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Impact of digitalization of supply chain management in ready-made garment industry of Bangladesh

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1.1 Introduction

Following its independence in 1971 from West Pakistan, Bangladesh had faced enormous economic barriers, including limited resources and the absence of large industries. During its time as East Pakistan, Bangladesh was not able to establish any big industry. Even so, the RMG industry evolved as a vital actor in the nation's recovery, becoming the top export earner, accounting for 84.58 percent of the nation's overall export revenues (BGMEA, 2020).

Bangladesh, formerly seen as a "bottomless basket," has recently reached to the annual average growth rate of 6% for GDP (BGMEA, 2020), resulting in amazing social and human advancement and recognition worldwide (BKMEA, 2022).

According to BGMEA (2020), the garment sector of Bangladesh began to operate in 1980s. The key person was Late Noorul Quader Khan who initiated the journey during the year. He was visionary about the country’s development and economic growth and realized the potential in the garments sector. With the aim and hope of overcoming the economic depression after the war, he helped 130 garment trainees to receive the necessary training from South Korea to know how to produce garment products and later to facilitate the country’s own production facilities (BGMEA, 2020).

The supply chain management concept is considered as a newcomer in many developing countries like Bangladesh (Griffiths et al., 2002). However, supply chain management and logistics are very crucial for the garment industry like in any other industry. Supply chain often carries more significance in the case of garment or textile industry as the industry deals with a complex supply chain operation (M. Ali et al., 2021a). It bears the similar importance in garments industry of Bangladesh.

Buyers of garment products have a wide variety of demands where they expect delivery within the least amount of time. Due to the large number of manufacturers, sustaining in the industry is also getting highly competitive in Bangladesh. The importance of maintaining smooth supply chain operation needed to be considered more than ever. It is also important to synchronize the manufacturing of garment products with the latest fashion trends and fulfill the demand as quickly as possible. Often the end customers expect to have their product in their hands immediately after ordering.

Keeping up with this pace is not a simple task for the Bangladeshi garment manufacturers. Being not digitalized in the supply chain, the majority of the companies are facing difficulties fulfilling these quicker demands of their customers. It seems the difficulties are not being solved due to holding on to the traditional supply chain management system and lack of the latest technologies in their supply chain operations.

The concept of digital supply chain management is greatly inspired by the fourth industrial revolution. With the introduction of Industry 4.0 concept, the business world is shifting towards digitalization and automation in their business process (S. B. Ali, 2022). While sitting at the center of the business, the supply chain is supposed to build an ecosystem consisting of digital technologies and concepts like IoT, Big Data and smart factories etc. and to turn into a more efficient and effective one. Digitalizing the supply chain can bring enormous benefits to the garment manufacturers in Bangladesh.

Beside coping up with diversified demand and latest fashion trends, it can contribute to the important aspect like reducing lead time where Bangladeshi garment industry is still struggling. Many companies had to close their businesses because of the hurdles they faced in recent years. The fact is that being one of the top RMG exporters in the world, Bangladesh still needs to overcome the obstacles to digitalize and automate the supply chain management to take a competitive advantage and hold their current position in the industry. Digitalizing the supply chain management is one of the current ruling issues in garment industry of Bangladesh.

1.2 Background of the study

With the instigation of Industry 4.0 concept the business world has seen a new face to influence all major functions in all small, medium, or large businesses around the world. It emphasizes on manufacturing products based on customer's demand by obtaining and analyzing data at first, then deliver the information to the production sector (Frank et al., 2019). Digitalization is the new face which is the reason why the customers get their desired products more quickly than ever before. The digitalization and automation of supply chain management has a great positive effect on the manufacturing of RMG products as well. It is capable of making the supply chain more flexible, responsive, and profitable. Several authors, (Ajwani-Ramchandani et al., 2021; Rajput & Singh, 2020), have agreed that the use of brand-new technologies can enable a firm to gain maximum advantage in its operation.

For instance, the supply chain management of manufacturing ready-made garment products is one of the best areas where digitalization can be put into practice. In case of Bangladeshi RMG sector, the process is more compounded where the designs come from first world countries like Spain, France etc., procurement of raw materials is done from developing countries like China, India, Vietnam etc., and the production goes to the local manufacturers.

Cheap labor and firms with larger manufacturing capacity are two main reasons for Bangladesh RMG to be recognized as world's one of the top RMG manufacturer and exporter(Akter, 2020; Chandra Majumder & Ferdaus, 2020). Mostly, the RMG industry focuses on fulfilling the demands of low-mid range garment products from the developed and developing countries (Tushar, 2021). According to Hasan (2017) , usually RMG industry of Bangladesh operates in two lower level of business modes. One is Free of Cost (FOC) where the buyers purchase the raw materials and send it to the manufacturers and only pay for cutting, sewing, and trimming purposes. While the second stage is Free on Board (FOB) where manufacturer takes responsibilities from procuring the raw material until the final finished good is delivered to the buyers (Hasan, 2017). The upper two stages of business modes i.e. Original Design Manufacturer (ODM) and Original Brand Manufacturing (OBM) are far-off to reach for the Bangladeshi RMG industry. Bangladesh sources majority of the raw materials like cotton, silk, yarn, dye chemicals and fabrics from China, Vietnam, India etc. As there are only a few numbers of companies having vertical integration, it requires a longer time to fulfill the demand by the RMG manufacturers of Bangladesh (Rahaman, 2022).

These longer procurement and production processes in the case of RMG industry of Bangladesh usually need handling of large amounts of data. In manual set up, information sharing becomes a lengthy process. (Farhan Shahriar et al., 2014) stated that, the quick response theory allows vendors, producers, and distributors to share data promptly across the supply chain. The use of IoT can help in reducing time and bring flexibility to cooperate and share information within the supply chain.

The buyers of Bangladeshi RMG products, often want fast delivery. Despite the large number of workforces, the manufacturers cannot make quicker deliveries due to the lengthy process of raw material sourcing, unskilled manual labor, and lack of use of technology across the supply chain. According to (ILO, 2022), along with other social, environmental, and economic aspects, the garment industry of Bangladesh needs to set the priority on implementing the technology

improvements and nurturing skills development among the employees in order to achieve higher productivity.

It seems that with the increased use of technologies the difficulties rising are very hard to tackle by the traditional production process. To fulfill the demand of the fast-paced world, the rapid production and quick delivery of RMG goods with the lowest defects can be facilitated with the smart factory concept where human involvement in inputting data into machines is reduced and the tasks are done by the machines using technology automatically.

Many RMG manufacturers like China, Vietnam, Indonesia has already embraced the concept of digital supply chain management which has made the industry more profitable. Smart production and smart warehousing facilities have already been operating successfully in several developed and developing countries across the globe.

To keep up with the modern trends and sustain in the competitive business it is very important for Bangladeshi RMG sector to initiate the digitalization process in their supply chain management. The RMG sector of Bangladesh can be benefited enormously with the implementation of DSCM.

1.3 Problem Statement

RMG's supply chain of Bangladesh frequently confronts problems at different stages during its operations. Sourcing of raw materials, production, packaging, warehousing, flow of inbound and outbound logistics are vital junctures for supply chain (Griffiths et al., 2002). A study shows that the necessity of sourcing, flow of information, smooth communication, keeping track and trace of each task involved in a supply chain have convinced many third world countries to agree with the disciplinary importance of supply chain and logistics (Abdur Razzaque & Shafreen Bin Sirat, 2001). These phases and functions are disrupted on numerous occasions. These are caused by factors like unskilled labor, poor infrastructure, unrealistic logistics system, unreliable transportation, natural calamities, political unrests etc. (Rakib & Adnan, 2015).

The apparel industry of Bangladesh is still vulnerable to the above factors and failing to build a dynamic ecosystem while giving rise to two major challenges of high production cost, and longer lead time (Shahadat et al., 2023). These problems seem to be very closely intertwined with the digitalization of supply chain management.

While digitalization is becoming a key to success for the businesses, the DSC has captured the attention of garment manufacturers across the globe with its ability to reduce lead time, efficient production resulting into reduced cost of production, and with the flexibility of real time data sharing among suppliers, producers, and buyers. Moreover, the RMG sector of Bangladesh is still sitting back on this occasion. The problem is well known in RMG industry of Bangladesh when it is about 'lead time' to fulfill the demand of their buyers. Bangladesh takes almost double time i.e. (90-120) days in comparison to India and China i.e. (40-70) days to finalize the exporting. Where China, India, Vietnam, Indonesia has their domestic source of raw materials, Bangladesh lacks in case of sourcing raw materials domestically. According to (Haider, 2007), the supreme priority of the RMG industry of Bangladesh is to minimize the lead time. Logistics and transportation have been a problem as it lacks digitalization. Often the companies have to bear a high cost due to the inefficient transportation and logistics process. Vehicles without sharing real time data often face problems during transportation. An immediate solution is not possible in case of traffic congestion, overload, or natural calamities when data and information sharing is leisurely. It is unimaginable to make a timely and intact delivery without an integrated digitalized transportation and logistics system.

Further, due to the presence of traditional supply chain and old-fashioned techniques in manufacturing process, the production cost is climbing high compared to those in developing and developed countries. Bangladesh is still fighting to capture the market segment of medium-high range products and struggling to keep up with the demand changes with fast-paced fashion trend. Due to the absence of latest technology like additive manufacturing in the production process, the demand of high value segment of customized products cannot be fulfilled by the RMG manufacturers of Bangladesh.

The ancient human resource techniques and tools to retain and manage employee data to provide performance appraisal often leads to dissatisfaction for the workforces in the RMG sector of Bangladesh. The production process of garment goods in Bangladesh demands a large scale of human involvement to deal with machines and processes. Employees face challenges for faster skill development as there are slow processes of handling their data and information. This reduces the productivity of the workers, driving towards an inefficient production process. Digitalization tools can escort the supply chain to concrete solutions and boost the supply chain performance by

removing the barricades. To sustain in the competitive industry, it is high time for the RMG industry of Bangladesh to focus on the DSCM and challenges for its implementation.

1.4 Research Objectives

This research primarily intends to depict the present scenario of digitalization of supply chain management and its importance in RMG sector of Bangladesh. This gives a theoretical understanding of the context of what is going on in case of digitalization methods and techniques applied in the RMG sector. This will also find out the lacking or drawbacks in case of automation or digitalization of SCM. Additionally, the effect of digitalization of SCM that why it is important in RMG sector of Bangladesh and how it can improve the supply chain will be determined. To accomplish this, different aspects of digital tools and techniques such as Industry 4.0, Internet of Things, Big Data, Cloud Computing, Additive Manufacturing etc. which can be used in SCM automation/digitalization will be discussed.

The objectives are more specified below:

- To know the current problems regarding the supply chain management in RMG sector of Bangladesh.
- To understand the usefulness of digitalization tools in SCM of RMG industry.
- To identify the scopes where the tools can be used in RMG's supply chain.
- To define the effect of DSCM on cost and lead time.

