefore, we can assume or predict that technology would not necessarily displace the employment opportunities in the apparel industry.

6.1.2 High skilled labor and low skilled labor

The substitution of human labor for machine labor has a long history. During the Industrial Revolution, there were some situations where people substituted human labor with machines, and eventually, it helped increase the productivity of their tasks. However, in this section, I would like to determine further which skill levels will be substituting for automation and other new technologies in the industry.

Generally, the apparel industry has various types of employees, from managerial level professionals to clerks, Sewing machine operators, packers, etc. These different job types have different tasks to perform in their job. For instance, Managers need to have cognitive abilities to perform their jobs, but packers do not need cognitive skills to perform their job. Therefore, we can categorize jobs in the industry as cognitive and non-cognitive jobs. Moreover, some jobs in this industry can categorize as routine jobs and non–routine jobs. The following table will give a basic understanding of cognitive and non-cognitive jobs in the industry and routine and non-routine jobs in the industry.

Jobs in the Garment sector	Share in Employment	Nature of Task Performed	Education	New technology	Probability of Automation	
					Next 5 years	10 to 15 years
Managers and professionals	2.5	Cognitive	College	None	NA	NA
Clerks	1.5	Routine cognitive	Senior secondary	None	NA	NA
Fabric Spreaders and cutters	8	Routine	Primary and below	CNC Spreaders and cutters	High	High
Tailors / Sewing machine operators	65	Routine	Primary and below	Sewbot	Nil	Very Low
Iron masters	5	Routine	Primary and below	Automatic Knitwear Finisher (Ironing Robot)	Low	High
Quality controllers	8	Cognitive	High school primary	None	Nil	Nil
Packers	2	Routine	Primary and below	Folding Robots	Nil	Very Low
Other support staff	8	Manual physical	Primary and below	None	NA	NA

Table 12. *Probability of Automation in the Indian garment sector (Pankaj and Nisha, 2019, p. 5).*

The above table shows the nature of some occupations available in the apparel sector and the educational qualifications required to perform these jobs. However, this table depicts that some jobs need both routine and cognitive levels to perform their jobs. For instance, clerks need cognitive abilities and routinization as well to perform his /her job. This means that, even though these jobs have some number of routine tasks in their jobs, they will be safe in the automation wave. Because clerical and executive jobs need interaction with other employees to make organizational-level decisions.

Moreover, managerial and professional jobs, such as Engineering-level jobs, need cognitive skills to perform their jobs. Therefore, these jobs also will be safe in this situation. Nevertheless, machine operator jobs and packing jobs are highly routinized, and these jobs are likely to be substituted with automation technology.

The Availability of technology and adapting to the technology are two different scenarios. Therefore, it is necessary to understand that even though some occupations can be automated, will they happen soon?. According to (Pankaj and Nisha, 2019), in India, apparel will not go into fully automated technology soon. Moreover, they state that unlike managerial and clerical jobs in the industry, sewing and packing jobs, fabric spreading, and cutting jobs can witness some amount of automation. However, it is not happening in very recently. Because as previously mentioned, the availability of technology and adapting to the technology are two different scenarios. Therefore, even if the jobs are at risk of automating, government and factory owners of these countries should agree to invest in automation technology to get the maximum productivity out of it.

In a nutshell, though, some routinized jobs will be turned into risk due to the automation. However, the industry should have enough resources and financial ability to do so, even if it is. Therefore, before concluding, we need to understand whether these countries have the financial ability to invest in automation and new technologies.

6.1.3 Employee demand and supply and wage distribution

Technological change in the apparel industry demands new skills, abilities, and knowledge to perform jobs in the field. Moreover, these new technologies require new employees to operate these new machines. However, people who have lower levels of skills and knowledge regarding operating these machines will not be able to adapt to these technologies quickly. Even if they are qualified enough to operate machines, they will take time to adapt to these machines. Until then, high skilled labor might have to perform these tasks, or firms have to recruit new employees who have the knowledge and ability to operate these machines.

Structural changes in the job market and economic events in the market directly affect the labor supply and demand in the market and wage distribution. As mentioned earlier in the discussion section, low-skill laborers will risk losing their jobs

due to technological changes, but high-skill employees will be complementary to the technology. Therefore, the following section will analyze the labor market changes happening due to the automation technology in the apparel industry.

In the first step, it is necessary to understand the industry's low-skill and high-skill labor market before arriving at the automation technology. The following two figures will indicate the supply and demand curves for both low-skill labor and technical changes for high-skill labor.

