Report On

Industry Revolution 4.0 and Digital Transformation - It's Implementation, Opportunity and Challenges in Bangladesh Textile Industry

By

Ismail Hossain Tushar
Student ID- 19164070

An internship report submitted to the BRAC Business School, Department of Business
Administration in partial fulfillment of the requirements for the degree of
Master of Business Administration (MBA)

BRAC Business School, Department of Business Administration
BRAC University
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Declaration

It is hereby declared that

1. The internship report submitted is my own original work while completing degree at Brac University.

2. The report does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.

3. The report does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.

4. I have acknowledged all main sources of help.

Student's Full Name & Signature:

_____

Ismail Hossain Tushar
Student ID- 19164070

Supervisor's Full Name & Signature:

_____

Monirul Islam Akhand
Professor, BRAC Business School
BRAC University

Letter of Transmittal

Monirul Islam Akhand

Professor,

BRAC Business School

BRAC University

66 Mohakhali, Dhaka-1212

Subject: Submission of Internship Report for the MBA Program

Dear Sir,

I would like to express to you my robust thanks for your valuable supervision and support to prepare my internship report. With immense pleasure, I am submitting my internship report on "**Industry Revolution 4.0 and Digital Transformation - It's Implementation, Opportunity and Challenges in Bangladesh Textile Industry**", which was assigned to me as a part of my MBA Program.

I have attempted my best to finish the report with the essential data and recommended proposition in a significant compact and comprehensive manner as possible.

I trust that the report will meet the desires.

Sincerely yours,

_____

Ismail Hossain Tushar

Student ID- 19164070

BRAC Business School

BRAC University

Date: January 10, 2021

Non-Disclosure Agreement

This agreement is made and entered into by and between **Groz-Beckert** and the undersigned

student at BRAC University Student **Ismail Hossain Tushar**, **Student ID – 19164070**.

Student's Full Name & Signature:

_____
Ismail Hossain Tushar
Student ID- 19164070

Line Supervisor's Full Name & Signature:

_____
Jimmy Singh
Senior Area Sales Manager, Weaving Division
Groz-Beckert

Acknowledgement

Executive Summary

The latest vide in the global industrial sector is the fourth industrial revolution termed as Industry 4.0 and the transformation that the manufacturing and service industries are going through. Hence, a big question arises about the impact of the fourth industrial revolution on Bangladesh textile and apparel industry and trade. Many analysts are enquiring whether the textile-apparel industry of Bangladesh is ready for the Industry 4.0 or not.

The textile industry worldwide is currently experiencing the effects of digitalization and implementation of Industry 4.0 practice, which resulting in increasing individualization, networking of devices and people as well as progressive automation of production and logistics processes are increasingly coming into focus. Technological innovations and changing customer expectations require new business models and organizational principles in the textile industry.

Now the question comes in front that **"Is Bangladesh ready to accept Digitalization and Industry 4.0"**? And the answer is **Yes**. We are ready for the digitalization and industrial revolution 4.0. In the situation of covid-19 corona pandemic we are all adopting the new technologies and ideas to recover. We are adopting new transformation ideas such as online shopping with zero contact, virtual office, online class, working from home, etc. concept. This will be helped us to face the upcoming trend of digitalization tools and processes and industry revolution 4.0 in textile industry.

Keeping this in mind, this research paper is designed for the implementation, opportunities and challenges of the digitalization and Industry 4.0 practices for Bangladesh textile industry.

Keywords:

IndustryRevolution4.0;DigitalTransformation;BangladeshTextileIndustry;Automation

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List of Acronyms

3D   Three Dimensional

AI   Artificial Intelligence

AR   Augmented Reality

BB   Bangladesh Bank

CAD   Computer Aided Drafting

CAM   Computer Aided Manufacturing

CS   Cyber Security

ERP   Enterprise Resource Planning

ICT   Information and Communication Technologies

IIoT   Industrial Internet of Things

IoA   Internet of Automation

IoR   Internet of Robotics

IoT   Internet of Things

IR   Industry Revolution

MaaS   Manufacturing as a Service

MES   Manufacturing Execution System

PLM   Product Lifecycle Management

RaaS   Robotics as a Service

RFID   Radio Frequency Identification Device

RMG   Ready Made Garments

SCM   Supply Chain Management

VR   Virtual Reality

Glossary

App

Apps for industrial scenarios – programs for defined, specific applications – are the answer that experienced specialists with extensive process and industry know-how offer up for customers' challenges. Intelligent mobile apps make modern companies Industry 4.0-capable.

Artificial Intelligence

Artificial Intelligence (AI) is the step required for implementing the fourth stage of the robotic revolutions. It presupposes that machines, information systems and robots are capable of becoming still much more intelligent and responsive.

Big Data

The term "Big Data" refers to quantities of data that are too large or too complex, that change too quickly or are too weakly structured for them to be evaluated with manual and conventional methods of data processing.

Digital Business Transformation

Digitization is upending a large number of existing business models. Networked automation, intelligent processes, shared expertise across companies and industries, and a holistic view of the value chain with involvement of the customer – these are the characteristics of digitized business models.

Digitization

Converting real products and analog sequences into digital data and processes is referred to as digitization. In Industry 4.0, people, machines and industrial processes are networked on the basis of cyber-physical systems incorporating state-of-the-art information and communications technology.

Flexibility	Flexibility is the ability to react quickly to changing influences. In the smart factory, utmost flexibility results primarily from the combination of IT technologies, such as the Cloud and Big Data, with intelligent, generic production units incorporating robots and autonomously controlled mobile units.
Horizontal Integration	Exact coordination is not only indispensable for internal process optimization within a company, but also between all companies involved in the value chain. This horizontal integration – networking between different enterprises and their assets – is the starting point for the flexible design of their shared value creation processes.
Individualized Production	Individualized, or customized, production refers to the concept of an intelligent, highly automated production system that allows high variance and dynamism in the product range with production costs at the level of mass production.
Industry 4.0	Industry 4.0, Smart Production or Internet of Things (IoT) – even if the names and terms used vary from one country to another, they all share the same goal. What is called for here is nothing less than a long-term transformation of our global perception of industrial production through the seamless connection of the digital and real worlds.
Internet of Automation (IoA)/ Internet of Robotics (IoR)	Both the Internet of Automation (IoA) and the Internet of Robotics (IoR) make use of defined open communications and data standards to network interoperable production processes even across company boundaries.
Internet of Things	Like Industry 4.0, the Internet of Things (IoT) presupposes a

(IoT)	network of physical objects – devices, vehicles, buildings and other items – which are fitted with electronic components, software and sensors, all of them being linked interoperable via the Internet.
Logistics	Customized products and same-day delivery – customers have a growing expectation that everything will be available in all places, at all times. This ubiquity places the utmost demands on the logistics and process chains and is increasingly embracing the stationary retail sector and the structure of merchandise flows.
Machine Learning	Intelligent machines garner their knowledge through experience. In the case of networked machines, it is irrelevant whether the experience is their own or originates from swarm intelligence.
Manufacturing as a Service (MaaS)/ Robotics as a Service (RaaS)	Digitization has substantially changed the approach to physical possession. This is increasingly being replaced by temporary access to goods or services. The best example: music streaming. What has already become an everyday situation in many consumer segments will also revolutionize the industrial environment over the next few years. As the name implies, manufacturing processes are provided as a service when offering "Manufacturing as a Service": the machine does not change ownership, and only the service of the machine is paid for (for example in the form of a cost-per-uptime model). What applies to complete production systems will, in the future, also hold true for individual elements within a manufacturing facility – for robots, for example. On the basis of a "pay-per-use" model, it will not be the physical object itself that is purchased in conjunction with "Robotics as a Service", but rather its performance, such as weld

spots in vehicle body production, for instance. The smart factory of the future integrates these services seamlessly into its production processes and thus has the capability of reacting to varying capacity requirements and goods flows exceedingly flexibly and efficiently while conserving resources at the same time. Ultimately, these business models uproot traditional ideas of what a value chain may look like: the principle of shared production will become more important, allowing the end user to act as a co-producer.

Manufacturing Ecosystem	If the best available expertise can be focused upon every single process step and every single level of activity, all parties involved benefit: product designers, developers, manufacturers, logistics specialists and end customers. A complex network that optimally brings together all relevant expertise in terms of personnel, economy and technology is considered an ecosystem. This comprises hardware and software resources, process and project know-how, consulting expertise and complex networked architectures of production and information technology.
Mobility	The production of the future requires greater flexibility – for both faster manufacturing and customized products. One indispensable prerequisite for creating a higher degree of flexibility in industrial environments is greater mobility. This can be achieved by means of episodic, periodic or permanent mobility concepts that each bring about acceleration in industrial production in their own specific ways.
Monitoring and	Monitoring and stream analytics compare and analyze data that is

Stream Analytics	available to the smart factory from diverse sources – devices, sensors, infrastructure, etc. In real time they make comparisons with data records from the past, recognize anomalies and are able to categorize faults with the aid of machine learning.
Safety and Security	In OT contexts, the term "safety" is used to refer to the safeguarding of people and machinery as well as the availability and reliability of production equipment. In the IT environment, the term "security" primarily relates to data security, integrity and confidentiality.
Smart Data	If Big Data is the oil of the future, then Smart Data is the fuel that drives the production of the future. Currently, data is just data. To turn it into information, it must be interpreted. This is the step from perception (recognizing) to cognition (understanding).
Smart Factory	The intelligent factory of the future is a production facility in which manufacturing systems, robots, logistics systems, products and their components are largely able to organize themselves autonomously. The smart factory is undergoing a paradigm shift towards an entirely new production logic: smart products, components, tools and machines are unambiguously identifiable, can be localized at all times and are aware of their history, their current status and multiple ways to the desired goal. With the smart factory's high degree of flexibility, customization with a batch size of 1 will become reality in the context of industrial mass production.
Traceability	Traceability here refers to the ability to fully trace all raw materials, producers, upstream suppliers, individual parts or assemblies as well as the complete product and its consumers in the digital value chain.

Value Data	Individual data is like isolated objects in a void. They only make sense in context, and meaningful data can yield information that increases in value through being made exploitable for various purposes. Without being assigned, processed, compared, etc., data about the actual states of different parameters of a machine are nothing but loosely connected numbers.
Vertical Integration	Networking the various assets within a company into an efficient production unit is one of the prerequisites for creating a smart factory. The different manufacturing stages with their respective specific assets can thus be merged into an integrated production process, for example. The networking of individual levels and assets via a cloud enables company-wide horizontal integration of the value chain as described in the Industry 4.0 concept.
Weaving	Weaving is an ancient textile art and craft that involves placing two sets of threads or yarn made of fiber called the warp and weft of the loom and turning them into cloth. This cloth can be plain (in one color or a simple pattern), or it can be woven in decorative or artistic designs, including tapestries.
Yarn	Yarn is a long continuous length of interlocked fibers, suitable for use in the production of textiles, sewing, crocheting, knitting, weaving and ropemaking.