2 Literature review

This chapter will provide a comprehended overview of existing research and findings about supply chain management, digital supply chain management, automation of supply chain and logistics processes in apparel and garment industries, to give a clear idea about the research topic. After the critical review of the literature, this section has been able to establish a theoretical model to carry on the future research for the purpose of the study.

2.1 Ready-made garment industry of Bangladesh

2.1.1 Present Scenario of the RMG industry of Bangladesh

Since the time when Bangladesh was recognized as an independent nation, the garments industry has been playing the leading role in the development of the country's economy till date. At present,

it is the main source of export earnings of the country. In total export earnings of 2022-2023, the share of RMG sector was 84.58 percent (BGMEA, 2020). It helped the country to create employment opportunities for its people thus impacting the per capita income and the buying power of the people significantly (BKMEA, 2022). The industry has several positive impacts in the society beside job creation such as reducing poverty, empowering women etc. The RMG is one of the main drivers of the economy of Bangladesh. Because of the rapid growth of the industry, Bangladesh's economy has been flourished and now considered as one of the fastest growing economies in the world. There are 3500 active garment manufacturing plants in the country where the total investment is 20 billion USD. As of today, Bangladesh has achieved the spot as one of the top RMG exporters in the world. Currently, Bangladesh stands at second among other RMG exporters in the world just after China (BGMEA, 2023). Bangladesh has seen a tremendous growth in exporting RMG in last five years. Statistics show that the maximum growth has been experienced in 2021-2022 fiscal year which was 35.47 percent, highest growth rate during the period of last five years. In 2022-2023, the industry was able to gain a growth rate of 10.27 percent which was equivalent to 46.99 million USD in export performance (BGMEA, 2023).

Fiscal Year	Woven (Value in million Dollar)	Knit (Value in million Dollar)	Total RMG (Value in million Dollar)	Growth
2018-2019	17.24	16.89	34.13	11.49%
2019-2020	**14.04**	**13.91**	**27.95**	**-18.12%**
2020-2021	14.5	16.96	31.46	12.55%
2021-2022	**19.4**	**23.21**	**42.61**	**35.47%**
2022-2023	21.25	25.74	46.99	10.27%

Table 1: Export conducted by Bangladesh in last five years (BGMEA, 2023).

The industry had been going through a tough competition in RMG export business worldwide where the competitors are big nations like China, India, Vietnam, Turkey etc. Despite of the intense competition in the market, Bangladesh's RMG was successful to overtake China by gaining an increase in the Compound Annual Growth Rate (CAGR) of 9.42 percent in the EU market during

last five years. Which derives that based on CAGR, Bangladesh is on the top as a growing exporter of RMG products in EU recently.

Country	2017	2018	2019	2020	2021	2022	CAGR in last 5 years
World	**83.49**	**90.54**	**89.46**	**78.64**	**85.23**	**103.1**	**4.31%**
China	26.03	27.3	25.87	23.6	25.76	30.15	2.98%
Bangladesh	**14.6**	**16.44**	**16.75**	**14.18**	**16.87**	**22.89**	**9.42%**
Turkey	9.23	9.93	9.86	9.3	10.88	11.98	5.35%
India	4.47	4.6	4.39	3.39	4.02	4.86	1.73%
Vietnam	2.96	3.33	3.49	3.16	3.38	4.57	9.11%
Pakistan	2.42	2.55	2.73	2.45	3.08	3.94	10.29%
Cambodia	3.37	3.83	3.68	2.8	2.81	3.81	2.51%
Morocco	2.83	3.06	2.95	2.32	2.93	3.12	1.98%
Sri Lanka	1.09	1.25	1.35	1.19	1.41	1.62	8.18%
Indonesia	1.26	1.27	1.28	1.04	1.1	1.36	1.59%

Table 2: EU's apparel imports in last five years from the world (in billion USD), (BGMEA, 2023).

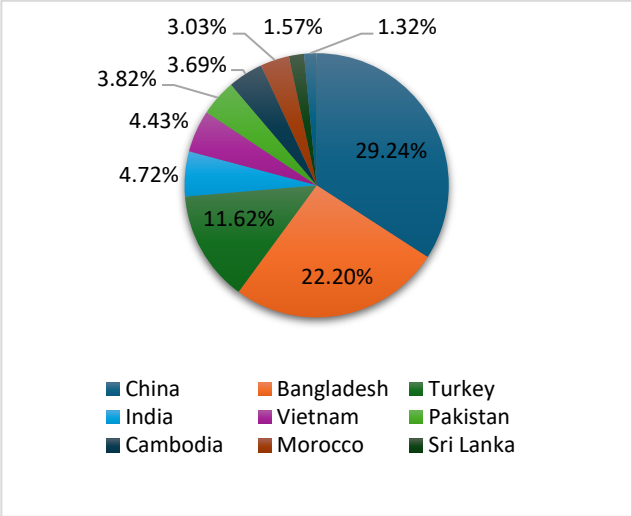


Chart 1: World's share in EU's apparel import in 2022 (BGMEA, 2023).

In addition to the EU market, the largest export market of Bangladesh, the US has doubled its imports from Bangladesh in between 2017 and 2022 which is a massive progress in the industry. Comparing to the import value of 5.06 billion USD in 2017 by US, it has now grown almost twice

of the previous value which accounts for 9.75 billion USD of apparel import from Bangladesh in 2022.

Country	2017	2018	2019	2020	2021	2022	CAGR in Last 5 years
World	**80.17**	**82.88**	**83.7**	**64.06**	**81.59**	**99.93**	**4.50%**
China	27.01	27.37	24.91	15.15	19.61	21.73	-4.25%
Vietnam	11.55	12.22	13.55	12.57	14.37	18.25	9.57%
Bangladesh	**5.06**	**5.4**	**5.92**	**5.23**	**7.15**	**9.75**	**13.99%**
India	3.68	3.81	4.06	3.02	4.2	5.68	9.09%
Indonesia	4.56	4.48	4.4	3.51	4.14	5.61	4.23%
Cambodia	2.15	2.41	2.68	2.82	3.39	4.35	15.20%
Honduras	2.46	2.57	2.79	1.83	2.66	3.19	5.30%
Mexico	3.57	3.36	3.12	2.2	2.84	3.16	-2.39%
Pakistan	1.27	1.36	1.46	1.4	2.22	2.75	16.61%
South Korea	0.23	0.22	0.2	0.15	0.18	0.23	0.03%

Table 3: USA's apparel imports from world in last five years (in billion USD) (BGMEA, 2023).

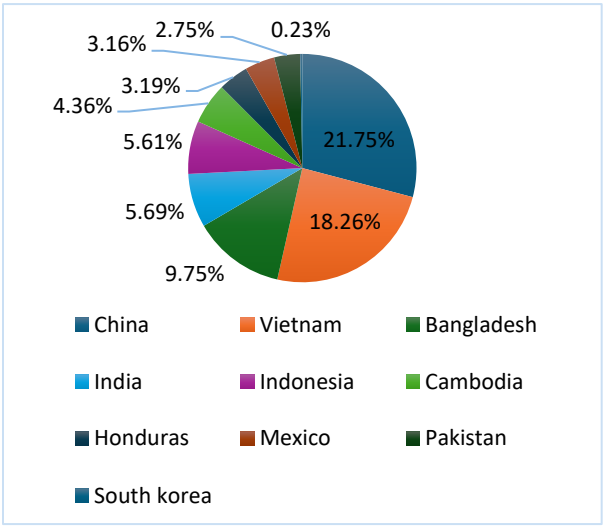


Chart 2: World's share in USA's apparel imports in 2022 (BGMEA, 2023).

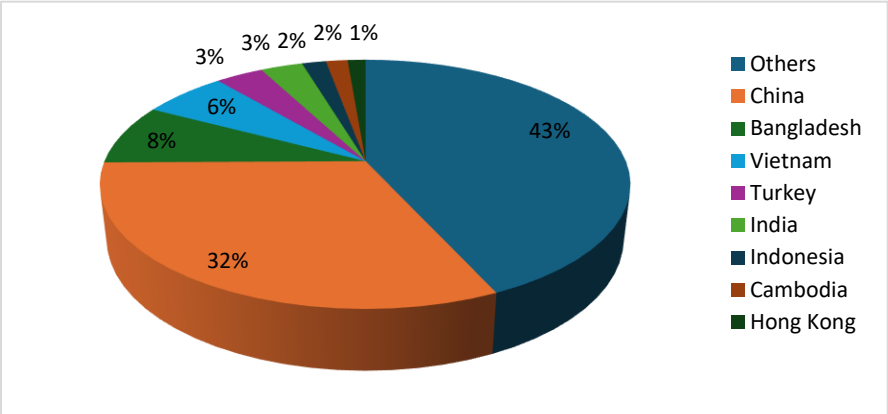


Chart 3*:* Global clothing export share in 2022 (BGMEA, 2023).

2.1.2 Unfavorable conditions in ready-made garment industry of Bangladesh

Although there has been a significant growth in the RMG sector of Bangladesh, still there are some important aspects to be addressed in the industry to improve. According to the Bangladesh Garment Manufacturers and Exporters Association (BGMEA), Bangladesh's RMG sector is still depriving of development related to the human labor and their skills along with some other major factors. The challenges are appearing due to the lack of attention from the owners and because of several external factors. This is causing the industry to face obstacles in its operation and making it hard to bring a balance between the cost of production and selling price of the products.

The major challenges faced by the RMG industry of Bangladesh according to the Bangladesh Garment Manufacturers and Exporters Association (BGMEA) are as follows:

1. **Shortages of skilled human resource and lack of scopes for skill development:**
   As there are a vast number of unskilled garment workers in the industry, they require more time to work compared to the skilled laborers. Thus, the production process gets slowed down while they consume more time than usual. This factor often drives to the inefficiency in the production process (BGMEA, 2020).
2. **High level of competition and high production cost:**
   Due to the huge number of garment factories, they are now obliged to make an investment in environmental and social aspects also. As the companies have been spending a lot and the whole cost of production is increasing, the selling price is not increasing consequently, due to the existence of huge competition in the market. Due to the difficulties caused by rising labor cost and process automation, with the ongoing trend of being sustainable, it is becoming more uncertain for the industry and the workers as well (BGMEA, 2020).
3. **Futuristic aspects of the industry:**

International buyers are conscious about some important humanitarian, social and economic factors while they make a purchase from Bangladesh which can also be seen from the futuristic view. Buyers around the world care about fair wages, no gender discrimination, elimination of child labor, safe working place, and environmental sustainability. On the other hand, Bangladeshi garment workers demand for job security, fair wages, and safety at workplace. So, it is burdensome for the owners to consider all the futuristic aspects at the same time and act simultaneously (BGMEA, 2020).

