

## Capacity Planning in A Sweater Factory -Challenges and Strategies: Case of Starlight Sweaters Limited, Gazipur, Dhaka, Bangladesh

Abdullah Al Mansur Bhuiyan

*School of Business and Management, Texila American University, East Bank Demerara, Georgetown, Guyana*

### **Abstract**

*Capacity planning is a critical but one of the most important aspects of operations management in manufacturing facilities, particularly in labour-intensive industries such as the Garments and Textile sector. Bangladeshi sweater industry as a part of Garments and Textiles industry, playing a significant role in the country's economy. Efficient capacity planning is essential to ensure optimal utilization of resources, timeline for raw materials sourcing, streamline production processes, and enhance competitiveness in every season with optimum productivity with best quality. This research paper focuses on capacity planning in a Bangladeshi sweater factory, analysing the challenges faced by the industry and exploring strategies to optimize capacity utilization. Through a combination of qualitative interviews, data analysis, case studies, and literature review, this paper aims to provide insights into the dynamics of capacity planning in the context of Bangladeshi sweater manufacturing. Starlight Sweaters Limited, which is considered as one of the top Sweater Manufacturing factories of Bangladesh, having more than 25 years' experience with very high reputation and also having a decent business all over the world, is considered as the case of this research work.*

**Keywords:** *Apparels, Capacity - Planning, Export, Productivity, Market, Supply - Chain.*

### **Introduction**

The Bangladeshi Garments and Textile industry plays a crucial role in the country's economy. More than 80% of export revenue is earned from this industry for the nation; with sweater manufacturing being a significant subsector. Capacity planning, which involves determining the production capacity needed to meet demand while minimizing costs, is essential for the efficient operation of sweater factories. However, the volatile nature of demand, labour issues, supply chain disruptions, and other factors present challenges for capacity planning in this context.

### **Background of the Bangladeshi Sweater Industry**

Apparels or clothing is one of the 5 basic materials for mankind. As human in the

civilized world, we need cloth to cover our body. Cloth protects our body skin from heat, dust or cold. Clothing is not only a necessity now but also one of the most important materials for the fashion. Appropriate clothing reflects the personality of a person in respective occasions. Based on the weather, need of clothing changes, fashion changes as well. Especially in winter, to remain active need for warm clothes increases a lot. Various first world countries remain in cold weather 4-5 months in every year. Sweater is one of the ancient, premiere and fashionable products to fight against winter. Though it is a seasonal product, the revolution of machineries, increase of expertise of human production and innovation in fashion made sweater utilization during spring or summer even. Therefore, a demand of production exists throughout the year in variable demand scale.

The Bangladeshi Garments and Textile industry being one of the top 3 apparel supplier countries in the world plays a crucial role in the country's economy. More than 80% of export revenue is earned from this industry for the nation; with sweater manufacturing being a significant subsector. Effective result in this sector holds the present and future growth of this country. Capacity planning, which involves determining the production capacity needed to meet demand while minimizing costs, is essential for effective business result and for the efficient operation of sweater factories. However, the volatile nature of demand, labor issues, supply chain disruptions, and other factors present challenges [1] for capacity planning in this context.

Sweater industry started functioning in early 90's in the last century. It started growing in the beginning of current century and expanded highest since 2010. With the evaluation of Jacquard machines for knitting of sweater, this industry grown a lot and started taking market share from other manufacturing countries, especially from China and Sri Lanka. Earlier with the manual knitting machines sweater production was limited to few basic styles only. However, using Jacquard knitting machines Bangladeshi sweater industry entered within fashion products as well and created more opportunities for business.

This section provides an overview of the Bangladeshi sweater industry, including its historical development, market trends, and key players. It also discusses the factors driving demand for sweaters internationally, and outlines the typical production process in a sweater factory.

## Geographical Position and Importance of Export from Bangladesh

Bangladesh liberated in 1971 is a small 3rd world country in the South Asian Subcontinent. Almost 90% land border area shared with emerging economic giant India and rest with Myanmar. Southern part of this country merged with Bay of Bengal which mixed with Indian ocean. This country was ruled by Pakistan before liberation for 24 years and prior that by British government for 190 years as a single country along with India and Pakistan.

This country is not blessed with various minerals, which can add source of income to the nation. But Bangladesh is blessed with good number of populations which is a very strong working resource for the country. Surrounded with many rivers and canals like nets across the country, Bangladesh having very good fertile lands for cultivation. Though land area is very less in comparison to population, still the fertility is a blessing for the country. Besides, weather of this country is not too cold and not too hot, which allows cultivation in different seasons throughout the year. Farming is one of the oldest and famous profession in this country. However, farming ensures good volume of food materials which consumed by the people of this country. Very few agricultural products (including fish and raw jute) are exported to other countries, the earning from agricultural products export are negligible (only 2.62% of total export revenue in FY 2022-23, as per EPB). Besides, various food materials need to be imported from other countries to fulfill the need of food for large population.