Chapter 1

1.0 Introduction

INDUSTRY 4.0 can be identified as the current trend of automation and data exchange in manufacturing technologies which includes cyber-physical systems, the Internet of things and cloud computing. The smart factory concept has been designed under the Industry 4.0 as a future aspect of the manufacturing industry. Currently the world is in the edge of Industry 3.0 which has been primarily driven by Information & Communications Technologies (ICT) enabling both manufacturing and service sectors to achieve many gains. Today, sensors, RFID chips, 'cyber physical' systems and the Internet of Things (IoT) are transforming manufacturing and services across their entire supply chains.

When considering about the concept of the fourth industrial revolution as a country, the major question that would arise could be, whether Bangladesh has the capability to adopt the concept. Even though this concept originated from the high end technological industrial world, Bangladesh should consider of adopting the concept as this shows the world is heading to a technological standardization process with the smart factory with digital and automation concept which is a backbone of the 4th industrial revolution. The Annual Survey of the Industries of Bangladesh reveals that the manufacturing is dominated by having 96.5% of the industrial establishments and 86% of them contain the apparel products. There are more than about 5000 garment factories, almost 4.4 million people are working. So, after the historic pandemic arises, this is the great time for Bangladesh textile industries to be transformed into digitalized smart factories with automation and Industry 4.0 practice.

This research study is specialized about what digital transformation possibilities can be achieved by Bangladesh textile industries and how industry revolution 4.0 will help them to be more competitive in the world textile and apparel market. This report will also show

challenges and opportunities of digital transformation and industrial revolution in the textile industry.

1.1 Problem Statement and Significance of the Study

The pattern of Bangladesh textile-apparel industry is still manufacturing low to mid-range ready wear apparel products backed by local textile industry supplying with around 50%-60% basic textile materials including yarns, knit and woven fabrics. Bangladesh still is dependent on overseas sources for sophisticated textiles including knit, woven, synthetics and dyes, chemicals, accessories etc. Matter of fact is that the demand of these consumer apparels of low to mid-range products and high due to the fast fashion trends in the western countries and all over the world.

Bangladesh is becoming an unprecedented player in this market segment due to its large capacity and relatively lower costs. In this circumstance, the dynamics of the global apparel market will push the Bangladesh apparel industry further to grow big in volume in the upcoming years. As a result, a big portion of the apparel industry will remain more labor intensive and less technology oriented to satisfy the big demand of consumer apparels. However, as unprecedented effort is also on the go to transform the apparel industry towards more sustainability addressing the compliance, working conditions, workers wage, environmental and ethical issues. Many tools of Industry 4.0 will come into play specially cases pertaining to the upskilling of the apparel industry workers to become more tech-savvy so create an environment where the more technology-oriented solutions can be adopted.

The analysis of this research study will clearly depict that the industry 4.0 tools are more relevant with the forward linkage industries of apparel manufacturers pertaining to the issues like simulating garment designs, digital marketing, supply chain integrations and consumer data analytics. However, the tools concerning with smart manufacturing will also come into

play in the recent future as the Bangladesh slowly enters into more technology-oriented solutions for value added manufacturing. It's important to take proper steps now to train our workers and management so that Bangladesh textile-apparel industry can transform smoothly to a more value added and sophisticated manufacturing industry.

1.2 Research Objective

Main objective of this report is to identify the current opportunities and challenges of the Bangladesh textile industry step into the digital transformation for different process and activities. This report will also find out the implementation possibilities of Industry 4.0 in the textile sector. Moreover, it provides a source of information on the latest market situation of digital transformation, usage of cloud-based operation, IoT and industry automation development which can be useful to realize the competitive position of Bangladesh in textile sector throughout the world. The specific aims are given below:

- To know about digital transformation and industry revolution 4.0

- To know about all industrial revolution and their contribution to textile industry

- To identify the organization making possible for digital transformation and Industry 4.0 to Bangladesh textile industries

- To acknowledge opportunities and challenges of digital transformation and industry 4.0 to Bangladesh textile industries

- To recommend some suggestions to overcome the challenges of digital transformation and Industry 4.0 in Bangladesh textile industry

1.3 Scope of the Study

The study focuses on digital transformation scope for the textile industry in Bangladesh and take part as a competitive market for apparel and clothing into world textile sector. This report will also highlight the factors like opportunities and challenges facing by the

companies who are involved in digital transformation of textile industries, implementation of Industry 4.0 practice in textile factories, benefit of the textile companies after implementing the digitalization and industry automation in Bangladesh. This study is completed based on research including online search, analyzing reports and potential interview with the digital transformation firm owners, employees and clients specially textile factories. Some remarkable scopes of this research are:

- Current and future opportunities for textile companies into digital transformation
- Challenges or difficulties faced or may arise in future for the implementation of digital transformation and Industry 4.0 practice
- Some possible solutions and recommendations to improve the strategies of the business

1.4 Limitation of the Study

This research report primarily depended on the input for the industry experts. Though this study provided a significant guideline on implementation, opportunity and challenges for industry 4.0, it still requires further in-depth investigation to validate the finding. However, the best outcome of this consultative meeting is the identification of areas that would require further research. There were some limitations of this research highlighted below-

- Due to barrier of information disclosure policy companies, respective personnel could not provide all information.
- Time constrains was one of the major limitations for data collection.
- Lack of information and data to analyze and recommendations given based on academic learnings and work experiences. There might be other solutions to the challenges.

- Insufficient implementation of textile digitalization process and industry automation into maximum number of textile industries did not allow me to do the research study properly.

Chapter 2

2.0 Literature Review

Since the 1800s, we have experienced three industrial revolutions. Each was powered by a disruptive new technology: the mechanics of the steam engine, the innovation of the assembly line, and the speed of the computer. The reason they were called industrial "revolutions" was because the innovation that drove them didn't just improve productivity and efficiency a little bit – it completely revolutionized how goods were produced and how work was done.

We are now in the Fourth Industrial Revolution, aka Industry 4.0, which takes the automation and computerization we saw in the Third Industrial Revolution into the future. Industry 4.0 is powered by the Industrial Internet of Things (IIoT) and cyber-physical systems – smart, autonomous systems that use computer-based algorithms to monitor and control physical things like machinery, robots, and vehicles. Industry 4.0 makes everything in Your supply chain "smart" – from smart manufacturing and factories to smart warehousing and logistics. But Industry 4.0 doesn't stop at the supply chain. It inter-connects with back-end systems, like enterprise resource planning (ERP), to give companies an unprecedented level of visibility and control. Ultimately, Industry 4.0 is a major part of any company's digital transformation.

While doing research and survey I have found multiple researchers' opinion regarding digital transformation of textile industry and implementation of Industry 4.0 in textile value chain process. Modern technology is changing the state of manufacturing, with most of it happening as a result of Industry 4.0's rise. Another element is an evolution in consumer demand, as people want higher-quality products delivered at unprecedented rates. Industry 4.0 has allowed manufacturers to keep up with market changes and consumer demand, thanks

to the incredible capabilities of technology. Computers, software and nuanced data have all become an instrumental part of the production process. Smart, connected devices and sensors better inform active processes, sometimes even allowing for complete autonomy.

According to the Professor Thomas Gries at the Russian-German event "Digital Transformation of Light Industry", organized by the Russian Union of Industrialists and Entrepreneurs (RUIE), in its structure more than half of the annual production volume falls on technical textiles and related products, which is due to domestic and foreign demand. At the same time, digitalization determines the further development of the German textile and light industry, where sub-sectors of light industry are intertwining more and more closely, literally. (1)

The future of truly smart textiles lies in the potential of technology convergence, where the processing of electroactive polymers and molecular electronics into fibers and fabrics. The polymers on being transferred to the textile industry, will be able to produce soft intelligent textile products that will permit a broad spectrum of functions and capabilities.

The installation of textile mechanical sensors which can sense and measure gestures and movements, Textile systems that can sense the physiological signals of the wearer to recognize how the wearer s feeling and respond accordingly, Effective bulk use of conductive fabric on which thermochromic ink can be printed and the use of electroactive polymers like light emitting polymers, power polymers and actuators as well as electronic ink can be extensively carried out with the progress of Industry 4.0.

Nanotechnology has now emerged as the future of fabrication. Multi-functional, responsive and adaptive fibers can be produced by modifying the surfaces of fibers and using grafting materials.

The information and communication technology unit's collaboration with the community of design and human sciences gives a whole new dimension to the fabric production process. Integration of electronic functionality into textiles ensure versatility and quality in the nature of the commodities.

Considering the Textile Industry 4.0, it represents a leap forward from traditional automation to a more flexible system in order to learn and adapt to new demands. It pushes the global manufacturers to a new level of optimization and productivity. The customers also have the advantage of obtaining customized personal quality products that were previously unavailable. Industry 4.0 can be primarily stated as an approach to merge the latest advancements in technology with industries with a view to entirely automate the process of production.

"We must live in this world in order always to learn industriously and to enlighten each other by means of discussion and to strive vigorously to promote science and technology."

-Wolfgang Amadeus Mozart (2)

Chapter 3

3.0 Methodology

I followed a comprehensive research methodology to develop this report. The research started with an extensive desk research that included review different international publications, policies of other countries and other related materials available online.

The desk study took guidance from a similar study that applied a research methodology developed by Carl Frey and Michael Osborne of the University of Oxford. Once the desk research was completed, I developed a framework and based on the framework consultative workshops with key stakeholders from textile sectors were conducted. The discussion from the workshops were encoded, transcript and analyzed to develop the first draft report. Based on the findings of the report the consultants conducted key informant interviews with leading experts on the subject to clarify some of the queries generated during the workshops.

As data is the vital part of the study and to make it more meaningful, it was collected from both primary and secondary sources.

- The primary data is collected or observed directly from first-hand experience through interviewing individuals and surveying different companies.

- The secondary data are those which have already collected by someone else and wish to pass through the statistical process.

3.1 Sources of Data

- **Primary Sources -** When data are collected directly from the field those are called primary sources of data. I collected primary data by using following methods:

- o Interview Method: The interview was a face to face situation where I asked particular questions to individuals who were employee of an organization, owner of an

organization and textile industries possible to implement digital transformation and automation. The questions were designed in such a way where answers would be relevant to the research.