2.2 Digital supply chain management

Businesses, regardless of their sizes have been greatly affected by the global trends in today's advanced business world (Agrawal & Narain, 2018). Digitalization of the business processes is one of the most important trends which global businesses are following till date. People's communication and interactions with their surroundings have been drastically affected by digital technologies. The future entails evaluating the impact of e-commerce on wholesale, retail, and distribution, as well as the merging of the physical and online worlds and the growing popularity of alternatives to home delivery. According to (Agrawal & Narain, 2018), future consumers are impatient and do not agree to wait but they desire to receive their products as soon as they order it, and businesses must adapt to these issues. Because of the drastic change in internet usage percentage of customers which is rapidly increasing on daily basis, frequent new information accessibility and the ability to compare product features and pricing all have a substantial impact on customer purchasing behavior and demand patterns. This has also influenced businesses and organizations to digitize and digitalize the systems in order to cope with the speed of communication of customers around the world. When discussing the digital supply chain, it needs a prior understanding of the concepts of "digitization" and "digitalization". The term "digitization" commonly describes the conversion of analog information into a digital form. On the other hand, "digitalization" refers to the conversion of processes inside of an organization and very likely all business models by "*adopting and using digital technologies in individual, organizational and social contexts*" (Legner et al., 2017). The impact of internet usage by customers and consumers has affected through all the way from production till delivery in a company's supply chain. The automation of the businesses in their operations has changed the way of communication from business to business and business to customers. Like the digital marketing, digital employee

tracking, integrated finance and accounting system, supply chain and logistics sectors are no exception (Büyüközkan & Göçer, 2018).

The development of information systems and the use of novel technologies that increase the integration and agility of the supply chain, thereby boosting customer service and the organization's long-term success, can be termed as digital supply chain (Ageron et al., 2020). In fact, the digital supply chain will surely combine technologies such as – IoT, big data, blockchain etc. with no exception and will focus on minimizing intra organizational and inter organizational expenses along with customers and consumers, which will create greater value for the organization. Digital or automated supply chain does not necessarily imply possessing cutting-edge digital technologies. It is primarily concerned with connecting digital activities with the main objectives of supply chain and implementing a digital approach to understand the untouched potential of current resources and abilities which must result in increased performance. As a result, it is critical to address concerns linked to DSC installation, optimization and development and most recent management techniques in order to better delight clients.

To digitalize the supply chain functions of a firm as well as the other functions not related to the supply chain, a simple method can be followed. This process is simplified with prior understandings of digitalization process. The method is as follows.

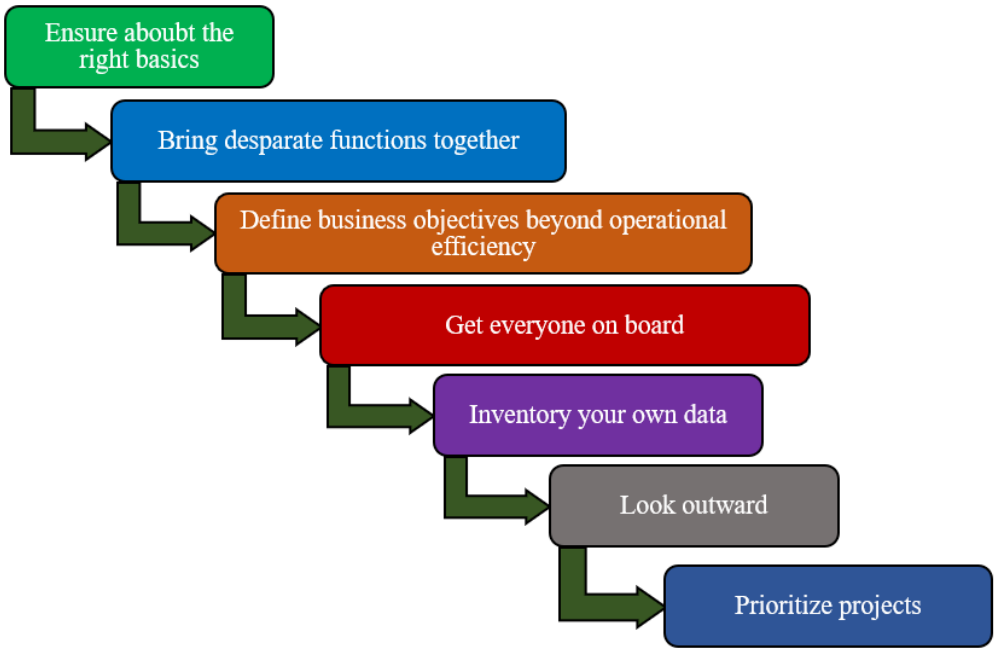


Figure 1: Seven steps to a digital supply chain (Abby Jenkins, 2022)

1. Prior to adding new technologies, it is important to enhance the current process where it is necessary if the present configuration is experiencing issues with supply chain performance.
2. It is more necessary to pay attention to different stakeholders and how they reach their desired results. Undertaking a survey can be allowed to gather requirements and gauge awareness.
3. Better demand planning could be one example. DSC can address queries with more transparency in case of a missed purchased order and can depict relationships between raw materials and final goods distinctly.
4. When you have your group of experts, it is your turn to disseminate the news: explain the supply chain strategy's message explicitly and precisely while ensuring that is reaches to everyone in the organization from high leadership through the shop floor of the company. In order to create cross-functional teams which attempt to accomplish smaller objects to reach greater goals, adopt an agile method in technical part.
5. Analyze the present data collection methods of the supply chain by the organization and identify ways to improve it. An option could be to employ an algorithm for forecasting requirements instead of conducting manual calculations for safety stock.
6. Start analyzing the data that your suppliers are free to provide and can share with you automatically through IoT and APIs.
7. Demand forecasting, dependable order processing, astute logistics planning, warehouse automation, improved end-to-end transparency, and real-time disruption response are just a few applications for predictive analytics (Abby Jenkins, 2022).

The concerning issues related to DSC have been analyzed by many practitioners which are now being accepted by many organizations with their increase in numbers day by day. Compared to the other aspects of digitalization, the concept of DSC is relatively less focused and studied by researchers, where the literature is focused in various research areas other than digital supply chain. Previous studies show that researchers had paid their attention mainly on the concepts of Industry 4.0, Big Data Management (BDM), Unmanned Aerial Vehicle (UAV), Internet of things (IoT), Cloud Computing (CC) etc. According to (Creazza et al., 2022). Human resources are additionally essential to increasing supply chain-based cyber security. (Dennehy et al., 2021) stated in his research that professional awareness is critical for allowing robust supply chains. As a result, the

researchers employ institutional mindfulness along with significant analytical skills to enhance understanding as they build resilience within the supply chain. The study by (Rogerson & Parry, 2020) shows that technological innovations have to be developed to buy food and make payments transfers. In the above-mentioned sense, there exist certain obstacles to utilize blockchain technology to transform the supply chain into a digital one in the food business. Customers' desire to make payment, customers' right to access data, administration, deception, and human failings due to technology's limitations are all obstacles. As a result, in these days of innovation, the implementation of blockchain throughout supply chains has become more popular. Thankfully blockchain improves visibility by boosting openness (Rogerson & Parry, 2020). The "IoT" known as the "Internet of Things" along with various digitized innovations promotes transparency in inventory management, preventing shortages and stockpiling. The Internet of Things is a crucial element to facilitate the planning, controlling and coordinating activity in a supply chain (Ben-Daya et al., 2019). IoT provides a route to faster communication system in a supply chain where the accessing & controlling of information is speedy, easier and time saving. A network combined of connected devices where each device has easy access to the shared data and can share information with each other without any interruptions, makes the supply chain processes more controllable and flexible. Additionally, the argument by (Gohil & Thakker, 2021) claims how the requirement to leverage the internet of things is a difficulty for the supply chain worldwide. Automated procedures allow firms to improve their ability to gather and interpret massive amounts of data, boost connections and data exposure, and provide trustworthy and rapid physical connectivity and shipping alternatives, all of which have an enormous effect on supply chain networks as well as logistics effectiveness (Herold et al., 2021). In a similar way, (Koh et al., 2019) realized that big data analytics has been used more often than any other technologies in industry 4.0. Big data analytics is becoming popular, therefore necessitates the implementation of methods for advancing in the direction of supply chain digitalization, a correspondent statement by (Haddud & Khare, 2020).

In relevance with the decision-making process in a supply chain with faster information exchange across it, the role of Industry 4.0 along with the impact of digital transformation have a great influence (Preindl et al., 2020). Thus, a digital supply chain must combine the digital technologies in its operation to make the processes more flexible and efficient. The pursuit of these revolutionary technologies is motivated not so much by the technology itself as it is by their

potential to revolutionize supply chain operations (Xue et al., 2013). So, this is an important aspect of understanding that the digitalization not only depends on the introduction of brand-new technologies in a supply chain system but also that the use of the technologies within the system must make the system more efficient and effective.

Organizations can expect different new ways to earn revenues and values by the proper utilization of the updated technologies in their operations. The main aim of supply chain digitalization (SCD) is that it will focus on improving the firm's operational performance by modernizing the supply chain capabilities. The ability of a corporation to discover, exploit and assimilate both types of resources i.e. internal and external, with the intent to facilitate the whole supply chain operations and processes is termed as supply chain capability (Bharadwaj, 2000).

The ability to quickly adopt and incorporate new market requirements is critical to maintain a competitive advantage in the coming days. Emerging technologies are projected to bring solutions to some significant difficulties in SCM, which will reduce costs, simplify complex processes, and will increase the volume of supply chain flexibility. As digital transformation is considered to be a shift, every project of organizational change should be handled with considerable caution. It is not only a single person who can accomplish the digital transformation across the whole supply chain. To accomplish digitalization across the supply chain, it is important to grasp the understanding of the concepts of digitalization and automation by supply chain managers and engineers and to have portfolio of all activities which will help in collaboration and will affect in noticeable change.

2.2.1 Digital transformation of supply chain management in garment industry

The garment sector is made up of businesses that design, manufacture, and sell clothing, footwear, and accessories. The garment industry is considered as one of the world's oldest and largest industries amongst other industries. In order to survive in global business, apparel manufacturers must always strive to improve the performance of production processes in response to rising global competition and erratic demand fluctuations. The production process in the garments industry consists of several steps. Furthermore, the manufacturing process is divided into three stages: pre-production, production, and post-production (Abd Jelil, 2018). In pre-production stage there are steps like sampling, procurement, and raw material handling, whereas manufacturing includes the activities of cutting, stitching, washing, and inspecting and finally, in the post-manufacturing

phase, there are activities including pressing, finishing, packaging, and shipping take place (Abd Jelil, 2018). The pre-production process for apparel begins with the treatment of raw fiber. Textile companies are then requiring transforming fibers into yarn by spinning method and after that knitting and weaving to create the required clothes. Then it is up to the apparel makers to cut, add value, stitch, check, and confirm the finished product (Kumar, 2005). High labor is required for this stage of manufacturing. Then the finished products are made safe in secured packaging following the shipment of the packages to the buyers which occurs in the final stage of the process. Since the early 1980s, there has been a growing need for the use of automated technology to improve efficiency, the quality of goods, flexibility. The garment business is currently undergoing the era of the fourth industrial revolution, which is transforming this sector into a *"tailored intelligent textile manufacturing facility"* (Jayatilake & Rupasinghe, 2016). The deployment of modern technology aims at boosting productivity, optimizing resource utilization, while lowering the amount of labor required. Each of the nine cornerstones of the “Industry 4.0” concept are converting and enhancing the garment industry's manufacturing system becoming a completely automated and smarter version (Vaidya et al., 2018).