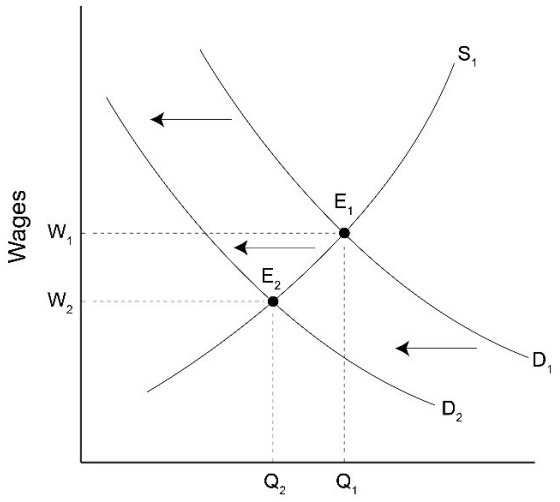

Figure 8. *Technological change and low-skilled labour*

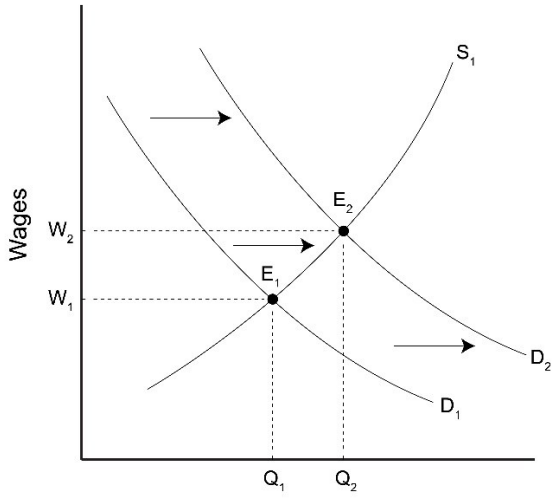

Figure 9. *Technological change and high-skilled labour*

According to figure 8 - S1, the original supply curve for the industry's low-skill labor, and D1 is the labor demand for the apparel industry's low-skill labor. E1 is the original market equilibrium, and E1 occurs in the price W1 and Q1 quantity in the market. The demand for the low-skill labor shifts to the left because once

technology comes into the industry, technology can perform the task previously done by the low-skill labor. Therefore, their wage level decreases to the W2, the new equilibrium is W1, and the quantity is Q2.

The second figure, figure number 9 - depicts the quantity of high-skill labor in the market. According to the figure, S1 is the original labor supply curve in the market, and D1 is the original demand curve of the market. The equilibrium point of figure 9 is E1, which occurs at the price W1 and quantity Q1. However, once the new technology arrives in the industry, demand for high-skill labor will increase because the industry needs more skilled laborers to perform these technical tasks. Therefore, demand for skilled labor will increase, and then the new demand curve is D2, and the Wage is W2.

The labor demand and supply curve predict that new automation technology in the apparel industry will raise the pay for the high-skilled labor and reduce the pay for low-skilled laborers in the industry. Apparel production mostly requires a low-skilled labor force to occupy the industry. The main reason for Asia´s competitiveness with the other countries globally is low labor cost, plentiful labor supply, and low material cost. These low labor costs and higher labor supply come with a comparative advantage for producing apparel for the world market. Therefore, this industry has plentiful employment opportunities for low-skilled laborers in the future. Nearly eight percent of employees recruited to the factory floor do not have the relevant skills to perform their job. However, with two or three weeks of training, these employees could be able to perform their job. For instance, a sewing machine operator only needs 4-6 weeks of training with education up to the primary level. Since these employees do not have sufficient educational proficiencies to do the high-skill jobs, these employees will risk losing there in the future(International Labour Organization, 2017, p. 54).

6.1.4 Investments

Chapter five presents the investment facilities in the apparel industry. However, South Asian countries mainly depend on FDI facilities because these countries do not have enough economic facilities to fund the apparel industry. Unfortunately, these FDI facilities are also not enough to make considerable adjustments in the technology field.

This research is mainly focused on the technological advancement of the apparel industry. Therefore, we need to determine how much countries have invested in developing automation technology in the apparel industry. As I found out through the empirical data, there is no specific information regarding the investment in developing the automation technology specifically. However, all the four countries have invested in developing the research and education facilities to do more research and future studies on apparel technology. For instance, as mentioned in the previous chapter, In April 2021, India´s ministry of textiles announced that the National Institute of Fashion Technology (NIFT) would work toward introducing technical textiles as an academic subject in the future. Moreover, except for Pakistan, the other two countries, Bangladesh and Sri Lanka have invested in developing technology-related subjects at the school and higher educational levels. Sri Lanka has invested Rs 100 million in introducing Fashion design and digital technology to the school level students as a school subject. Other than that, the country decided to invest Rs. Two hundred fifty million to the Sri Lanka Institute of Technology and Rs. Fifty million to the Centre in Robotics Applications to continue research in technology and innovations.