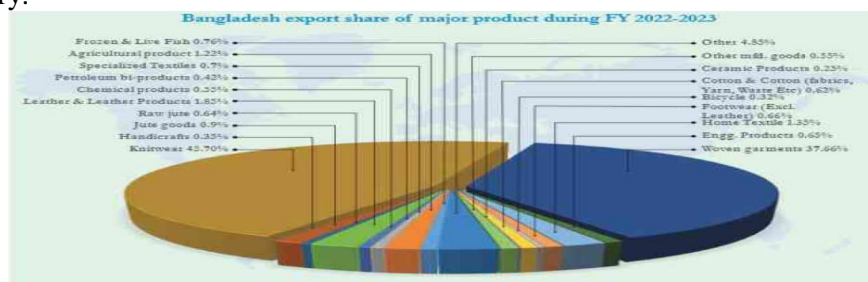


Figure 1. Bangladesh Export Share in FY 2022-23

Before liberation jute was the biggest export material from this country and the economy of country raised with jute export. Later on, demand of jute and jute made materials reduced a lot, especially with the innovation of various plastic materials. Since then, Bangladesh looked for alternative materials which can be produced here and can be exported to other countries to earn good amount of export revenue. In 70's of the last century Bangladesh entered in apparel business with the help of South Korea. Gradually this country developed in this sector and now more than 80% export revenue is earned from this industry, (shown in figure: 1) in every year. More than 40 million people work in this apparel industry. Which is the biggest working sector of the country. Thus, this apparel business is the biggest support for country GDP. Many other sectors like transport, food, shipping etc. share a big portion of their business with apparel industry. These other sectors also grew a lot to provide required service for apparel industry and its workforce.

### **Types of Apparels Business in Bangladesh**

Apparels business is basically divided in 2 types, based on production and end product as follows:

**a. Textiles:** This is the process of making fabric from yarn. Normally this is an internal process where textile mill owners import raw materials from other countries (mostly China and India) and produce fabric. These fabrics are sold to various local RMG factories. These fabrics are tax free. Therefore, government ensure usage of these fabrics through various government agencies and also through BTMA. BTMA is the government approved owners' association for textiles mills, which provides central instructions for all factories and monitor day to day production with sales to RMG factories. This sector is again divided in 3 types of process:

- i. Spinning:** Preparing raw yarns from fibers. There is various mechanism, many different operations which comprises this spinning process. However, based on finished product delivery form, spinning process also divided in 2 types:
  - 1. Hank Form Yarn Delivery:** Yarn produced in spinning is delivered in hank form.
  - 2. Cone Form Yarn Delivery:** Yarn produced in spinning is delivered in cone form.
- ii. Dyeing:** This is the process of coloring apparel products. There are several different methods, many different operations, different kinds of machines, different support materials used in dyeing process based on end product requirements. However, dyeing process is again divided in 2 basic types based on types of materials dyeing:
  - 1. Yarn Dyeing:** Where raw yarn is dyed to color yarn as per requirement. Yarn dyeing process are different for hank form yarns and cone form yarns.
  - 2. Fabric Dyeing:** Where fabric is prepared from raw yarn and dyed to bring color as per requirement.
- iii. Knitting:** This is the process of making fabric from yarn. There are basically 2 types of fabrics:
  - 1. Woven Fabric:** This is the fabric produced through woven process and these fabrics used mostly for shirts and pants.
  - 2. Knit Fabric:** This is the fabric produced through knitting process and these fabrics mostly used for t shirt, polo shirt etc.
- b. RMG (Ready Made Garments):** This is the process where from fabric final usable apparel product is prepared and exported to various destination. Garment product produced to export to other countries are

tax free and not authorized to sell locally. Therefore, government ensure export and usage of these products through various government agencies and also through BGMEA and BKMEA. BGMEA and BKMEA are government approved owners' associations for garments and knitwear manufacturers and exporters, which provide central instructions for all factories and monitor day to day production with export to other countries. This sector is divided in 2 types based on the products produced:

- i. **Woven Factory:** Where garments produced from woven fabrics. Almost 38% of yearly total export revenue is earned by Bangladesh from this sector.
- ii. **Knit Factory:** Where garments produced from knit fabrics. Almost 46% of yearly total export revenue is earned by Bangladesh from this sector. Knit production process or knit factories are again divided in 2 types based on garment manufacturing process:

1. **Circular Knit Factory:** Knit garments are produced from knit fabrics. Process starts from cutting, followed through various stitching methods, ends with packing.

2. **Flat knit/ Sweater Factory:** Sweater produced directly from yarns. Here all garment products are prepared individually in knitting machines. There is no cutting or stitching process in sweater factory. After knitting there are several manual processes like linking, trimming, mending etc. up to packing.

### Statement of the Problem

Production in sweater factory is very critical. Here each and every product is produced separately one by one from knitting. After knitting rest all the processes are done by operators individually. So, requirement of

skilled operator is huge. Unskilled operators cannot work through several sweater production processes. Wrong work may damage a complete garment. Moreover, with times living costs increasing in the country. Therefore, wages also increasing for operators, which raising production and overhead cost of the factory. As a result, factory owners need to reduce profit margin a lot to remain competitive in the market. Only solution to keep workable margin from business is to increase PPM (Productivity per Man). Which again diverts towards very skilled operators.