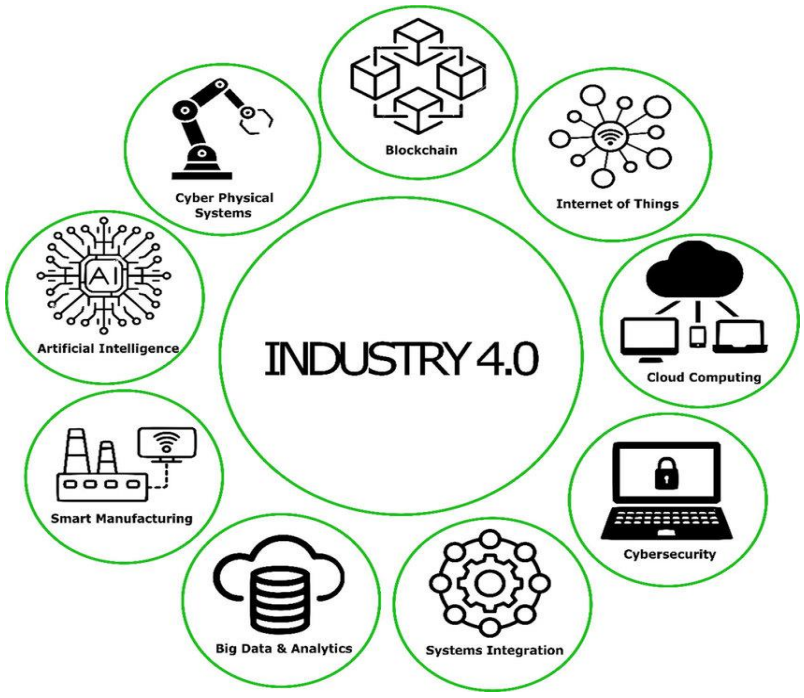


Figure 2: Nine pillars of industry 4.0 (Gomez et al., 2022)

These important facts about the digitalization of supply chain management have been realized and implemented by first and second world countries. On the contrary, there are businesses which are still deprived of enough technologies to digitalize in their business operations, especially in third world countries or underdeveloped countries due to the cost of maintenance. Presently, the expanding competitive world of garment firms has compelled them to follow new criteria in order to stay afloat and flourish (Bonfanti et al., 2018). With the introduction of new technology, apparel companies aim to provide tailor-made clothes and improve client engagement in the creation of goods. Leading athletic groups have begun to invest in technologies that use big data to produce new training, sports and workout items and enhance the user experience (Rindfleisch et al., 2017). As a result, they will acquire an economic edge against enterprises that specialize in large-scale manufacturing and low-cost quick fashion. The likes of Adidas, Nike, and the Levi Strauss brand are just a few of the clothing manufacturers that have automated their supply chains and are changing the textile and clothing manufacturing landscape. Their innovations have technologically altered business processes to create a more sustainable, and personalized experience for consumers.

The adoption of technological innovations by the lion's share of enterprises undergoing the digital shift has led to a greater use of gadgets and sensors in the process of production, resulting in a continual and expanding flow of data (Oks et al., 2018) Big Data is frequently employed in the garment sector for "trend projections, supply chain management, assessing consumer buying habits, likes, dislikes and sentiments" (Jain et al., 2017). Cloud computing is an additional digital innovation that has an impact on the garment production process. The implementation of this technology promotes innovative product creation, flexibility in manufacturing and supply chain management, and the use of data analysis for enhancing the process of manufacture. In the garment sector, thanks to cloud computing, " manufacturing scheduling, primary material handling, expenses, handling of final purchases, sampling, tracking the collection of final purchases and the eventual dispatch of those goods are able to be reached anyplace at any moment" (Suyati Technologies, 2016).

In the garment industry, methods of simulation are employed for avoiding critical manufacturing and service problems and to enhance the entire manufacturing process. Three-dimensional models of products and manufacturing processes enable technicians to review and improve machine

configurations for the production of the subsequent commodity in the digital realm prior to what actually occurs in the world of reality. By performing so, the garment maker reduces time required for setup while improving the quality of the goods and its innovation.

Augmented-reality-based platforms offer a variety of amenities in the textile production procedure, including choosing equipment within a storage facility and providing restoration directions via smart gadgets. In the garment production workflow, augmented reality-based remedies can be utilized to deliver current forms of information to the workforce with the objective to boost the way they make choices and labor protocols. Furthermore, augmented reality is competent to yield in simulated education to personnel addressing crises and the best way to interface with automated systems (Rüßmann et al., 2015).

Solid connections across the tangible, service, and technological realms can bestow optimizing production system and its operation (Landherr et al., 2016). As a result of increased accessibility of data owing to cyber-physical infrastructure, there is going to be more chances of loss of information, hacking attacks, and espionage. Furthermore, as connection grows, cybersecurity will be vital for guaranteeing the security of manufacturing operations and a critical instrument to assure trusted and safe connectivity in the textile sector.

The advent of Industry 4.0 causes both vertical and horizontal collaboration between systems. Textile producers are in a position to gain through systemic collaboration when firms, sections, activities, and abilities become more integrated like cross-company, broadly applicable data-integration systems emerge along with enabling genuinely integrated value chains. The deployment of the concept of Industry 4.0 results in successful global collaboration among buyers, actions, production, and logistics (Wang et al., 2016).

The IoT comprises an interconnected set of devices that have localized intelligence and can communicate not just with each other yet additionally with centrally located controllers. Artificial intelligence, Big Data, detectors, technological advances in automation, and connectivity between machines are all part of the IoT network. Integrating an integrated network into the garment manufacturing process enables its manufacturing system to become flexible and controllable (Vaidya et al., 2018).

Robots tend to grow increasingly autonomous, open to change, and compassionate as the fourth industrial revolution progresses, allowing them to engage with other creatures and operate carefully alongside people (Bahrin et al., 2016). Through growing product ion, self-driving robots are transforming garment manufacturing.

The term additive manufacturing (AM) refers to methods which create three-dimensional components by layering on layer of any substance (Savastano et al., 2018). As a result, AM provides a dynamic, rapid, and adaptable method of producing items, allowing firms in the garment industry to achieve an edge over their competitors. Moreover, the technology of additive manufacturing or three-dimensional printing, is fast transforming the method by which apparel is manufactured, allowing additional personalized goods (Yap & Yeong, 2014).

2.2.2 Benefits of digital automated supply chain

a) By giving visibility throughout the movement of products and services, DSCM enables organizations to get an improved comprehension of how well their supply chains are doing. This visibility enables producers and manufacturers to find more accurate choices, optimize their manufacturing processes, and more efficiently operate the SCM (Nalini, 2023).
b) Businesses that are operating in garment industries can optimize the methods in their operations by integrating digital solutions like sophisticated analytics, and artificial intelligence (AI). This can save costs and time. (Nalini, 2023).
c) When businesses use digital transformation, the entire thing in the supply chain is completed inevitably. Data distribution to managers needs to be done rationally and error-free. It aids in the easy understanding of daily actions into a preset digital blueprint, resulting in a network which is both reliable and extremely exact.
d) All digital evolution initiatives are built on the foundation of innovation. It optimizes traditional SCM tactics while also supporting the company strategy. Additionally, it strengthens the relationships with vendors and consumers.
e) Fostering a digital shift can help a textile manufacturer increase its capacity to collaborate with partners, providers, and customers. This can result in greater information exchange, quicker responding periods, and enhanced service.

f) When there are interconnected communication systems and available real time data, it will get easier to make a perfect choice for the companies. Furthermore, by merging data from transactions with freely accessible data, productivity may be assessed quickly and precisely (Nalini, 2023).

g) The involvement of customers will increase as the outcome of digital transformation. Consumers are then going to receive adequate authority, and experience while ordering from that particular company (Nalini, 2023).

2.2.3 Risks associated with DSCM

Despite its enormous potential, the digital supply chain is open to vulnerability since it embraces cutting-edge technology and shifts to platforms within the shop floor where it was never supposed to be linked using the Web. A specific field of emphasis is the possibility of IoT vulnerabilities Sensors are capable of measuring a machine's weather conditions, sound level, and vibratory rate. Rises within any one of these features may indicate an impending collapse. Maintenance personnel can correct problems before they become catastrophic with proper surveillance. Spreading threats all over supply chain can be a consequence for digitalization.

If activities are electronic and automated, they are vulnerable to the threat of hacking, and if efficient cybersecurity protocols to govern and regulate rights are not implemented, a supply chain firm faces numerous hazards. The following represent a few among the biggest prevalent threats associated with digital supply chain:

1. The threat of confidential data being leaked

Participants in a supply chain embrace digitally exchanging huge volumes of extremely valuable data, whether it is technology-related details, client data, proprietary knowledge, or else. Just one hacking incident might reveal these precious assets, and digital spying among rival supply chain businesses would not be unthinkable (Imprivata, 2022).

2. Infrastructure breaches such as IT systems, software, cloud-based services etc.

Because many components of a logistics network or supply chain are electronic, they are vulnerable to ransomware assaults. Consider the 2021 Kaseya assault, which was ended up in 1,500 firms being taken captive for ransom at the same time (Forbes, 2022). That amounts to a

significant quantity of interruptions, potential revenue loss, and operational technological concerns.

3. Hacks leveraging widely used corporate along with free software

One thing every supply chain are sharing in similar is the employment of software developed by third parties. Third parties remain a significant risk to enterprises because hackers realize they may utilize them in order to get access to other organizations and accomplish the "attack one, breach others" goal (Imprivata, 2022).

4. The intentional incorporation of security weaknesses in digital items marketed to purchasers

Applications are as important for a supply chain as plastic components are for Toyota's manufacturing plants. SolarWinds is a company develops and provides applications and software for their customers, and by compromising a component of digital technology distributed to clients, 18,000 clients, including significant government institutions, became affected by viruses (Martínez & Durán, 2021).

Thus, it is to be said that digitalization and automation of supply chain is a blessing unquestionably, yet there will remain the threats of hackers and malware functions over the internet and computer networking system for which the logistics companies and the companies maintaining digital supply chain are on pursuit of solutions on this aspect.

3 Research methodology:

This chapter aims to describe the methods applied in the research. This will provide an idea of the process for collecting and interpreting data used for this research. Furthermore, it will dig into the tools and techniques for the data analysis which is done to achieve the main objective of this research work. Moreover, this research methodology part will outline research approach, data collection, analyses, and results etc. The particulars are described in next.