- Survey Method: Though survey and interview methods are closely related but it was performed particularly to gain an understanding of an individual's attitude towards the necessity of Industry 4.0 implementation in the textile value chain processes. Survey was a combination of some close-ended questions which were helpful for this study. The target group for this survey was mostly senior people who aged between 50-70 years to particularly understand their thoughts and beliefs toward the textile automation and digital development. The survey was completely done through contacting people on online and it was easier than other methods.

- **Secondary Sources –** Following are the techniques of collecting secondary information:

- Sustainable reports of textile retail brands

- Different journals, publications, websites and newsletters regarding digital transformation, industry automation, industry revolution 4.0

- Internet was also used as theoretical source of information

3.2 Research Questions

I have generated some research questions which helped me to think more deeply about my research topic. These questions guided me toward the analysis and interpretation of the data, findings as well as recommendation. The questions are based on the perspective of Bangladesh's companies and the people related with it. The questions are given below:

- What is Industry 4.0 and digital transformation mean?

- How do Factory think of digital transformation and Industry 4.0 will help to textile manufacturing?

- Do Factory think adaptation of digital transformation and industry automation will be beneficial for getting more orders from retail buyers?

- How do Factory think Factory will be ahead of Your competitors after implementing digital presence into the market?

- What steps should be taken to implement industry automation process?

Chapter 4

4.0 Industry 4.0

The term of Industry 4.0 is used to be defined, "A set of technology transformations in systems and product design, production and distribution and to describe the production process organization that are based on communicating technologies and devices." Industrial Revolution 4.0 or IR 4.0 is a combination of Artificial Intelligence, Robotics, the Internet of Things (IoT), Genetic Engineering, 3D Printing, Quantum Computing, and so on. (3)

4.1 Pillars of Industry 4.0

Industry 4.0 is built on nine technology pillars. These innovations bridge the physical and digital worlds and make smart and autonomous systems possible. Businesses and supply chains already use some of these advanced technologies, but the full potential of Industry 4.0 comes to life when they're used together.

- **Big Data and AI analytics:** In Industry 4.0, Big Data is collected from a wide range of sources, from factory equipment and Internet of Things (IoT) devices, to ERP and CRM systems, to weather and traffic apps. Analytics powered by artificial intelligence (AI) and machine learning are applied to the data in real time – and insights are leveraged to improve decision-making and automation in every area of supply chain management: supply chain planning, logistics management, manufacturing, R&D and engineering, enterprise asset management (EAM), and procurement.

- **Horizontal and vertical integration:** The backbone of Industry 4.0 is horizontal and vertical integration. With horizontal integration, processes are tightly integrated at the "field level" – on the production floor, across multiple production facilities, and across the entire supply chain. With vertical integration, all the layers of an

organization are tied together – and data flows freely from the shop floor to the top floor and back down again. In other words, production is tightly integrated with business processes like R&D, quality assurance, sales and marketing, and other departments – and data and knowledge silos are a thing of the past.
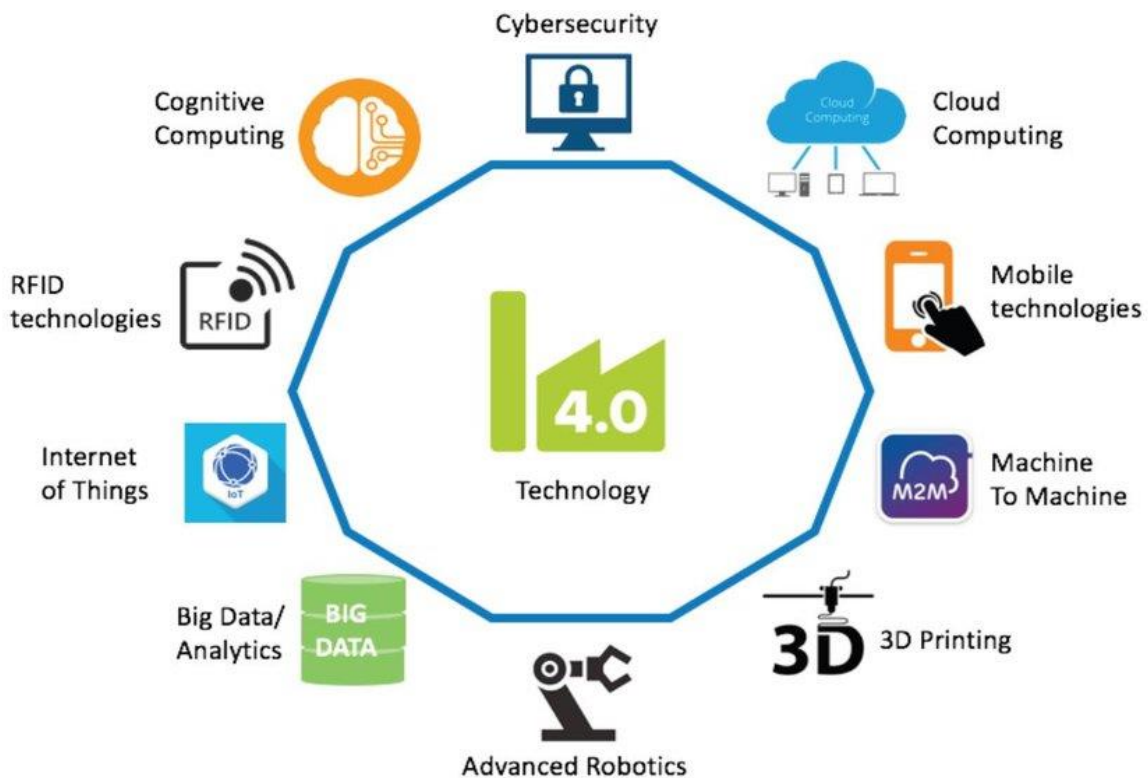
Figure 1: 9 Pillars of Industry 4.0

- **Cloud computing:** Cloud computing is the "great enabler" of Industry 4.0 and digital transformation. Today's cloud technology goes way beyond speed, scalability, storage, and cost efficiencies. It provides the foundation for most advanced technologies – from AI and machine learning to the Internet of Things – and gives businesses the means to innovate. The data that fuels Industry 4.0 technologies resides in the cloud, and the cyber-physical systems at the core of Industry 4.0 use the cloud to communicate and coordinate.

- **Augmented reality (AR):** Augmented reality, which overlays digital content on a real environment, is a core concept of Industry 4.0. With an AR system, employees use smart glasses or mobile devices to visualize real-time IoT data, digitized parts, repair or assembly instructions, training content, and more when looking at a physical thing – like a piece of equipment or a product. AR is still emerging but has major implications for maintenance, service, and quality assurance as well as technician training and safety.

- **Industrial Internet of Things (IIoT):** The Internet of Things (IoT) – more specifically, the Industrial Internet of Things – is so central to Industry 4.0 that the two terms are often used interchangeably. Most physical things in Industry 4.0 – devices, robots, machinery, equipment, products – use sensors and RFID tags to provide real-time data about their condition, performance, or location. This technology lets companies run smoother supply chains, rapidly design and modify products, prevent equipment downtime, stay on top of consumer preferences, track products and inventory, and much more.

- **Additive manufacturing/3D printing:** Additive manufacturing, or 3D printing, is another key technology driving Industry 4.0. 3D printing was initially used to as a rapid prototyping tool but now offers a broader range of applications, from mass customization to distributed manufacturing. With 3D printing, for example, parts and products can be stored as design files in virtual inventories and printed on demand at the point of need – reducing both transportation distances and costs.

- **Autonomous robots:** With Industry 4.0, a new generation of autonomous robots is emerging. Programmed to perform tasks with minimal human intervention, autonomous robots vary greatly in size and function, from inventory scanning drones

to autonomous mobile robots for pick and place operations. Equipped with cutting-edge software, AI, sensors, and machine vision, these robots are capable of performing difficult and delicate tasks – and can recognize, analyze, and act on information they receive from their surroundings.

- **Simulation/digital twins:** A digital twin is a virtual simulation of a real-world machine, product, process, or system based on IoT sensor data. This core component of Industry 4.0 allows businesses to better understand, analyze, and improve the performance and maintenance of industrial systems and products. An asset operator, for example, can use a digital twin to identify a specific malfunctioning part, predict potential issues, and improve uptime.

- **Cybersecurity:** With the increased connectivity and use of Big Data in Industry 4.0, effective cybersecurity is paramount. By implementing a Zero Trust architecture and technologies like machine learning and blockchain, companies can automate threat detection, prevention, and response – and minimize the risk of data breaches and production delays across their networks.

(3)

4.2 Textile Industry Transformation through Industry Revolution 1.0 – 4.0

Industrial Revolution	Year	Transformation	Impact on Textile Industry
The 1st Industrial Revolution	1784	• Mechanization • Steam Power • Weaving Loom	The first mechanical weaving loom developed in 1785 by Edmund Cartwright. Spinning and weaving mills become mechanized. It caused the end

			of hand wheeled production era
The 2nd Industrial Revolution	1870	• Mass Production, • Assembly Line, • Electrical Energy	The serial production was first invented in 1910 by Henry Ford as part of IR 2.0. Textile industry transformed from cottage based to industrial assembly lines and shifted from western to Asian countries.
The 3rd Industrial Revolution	1969	• Automation, • Computers and websites • Electronics	Textile machineries become sophisticated and automated. China become a giant in textile sector. Western industries became bankrupts and shifted their production to Asian countries.
Industry Revolution 4.0	Today	• Cyber Physical Systems, • Internet of Things, • Cloud Networks	Textile industries are becoming more productive, more efficient, more secure, supply chain.

Table-1: Textile Industry Transformation through IR 1.0 - 4.0

4.3 Incorporation of Industry 4.0 in Textile-Apparel Supply Chain

Big Data Analytics	With big data and business analytics solutions, data driven decision making and representation has become really easy. Specially, in the consumer behavior research, apparel retailer market decision

	making is now more realistic and effective.
Autonomous Robots	The use of autonomous robots in textile or apparel manufacturing is still indistinguishable. However, autonomous robots may come in to play in delicate manufacturing of textile components where human interaction is difficult.
Simulation	Simulation technology opens scope for virtual garments design, machine settings for new textile products development and virtual plant operations.
Horizontal and Vertical System Integration	Flow of material, information and finance from fiber manufacturers to the clothing manufacturers to the retailers will be more effective through horizontal and vertical system integration.
The Industrial Internet of Things	It's a technology to develop an interacting network among the controlling points of a manufacturing system which will allow simplifying supply chain variables, merchandising activities and business decision making.
Cyber Security and Cyber Physical Systems	The Cyber Security and the CPS is more concerned with the IT products, however, as communication is a big issue in textile-apparel global supply chain this technology will ensure mote security and integrity of information access between consumer and manufacturers. Technologies like RFID which is already in use will be a common practice to track down the product location, identity and important facts that the stake-holders should know about.
The Cloud	The cloud technology was already there but Industry 4.0 opens new

	dimension in digital marketing, consumer driven garment design and the bespoke retail market.
Additive Manufacturing	Additive manufacturing technology will be used in more sophisticated textile manufacturing like medical textiles, agro-textile, geo-textile etc. which will result is effective production, fault prevention and reduction of production costs.
Augmented Reality	Augmented reality can be an effective tool in training of the operators and engineers working with textile and apparel manufacturing machines and systems. It will also help in decision making with a more realistic physical-environmental conditions.