Day by day availability of skilled operators reducing due to the economic development of the country. Factory need to recruit many unskilled/ fresh operators to train and make skilled. Such process effects productivity of the factory and capacity of the factory reduces. Less production capacity rationally increases overhead cost ratio and threatens business sustainability [2].

There are few other factors which are increasing every year and increasing CM (Cost of Manufacturing), resulting less profitability and threatens sustainability of factory. These are:

1. Utility cost
2. Transport cost
3. Living cost etc

Buyers are reducing style wise order quantities. Operators can increase productivity, when they can run a style for longer duration. If style volume reducing, difficult to continue same style by operators for a long duration. Therefore, as a whole factory productivity reducing and CM increasing.

Buyers focusing more and more on fashion products. For fashion products need various additional operations like, print, embroidery, ornamental attachments, buds/ studs' attachments etc. Every additional operation increases wastage ratio and effecting final product cost. All additional operation increases production time as well.

Shipping cost by sea and air increased a lot. Besides, due to various war situation, all sea routes are not available to use for commercial ships. Commercial ships need to travel longer distance. As a result, they need 14-21 days longer period than normal time. Costing 20-30% higher, effecting product price and extended duration reducing production lead time.

Brands focusing more on fast fashion. They need products soonest from order placement. They are focusing more to reduce lead time. Factories most of the cases unable to meet brands required lead times due to lack of productivity and required support in every production sectors.

Since 2020 when Covid started, many brands suffered in sells due to several lock downs. Later, many renowned brands were closed/ bankrupt/ sold due to financial instability. War between Russia – Ukraine started in February 2022 turned the overall situation to worse condition. Bangladesh also suffering financially since then. Due to inflation western country citizens reduced purchasing apparels. Demand reduced a lot, apparel producing countries having very less orders. Competition increases, which results towards reducing price to grab orders. At the end price of products falls. Factories cannot increase productivity and cannot reduce wastages, will not be able to survive.

Taxation on apparels products from different customers varies. Therefore, demand also varies. European countries allow tax free apparel trade from Bangladesh. USA do not allow tax free apparel entry from Bangladesh, which they allow from Vietnam, Cambodia, etc. As a result, exporting to USA is more challenging on price issue. Factories those can ensure minimum production cost, higher productivity and minimum wastage, can only effectively export to USA market.

Finally, sweater is a seasonal product. Always sweater demand is high considering the winter. Due to advancement of technology and

introduction of highly improved robotic jacquard machines, sweater can be produced in very light version. Therefore, sweater is also required in other seasons in cold countries. Still sweater demand is almost 50-60% in other seasons compare to winter. This is a big challenge for factories to adjust work force. If a factory considers winter time demand as capacity, then work force would be high and during other season demand, work force would be abandoned. Again, capacity differs with number of operations in the garment and SMV of each operation. Therefore, any factory not expert in capacity planning cannot comply with brands requirements. [3] [4] [5] [6].

### **Challenges in Capacity Planning**

Capacity planning in Bangladeshi sweater factories faces several challenges, including:

**Fluctuating Demand:** Demand for sweaters is highly seasonal, with peaks during the winter months and lulls during the rest of the year. This seasonality makes it challenging to maintain a consistent level of production throughout the year.

**Machine Limitation:** In sweater production vital 2 steps are Knitting and Linking, which are identically limited for production in machines based on garments thickness. This thickness is identified as Gauge in sweater production. Thicker products can be produced in 3/5/7 Gauge machines and thinner products can be produced in 9/12/14 Gauge machines. Therefore, machines available in a factory is very important consideration in order to confirm demands from buyers.

**Labor Availability and Skill Shortages:** Except knitting and linking all other vital operations in sweater manufacturing relies heavily on manual labor. Therefore, shortages of skilled workers can impact production capacity. Moreover, labor strikes and unrest can disrupt factory operations.

**Limitation of Working Hour:** Working hour for production are limited and controlled

as per country Labor Law. Besides various brands provide different code of conduct which may further reduce working hours.

**Supply Chain Disruptions:** Sweater manufacturing requires various raw materials, including yarns, dyes, and accessories, which are often sourced from multiple suppliers. Supply chain disruptions, such as delays in material delivery or quality issues, can hinder production schedules.

**Infrastructure Limitations:** Infrastructure constraints, such as unreliable electricity supply and inadequate transportation networks, can affect factory productivity and capacity utilization.

**Nature of Workers:** By nature, and common practice workers turn over fluctuates during various occasions like Eid festivals, Ramadan etc.

**Utility and Power Shortage:** Disruption in power supply and utility services often interrupts production and reduces productivity. Some seasonal effect on gas supply especially reduction of gas pressure causes similar loss of production.