3.1 Research of the industry

The 'Ready Made Garment Industry' of Bangladesh, known in short as the 'RMG' industry had been the most contributing sector in the economy of Bangladesh for past few decades. It is creating an amazing impact in the economy while it has employed more that 4.4 million workers where 80% are females (M. Ali et al., 2021b). Prior to the introduction of the RMG industry in Bangladesh, the jute industry was the main contributor. Whereas the RMG sector is considered as the principal export earner of the country as of today.

The industry is controlled and monitored by a central trade association known as Bangladesh Garment Manufacturers and Exporters Association (BGMEA). The physical entity of the association is centered in the capital of Bangladesh, Dhaka.

According to BGMEA (2020), the garment sector of Bangladesh began to operate in 1980s what was momentous after the war in 1971. The key person was Late Noorul Quader Khan who initiated the journey during the year. He was visionary about the country's development, and economic growth, and realized the potential in the garment sector. With the aim and hope of overcoming the economic depression following the conflict, he helped 130 garment trainees to receive the necessary training about the technical know-how on the garment production process from South Korea and later to facilitate the country's own production facilities (BGMEA, 2020). Afterwards the liberation war of 1971, Bangladesh made its first export of 10,000 pieces men's shirts to a firm in Paris which was worth of 13 million French Franc. Later, with foreign direct investments and growing demands from foreign buyers the industry expanded as it could and has reached the current position.

Today, the RMG industry of Bangladesh goes through massive functions of fulfilling both the domestic and foreign demands of garment products. The majority of the garment companies must undertake the export procedure along with the domestic supplies. At present, besides fulfilling the demands of the customers, the industry is also impacting the social and human development of the country. The utmost contributions the industry is doing by creating jobs for millions of people reducing the poverty level, empowering women, and increasing the literacy rates of the workers by providing education.

3.2 Research approach

This paper is made mostly on the review of existing literatures and concepts about the RMG industry of Bangladesh, and the digitalization of supply chain management. The study is mainly focused on the descriptions about the current scenario of DSCM in RMG sector of Bangladesh, and the future impact of DSCM across the industry. The descriptions have been made to provide an overall understanding on digitalizing the supply chain management in RMG industry of Bangladesh. The character of the research, including analyzing the impact of digitalization of SCM, shows that it is quantitative research. The primary research tactics is based on the respondents' feedback collected from several individuals. These responses will help to reach the objectives and draw the conclusion for this paper. The approach of this research follows gathering information from previous research and theories. The aim of this research is quantitative which includes analyzing the collected data with numeric characters.

3.3 Research design

Successful research is designed on all three mandatory steps i.e. researchers' assumptions and knowledge, approach of the research, and collecting, analyzing, and evaluating the result (Wright et al., 2016). This paper contains descriptions on the assumptions and knowledge gained, the numeric data collection, and assessing the result based on the quantitative data. This is descriptive research as it contains explanation about the current scenario of RMG industry of Bangladesh, the issues with supply chain management in RMG industry, digital supply chain and its transformation in the RMG industry.

Together all of these will develop an overall image of the impact of DSCM in the RMG sector. It also provides a proposed framework for the research design which is given below.

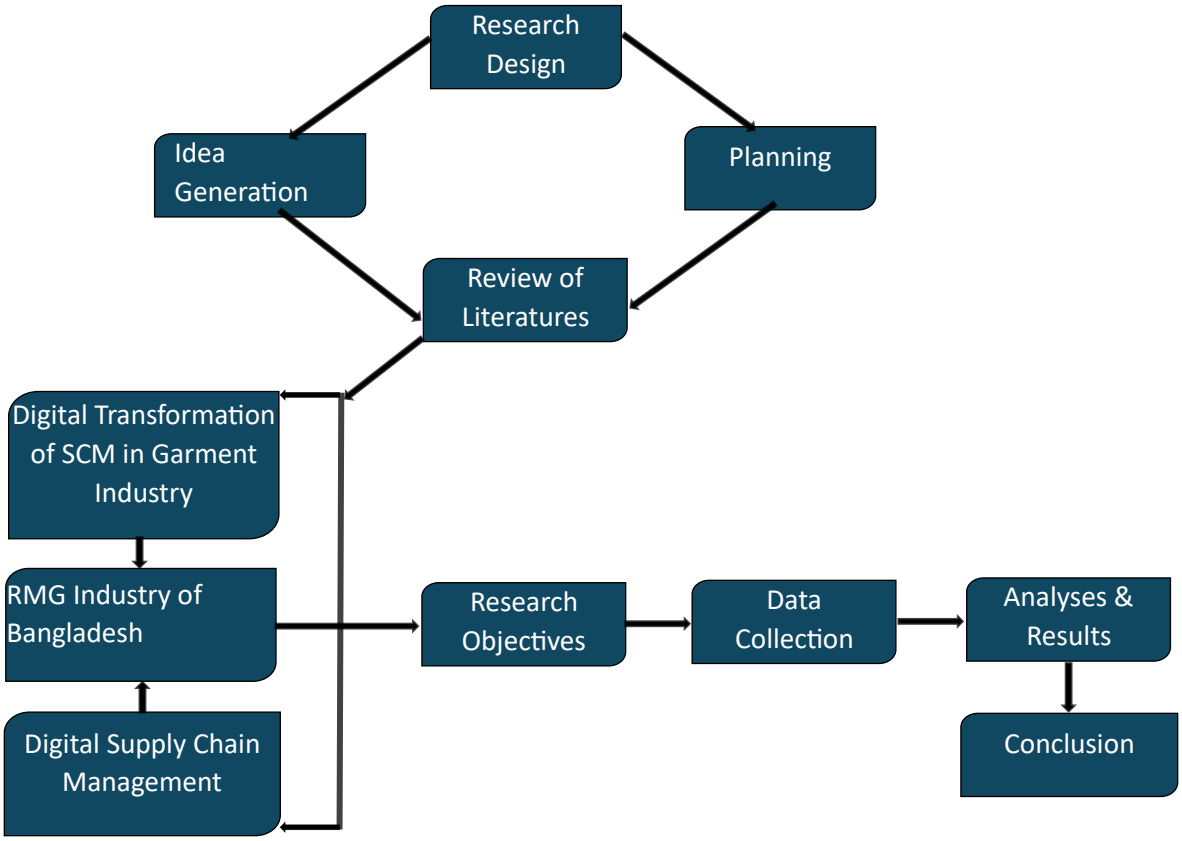


Figure 3: Proposed research framework (own research design)

3.4 Population of the research and the range of sample

This study is made on the non-probability sampling technique. The desired population by this study is the people currently and previously involved in the supply chain management of RMG industry of Bangladesh including ranging from procurement department till the transportation department. Additionally, it targets the population from RMG businesses, merchandisers, and logistics companies. As the sampling is non-probabilistic, the whole portion of the population might not be chosen as the primary subject for this research. The respondents are targeted as they meet requirements for this research. This paper includes purposive sampling. Sing & Masuku (Singh & Masuku, 2014), defined that the sampling done based on the purpose of a research is the purposive sampling. However, convenience sampling is also a part of this research. The sources are used according to their convenience, which is the simplicity and flexibility to reach the respondents within a smaller period of time.

3.5 Data collection

The data collection section describes how the data is collected for this paper. The sources of both primary and secondary data have been used to obtain the data required. The primary data for this research is collected from the working people in RMG industry of Bangladesh across several

departments and who are involved with the industry in a way. However, the respondents from the industry were given a set of questionnaires containing 25 questions which was made online. The location of the survey was chosen according to the relevancy with the industry. Where Dhaka the capital, was the main location with other two biggest port cities of Bangladesh i.e. Chittagong and Khulna. The data is collected from only 151 respondents.

3.6 Questionnaire setting

The questionnaire for this study consists of 4 sections including 25 questions. The first section is focused on information about respondents and their workplace. It consists of 6 questions. The questions are multiple choice for this section. The second section has 4 questions. They are multiple choice questions as well. This section is made to make a comparison between the traditional and digital supply chain.

On the other hand, the third section consists of 5 questions. There are both Likert scale and multiple choice in this part. The five-point Likert scale is set as 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree and 5=Strongly Agree. This part focuses on the questions pointing to the issue of the high cost of production. The probable causes for the high cost of production are included. The next part focuses on the issues related to the longer lead time. Here, the causes are included to get justified by the respondents. In this section, there are also both types of questions, i.e. multiple choice and five-point Likert scale.

However, the last section of the questionnaire consists of 4 questions regarding the effectiveness of digitalization tools.

3.7 Data Analysis

For the data analysis, this study has used IBM SPSS STATISTICS 29.0.1.0 software. Firstly, it determined the Cronbach's alpha for the reliability analysis. It is also used for descriptive statistics finding frequencies, mean, median, mode etc. This analysis also figured out the value of Skewness and Kurtosis in some cases. Moreover, there are visualizations of data on pie chart and histograms from the output of the analysis. As the study is mostly descriptive, it focuses on more descriptives of statistics.

4 Analysis and findings

The data analysis and finding part will give results on the data collected and analyzed. The analysis is done according to the objectives of the research. This analysis part contains reliability test by Cronbach's alpha, descriptive analysis, pie charts, and histograms on the collected data.

4.1 Reliability analysis

The reliability test on the obtained data can be done using different measures. It is done to determine the quality of the survey data. This research uses Cronbach's α alpha to determine the reliability of the data. Cronbach's alpha assists in defining the focus of the data. It shows how the questions in the survey are closely related, and relevant to each other. It is suggested that the Cronbach's alpha is more accurate for large number of scale data and tends to be inappropriate for smaller quantity of data to be measured (Christmann & Van Aelst, 2006).

Table 4: Case processing summary

		N	%
Cases	Valid	151	100.0
	Excluded[a]	0	.0
	Total	151	100.0

Source: Own calculation from survey data.

Table 5: Reliability statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.798	.818	16

Source: Own calculation from survey data.

Table 1 provides the information about the validity on the total number of responses been used for the analysis and how many of them are excluded from the process. Here, all the responses are valid, which is 151 and none of the data has been excluded from the process. So, 100% of valid data has been used for this process.

Table 2 defines reliability based on Cronbach's alpha. To determine this, scale variables are required. As the questionnaire for this research has variations in questions i.e. multiple choice, Likert scale etc., the Likert scales have only been tasted. There are 16 items on Likert scale in the survey questionnaire. The overall value of Cronbach's alpha is 0.798. This expression means that there is strong evidence of the construct of the questionnaire where they are aimed on same direction of this research. So, the data are reliable for the analysis according to the value of Cronbach's alpha.

4.2 Analysis on respondents

This study set several questions about respondents and the place of their work. The answers from the respondents about themselves will provide an understanding of the features of the population. Questionnaire also includes which items the companies are producing or dealing with and what are the most confronted problems by the respondents' company. The questions were asked to collect the essential insights about the respondents for this study.