Table-2: Incorporation of IR in Textile-Apparel Value Chain
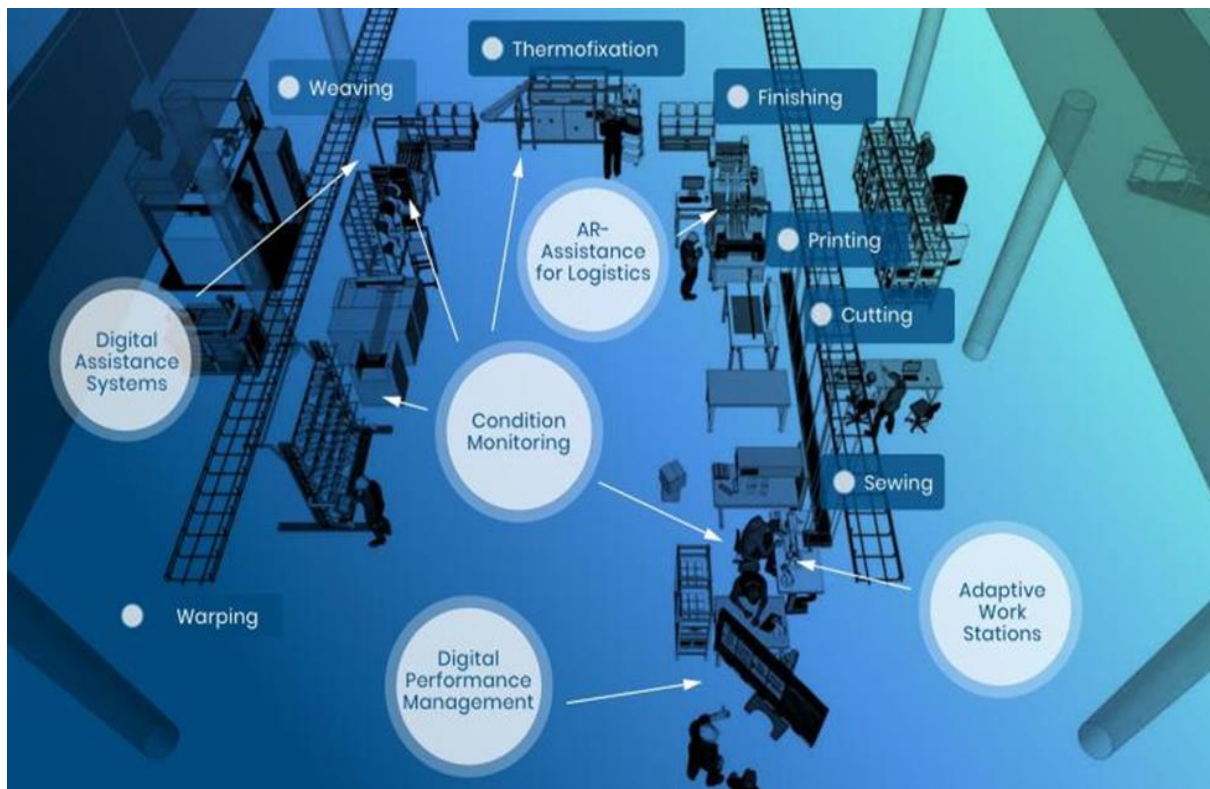
Figure 2: Industry Automation in Different Textile Process

4.4 Industry 4.0 Requirement in Bangladesh Textile Industry

Bangladesh has drawn global attention as a "development surprise," thanks to our impressive economic performance – with an average GDP growth of over 7% for the last two years -- and improvements in other socio-economic parameters. It has already attainted the status of lower middle-income country and made tangible progress in the areas of industrialization, education, health, trade, infrastructure, energy and power, ICT and other service sectors. According to PWC's predictions, Bangladesh will be the 28th largest economy by 2030. Industrial development has a major role to play in realizing this potential as it will be a key driver of our economic growth. The ready-made garments (RMG) industry of Bangladesh has considerable strengths and immense potentials to complement this growth.

Bangladesh textile industry is still manufacturing low to mid-range ready-made garments (RMG) products backed by local textile industry. Which is supplying with around 50-60 percent's textile materials. Bangladesh still is not independent on overseas sources for sophisticated textiles including knit, woven, dyes-chemicals, accessories etc. Demand of consumer apparels of low to mid-range products and high due to the fast fashion trends all over the world. Bangladesh is becoming an unprecedented player due to its large capacity and lower costs. In this case, the dynamics of the global apparel market will push the Bangladesh Textile industry further to grow big in volume in the upcoming years.

While it's excellent that we are responding to environmental needs, we must also make use of new patterns and fourth generation technologies including the advanced applications of information technologies in our supply chain management. At the same time, we have to enhance our productivity and efficiency, which requires technology upgrades and modernization of factories. For below requirements Bangladesh textile industry need to adapt quick digital transformation, automation and Industry 4.0 practice:

- With the diversity in demands, the need for hybrid and highly fragmented value chains has increased. In order to emerge as successful key suppliers and effectively adopting digital technologies for rapid rate of production, accepting the revolution 4.0 becomes mandatory. The industry as a result becomes a center of progressive production technologies and a base for piloting and scaling up new digital solutions. (2)

- The rapid advance of digital operation technologies and Industry 4.0 solutions represents a great opportunity to increase the competitiveness of the textile manufacturing industry. The increasing connectivity of functions across the value chains, smart connected products and data driven services ensure a productivity increase of around 20%, savings in services and maintenance costs of up to 10-40% and increase in time to market of around 20-50%. (2)

- Textile Industry 4.0 enables smart connected products to serve as a technological foundation for incorporating new business models or data driven business models in textiles and thereby exploit new revenue pools. (2)

- Smart textile products hold large growth potential. According to market forecasts, the global market for smart textiles will grow to about USD 3 billion by 2026. For the mass production of smart textile products, the hybrid and typically highly fragmented value chains are required to become increasingly interconnected, which is achievable by Industry 4.0 developments. (2)

- Speed and optimum use of resources will be the key to future business success and sustainability. Looking further forward, 3D printing technologies is anticipated to bring major disruption in fashion manufacturing and retailing.

- Considering the importance of technological upgrades for the future success of apparel industries, our competing countries have introduced special policy support like the Technology Upgradation Fund Scheme (TUFS) for the garment and textile industry in India. Bangladesh has made tremendous progress in digital transformation over the last decade under the government's "Digital Bangladesh" initiative; we have to now reap the benefits of digitalization by embedding it in our industry for which we need policy support.

4.5 Tools for Digital Transformation and Automation of Bangladesh Apparel and Textile Industry

In a general sense, the manufacturing innovations brought on by Industry 4.0 allow companies to optimize their existing systems and grow to create more efficient processes. More specifically, smart manufacturing can turn the concept of affordable mass customization into reality. Several companies have already put it into play with experimental trials.

There are many forms of advanced digital technologies that come into play with a custom clothing or footwear company. Some of the tools include:

- Augmented reality and computer vision for fitting and design

- Thermal imaging for niche uses

- Artificial intelligence for shop floor operations

- Machine learning for logistics

- 3D printing and knitting for producing personalized garments

- Robotics for packaging and distribution

These tools are just some of what makes the fashion industry capable of creating individualized articles of clothing for consumers. And the production methods lend themselves to efficient production — completely custom items produce zero waste materials, making it a lean practice by default. In the near future, the increasing number and efficiency of smart factories will make ordering bespoke clothing easy and common.

4.6 How Bangladesh Apparel and Textile Manufacturers Can Prepare

While keeping up with the hardware and software trends of Industry 4.0 can be highly beneficial to Your apparel business, Factory need to know where to start. Factory can't just start to implement new forms of software and devices in Your current system without considering what foundations Factory have set up and how Factory should go about advancing them.

Apparel manufacturers can prepare their systems by:

- **Redirecting internal IT:** Rather than keep an IT team to deal with on-site software and hardware issues, get rid of the issues at the root. Change Factory's focus to innovative off-site systems, where Factory can host all Factory's data in the cloud. It's a beneficial switch that's more compatible with other Industry 4.0 systems. (4)
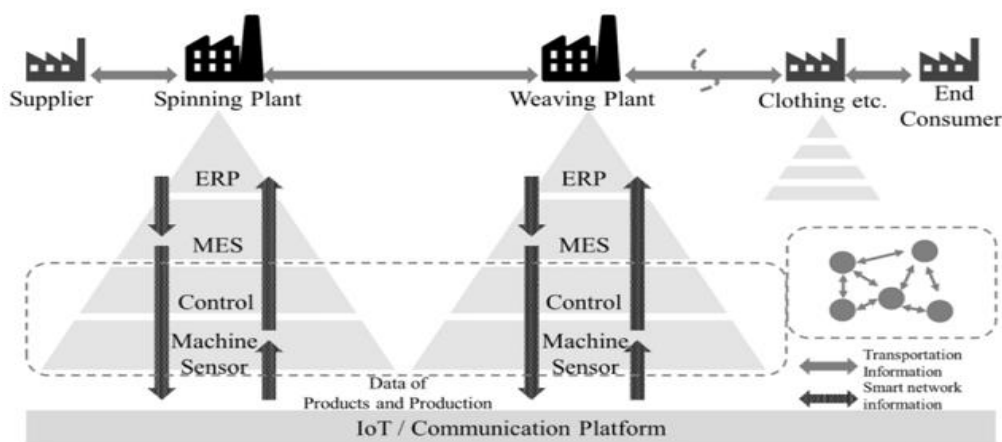
Figure 3: Schematic Diagram of Information Transformation in Textile 4.0

- **Implementing an IoT network:** An IoT network is a complex ecosystem of machines, devices and software, and requires advanced programming skill sets. Programmers who have the know-how to set up an IoT network are not easy to come by. Factory need to prepare in advance with all the correct working pieces and a knowledgeable team. The Internet of Things (IoT) is a process that starts with the emergence of various defined conditions or movements.