6.1.5 Workers and automation: Who is at risk of being left behind

Since the apparel industry is highly labor-intensive, investing in developing human capital is very important. Improving employees' labor productivity helps improve the sustainable development of the industry. Therefore, it is very important to invest in improving human labor. In the section, the following graph shows the labor productivity in apparel firms with more than 25 employees in Sri Lanka.

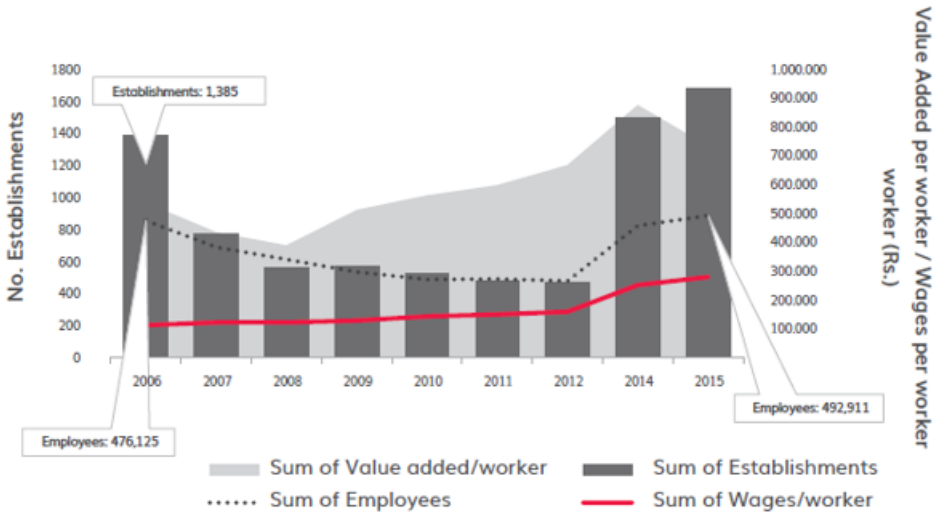

Figure 10. *Labour productivity in apparel firms with more than 25 employees, Sri Lanka (Fernando et al., 2020, p. 25).*

The above graph depicted employee productivity improvement over one decade in Sri Lanka. Beginning of the year, 2006 apparel sector employed 476,125 employees. However, between 2007 and 2014 number of employees was reduced due to the civil conflicts in the country. After many consequences happened in the country, the industry has managed to occupy more employees, and they have improved its human capital with training and development programs. Even after establishing new equipment in the industry, factory owners still prefer to occupy and develop their human capital in the industry (Fernando *et al.*, 2020, p. 24).

Bangladesh has made significant progress in exporting readymade apparel to world markets. During the past 15 years, the country has managed to increase some level of technology usage in its apparel factories, but it does not necessarily help decrease its employment opportunities. The following table will show the sample of automation status in the Bangladeshi readymade garment (RMG) industry and employment status in the industry.

Fiscal year	Factory (Cumulative)	Employment (In million)	RMG export (In million USD)	Export per employee (USD)	Export per factory (Million USD)
2004-2005	4,107	2	6,417.67	3,208.84	1.56
2005-2006	4,220	2	7,900.8	3,591.27	1.87
2006-2007	4,490	2.2	9,211.23	3,838.01	2.05
2007-2008	4,743	2.4	10,699.23	3,821.36	2.26
2008-2009	4,925	2.8	12,347.77	3,527.93	2.51
2009-2010	5,063	3.5	12,496.72	3,471.31	2.47
2010-2011	5,158	3.6	17,914.46	4,976.24	2.47
2011-2012	5,876	3.6	19,089.73	4,772.43	3.25
2012-2013	5,600	4	21,515.73	5,378.93	3.84
2013-2014	4,222	4	24,491.88	6,122.97	5.8
2014-2015	4,296	4	25,491.4	6,372.85	5.93
2015-2016	4,328	4	28,094.16	7,023.54	6.49
2016-2017	4,482	4	28,149.84	7,037.46	6.28
2017-2018	4560	4	30,614.76	7,653.69	6.71
2018-2019	4,621	4.5	34,133.27	7,585.17	7.39

Table 13. *Trends in employment and export performance (Hoque* et al.*, 2021, p. 2).*

The increase in export opportunities in the industry has stimulated the country to invest in improving the technology. However, it does not cause to reduce the employment opportunity in the industry. Instead, the number of employees has increased over the past decade in Bangladesh. According to (Hoque *et al.* (2021), automation in the Bangladeshi apparel industry has helped increase employment opportunities. While the machine supports performing complex tasks in the manufacturing process, human labor needs to maintain line balancing and operate these machines.