Table 6*:* Analysis of respondents and their workplace

Variables		Frequency	Percentage
Profession	Supply chain management-RMG industry	39	25.8
	Logistics and transportation-RMG industry	8	5.3
	Production and manufacturing-RMG industry	17	11.3
	Merchandiser	35	23.2
	Retailer/wholesaler of RMG goods	8	5.3
	Former employee/employer of RMG industry	7	4.6
	Other fields related to garment/textile industry	7	4.6
	Other fields related to supply chain management	23	15.2
	Researcher	6	4.0
	Other	1	.7
Years of experience	0-5 years	86	57.0
	5-10 years	49	32.5
	10-15 Years	13	8.6
	More than 15 years	2	1.3
Missing System		1	.7
Company focuses on exports	Yes	54	35.8
	No	94	62.3
Commodities of companies	Woven items	19	12.6
	Knit items	22	14.6
	Both woven and knit items	87	57.6
	Only raw materials	14	9.3
Missing system		9	6.0
Workplace setup	Traditional/analog	93	61.6
	Digital/automated	58	38.4

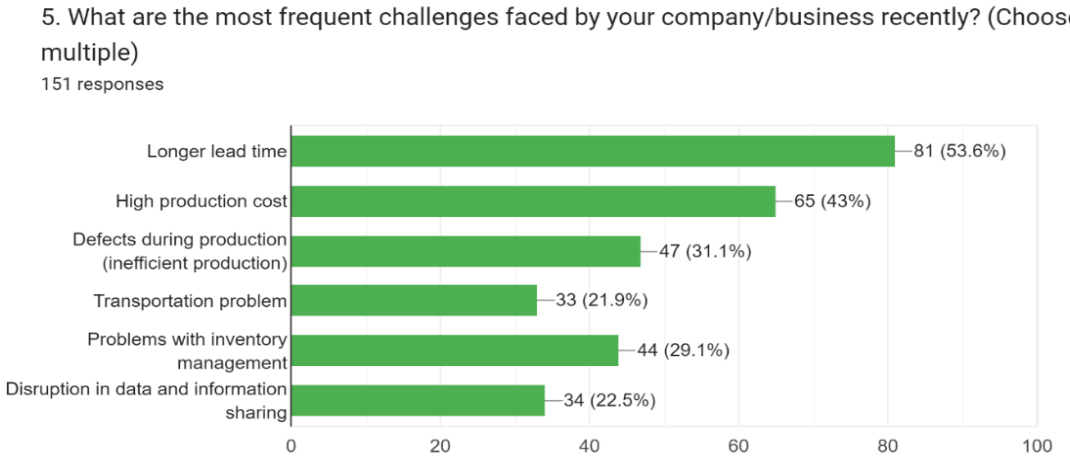
Source: Own calculation from survey data.

Table 3 shows the analysis on respondents using frequency and percentage. There are 10 different types of professions to which the respondents belong to. The majority of the respondents are from the supply chain management of RMG sector of Bangladesh and Bangladeshi RMG merchandisers i.e. 25.8% and 23.2% respectively. A medium portion, 11.3% and 15.2% of respondents belong to the production/manufacturing sector of RMG industry and other fields of SCM outside of RMG industry. On the other hand, there are smaller parts of the respondents who are from the backgrounds like logistics and transportation of RMG industry, retailer and wholesaler of RMG goods, former employer/employee of RMG industry, other sectors in garment industry, researchers, and others with a percentage of 5.3%, 5.3%, 4.6%, 4.6%, 4%, and 0.7% respectively. Moreover, more than half of the respondents have the work experience in their respective job fields between 0-5 years resulting in 57% in total. A little senior to them are 32.5% of the respondents who worked between 5-10 years in RMG industry. 8.6% and 1.3% of the people are experienced over10 years and 15 years respectively.

In addition to the questions solely focused on respondents, there were also questions based on their workplace. This is to determine the current condition on the digitalization of the workplaces and the goods dealt with by their respective companies. Here, 62.3% of the companies are not 'only export' oriented which means they sell their products to both foreign and domestic markets. And 35.8% of the companies are only export oriented, that identifies a major portion of the Bangladeshi ready-made garment companies are only selling their products to the foreign buyers. Lion's share among these companies is dealing with both woven and knit items which is 57.6%. Where few companies focused on only specific items like woven items, knit items, and raw materials which is 12.6%, 14.6%, and 9.3% accordingly.

Further we can see that the maximum number of respondents are working in traditional or analog setup at their workplace. Selection of traditional setup by 61.6% and selection of digital setup by 38.4% of the people describes that there are a significant number of the companies still not digitalized yet. This is significant not only by numbers, but also by the current world business trend.

Chart 4: Most frequent challenges faced by RMG industry of Bangladesh



Source: Own calculation from survey data.

Lastly, the RMG industry of Bangladesh faces enormous problems as we already know from the above study. Nevertheless, this study tried to find out the most frequent challenges in recent times. The responednts were given a chance to select multiple problems because of the variations and large number of problems exists. The string of data resulted in the bar chart given below. The chart 1, depicts that the longer lead time is on the top consisting 81 responses as the most frequent problem faced by the RMG industry of Bangladesh. Next, is the high cost of production with 65 selections stands as the second most frequent barrier in the industry. The third and fourth problem exists very closely to each other. The inefficient production is the third most faced problem according to the analysis. With a difference of only 3 responses, inventory management appears to be the next in the sequence. Inventory management seems to be a hidden problem as the study of this factor have been less focused but received large responses. Disruption of data and information sharing is ranked next to inventory management with 34 responses. Transportation problem occurs to be the last with 33 selections in the questionnaire.

4.3 Comparison analysis between traditional and digital supply chain

This part of the analysis describes that for some specific cases in the RMG industry of Bangladesh which of the forms of SCM is a best suit according to the respondents. The specific cases are represented in the following table as variables. The questionnaire was set as a multiple-choice giving option for 1 and 2 i.e. ‘Traditional/analog supply chain’ and ‘Digital/automated supply chain’. The first option is coded as 1 and the second is as 2.

Table 4 containing the descriptive statistics shows that there are 4 variables on which both forms of SCM have been compared. Here, all 151 responses were calculated with no missing value. The mean value gives the average score. The first variable, cost effectiveness has the mean value of 1.84, the second variable, improving lead time has 1.86 little more than the first variable. The digital supply chain tends to be the most effective according to the mean value here. The third variable, efficient production system has received a mean value of 1.91 which is almost 2, and the fourth, improving transportation system has obtained 1.83. Similar to the first two variables, the third and fourth variables are also close to the digital supply chain. The mode value of 2 for each variable concludes that each of the cases got the most responses of option 2. For these cases, DSC is mostly suitable for efficient production and then for improving lead time, cost effectiveness, and improving transportation system respectively.

Table 7: Comparison between traditional and digital supply chain.

		Cost effectiveness	Improving lead time	Efficient production system	Improving transportation system
N	Valid	151	151	151	151
	Missing	0	0	0	0
Mean		1.84	1.86	1.91	1.83
Median		2.00	2.00	2.00	2.00
Mode		2	2	2	2
Std. Deviation		.367	.347	.291	.373
Range		1	1	1	1
Maximum		2	2	2	2
Sum		278	281	288	277

Source: Own calculation from survey data.

4.4 Analysis on the causes of high production cost and longer lead time

Table 6 posseses the analysis on the causes of the high cost of production and the longer lead time. The analysis is based on the frequency of descriptive statistics. It contains the number of data, minimum and maximum value which can be obtained, the sum of the total points received, the mean value, and the standard deviation. Here the minimum value is 1 and the maximum is 5. The Likert scale values were set from 1 to 5 to express strongly disagree to strongly agree.

Each case has three variables. For the high production cost, the first cause shown as the wastage of raw materials. It has the mean value of 5 expressing a moderate agreement. Mean value of 3.46, almost same to previous one, stating that the direct involvement of human labor is a moderate problem for high production cost. On the other hand, almost all the respondents agreed with the absence of latest technologies to be a reason for the similar scenario providing a mean value of 3.83.

Further, from the descriptives of longer lead time in the table we can see that, all three reasons mentioned i.e. transport vehicles without smart technologies, deficiency of real time data for suppliers, buyers, and producers, and the lack of technologies in manufacturing processes is a medium level of problem for the longer lead time. The mean values are 3.46, 3.63, and 3.74 respectively. The lack of technologies in manufacturing process was agreed more than the other two causes.

Table 8: Reasons for high production cost and lengthy lead time.

Variables		N Statistic	Minimum Statistic	Maximum Statistic	Sum Statistic	Mean Statistic	Std. Deviation Statistic
Causes of high production cost	The wastage of raw materials	151	1	5	521	3.45	1.389
	The direct, and intense involvement of human labor	151	1	5	522	3.46	1.264
	The absence of the latest technologies in manufacturing	151	1	5	579	3.83	1.163
Causes of longer lead time	Transport vehicles without smart technologies	151	1	5	522	3.46	1.305
	Deficiency of real time data for suppliers, buyers, and producers	151	1	5	548	3.63	1.236
	The lack of the latest	151	1	5	565	3.74	1.191

	technologies in manufacturing						
Valid N (listwise)		151					

Source: Own calculation from survey data.

4.5 Effectiveness of digital supply chain for reducing cost and lead time

Table 7 gives results on the basis of percentage and frequency for each variable. It describes the current lead times for the companies across the RMG industry. We can easily observe that it takes 90-100 days of time until making the final delivery according to the 40.4% of the respondents. Where for 11.3% it takes 110-120 days which is much longer span of time. Little bigger i.e. 18.5% of the respondents companies take less than 90 days of time. Further, it requires more than 120 days of time for 2% of the companies to complete the whole process till delivery. The current state of lead time proves that it is still taking longer than other manfucturers from developing countries.

Table 9*:* Current lead time in RMG industry of Bangladesh

Variable		Frequency	Percent
Lead Time	Less than 90 days	28	18.5
	90-100 days	61	40.4
	100-110 days	42	27.8
	110-120 days	17	11.3
	More than 120 days	3	2.0
	Total	151	100.0

Source: Own calculation from survey data.

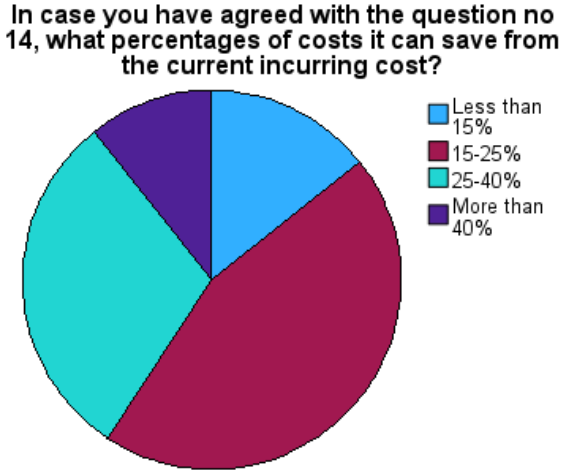
However, according to the examined data in table 8 and 9 it can be explained as DSCM is capable of saving both time and money. The question has received 139 responses among 151 respondents where there was option to skip. the DSC can reduce 15-25 days from the current lead time. Nearest to the highest percent, 31.8% says that it can save from 25-35 days to complete the whole procedure of manufacturing and delivering goods. Where the number of most optimistic people are only 4.6% hoping for reduction of lead time by more than 35 days, if there is proper implementation of DSCM. On the contrary, still there are 17.2% of the population, who think the DSCM can reduce lead time by less than 15 days.