All data related to movement and situations are detected by sensors and are automatically sent to the system for data processing. Previously, all conditions have been described in the system numerically by operators. (4)
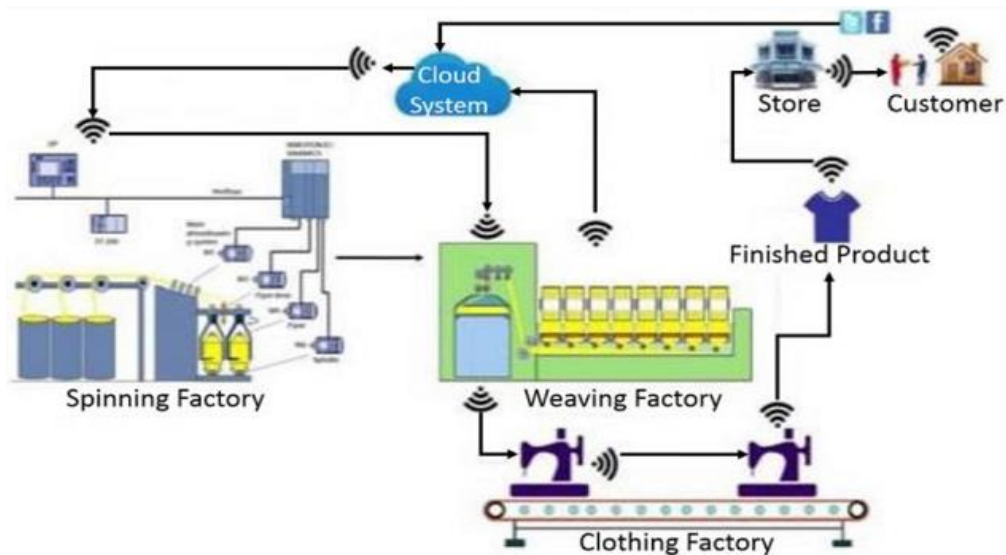
Figure 4: Implementation of IoT in Textile Value Chain

- **Having patience and drive:** While the changes may seem fast-paced, it's important to remember that no one can make a total shift overnight. Most manufacturers cannot facilitate switching from a human-powered system to a majority computer-run in a short time span. Ease into the process and take it at a comfortable pace so Factory don't miss any opportunities or overlook details. However, waiting too long or getting held up can be a competitive disadvantage if Factory fall behind.

- **Integrating pre-existing systems:** Use what Factory already have to Your advantage. Business systems like Computer Aided Drafting (CAD), Computer Aided Manufacturing (CAM), Enterprise Resource Planning (ERP), Manufacturing Execution Systems (MES) and Product Lifecycle Management (PLM) are all compatible with the goals of Industry 4.0. Focus Your internal resources on implementing necessary innovations rather than replacing systems that will already work with Factory's updated processes. (4)
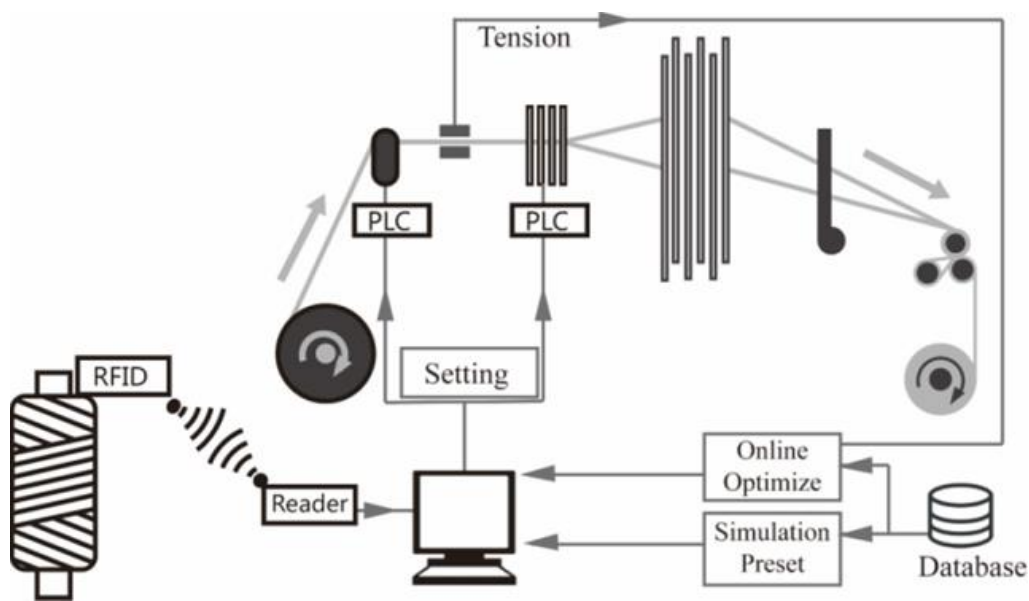
Figure 5: Self-optimizing of the Weaving Process

With the right frame of mind and clear goals, apparel manufacturers of all sizes can easily lay the groundwork for new and improved systems. Industry 4.0 can be a total game-changer for underdogs, boosting them with a competitive edge, but manufacturers of all sizes are bound to benefit from creating the right foundation. Factory also need to be sure Your current ERP solutions will mesh well with Industry 4.0 ideals and practices.

4.7 Organization Providing Digital Transformation and Automation towards Industry 4.0 to Textile Industry in Bangladesh

From harvesting cotton in the farms to make a thread, then weaving it into cloth in looms, followed by the stage of printing the textile manufacturing cycle has largely been automated in the past two hundred years. What remains in the hands of humans is when the fabric is sewed into the clothes that we wear. That might change as tech start-ups, encouraged by lightning technological changes, make robots that can imitate humans. Software Automation, a company based in Atlanta, in the US, has built an entire assembly line manned by robots that can pick a piece of garment, arrange it properly and then sew it. This technology is called the Sewbot. Just picking up a piece of fabric is a massive step forward for robots. Sewing and stitching have eluded machines because cloth is floppy and crumbly, difficult to handle even for humans who are not trained, tailors. Nimble finger movements can quickly adjust a piece of fabric under the needle of a sewing machine. It's a grueling job for a worker to continuously adjust the garment under the striking needle, making sure the seam stays straight and smooth. It's a skill that garment factory workers in Bangladesh acquire over many years of mentorship. (5)

Several local and international organization are working to establish digital transformation and industrial automation to Bangladesh textile industry. Some are focusing on individual digitalization process for single or multiple tasks of the textile value chain process and some are focusing on automation for making textile factories into smart factory. Below are some names:

- **Merchant Bay Ltd.**

Merchant Bay is a Bangladeshi organization established in 2019. It is an e-b2b platform, a sourcing and a production management tool, working to contribute in digitalizing of textile

supply chain and making sourcing easy for both buyers and manufacturers. This platform helps buyers to connect with suppliers fast and stay updated with their order processing, assuring high transparency and convenience. Using the same platform, suppliers can manage their order more easily and gain efficiency with access to data analytics which can help them make better business decision and lower their cost. When sourcing and manufacturing apparel from Bangladesh through Merchant Bay Ltd. the buyer can get complicate merchandising and quality team support to assure smooth shipment. (6)

- **Serai**

Serai is a Hong Kong based multinational organization, invested by HSBC Bank established in 2020. This is also a b2b platform for connecting textile buyers and suppliers for smooth sourcing, merchandising and supply chain processes. They create a b2b marketplace for textile manufacturers and buyers in the textile industry and currently focusing on Bangladesh. (7)

- **Dhakai.com**

Dhakai.com is a TechStars' backed company headquartered in US and operation in Bangladesh, established in 2020. It is a premium b2b marketplace connecting South Asian apparel manufactures directly to US private labels and retailers. Dhakai is bringing data driven innovation to apparel sourcing industry having goal of helping textile buyers, consultants, and clothing manufacturer to gain global market transparency through data, virtual tours, video tours, visual touch points, compliance, sustainability and ethical responsibilities. (8)

- **eRMG**

eRMG connects fashion brands, wholesalers and other buyers with clothing manufacturers in Bangladesh, having headquarter in US and operation in Singapore and Bangladesh. Through a proprietary platform, eRMG allow all entities in the fashion and apparel ecosystem to manage their supply chains, ensuring a bigger chunk of profit for all parties. (9)

- **Nitto Digital Service and Analytics Ltd.**

Nitto Digital Service and Analytics Ltd. is a Bangladeshi tech-based organization primarily focusing on technology and software solution to different industry. Having great mission of helping customers with the best use of technology to increase productivity in business and improve quality of everyday life. Currently they are focusing on textile industry automation and transforming into Smart Textile Factory. (10)

- **Accentus Consulting Private Limited**

Accentus Consulting Private Limited is an India based industry automation providing organization specially working with Textile and Apparel Manufacturing Industry from 2016. By assisting managements and owners for transforming their factories into SMART Factory and step into Industry 4.0 generation. Intramex Group, a Bangladesh textile industry is the first organization in Bangladesh turning themselves into SMART Factory with the help of Accentus Consulting. (11)

- **Reverse Resources**

Reverse Resources is developing software solution for major fashion brands, their garment suppliers and recycling partners to cooperation on closing the loop for production leftovers. With making leftover information from garment factories visible online, they enable virtual

traceability of fabrics through circular life-cycles from factory onwards. This organization founded in 2014 and achieved Global Change Award from H&M for their business idea. (12)

- **Aware**

Aware is an organization helps textile fibers and yarn manufacturers a traceable solution of their recycled products towards the sustainability and circularity of textile value chain process. They started working with Bangladesh Yarn Manufacturer named Cyclo Recycle Fibers Ltd. for producing traceable product through blockchain technology. (13)

- **Tailorlux GMBH**

Tailorlux is a provider for authentication and traceability solutions by means of covert markings that are inextricably linked to the product. Through its interdisciplinary expertise in light emitting materials and their detection by hand sensors, Tailorlux contributes to making transparency, authenticity and traceability a reality in value chains. (14)

- **Prodsmart**

With digital connectivity on desktop and mobile, Prodsmart facilitates smart, data-driven decisions 24/7 from virtually any location - on-site and off-site – to keep the business profitable and competitive. Prodsmart delivers the tracking tools manufacturers and fabricators need to keep up with ever-increasing customer demands and the pace of today's highly competitive global marketplace. Easy to get started - for managers and workers - Prodsmart is uniquely adaptable to Your industry and shop floor needs. (15)

- **The Fabricant**

A digital fashion house leading the fashion industry towards a new sector of digital only for clothing. As a company of creative technologists Fabricant envisions a future where fashion transcends the physical body, and digital identities permeates daily life to become the new

reality. The Fabricant will be a leader in the movement that uploads the human to the next level of existence. They are building a business that prepares for that eventuality. They develop end-to-end 3D narratives for customers and consumers, from concept to implementation. They merge physical and digital capabilities to create interactive brand experiences. They create digital-only fashion that can be used and traded in virtual realities. (16)

4.8 Automation and Digitalization in Bangladesh Textile Sector

There are few companies in Bangladesh are at the tip of implementing automation in their operation in a bid to cushion the advent of industry 4.0.