## **Strategies for Capacity Planning Optimization**

To address these challenges, several strategies can be adopted to optimize capacity planning:

**Capacity Based Marketing:** Machine based production limited to fixed Gauge works, which only can be managed by ensuring Gauge wise marketing considering factory machine capacity available. Need to ensure capacity based on SMV/ PPM of style confirmed. Again, for seasonal effects on demand, marketing team need to focus on southern hemisphere market, where winter starts from JUN and demand for sweater is higher. Again, for regular EU, USA or Asian market of countries within northern hemisphere, need to convince brands to place certain volume of orders in advance with longer lead time. So that, factory can produce

products ahead of requirements and utilize capacity in a balanced way.

**Flexible Production Systems:** Investing in flexible manufacturing systems that can quickly adapt to changes in demand or production requirements can enhance capacity utilization. Based on marketing forecast, planning for production should be made 2/3 months ahead to understand the number of machines and men requirements.

**Cross-Training and Workforce Development:** Training programs to upskill workers, cross-train in multiple tasks can improve workforce flexibility to mitigate the impact of labor shortages.

**Country Labor Law and Buyer Code of Conduct Simulation:** Compliance as per the code of conduct of any brand need to be carefully evaluated and matched with country Labor Law. Ensuring proper simulation amongst both to avoid confusion and reduce loss of production.

**Supplier Relationship Management:** Developing strong relationships with suppliers and implementing risk mitigation strategies, such as maintaining buffer stocks or diversifying sourcing options, can reduce the risk of supply chain disruptions.

**Infrastructure Investment:** Advocating for improvements in infrastructure, such as reliable power supply and better transportation networks, can enhance factory efficiency and productivity.

**Alternative Power System:** Factories can introduce alternative power systems to keep factory functional in any and every situation. Like in Starlight Sweaters Limited 3 types of power system adopted. Electricity production with gas generator is the cheapest method. Then the government supplied electricity and finally electricity back up power by diesel generator. All the production floors should be phased out and divided in several groups to ensure proper utilization of resources. For example, if gas supply is less with low pressure, may be 50% electricity can be

produced than requirement. In such case 2 options of power can be used together. 50% of factory with gas generator and rest 50% with other way.

#### **Seasonal Power and Utility Planning:**

Alternative plan and redesigning shift timings considering power and utility service impacts from previous experience can recover from loss of production.

### **Objectives of the Research**

**Principal Objective:** To find out the challenges in a Sweater factory in Bangladesh and to select strategies through effective capacity planning in an actual factory scenario.

#### **Specific Objectives**

- a. To find out the challenges of effective capacity planning in a sweater factory.
- b. To evaluate Sweater factory scenario without effective capacity planning.
- c. To find out the results of effective capacity planning in a sweater factory.
- d. To find out the changes in workers lifestyle when capacity planning implemented effectively.

### **Research Questions**

**Principal Research Question:** This research will answer the question, how effective capacity planning can bring stability and progress in business in a sweater manufacturing factory?

#### **Specific Research Questions**

- a. What are the challenges for effective capacity planning in a sweater factory?
- b. What can be the effect if capacity planning is not done in a sweater factory?
- c. What are the results of effective capacity planning in a sweater factory?
- d. How effective capacity planning can bring improvement in lifestyle of workers?

### **Scope of the Research**

This research focused on importance of effective capacity planning in Bangladeshi sweater factory where flat knit garment

produced with an intention to export products to other countries. The focus based on a case study at Starlight Sweaters Limited, one of the oldest and renowned sweater factories of Bangladesh and also a sister concern of countries largest sweater manufacturing group of industries i.e. Labib Group. This research analyzed why capacity planning is important for such factories, how to determine the accurate capacity, challenges in capacity planning and best suitable strategies to optimize capacity planning. This research analyzed business and production data of the factory from its effective date that is from 01 July 2019 to 31 December 2023, a tenure of 4 years and 6 months, to determine the complete business scenario, brands demand, production diversity with effective productivity and finally calculation of effective capacity with workable result-oriented capacity planning.

### **Significance of the Research**

Capacity planning is a complex process in the Bangladeshi sweater industry, characterized by fluctuating demand, machine limitations, labor issues, supply chain disruptions, and infrastructure limitations. However, by implementing appropriate strategies, such as forecasting, capacity-based marketing, flexible production systems, workforce development, supplier relationship management, simulated implementation of laws and accurate infrastructure investment, sweater factories can optimize capacity utilization and improve overall efficiency [7]. This research paper contributes to the understanding of capacity planning in the context of Bangladeshi sweater manufacturing factories and provides practical recommendations for industry stakeholders.

This research work will assist us to find out the challenges we face in a sweater manufacturing factory for smooth operation and also while capacity planning. Strategies guided in this research to overcome the challenges will assist to plan effectively capacity of every factory effectively.

Well - planned effective capacity utilization will ensure reduction of wastage and increase profitability [8]. Effective planning will guide factory management to avoid system losses, which will result more productivity for factory and more income for workers. Effective time planning within capacity utilization will reduce extra time works, thus resulting more free time for workers and ensuring better social life.

Well organized capacity planning will ensure smooth timely production with best quality. Therefore, the reputation of the factory will be increasing gradually. Grabbing different market demands would be easier for marketing team.

Effective capacity planning would ensure better productivity with least possible cost. Therefore, factory can support different brands in different parts of the globe. Thus, ensuring more business opportunities.