Table 10: DSCM's ability to save manufacturing cost and optimizing lead time.

Variable		Frequency	Percent
Reduced lead time	Less than 15 days	26	17.2
	15-25 days	58	38.4
	25-35 days	48	31.8
	More than 35 days	7	4.6
	Total	139	92.1
Missing System		12	7.9
Total		151	100.0
Cost Saving	Less than 15%	20	13.2
	15-25%	63	41.7
	25-40%	42	27.8
	More than 40%	15	9.9
	Total	140	92.7
Missing System		11	7.3
Total	151	100.0	

Source: Own calculation from survey data.

Chart 5: Percentages of costs can be saved by DSCM.



Source: Own calculation from survey data.

Chart 6*:* Number of days can be reduced by DSCM.

Source: Own calculation from survey data.

In addition to the lead time reduction, the table also explains what percentages of costs the DSCM can reduce from the current incurring cost. The charts above, give a visual representation of the size of the population and the extent of their belief on the capacity of DSCM to decrease cost and time. According to the mass of the respondents of 41.7%, DSCM can lower 15%-25% of costs existing during production. The second large segment of the respondents i.e. 27.8% are more positive on the ability of DSCM. This segment believes, DSCM can be even better reulting into 25%-40% of cost reduction. The most supporting segment of respondents consists of 9.9% of the total population showing more than 40% of costs can be decreased with the implementation of DSCM. However, 13.2% supports for the reduction of less than 15% cost according to the table.

4.6 Application of digital tools

The table111 describes the frequencies from examining the data obtained. The table also provides the value for Skewness and Kurtosis on the analyzed data. The value, SK>0 means positively skewed where there are more number of lower values exists. When the skewed value=0, it is meaningful that the distribution is symmetric. Moreover, the SK<0 expresses that there are more number of high values in the distribution.

The skewness for each item in the table is -0.841, -0.709, -0.994, and -1.071. The skewness values prove that the data has more number of high values used in the scale for the measurement. Here the values for additive manufacturing for improving efficiency in production is -0.841, for

intelligent transport system to optimize the lead time is -0.709, for Blockchain, IoT toenhance data and information sharing is -0.994 contain large number of high values, and are highly accepted. On the other hand, the value for IoT to provide better resource monitoring system in production process is -1.071 which means there are little more number of lower values in the distribution than the other three categories.

The kurtosis values are -0.272, -0.485, 0.107, and 0.506 for the respective items in the column.

Table 11*:* Frequency table for digital tools of SCM

		Additive manufacturing for improving the efficiency of production	Intelligent Transport System (ITS) for optimizing the lead time	Blockchain, IoT etc., can enhance data and information sharing	IoT for providing better resource monitoring system in production process
N	Valid	151	151	151	151
	Missing	0	0	0	0
Mean		3.63	3.60	3.87	3.94
Median		4.00	4.00	4.00	4.00
Mode		4	4	4	5
Std. Deviation		1.268	1.250	1.181	1.127
Skewness		-.841	-.709	-.994	-1.071
Std. Error of Skewness		.197	.197	.197	.197
Kurtosis		-.272	-.485	.107	.506
Std. Error of Kurtosis		.392	.392	.392	.392
Sum		548	543	584	595

Source: Own calculation from survey data.

For Kurtosis values, when is k>0, it is said to be Leptokurtik, means there are large number of extreme values i.e. strongly agree, strongly disagree etc. present in the distribution. When the K=0, it mean that the distribution is Mesokurtic or symmetrical distribution. Moreover, K<0 means the distribution is Platykurtic, where there exists a few number of extreme values in the distribution.

Here, the first two columns have the value k<0, resulting in the possession of lesser number of extreme values in the distribution. On the contrary, the third and fourth column have the value k>0,

where there are a greater number of extreme value is present in the distribution. The values are acceptable according to the values of K in the table.

However, the mean values for the additive manufacturing is 3.63 and for the intelligent transport system is 3.60. Where it remains in between neutrality and agreement, it tends to be more closer to the agreement. Consecutively, the mean values for Blockchain, IoT for data sharing, and IoT for providing better resource monitoring system are 3.87 and 3.94 respectively. Here both of the factors are can be considered as almost agreed as the values show they are very near to the level of agreement.

From the agreement based on the mean values, it can be said that, where there is no disagreement exists, the tools for DSCM can be applied for the better performance of the SCM in the RMG industry of Bangladesh.

4.7 Impact of digitalization of supply chain management

Table 11, 12, and table 13 portray the level of agreement and disagreement on the prospect of DSCM in RMG industry. The number of respondents showing their level of positive view which is expressed here by the frequency. A total of 151 data were analyzed with the help of descriptive statistics and all the data are valid and included in the procedure.

By combining the data describing frequencies with mean values, we can find the future prospect of DSCM based on production cost reduction and optimizing lead time. Here, the highest no of responses recorded for the strongly agree which is 54.3% and the next greater percentage is 27.8% for agreement. Regarding minimizing the production cost, the mean value is 4.23 which means that the value is in between agree and strongly agree on the scale and nearest to the agree point. On the other hand, the mean value for DSCM in decreasing lead time is 4.21 with 50.3% of strong agreement and 34.4% of agreement level on the 5 points Likert scale. This shows the same extent of harmony as the effectiveness of DSCM in lowering expenses.

Table 12: Frequency table on cost reduction and minimizing lead time by DSCM.

		DSCM can reduce the cost of production	DSCM can decrease the lead time
N	Valid	151	151
	Missing	0	0
Mean		4.23	4.21
Median		5.00	5.00
Mode		5	5
Std. Deviation		1.080	1.073
Sum		639	635

Source: Own calculations from survey data.

According to the frequency table, both factors got the highest number of ratings with 5 where the highest possible ratings could be obtained is also 5. The value of mode shows the possible highest point which can be received.

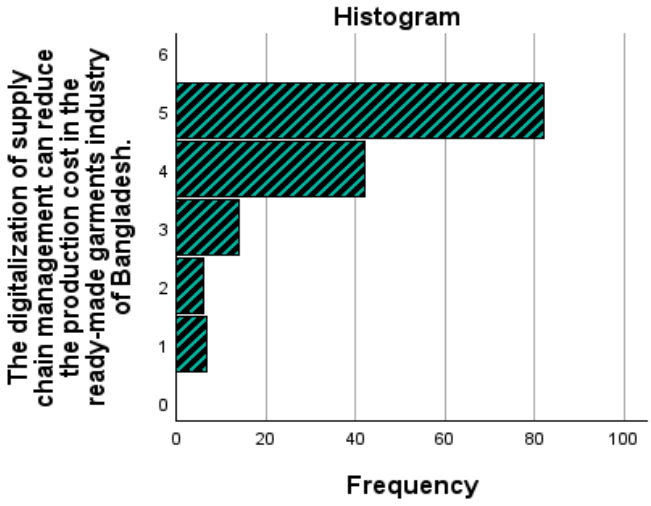
Hence, 9.3% of people are neutral for the cost reduction. Very few extents of disagreement and strong disagreement are observed which are 4% and 4.6% consecutively. Moreover, the neutral value is only 5.3% on the scale which appears to be exactly same as the disagreement state for lowering the lead time by DSCM. Meanwhile, only 4.6% of respondents seem to highly disagree the statement.

Table 13: The digitalization of supply chain management can reduce the production cost in the ready-made garments industry of Bangladesh

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	7	4.6	4.6	4.6
	Disagree	6	4.0	4.0	8.6
	Neutral	14	9.3	9.3	17.9
	Agree	42	27.8	27.8	45.7
	Strongly Agree	82	54.3	54.3	100.0
	Total	151	100.0	100.0	

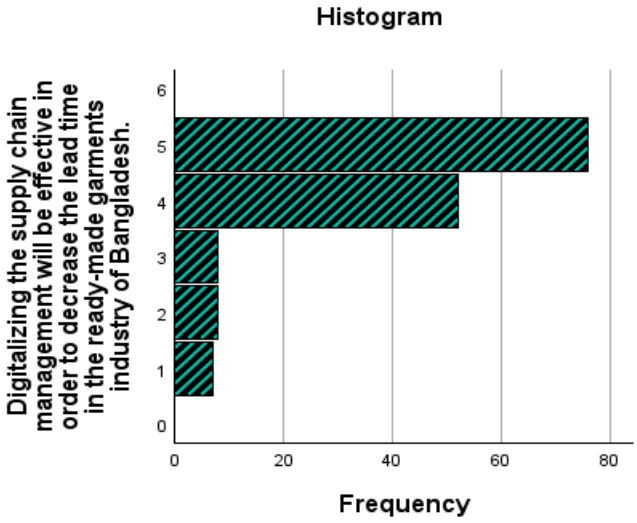
Source: Own calculation from survey data.

Chart 7: Histogram based on agreement level for reduction of cost by DSCM



Source: Own calculation from survey data.

Chart 8: Histogram based on agreement level for lowering lead time by DSCM



Source: Own calculation from survey data.

The histograms graphically demonstrate the frequencies obtained from the Likert scale for both of the factors. Here, it is very clear that the extent of strong agreement is the maximum for both charts. These also picture that there are very small differences among neutrality, disagreement, and strong disagreement among the people.

Altogether, a clear picture about the digitalization of the supply chain management can be imagined here. The analyses show that DSCM can impact very positively on cost of production, lead time along with the factors causing these problems in the RMG industry of Bangladesh.

5 Conclusion

5.1 Conclusion and recommendations

The focus of this study is to evaluate the impact of DSCM in the RMG industry of Bangladesh. The sector has been the backbone for the economy for a long time. The swiftly growing market and strong competition makes it difficult to sustain in the business. Moreover, technologies are taking over the floor for most of the businesses in the world as in our daily life. While the world is moving forward quickly towards digitalization, Bangladesh lacks on the technological development aspect for RMG industry, as well in other industries. Prior understanding is necessary from top level to bottom level to comprehend the concept of DSCM in RMG's supply chain. As the industry is expanding day by day, there is a higher chance of increased profit with the implementation of DSC. The problems in SCM of RMG sector need to be addressed with the tools of DSC and the performance of the tools needs to be evaluated before the final implication. The massive quantity of problems including the political unrests, low investments, natural disaster, weak infrastructure etc. have blocked the industry from achieving a higher profit margin. Where there exist, workers riot due to low wages, less facilities etc. the profit maximization for the RMG companies is an essential factor to take into consideration.

As this study addressed a few problems in the industry, there is evidence that the high cost of production and longer lead time has been present in the RMG industry for a long time. In addition, there are causes for specific problems which have also been examined. It can be seen that, the lack of digital technologies is a stronger reason behind lead time and production cost than others. On other instance, the digital tools seem to be effective for minimizing the problems. From the analyses of the study, the overall impact of DSCM can be seen as positive. It can help to lower the issues with current problems and provide a more enhanced supply chain reducing cost of production and longer lead time. Other than these two problems, other barriers can also be affected positively by the DSCM.