However, some studies contradict the view of unemployment in the apparel industry in Bangladesh. The following table will show the automation status in the apparel industry in Bangladesh and how many workers are employed in a specific task.

Task	Machine/Technology Used for automation	Workforce requirements at With automation	Workforce requirements at Before automation	Workforce requirements at With automation	Workforce requirements at Before automation
Fabric spreading	Auto spreader/Computer-aided spreader	4	8	2	10
Fabric lay-cut	Auto cutter	2	4	2	4
Fusing attach	Fusing machine	2	6	1	4
CAD pattern	Auto CAD	1	2	1	2
Back pocket making	Auto pocket welt machine	1	8	1	8
Waistband elastic joint	Waistband elastic automation machine	1	3	1	3
Loop joint	Auto loop setter	1	5	1	5
Marker	Auto plotter	1	3	1	3
Knitting	Modern sweater machines	1	5	1	5
Linning		1	23	1	23
Bar-tack attach		1	10	1	10
Pressing	Modern pressing machine	1	3	1	3
Auto folding	Auto folder	1	6	1	6
Auto carton	Cartoon makers	1	4	1	4
Autoloading roll	Autoloading machine	1	3	1	3

Table 14. *Automation status in Bangladeshi readymade garment industry (Hoque* et al.*, 2021, p. 7).*

The above table represents the two situations. The first situation shows the automation status of a woven factory in Bangladesh, and the second situation represents the workforce requirement of a knitwear factory in the same country. Before automation came to the industry, many employees were required to perform one task, but after automation came to the industry, the factory needed only one or

few employees to perform the same task. This depicts that automation has reduced the number of employees required to perform one task but replaced them with another task.

However, automation supports displacing some employees from the industry. The tables 14 shows that even though automation reduces the number of employees occupied to perform a specific task, the whole industry has increased the number of employees occupied the industry. What is the reason behind that? The factories use automation to improve the productivity of the manufacturing process and lower the production cost. As a result, these factories managed to get more orders from their clients and international markets. Therefore, the industry increases the total number of employees to increase its productivity of the industry. (Hoque *et al.*, 2021, p. 8)

7. CONCLUSION

The apparel industry in South Asia has been going through a remarkable phase of changing its job structure due to automation technology. The technology upgradation in India, Bangladesh, Pakistan, and Sri Lanka has opened up this industry to a new growth phase towards a more competitive industry with other apparel-producing countries. Unlike other apparel-producing countries in the region, these countries have fewer investment opportunities but human resources. However, this industry has fewer opportunities to invest in technology; employees fear losing their jobs due to the situation. Therefore, this industry has some complications regarding the coming situation.

According to the theories discussed in chapter four, it is clear that due to technological changes, industries would change their occupation structures. Since the apparel industry has two types of labor (high skill and low skill), the industry must decide which type of labor should keep with them. As the given economic model discussed, the industry does not necessarily reduce both high skill and low skill labor, but high skill labor has a more comparative advantage.

Empirical data available in this industry implies that these countries do not have enough investment in developing technologies for the industry. However, some foreign direct investments make some progress, but there is much more to be done. Further implied by the empirical data, automation in the industry reduce the number of employees occupied to finish a specific task done by low-skilled labor. This low-skilled labor is highly routinized and less likely to have cognitive skills. Therefore, these jobs will be reduced in the future. Instead, high-skill jobs requiring more cognitive skills such as analytical skills and data processing skills will have higher demand in the future job market.

In conclusion, automation´s impact will be most significant on low-skill labor in the industry. However, there is no consensus on the scale of unemployment that could be caused by automation in South Asia. Even though this region has a low potential of completely adapting to automation technology, governments in these four countries should prepare to adapt to the changes in the labor market. As the study illustrates, this region lacks empirical studies regarding technological labor

market changes. Therefore, I would like to suggest the following recommendations to formulate responsive labor market reforms for the South Asian apparel industry.

7.1 The way forward: Some Recommendations

I suggest the following recommendations to formulate responsive labor market reforms for the South Asian apparel industry.

Governments should introduce and implement policy proposals that strongly support investing in developing technologies in the apparel industry. Direct government subsidies can reduce the risk of factory owners on investment in technology upgradation. Moreover, governments can attract more investment through foreign partnerships. Due to the lack of financial stability in the countries, the industry cannot entirely rely on the local partners. Therefore, the government can invite foreign partners to invest in the industry by giving them friendly tax policy reforms and financial incentives to create more industry jobs.