However, instances are very few. Therefore, the below-mentioned table draws the evidence available on secondary sources means that there may be more players in our scenario who are in the process of embodying industry 4.0 in their operation.

Company	Intervention
Mohammadi Fashion Sweaters Ltd.	Installed 173 German made automated knitting machines for knit black sweaters. The human intervention required only in case program designs or to clean the machines.
Envoy Textiles Ltd (ETL)	Employed 14 robotic autoconers in spinning and rotor at its Bhaluka factory to produce 55 tons of denim yarn per day.
DBL Group	Using Fast React Enterprise Resource Planning software, SedoMaster textile production and dye management

	software, ColorMaster – a dye recipe management system to monitor and capture data of daily operations. Also, they added two new 16-color printing machines to its rotary screen-printing capacity which is doubling capacity at its DB Tex Fabric and garment printing unit to 40 tons per day.
Beximco, Liz Fashion Industries Ltd., and EOS Textile Ltd	Using Datatex software – an artificial intelligence (AI) infused software offering integrated automation in the area of resource and Management Information System.
Ad-Din Group	Using three HTM Double Twine Sequin Embroidery Machines in Bangladesh, offering flat embroidery, cording embroidery, and chenille embroidery – readily available on order and upon demand within bargain prices. The three machines are completely automated.
Fatullah Apparels	Using AI-infused Enterprise Resource Planning (ERP) software. The software has different modules set up for different departments throughout his factory, like human resource, marketing, inventory, sales, finance and others. All of these modules take input manually, separately, but also reflect on a central database that all the modules the software has. This essentially rules out any duplication of data.

Karim textile	In their cutting section has installed 6 European automatic fabric spreading machines and 2 robotic auto-cutters.
Akij Textiles	Using Robotics piers Carriage on Schlafhrost Autocoro (i.e. automatic rotor spinning machine), which increase productivity as well as quality of the end product.
Khalil Knit Composite Ltd.	Have a dyeing laboratory equipped with some Hi-Fi technical appliances like fully computerized automatic dispenser (Robolab) which can contain 240 bottles and can make measured, error-free recipe dispensing for dye house in working conditions of fully robotic motion.

Table-3: Bangladesh Textile Industry Started Using Industry 4.0

Chapter 5

5.0 Findings of the Study

Like any other manufacturing segment in Bangladesh, the textile industry is seeing the rise of more advanced and smarter technologies such as artificial intelligence, machine learning, big data, automation systems, 3D printing and many more which are all the results of Digital Transformation and Industry Revolution 4.0. The technology has created a perpetual state of change, and it's something that will likely stick around for quite some time. The trend is mainly positive, offering considerable improvements across the board. In reality, while many of the related technologies already provide incredible features and functionality, there is still a lot of experimentation going on where opportunity lies for both the implementation installation parties and their customers. It would not be wise to just point out the opportunities whereas there lies abundance of challenges which are already faced by businesses or might appear in the near future. In this part of study, I will focus mainly on opportunities and challenges of this technological development of digitalization process in Bangladesh textile industry.

5.1 Opportunities and Benefits of Industry 4.0 and Digital Transformation in Bangladesh Textile Sector

- **Focusing on Customer Need Based Operation Model:** In future there will no longer be the standard customer who is looking for a certain item of clothing. People's lives are increasingly influenced by devices that allow access to the digital world at all times. This not only has an impact on communication behavior, but also has a major impact on consumer behavior. Because the demands of customers are becoming more and more individual, with standard products and standard communication they will no longer be addressable in the future. On the contrary, in future it will even be possible

to offer textile products and services that can adapt to changing customer needs even after the purchase.

- **The Digital Profile of the Customer:** In order to realize a corresponding dialogue with the customer, a detailed, digital image of the customer is required. Big data and clever CMS systems are an essential basis for achieving a completely new form of customer transparency. Few companies worldwide including Bangladesh are working on creating digital profile for textile buyers and suppliers.

- **Individual Customer Approach:** Modern targeting methods make the targeted approach to customers with individualized purchase offers considerably easier. For example, the clothing brand **Nu-In.com** addressed exclusively sustainable and circular textile with a smart poster.

- **From Multichannel to Omnichannel:** From presale and marketing activities to sales contacts and customer service, new communication channels have emerged in the course of digitization with apps, social networks and online portals, which must be integrated into the overall strategy. In the course of digitalization, Bangladesh textile industry is also increasingly decoupling infrastructure and supply. Stationary trade is affected in two ways in this respect- On the one hand, online shops and marketplaces have skimmed considerable market shares before the textile industry was able to react adequately. On the other hand, the point of sale will increasingly shift to the digital sector in the future. Communication and information platforms such as Pinterest, WeChat and Facebook are increasingly developing into sales channels.

- **The Stationary Textile Trade of the Future:** There will still be stationary shops in the future, but they will change massively. In future, the classic analog stores will only appeal to a few customer segments - virtual shopping experiences and additional

services outside the actual business model will be the main motivators for customers to visit a stationary store. With the "The Sampler" app, for example, Converse offered its customers the opportunity to try on shoes virtually in augmented reality.

- **The Fusion of Online and Stationary:** The purchasing process must be made possible at all locations where customers can be approached for shopping. It is a suitable combination of digital and analog concepts that are suitable for the individual customer. Near future the supermarket chain shops will be offering virtual shops, which will be primarily intended for commuters. Customers can scan QR codes on the walls and shop via their smartphones. The purchase is then delivered home.

- **Trend towards Individual and Technologized Clothing:** The effects of digitization are not limited to customer needs and communication. The demands on the products themselves are changing. The individualization and technologized clothing are major trends here, which will continue in the future. Wearable technology and functional clothing will be part of everyday life in the near future. Bangladesh textile and technology industry jointly will work on this for producing more wearable clothing. Denim Expert, a foreign export denim composite textile mills already take steps of showcasing their wearable textile products.

- **Trend towards Automation of the Value Chain:** In a few years the value chains of the textile industry in Bangladesh will be largely automated, especially in the areas of production and logistics. Some local and foreign industries are working on this for industrial automation and digital transformation of textile industries value chain process.

- **Drastic Reduction of Production Time:** Disruptive innovations such as automatic sewing machines and industrial 3D printers enable a significant reduction in

production time. Natural and near-natural fibers can also be printed in 3D within a few years. One of the pioneers in this field is Adidas who is planning to establish 3D printing option in Bangladesh production. An individualization is therefore obvious. Worth mentioning here are also the meanwhile affordable prices of 3D printers in the consumer area. Customers will therefore be able to produce their own clothing at home in the future, or 3D printshops will take over this task. Of course, this also has an impact on clothing manufacturers and designers. The textile industry will also have to create space for DIY customers. Clothing companies could retain customers by selling design files, fabrics, patterns, 3D printers, sewing machines and software.

- **Acceleration of Logistics Processes:** Online customers do not want to wait long for their products. They are used to short delivery times through suppliers like Amazon. Speed is therefore one of the most important challenges facing the textile industry. Efficient ways are decentralized, highly automated warehouses with storage robots, shelving systems and sorting machines as well as the integration of Big Data into warehouse logistics to anticipate consumer behavior. Furthermore, an acceleration of the logistics processes is made possible by the technology of the clothing. Smart clothing with sensors and geo-location chips can communicate directly with the logistics systems and can thus be clearly identified and localized along the entire value chain. At the same time, however, customers also receive information on the production of the clothing or when it was last washed.

5.2 Challenges Bangladesh Textile Industry will Face for Implementing Digitalization and Industry 4.0

Participants from all interviews have given similar insights that there are very few applications or applications of automation in important manufacturing industries related to

RMG. Therefore, the existence of industrial 4.0 and its establishment level has not yet been proved in Bangladesh. Some themes have been allocated in relation to the issues related to the implementation of the industries in Bangladesh. The themes are shown in the table based on the results of the interview. Following are some challenges for the textile industry for adopting digital transformation and Industry 4.0:

- **Employment:**

Industry 4.0 compels the employees to develop altogether a new set of skills. This can cause alienation of big sector workers. Workers having a repetitive nature of work will face a challenge in keeping up with the industry. Older senior workers tend to find it difficult to undergo the learning process of new skills. (17)

New occupation	Areas of application
Computer-aided process planning professional	Production planning linkage between CAD and CAM
Computer-aided quality-control professional	Garment inspection, statistical process control
Computer-aided training professional	Intermediate testing of semi-finished materials or final inspection
Automated inspection	Fabric trims inspection
Automated material handling devices	Fabric, pattern, semi-finished garment handling
Artificial neural network expert	Fabrics inspection, color solutions, garment inspection, supply chain, retail management

Pick and place robot operator	Fabric handling for sewing
Numerical controller	Sewing, buttonholing and button attaching
Automated fusing and pressing machine operator	Fusing and pressing operation
Enterprise resource planning expert	Fabric storage, spreading, cutting, sewing, pressing packaging, human resources, inspection, supply chain, and retailing

Table-4: Major New Occupations That Will Emerge in the RMG and Textile Sector

- **Job Loss:**

Around 60 per cent garment workers will lose their jobs in Bangladesh by 2030 when robots will replace the workers with the invasion of the automation by the factory management. (17)

Occupations	Possible number of job loss by 2041
Sewing operators who operate single and double-needle lockstitch machine, single and double-needle chain stitch machine, sewing machine mechanic	500,000
Floor supervisor, pattern maker	10,000
Pattern making for knitwear, quality control, production	10,000

planner, merchandiser	
Fashion designer, CAD-CAM operator, portfolio developer, production planner, and controller	5,000

Table-5: Major Occupations That are in Threat Due to Automation in the RMG and Textile

- **Capital:**

The investment in a new technology always requires a considerable amount of capital. A lot **of** planning and a good understanding of the industry requirements is of due importance. Smaller businesses might have to risk their market shares in the future. Considering all this, calculated risks are required to be taken.

- **Privacy:**

This not just a matter of concern for the consumers but also for the producers. The collection and analyzing of data by the producers are taken to be a threat to the privacy of the consumers. Besides this, the smaller companies that have never handled data are exposed to a transparent environment in no time.

- **Initial Investment Cost:**

Cyber systems, robotics, virtual reality (VR), 3D product design, wireless sensor networks, data infrastructures and their integrations are very costly.