The business world has been changing since the beginning of the fourth industrial revolution. The production processes became more customer focused, not on producer focused where a great channel of communication is necessary. Application of DSCM is very significant for the manufacturers to gain the necessary information about customers to develop their products and production. Consequently, more customer centric businesses tend to be more profitable. Bangladesh's RMG sector is missing out the more profitable customer segment of tailored products as it lacks automation in business processes. The competitors from other countries have already shifted their gears towards automation of processes and earning more profits as a result. It is recommended that the RMG industry of Bangladesh needs to develop skills of their workers with necessary training on digitalization and automated processes. Combining new technologies, trained employees and demands from high value customer segments, will result in an increased profitability for the industry.

The digitalization aspect is not only important for earning revenues. It is as important as enhancing the quality of life of the people working within the scope of the industry. There are also other social and environmental aspects which can be improved with the installation of automation process in RMG industry. To oppose digitalization, there will be factors to be considered as money, time, people etc. It might be costly, time consuming, and people may require intense training on automation. Regardless of the hurdles, the importance cannot be overlooked. The recommendation on this aspect is to begin with starting new projects on digitalization, evaluate the time frame for different sizes of companies, and the costs of implementation before starting the application of automation.

To conclude, we can say that, whether it will be easy or not, it is a matter of combined effort of the government of Bangladesh, BGMEA, owners of garment factories, investors, and all other relevant parties to put their keen and sincere attention to overcome the challenges for developing an efficient digital supply chain in RMG industry of Bangladesh.

5.2 Future scope of study

The future study on RMG industry of Bangladesh with digitalization can aim to many other aspects. As the industry is labor intensive, a study can focus on human resource management within the scope of digitalization factors. The evaluation can address employee tracking, performance appraisal by software, and data management on full electronic platforms. Particular research can be carried out on each specific tool of automation. The tools can be evaluated based on their performance to solve each specific problem arising and existing in the industry.

Along with the above studies, comprehensive or separate research can be undertaken on the barriers in supply chain management in RMG industry. This research will be helpful to identify each problem with details. In addition, the factors causing the problems can be studied as well to find out barriers faced by each department of the business.

Moreover, a study on the challenges for implementing digitalization seems to be effective for the people who are responsible for the initiation of digitalization. The research for each of the cases will be effective for the industry to become more stable.

In a nutshell, future studies on digitalization of supply chain in RMG industry should aim on the importance of understanding the ability of digitalization for each case. Thus, it will provide a meaningful insight into issues regarding the supply chain of RMG industry.

6 Summary

In the advanced technological business world, it is important to comply with the trend to sustain in the competition. Automation is making business processes more efficient while putting on huge competition in the respective industries. The garment industry has also been changed around the world where all manufacturers are trying to embrace the shift to digitalization to become successful. Manufacturers of developing countries have more lucrative customer segment where they can deliver faster than others. The RMG industry of Bangladesh also needs to apply digitalization of supply chain management to make faster delivery of products for their customers.

The principal goal of this paper is to show the impact of digitalization of supply chain in the RMG industry, where it can bring goodness. To evaluate the impact of digitalization, several factors were included and analyzed. The current setup in the workplace within RMG industry whether it is an analog or digital workplace was evaluated. Recent and most frequently appeared problems across

the industry have been found to identify the specific issues where the digital tools can be utilized. For evaluating the major problems and causes behind those, the high cost of production and longer lead time have been analyzed along the reasons behind. The wastage of raw materials, direct involvement human labor, and lack of latest technologies in the manufacturing process are the factors causing the high cost of production. Among the three causes, the lack of technologies appears to be the strongest factor. On the other hand, the longer lead time is another vital problem in the supply chain of RMG industry. This problem is mostly caused by the lack of digital technologies as well, which affects the production, produces disruptions in data and information sharing among suppliers, producers, and customers, and because of the lack of optimized and integrated transportation system.

To continue evaluating the impact of DSCM, it has been determined that digital tools like Blockchain, IoT, Additive Manufacturing etc. can result in a smooth transition for the communication and production in the supply chain. With the high possibility to provide enhaced information sharing process and resource monitoring system, along with automated data input into machines, the IoT stands as the strongest element among the other tools.

This study finds that the digitalization of supply chain management can bring positive results for the industry. To get positive outcomes, at first it is necessary for the companies to begin developing the concept of digitalization in their business processes and implement it according to the guidelines for digitalization.

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Appendix

Appendix 1

Questionnaire for digitalization of supply chain management and its impact in ready-made garments industry of Bangladesh

This survey questionnaire has been set with the aim to collect data related to the digitalization of supply chain management and its impact on cost of production, and lead time in ready-made garment industry of Bangladesh. This survey data will greatly contribute to my thesis paper. All the responses collected will only be used academically for the thesis work. The survey is anonymous. I would gladly appreciate your kind effort for 4-6 minutes to fill the questionnaire.

Question about respondents and their workplace. *

1. Which of the following option(s) best suits your career position?

- ◯ Supply chain management- Ready Made Garment (RMG) industry
- ◯ Logistics and transportation-RMG industry
- ◯ Production/manufacturing division-RMG industry
- ◯ Merchandiser
- ◯ Retailer/wholesaler of RMG goods
- ◯ Former employee/employer of RMG industry
- ◯ Other fields related to garment/textile industry
- ◯ Other fields related to supply chain management
- ◯ Other: _____

2. How long have you been working in/doing business with RMG industry?

- ( ) 0-5 years
- ( ) 5-10 years
- ( ) 10-15 years
- ( ) More than 15 years

3. Does your company only focus on exports?

- ( ) Yes
- ( ) No

4. Which one of the following options your company/business deals with?

- ( ) Woven items
- ( ) Knit items
- ( ) Both woven and knit items
- ( ) Only raw materials

5. What are the most frequent challenges faced by your company/business recently? (Choose multiple) *

- [ ] Longer lead time
- [ ] High production cost
- [ ] Defects during production (inefficient production)
- [ ] Transportation problem
- [ ] Problems with inventory management
- [ ] Disruption in data and information sharing

6. Your workplace/store/company contains a traditional/analog setup (without blockchain, IoT, additive manufacturing etc.) or digital setup (with blockchain, IoT, additive manufacturing etc.)? *

- Traditional/analog setup
- Digital/automated setup

Comparison between analog and digital supply chain. *

7. Which of the following you think to be the most cost effective for RMG industry of Bangladesh?

- Traditional/analog supply chain
- Digital/automated supply chain.

8. Which of the following you believe as more capable of improving the lead time in RMG industry of Bangladesh? *

- Traditional/analog supply chain
- Digital/automated supply chain

9. To build a more efficient and effective production/manufacturing system which one is more suitable? *

- Traditional/analog supply chain
- Digital/automated supply chain

10. Which one of the following do you believe can improve the quality of transportation system? *

- ◯ Traditional/analog supply chain
- ◯ Digital/automated supply chain

Reasons for high cost of production. *

Please select your level of agreement and disagreement for the following causes.
(1=Strongly disagree, 2=Disagree, 3=Neutral, 4=Agree & 5=Strongly Agree)

In my opinion, the following factors are accountable for high production cost in the ready-made garments industry of Bangladesh.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
11. The wastage of raw materials is a major cause for cost inefficacy	◯	◯	◯	◯	◯
12. The direct, and intense involvement of human labor often results into high production cost	◯	◯	◯	◯	◯
13. The absence of the latest technologies in manufacturing process results in high production cost	◯	◯	◯	◯	◯

14. The digitalization of supply chain management can reduce the production cost in the ready-made garments industry of Bangladesh. *

1	2	3	4	5
○	○	○	○	○

15. In case you have agreed with the question no 14, what percentages of costs it can save from the current incurring cost?

- ○ Less than 15%
- ○ 15%-25%
- ○ 25%-40%
- ○ More than 40%

Reasons for longer lead time. *

Please select your level of agreement and disagreement for the following causes.
(1=Strongly disagree, 2=Disagree, 3=Neutral, 4=Agree & 5=Strongly Agree)

In my opinion, the following factors are responsible for longer lead time in the ready-made garments industry of Bangladesh.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
16. Transport vehicles without smart technologies are responsible for longer lead time	◯	◯	◯	◯	◯
17. Deficiency of real time data for suppliers, buyers, and producers results in longer lead time	◯	◯	◯	◯	◯
18. The lack of the latest technologies in manufacturing process causes longer lead time	◯	◯	◯	◯	◯

19. Digitalizing the supply chain management will be effective in order to decrease the lead time in the ready-made garments industry of Bangladesh. *

1	2	3	4	5
◯	◯	◯	◯	◯

20. In case you have agreed with the question no 19, how many days it can save till the final delivery?

- ◯ Less than 15 days
- ◯ 15-25 days
- ◯ 25-35 days
- ◯ More than 35 days

21. What is the current lead time till the final delivery for your company/business? *

- ◯ Less than 90 days
- ◯ 90-100 days
- ◯ 100-110 days
- ◯ 110-120 days
- ◯ More than 120 days

Efficiency of digital tools. *

Please select your level of agreement and disagreement for the following causes.
(1=Strongly disagree, 2=Disagree, 3=Neutral, 4=Agree & 5=Strongly Agree)

22. As one of the latest digital techniques, additive manufacturing can improve the efficiency of production process and prevent raw materials' wastage?

1	2	3	4	5
○	○	○	○	○

23. The application of Intelligent Transport System (ITS) with optimized vehicles containing trackers and sensors can improve the lead time. *

1	2	3	4	5
○	○	○	○	○

24. The use of digital tools like blockchain, IoT etc., can enhance data and information sharing, and able to optimize the lead time. *

1	2	3	4	5
○	○	○	○	○

25. The use of Internet of Things can deliver a better resource monitoring system in production process, reducing the human labor, and lowering the wastage of raw materials. *

1	2	3	4	5
○	○	○	○	○

Appendix 2

STATEMENT ON CONSULTATION PRACTICES

As a supervisor of **Faisal Ahmed** (Student's name) **L675AQ** (Student's NEPTUN ID), I here declare that the final essay/thesis/master's thesis/portfolio[1] has been reviewed by me, the student was informed about the requirements of literary sources management and its legal and ethical rules.

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DECLARATION

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Student's name:	Faisal Ahmed
Student's Neptun ID:	L675AQ
Title of the document:	Impact of digitalization of supply chain management in ready-made garment industry of Bangladesh
Year of publication:	2024
Department:	Supply Chain Management

I declare that the submitted final essay/thesis/master's thesis/portfolio[2] is my own, original individual creation. Any parts taken from an another author's work are clearly marked, and listed in the table of contents.

If the statements above are not true, I acknowledge that the Final examination board excludes me from participation in the final exam, and I am only allowed to take final exam if I submit another final essay/thesis/master's thesis/portfolio.

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