Although we already know that education and training facilities are available in the industry, it is important to emphasize how much technology-related education is important in the industry. Many highly skilled and technology-related job positions are unfilled because of a lack of technology knowledge. Therefore, it is necessary to implement educational reforms that increase access to scientific knowledge, mathematical skills, and creative thinking skills essential to promote technology-based occupations. Further, facilitating technology-based higher studies and encouraging students to participate in an internship in the technology-based industrial firms will be helpful for them to adapt to the technology-based working environment at an early age in career life.

Providing adequate social security programs for the people at risk of losing their jobs in the future is another step governments should take immediately. Providing education loans for people who are willing to learn the new knowledge to adapt to a new field and providing unemployment benefits for people who are in the transition period (moving from one occupation to another) will help them become less vulnerable to the situation (Fernando *et al.*, 2020, p. 43).

Moreover, trade unions in this industry should raise their awareness about the upcoming situation in the industry. They should educate their followers about the policy changes happening in the industry and rules and regulations regarding the new changes in the industry. In addition to that, trade union leaders should represent the vulnerable employees in the industry, and they should always stand with these people when necessary. Further, trade unions always represent employee's demands with the government and other responsible parties through dialogues, negotiations, and collective bargaining (Lan., 2020, p. 23)

7.2 Limitations and Future Research Avenues

In the last two decades, significant changes have been made in the South Asian apparel industry. As a result, this industry made massive progress in economic, social, and legal aspects. However, compared to the apparel industry in other developing countries globally, such as China, South Korea, and Turkey, the South Asian region is still far behind these countries. Since South Asia still has a labor-intensive industry, they are far behind developed countries. Therefore, before discussing the limitations of the studies, it is necessary to keep in mind that this industry still needs more investment and attention from the governments of these countries.

As mentioned previously in chapter five, most apparel firms in these countries (India, Bangladesh, Pakistan, and Sri Lanka) are owned by the private sector. Therefore, these firms did not allow to reveal information regarding their financial status and investment capacities. This limited access to some necessary information about the industry and the technological status. Some information mentioned in the research was collected through interviews with employees working in the industry. However, we cannot wholly bargain with the employees to reveal more information regarding this matter to them. Since the financial situation of some of these countries are not in a good state, these employees were trying to keep their jobs in any cost. Therefore, I couldn't encourage them to reveal more industry information.

Technological unemployment is an important yet broad topic. It has many dimensions and aspects to discuss. Discussing employee displacement and employee wage distribution is not enough to cover the total topic. Since this is a master

thesis, I have a limited time frame and limited resources (access to necessary information) to cover up all the necessary information regarding the topic. Therefore, this study is only limited to a small range of a broad topic.

It was challenging to access data from four countries. However, the situation of all four countries is somewhat the same, and some firms I used to analyze operate in multiple countries. Therefore, I could use some data from one firm across the region. Additionally, this industry has a large scale of quantitative data. Therefore, it is not easy to analyze all data in this industry.

South Asia's economy mainly relies on the apparel industry and apparel exportation. Moreover, considerable employment opportunities are available in this industry for people with different skill levels. Even though this industry generates more than a million job opportunities in the field, the governments of these countries do not provide needed research facilities to improve research in this area. Further, very little academic research is available on this matter (Technological Unemployment).

Besides, studies on the future may not be confirmed until the future has arrived. Therefore, what I have mentioned in the discussion section may not be valid in the future. As this research is based on these countries' current information, economic situations, and political stabilities (2021/2022), things might change in the future. Therefore, future scenarios in the apparel industry might be entirely different from the aspects we discussed throughout the thesis.

In addition to the limitation of the studies, I would like to propose future research directions for the students who would like to explore further in this matter. Technological unemployment is still a new topic for the people of the South Asian region. Moreover, some employees in this region are not yet ready to adjust to the new situation coming with the technology. Due to that, there will be some changes in their occupational life, career perspectives, and personal life. Therefore, I recommend that future researchers explore their psychological well-being and mental health more.

Moreover, more research should be done to study policies affecting the industry's automation technology and how policies support securing unskilled female employees in developing countries. In developing countries, predominantly South

Asian and South African regions employ more female workers than male workers. However, unfortunately, these female workers do not have sufficient knowledge to work with new technologies. In addition, poverty prevailing in these families and the lack of social security systems to prevent poor and unemployed people make these people more vulnerable. Therefore, it is necessary to study this situation more and take further action.

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