With effective capacity planning when factory can ensure best support with best quality and better price, all reputed brands will focus to work with this factory. Which would result better reputation for the factory, for the industry as well as for country.

## Literature Review

### Definition of Key Terms

In this subsection, various key terms are defined in order to understand their meaning in the course of the study.

**Capacity Planning:** Capacity planning design is the first level planning for the inputs, conversion activities and outputs of a production operation. Design decisions are very important because they are often associated with significant investment of funds.

**Effectiveness:** This is a measure of the extent to which an intervention's intended outcomes; that is its specific objectives and intermediate results have been achieved. Project effectiveness defines the relationship between an intervention's outputs and its outcomes that represent the intended benefits to a targeted group of beneficiaries.

**Capacity Measurement:** Capacity of a plant can be expressed as the rate of output viz., units per hour or per day or per week or per month, tones per month, gallons per hour, labor hours /day, etc. But for organizations whose product lines are more diverse, it is difficult to find a common unit of output.

**Quality:** Quality could be defined as a basic tool for a natural property of any good or service that allows it to be compared with any other good or service of its kind. The word quality has many meanings, but basically, it refers to the set of inherent properties of an object that allows satisfying stated or implied needs. Quality is the degree to which an object or entity (e.g., process, product, or service) satisfies a specified set of attributes or requirements.

**Export and Import:** Exporting refers to the selling of goods and services from the home country to a foreign nation. Whereas, importing refers to the purchase of foreign products and bringing them into one's home country.

**Trend:** A Trend is a general direction into which something is changing, developing, or veering toward. The term may also mean a fashion or craze, i.e., a fad. In the world of business, a trend is a pattern of gradual change in a process, output, or condition. It is an average or general tendency.

**Process:** A process is a series of progressive and interdependent steps by which an end is attained: a chemical process. Procedure usually implies a formal or set order of doing a thing, a method of conducting affairs: parliamentary procedure.

**Sourcing:** Sourcing is an upstream part of the supply chain: It's the process of strategically choosing the right services and goods that a company needs to run their business. Sourcing is also the act of buying goods, including seller selection, contract negotiation and measuring the long-term performance of your suppliers.



**Strategy:** Strategy is the direction and scope of an organization over the long-term. It helps achieve an advantage for the organization through its configuration of resources within a challenging environment, to meet the needs of markets and fulfill stakeholder expectations.

## Theoretical Review

### **Economic Production Quantity (EPQ)**

**Model:** This model helps in determining the optimal production quantity to minimize total production costs, including setup costs, holding costs, and unit production costs. Calculation of SMV for every operation, maintaining SMV within sections is very important. Planning of styles in production for every section will ensure effective use of full working period to minimize unit production cost reducing setup/ holding costs.

**Theory of Constraints (TOC):** TOC focuses on identifying and managing the constraints within a production system to improve throughput and overall efficiency. R&D in factories can make improvement in process which can only be implemented if operators accept the change. It is a big constraint in Bangladesh social life to make people understand that the change is for better result. Fear of unknown and comfort of whatever doing with a negative mentality to come out of comfort zone is common constraints. Identifying these constraints and working against these with effective planning would increase productivity and efficiency.

**Just-In-Time(JIT):** JIT emphasizes minimizing inventory levels and production lead times by synchronizing production with customer demand, thereby reducing waste and improving efficiency. Supply Chain Department (SCD) and accountability plays a vital role here. If SCD controls purchase considering actual requirements and can provide products in accurate time, factory can save wastage and money. Proper

accountability of issued products further reduces wastage and save money.

**Capacity Utilization Theory:** This theory explores how effectively a factory's resources are being used to meet production demands, considering factors like labor, machinery, and space. Number of machines with effective operation ensures machine-based capacity. Again, operations which are handmade are controlling the capacity of man-based productivity. Simulation within both types of capacities is very important.

**Queuing Theory:** Queuing theory helps in analyzing waiting lines and optimizing service levels by balancing capacity and demand in production processes. Flexibility in production system can help to plan waiting lines effectively with best output.

**Aggregate Planning Theory:** This theory focuses on developing strategies for matching capacity with anticipated demand. Smart factories can choose their buyers purposefully. Many brands provide longer lead times for production. Sufficient number of orders from such brands can make possibility of production in low season. Again, many brands work with Never Out of Stock (NOOS) programs. More orders from NOOS programs gives factory opportunity to produce advanced products in low season and create opportunities to grab more orders in peak demands with good price.

**Forecasting Theory:** Forecasting methods are essential for predicting future demand accurately, which is crucial for effective capacity planning [9]. In sweater production recruitment of people in correct time is very important to ensure man-made capacity. Also, good numbers of people needed to run machines as well. Very effective forecasting is must to calculate production demand as per date. Demand will guide towards capacity and to ensure capacity recruitment in correct time is essential [10].