- **Technical Challenges:**

Textile Industry have to relatively face new technological. As a result, the shortage of experienced workers in these technologies is a serious constraint.

- **Lack of a Global Standard:**

The lack of global standard developed for IR 4.0 causes another difficulty.

- **Social Difficulties:**

Number of required low-skilled labor force to shift towards more high-skilled complex jobs. Which requires more intense focus on emerging technologies. This brings important social problem like unemployment.

- **Up-Skilling:**

Companies needs to up-skill their workforce via in-house or external training centers.

- **Re-Skilling:**

IR 4.0 is expected to result in many job displacements to a certain extent. Companies should have to make the investment in the re-skilling of the labor force to prepare for this expected shift.

- **Continuous Learning:**

Technologies will become obsolete at a faster rate. Continuous professional development strategies need to adapt the changes of technological advancement.

- **Mindset Change:**

Labor force will have to adapt to a number of changes, they will resist and oppose the implementation of newer technologies. Companies have to plan for mindset change of its employees to facilitate a transformation.

Chapter 6

6.0 Recommendation

As my vision to write on the subject about **Industry Revolution 4.0 and Digital Transformation - It's Implementation, Opportunity and Challenges in Bangladesh Textile Industry** has come to a point where I have been able to gather some information on opportunities and challenges, I would like to write some recommendations based on challenges. These recommendations will be totally based on my discernments and these are described below:

- **Keeping Up with Technology:**

While it's excellent that we are responding to environmental needs, we must also make use of new patterns and fourth generation technologies including the advanced applications of information technologies in our supply chain management, i.e. IOT (internet of things). At the same time, we have to enhance our productivity and efficiency, which requires technology upgrades and modernization of factories. Speed and optimum use of resources will be the key to future business success and sustainability. Looking further forward, 3D printing technologies is anticipated to bring major disruption in fashion manufacturing and retailing. It's important not to get complacent about the fact that China is gradually shifting from basic to mid-range apparel because of growing production costs. While this may be an opportunity for us to grow our market share in basic apparel, it can also keep us trapped in the lower-end of the market, as China gets relatively richer by selling more expensive apparel. We should, therefore, closely observe how China is re-structuring their industry through the use of new technology, automation, and advanced robotics to gain more competitive advantage and offer innovative products at lower prices. Diversification of fashion items and innovation is a critical area for our long-term growth sustainability. It's a

good sign that Bangladesh is gearing up to cater to the needs of high-end and branded fashion segments. In recent years, our RMG exports have expanded to include items like suits and blazers, lingerie, active-wear and outerwear, and non-cotton items. We have to reduce our dependence on basic products and build our capacity ourselves to meet the demand of high-end and branded fashion segments in order to accelerate the industry's growth. Considering the importance of technological upgrades for the future success of apparel industries, our competing countries have introduced special policy support like the Technology Upgradation Fund Scheme (TUFS) for the garment and textile industry in India. Bangladesh has made tremendous progress in digital transformation over the last decade under the government's "Digital Bangladesh" initiative; we have to now reap the benefits of digitalization by embedding it in our industry for which we need policy support. This will ultimately result in more export earnings for the country. Besides, our entrepreneurs need to be up-to-date about the latest technological advances in the industry and proactive in embracing them. (18)

- **Improve Skills:**

Bangladesh is now passing through a golden age in term of its population dividend. About 70% of our population is under 40. While there is a concern about technologies killing jobs, we should rather be more concerned about why a significant part of our talented youths are unemployed whereas a good number of foreign experts are working in Bangladesh in highly-paid managerial positions. The gap between our education system and industry needs to close. We need to identify the gap between demand and supply for skills, factoring in the changing needs of industry in the near-future. We need a stronger collaboration between manufacturers, buyers and experts to identify present and future needs in terms of skills in the job market. We need a harmonious balance of informed policy, appropriate institutional framework, and efficient allocation of resources to produce market-driven skills. Needless to say, that Bangladesh has successfully faced a number of challenges in its 35 years of

experience in apparel manufacturing, including the elimination of child labor in 1994, and made progress in the areas of social compliance. Currently we are working on workplace safety and environmental sustainability issues. We are working with the government, ILO, brands & retailers, donors, international agencies and foreign governments to ensure workplace safety factory by factory. Today we are proud to say that Bangladesh is in a new era of industrialization having probably one of the safest apparel industries. While we are taking all these positive steps and our factories are increasingly investing money in safety and sustainability, we are still living in the age of price cuts! In a highly competitive free market economy, prices cannot be dictated by individual producers. But at the same time, the price must be high enough to ensure that workers are paid a fair, living-wage. Since technological advancement would be a new horizon of opportunities for all the partners in the global fashion supply chain, there needs to be a collaborative approach between buyers and suppliers supported by the government and development partners so that it creates a win-win situation for all. The opportunities in global sourcing can only be tapped into when there is collective and collaborative action by stakeholders across the global value chain. (18)

- **Basic ICT Education for All:**

Part of the task is to ensure that initial education equips all students with basic ICT skills as well as solid literacy, numeracy and problem-solving skills to use ICT effectively. Many of these skills are acquired also outside education and training institutions for instance, in the workplace emphasizing the need to recognize skills acquired outside formal channels. For ICT specialist skills, basic programming is no longer enough. For instance, advanced engineering and experience with machine learning are increasingly important. In addition, ICT specialists also need domain- specific knowledge, given the potential applications of ICT in business, health, education and industry.

- **Employers and Organization Owner's Need to be Updated with Technology:**

It is not just sufficient for workers to have the skills needed for the digital economy but employers must fully use these skills to reap their benefits in terms of higher productivity and greater competitiveness. The use of skills, including reading, numeracy and problem-solving in a technologically-rich environment, varies substantially across countries. A key factor driving this variation is the use of high-performance work practices such as teamwork, work autonomy, training, flexible work hours, etc. Thus, it is important to promote better work organization and management practices within firms and across the economy, as well as fostering the skills needed to support these practices.

- **Textile Industries of Bangladesh Can Adopt Two Production Models to be Benefited with Industry 4.0:**

Mini Factory- The most important components of Industry Revolution 4.0 are smart factories, e-production applications and interaction between smart systems for excellent production processes.

Smart Factory: A smart factory is a highly digitized and connected production facility that relies on smart manufacturing. The concept of the smart factory is considered to be the most important outcome of the fourth IR 4.0 will boost these models to thrive.

- **Implementation of New Business Model:**

The market shares of conventional textile companies are increasingly being skimmed off by players from outside the industry. Wearable Technology and Functional Clothing accelerate this process. In addition, new production mechanisms such as 3D printing enable customers to print clothes at home or in decentralized print shops. The brand image will therefore no longer be decisive for winning and retaining customers in the future. Rather, the trend is

towards data-supported recognition and addressing of the individual needs of the customer. Many providers will therefore have to radically rethink their business models.

- **Implementation of Vertical and Horizontal Integration in the Textile Factories:**

Vertical integration is the integrating of textile organization from the physical sensors in the production machine to the ERP level of profitability and sales orders and Horizontal integration is the integration from one production machine to the next, from one plant to the next, and beyond the company borders to the up- and downstream value chain partners. Textile companies should adopt ERP-level business context for smarter operator decisions and decision support systems, and using sensor data to trigger and adapt business process decisions. In this way they can raise production efficiency to the next level by new insights on best practices; continuously improving the "golden run" – like six sigma – but with big data smartness. This will also help to the speed and agility, dramatically reducing waste through pull supply chains.

- **Government Policy on Protection and Security:**

The fourth industrial era has opened new platforms for citizens to engage with governments, express their opinions, organise their efforts, and even circumvent supervision of public authorities. At the same time, governments can use digital means to control citizens and manufacture consents. Nevertheless, regulatory role of governments depends on the nature of a state. Government can regulate misuse of digital platforms using policies, means and instruments. Yet controlling provisions of governments may also go against fundamental rights of citizens. For example, "Digital Security Act" in Bangladesh has been, decried by human rights defenders as a means to silence dissent. Hence, regulatory policies should be made adhering to civil and political rights so that authoritarian states may not be able to turn those as weapons of reigning in atmospheres of fear and domination. There should be a

balance of government's efforts to reach people through promotion of their services and people's opportunity to express their opinions. If justice cannot be ensured, coercion would prevail. In the flow of movement towards digital transformation, security and privacy are two pivotal issues that too have become notable concerns. This creates a mounting challenge in countries with authoritarian regimes and fragile institutions. In order to integrate the whole, multilateral enforceable security and privacy regulatory mechanisms should be developed. Innovative and resilient privacy and security system will lead towards faster and more flexible collaborative value networks and smart production provisions. More challenges are yet to come hand in hand with increased use of data analytics. "Trust" is a significant issue and also an imperative in this new era.

- **Government and Financial Institutions Should Declare About Low Interest Capital Investment:**

Government and Bangladesh Bank should raise their funding to the technological improvement of Bangladesh textile sector to protect country's most earning foreign revenue. Bangladesh Bank is forming a Tk 1,000 crore fund to provide cheap loans to export-oriented industries to upgrade technologies they currently use. The eligible industries are of 32 types, all falling under top-priority and special development sectors. They include readymade garment factories making high-value additions in production, pharmaceuticals, software and IT-enabled services, jute goods and footwear and leather goods. The fund will run under a refinancing scheme, meaning banks will first give out the loans before being reimbursed by the central bank. The interest rate will range between 5 per cent and 6 per cent, according to a central bank document. The transformation can be brought about in 11 types of existing industrial production-related operations to replace outdated technologies with the latest ones such that industrial production gains momentum. Replacement of outdated machinery,

adoption of technology for renewable energy and upgradation of machinery used in business operations and waste management will get priority. (19)

- **Reduce Dependence on Basic Products:**

To create a technology-proof workforce in our textiles and garments sector, we have to reduce our dependence on basic products. Because the scope of applying 4IR led technology is very limited in basic product manufacturing whereas high-end value-added opens the opportunity to implement latest technology. And, compel the management to train its workers on the industrial applications of the latest technologies. So, we need to build our capacity to meet the demand for high-end and branded fashion segments in order to prepare the industry for 4IR technologies.

Chapter 7

7.0 Conclusion

Industry 4.0 is the result of a tipping point in technology innovation. The groundwork for the revolution was laid decades ago. The IoT, cloud, big data, and more is pushing industry 4.0 forward. Textile and clothing industries should be aware of the new paradigms on the brink of the fourth industrial revolution. In the coming years, becoming a smart factory will be one way to meet customer requirements as a result of the extremely variable market conditions. In this way, textile industry can solve its structural problems arising from intensive labor use, energy costs, and market uncertainties. At the same time, they can increase the efficiency and productivity in the production processes, and logistics operations can be carried out at high levels of performance.

So, stay alive in this competitive environment, organizations will want to use the benefits of industry 4.0 to develop a competitive advantage, improve revenue and profits, and offer better customer experiences. The textile industry must be aware of the new challenges and respond with judicious action in order to reduce the production cost, improve manufacturing productivity, promote industrial growth, change the labor force structure and ultimately change the competitiveness of the company and the region.

The changing scenario in the apparel and textile industry has made it clear that automation, digitalization and implementation of Industry 4.0 are the key to success in long-term perspective. As technology is improving at faster rate and labor cost increases at the same rate, it is right to say that replacing labor with automated systems is a smart move to survive in long race of global competition. If the layout is planned properly, then automation will lead to saving of the space required. The space acquired by the conventional system can accommodate more manufacturing facility. The new manufacturing facilities will require

much less space. Hence the unemployment created due to automation will be compensated by the new companies coming up. By automation, the industry will become knowledge-driven not labor-driven. Obviously, it will add to the productivity of the firm. Before implementing the automation, some factors like the size of the organization, layout feasibility and manpower aspects should be considered. As ROI period is a long and the initial investment is high, it is good for small and medium firms to implement automation module-wise and not full at once.

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Appendix A.

1. PWC analysis of Industry 4.0 from 2016 to 2021
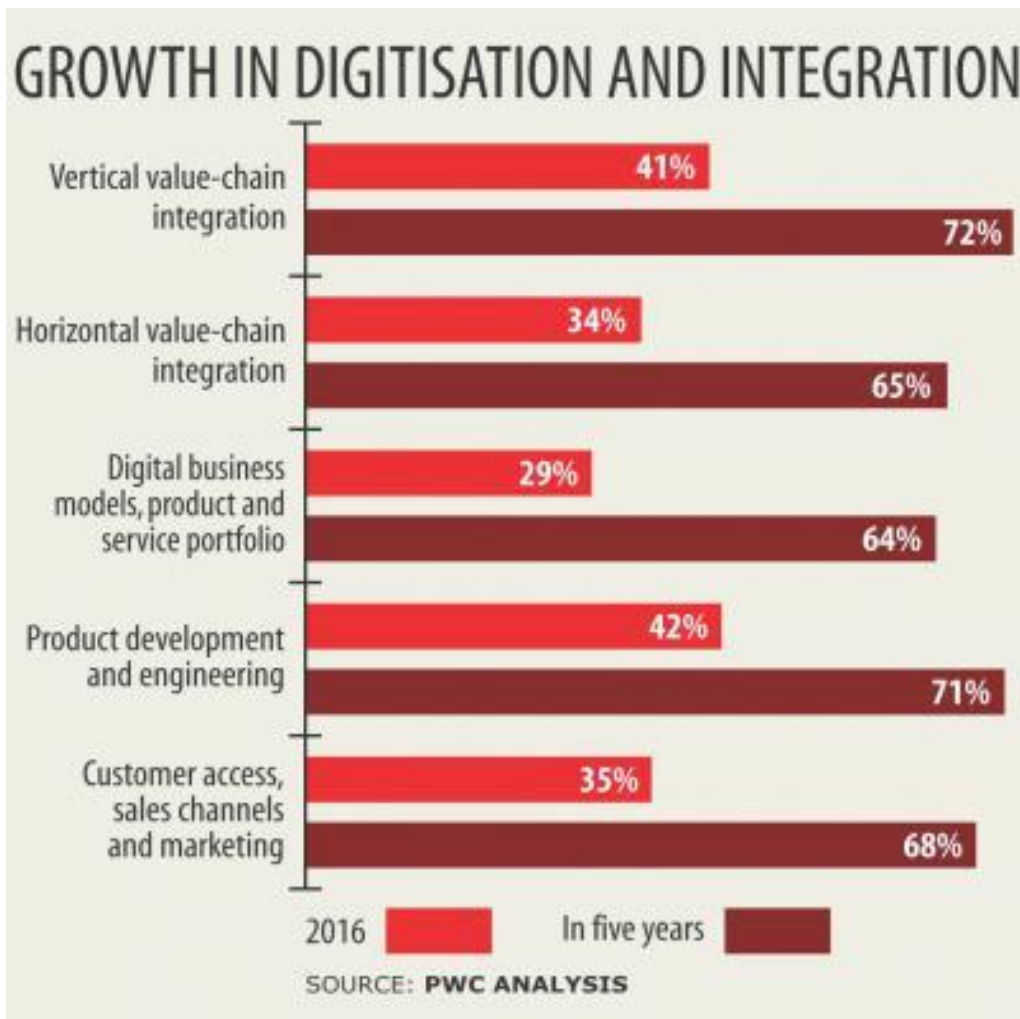
2. Risk of automation in job sector by 2041
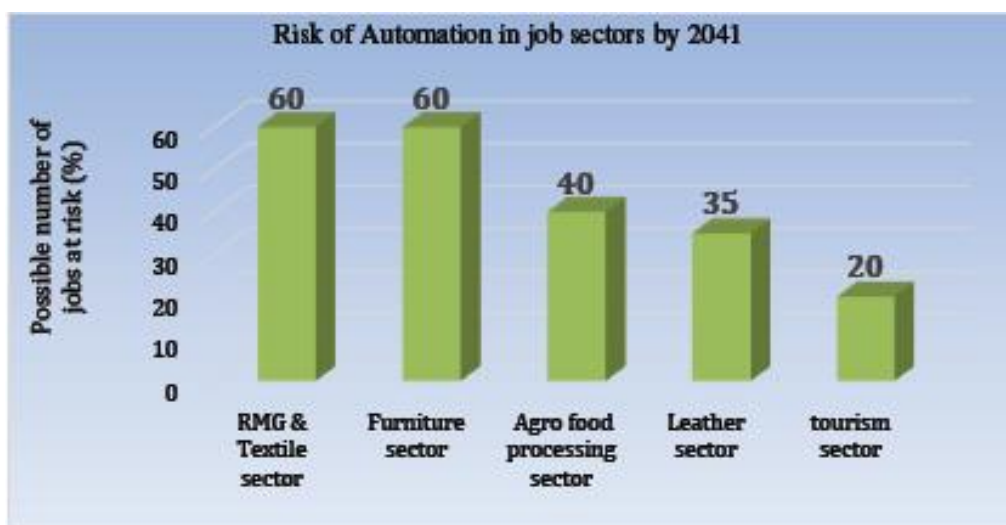
Appendix B.

Questionnaire and General Answer about Industry 4.0 Implementation to Textile Industry Leader:

1) **What are the first steps we should take to get our business ready for Industry 4.0?**

    Answer: Before you can determine a route, you need to know your starting point. A good first step is to audit and analyze existing processes, assets, and business systems. This will tell you where you are, help establish priorities, and even identify quick wins. Industry 4.0 solutions will result in significant benefit and impact across every area of your business. It is more than just an IT upgrade, so you should also ensure that you have executive buy-in and engagement.

2) **Is there a way to connect much older machinery to a digital network?**

    Answer: The simple answer is yes. IoT gateway devices can often be retrofitted to older machinery. These devices empower IoT sensors to transmit performance data. In some cases, video cameras and heat sensors can be also be fitted and connected to provide a more robust picture. The age and function of the machinery will determine the best solution – and an audit and analysis can help determine the long-term value of retrofitting versus replacing legacy assets.

3) **Do these new technologies integrate with our existing ERP?**

    Answer: A robust ERP system is the "brains" behind an Industry 4.0 technology stack. The ERP of the past largely ran office-based processes whereas today an intelligent ERP system is the hub for connected processes across manufacturing,

logistics, engineering, and many other areas of the business. Part of your digital transformation will be to determine if your existing ERP system is equal to the task.

4) **Are our existing business systems and databases equal to running Industry 4.0 technologies?**

   Answer: Legacy ERP systems running on outdated, disk-based databases are being pushed to the limits of what they can do. The ability to leverage the data you receive from connected factories, assets, products, and people will be dependent upon the capabilities of your ERP. Is it intelligent? Does it offer embedded technologies like AI, machine learning, and analytics? How fast is its database? If you are running an older system, it might be time to upgrade in order to take advantage of Industry 4.0.

5) **How do I know which Industry 4.0 technologies are best for our business?**

   Answer: Which technologies you start with will depend on which processes are the most critical to your core business model – and which areas of your company stand to benefit the most from transformation. When getting started, companies often focus on one core technology at a time. By their design, Industry 4.0 solutions deliver a lot of robust Big Data and insights that can help you accurately assess their ROI and benefits. This makes it increasingly smooth to integrate subsequent areas of the business.

6) **How long will it take to achieve our Industry 4.0 transformation goals?**

   Answer: Unlike many major foundational changes, digital transformation can be undertaken incrementally, without significant disruption to the business. Starting with a robust ERP system and digital transformation roadmap, many Industry 4.0 solutions can be rolled out almost immediately.

7) **Will Industry 4.0 require a lot of retraining for our staff?**

Answer: Change is hard. We get that. When companies switched to computers from typewriters, it was met with resistance by a workforce that felt overwhelmed by their complexity. But unlike those early technological transformations, Industry 4.0 solutions actually reduce complexity for the user, rather than add to it. Workflows are streamlined, manual and repetitive tasks are automated, and the interfaces are more intuitive. Furthermore, many 4.0 technologies facilitate training, such as AR wearables and mobile-optimized experiences.

8) **How can we be sure the Industry 4.0 solutions we implement will be adaptable for the future?**

Answer: If 2020 has taught us anything, it's that we can't always see what's coming. And while we can't predict the future, we can take steps to ensure that we're more resilient and better prepared for it. The best in-memory ERP systems are scalable and support unlimited workloads, and Industry 4.0 technologies are developed specifically to ramp up to support future growth and adapt to unexpected change.

9) **What if we invest in Industry 4.0 solutions and then our business model changes?**

Answer: Some of the most fundamental elements of Industry 4.0 software solutions are built-in scalability and the capacity for agility and resilience. If your business or production model has to radically change to meet market demands, your Industry 4.0 systems will give you the insights and confidence you need to adapt and implement change quickly across.

10) How do we respond to concerns that Industry 4.0 automation will take away jobs?

Answer: There is no question that the fourth industrial revolution will change the workforce. But it's not repetitive labor that leads to innovation – it's ideas and creative thinking. A digitally augmented workforce is freed up to use their heads instead of just their muscles. In 1980, there were only a few thousand computer programmers in the whole world. Today there are over 20 million. While many physical tasks will be taken over by robots, many more tasks will be created to run a digitally enhanced business.