**Simulation Modeling:** Simulation models help in assessing different capacity planning

scenarios and their impacts on factory performance [11]. Marketing team need to simulate orders in different gauges based on factory capacity. Raw materials availability differs based on types and source. Many raw materials especially yarn need to import from abroad (mostly China and India). Again, many yarns available in local market. To run any style for production factory, need various sampling process and need approval from brands in different stages of sampling. Here also approval process differs brand to brand. Calculation of sample approval lead time is another calculation before final production. Simulation between all these factors is essential for production planning. Therefore, simulation in each and every planning within all sections are very important. Smart simulation within country laws, policies are very important. Besides, all brands code of conducts needs to be followed with simulation to country laws and regulations.

### Empirical Review

#### Sweater Production Evolution in Global Perspective

Sweater being a warm cloth considered as a premium apparel product in winter prone countries. For this products fashion value now

a days this is also used in all seasons. Considering seasonal requirements various kinds of sweater products are produced in various thickness. Later part of earlier century computerized flat knitting machine introduced which made sweater panel knitting very easy and possible in thinner gauge to make this product available for all seasons.

Sweater production history started from Europe. Later this production migrated to Asia through Japan. Gradually sweater production spread to other countries of Asia through South Korea and China. South Korea introduced this production in Bangladesh, whereas China introduced this in Sri Lanka, Vietnam, Cambodia, Myanmar etc. Few other Asian countries like India, Pakistan, Indonesia also produce sweater products. Besides, still few European countries Like Germany, France, Spain, Italy, Netherlands, Turkey etc. are still producing sweater products. Few African countries like Ethiopia, Haiti also producing sweaters. Now China is the largest sweater manufacturer and exporter in the world, whereas USA is the largest importer followed by Germany, Japan etc. Bangladesh is now 2<sup>nd</sup> largest sweater exporters in the world. Export and import share data is shown in the following figure:2 and figure:3 with data of the year 2022 where total export/ import was \$71.3B:

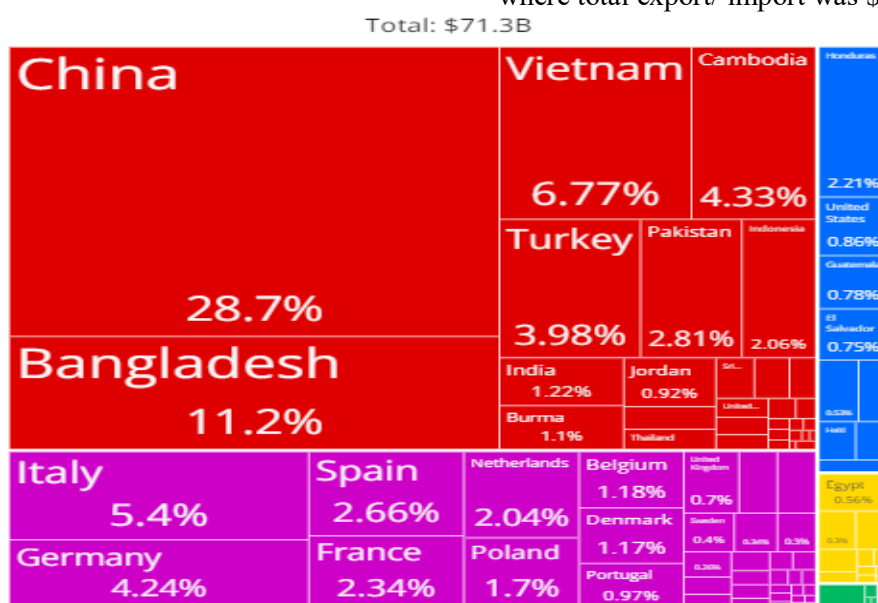


Figure 2. Exporters Share of Sweaters in 2022

Total: \$71.3B

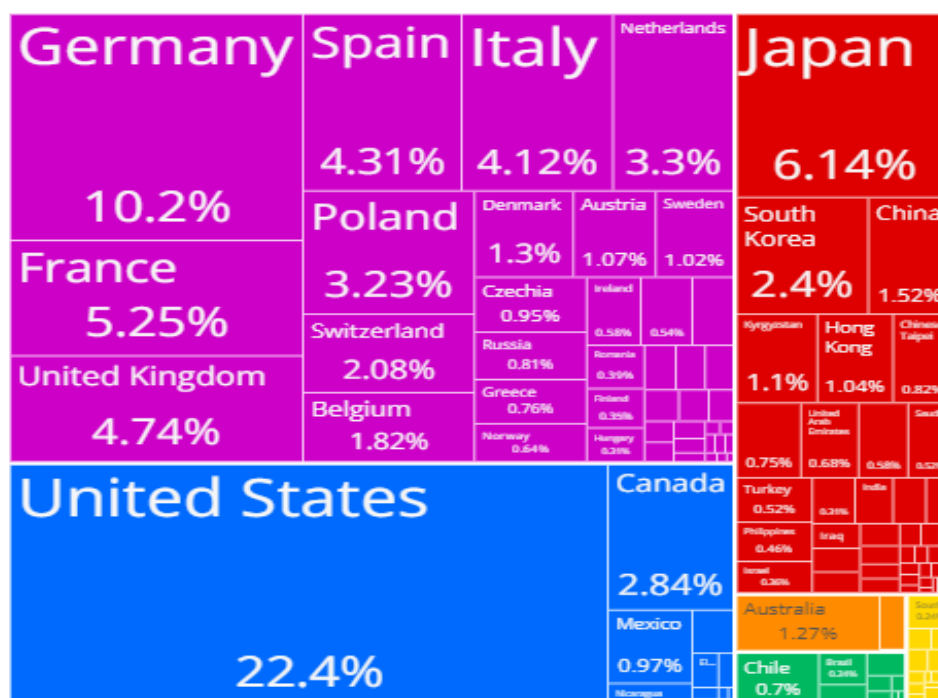


Figure 3. Importers Share of Sweaters in 2022

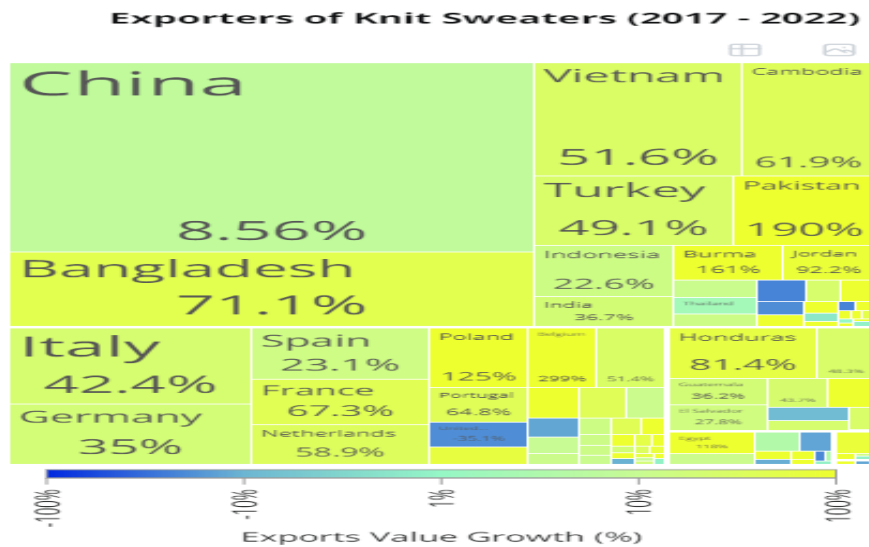
Sweater or flat knit production is unlike other apparels production. Here, workers skill is very important as every single piece is made separately with different processes. Most of the processes are completely workers hand made. Therefore, a large number of skilled workers are required. 1<sup>st</sup> world countries cannot effort so large-scale workers for production. That is the most important factor to divert this production to different countries. Countries with high population and where labour cost is comparatively cheaper, can produce such products.

China being the highest populated country is leading sweater production. Bangladesh being 8<sup>th</sup> largest populated and 6<sup>th</sup> most densely populated country in the world offering huge labour in apparel industry. More than 4 million workers work in apparel industry in this country. Commodities and living cost in this country is comparatively reasonable compare to all are apparel producing countries. As a result, here minimum wages are less than other countries. Besides, Bangladeshi labours are

skilled. They are developing gradually. They may not be as skilled as China, Vietnam or Turkey; still, they are much more skilled than other countries like India, Pakistan, Cambodia, Myanmar, Ethiopia etc. Therefore, a large number of flat knit or sweater manufacturing factories raised here. Now Bangladesh is 2<sup>nd</sup> highest flat knit exporter in the world.

### Sweater/ Flat Knit Business in Bangladesh

Bangladesh is the 2<sup>nd</sup> highest flat knit exporter in the world with 11.2% share. China leading the table with 28.7% share and Vietnam is in 3<sup>rd</sup> position with 6.77% share. Although export data shows there is growth in export year on year except 2020, this growth is in revenue. Comparatively product value raised a lot and per piece export price also increased. Therefore, in terms of volume/ number of pieces demand reduced, but the revenue increased due to high price. Within this situation, Bangladesh has the highest growth in sweater export amongst all top 5 sweater exporting countries, shown in figure:4.



**Figure 4.** Exporters Growth Percentage of Knit Sweaters (2017-2022)

Countries like Pakistan, Myanmar, Poland having outstanding growth in sweater business in comparison from 2017-2022. However, this outstanding growth is showing as they had very nominal export earlier. Still after such growth Cambodia shares 4.33% and Pakistan shares

2.81% export share in 2022. Obviously, these countries can grow further, but considering all situation, Bangladesh is the most potential country to grow sweater business further in the world in near future. The reasons are described below:

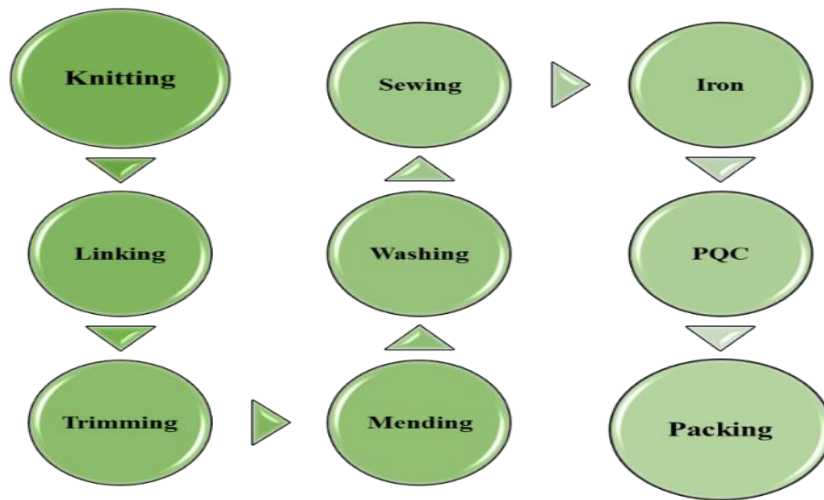
<p><b>Business Reduction in China</b></p> <p>China is facing trade war against USA, which reducing their business            China labor cost increasing gradually, which increasing production cost and product price            Chinese government reducing incentives on apparels business and discouraging textiles business</p>
<p><b>Vietnam cannot increase Capacity</b></p> <p>Vietnam with their limited work force no more interested increasing apparel business.            Vietnam focusing more on technological business/ production.            Labor wages increasing in Vietnam as well.</p>
<p><b>Cambodia, Ethiopia, India, Pakistan, Myanmar, Indonesia or others are not the Alternative</b></p> <p>These countries lack in skill.            Myanmar is suffering from internal civil war.            Their labor cost is not very cheap, comparatively higher than Bangladesh.            Quality assurance especially in fashion products like sweater is a big challenge.</p>
<p><b>European or Developed Countries cannot be an alternative</b></p> <p>These countries cannot meet buyers price for most products due to higher living cost and high wages.            They have very limited work force.</p>

**Figure 5.** Reasons Behind Possibilities of Increasing Sweater Business in Bangladesh

Considering all facts shown in figure: 5 it is very well comprehensible that sweater business will grow more in Bangladesh. Bangladesh equipped with very high number of operators with moderately good skill and having opportunity to manage production with lower cost, is having all potentiality to continue sweater business with very high pace at least more 10-12 years.

### Sweater Production Processes and Capacity Confirmation

Sweater production process starts from raw materials sourcing and ends with the process of final quality check inspection. In the total process the production is divided in major 9 operations, shown in following figure: 6 as per work sequence:



**Figure 6.** Major Operations / Sections in Sweater Factories

There are many other small operations to support all these major 9 operations like winding, overlock, bar-tuck, attachment etc. After each and every process there are quality check by the quality inspectors. Besides, section wise FQC will carry out random in line checks and AQL check. Finally, after packing the goods will be checked centrally to ensure AQL which is termed as pre final. This is the last check before Final Random Inspection (FRI) by buyer/ brand selected quality personnel. All these processes are factors to calculate capacity of a factory.

To determine and confirm capacity of a factory, 9 major operations are described in brief as follows:

- a. Knitting:** This is the process of making knitted panel from yarn. Normally for every piece of sweater 4 panels (front, back and 2 sleeves) are prepared along with neck. Now a days almost 98% factories using computerized jacquard machine for knitting. One worker can run 4/ 6/ 8/10 machines based on his/ her skill. In Bangladesh in average workers run 6 machine per person.
- b. Linking:** This is the process of attaching all knitted panels together with neck. This process is produced in linking machine. Every worker run one individual machine.
- c. Trimming:** In this process additional yarns removed and few minor beautifications

work is conducted. This is completely handmade production only hand needle is used for this work. Here skill is very important. Productivity is higher for lower gauge products.

- d. Mending:** In this process few minor repairs work is done and also all joints checked by pulling. This is completely handmade production only hand needle is used for this work. Here skill is very important. Productivity is higher for lower gauge products.
- e. Washing:** This process is again machine based. All products are washed and then dried. Wash is done using detergent and softener based on yarn quality to achieve required hand feel. Dry process is very important to ensure correct hand feel and correct measurement. Here production is common for all gauge but productivity of dry process differs based on yarn quality.
- f. Sewing:** In this process size wise products segregated and all labels are attached. This is again machine-based production and common machine used for all gauges.
- g. Iron:** In this process all garments are ironed with steam. This process is important to keep garments shape and measurement correct. This process is done by individual steam iron. However, this is very important part where worker skill is must to keep product shape correct.

- h. PQC:** This is a process of quality check by production people. Normally this section work is done in 3/4 stations. These stations are called one check, re-final, final and get-up. This is completely hand-held production. Skill of workers differs the productivity.
- i. Packing:** This is the final stage where products are folded, price stickers attached, additional tags attached and packed within poly bag. Then products are stocked within carton boxes as per brand requirements. The more attachment or folding process need to follow in packing, the less productivity can be achieved. Again, stocking within carton box differs as per brands requirements. Many accepts same sizes and color in same box. Again, many need different color and sizes in individual boxes, which process is called assortment. The more difficult assort process is, the less productivity achieved.

These operations are vital factors to determine capacity of a sweater factory. Factory management need to make balance of production as per processes and types of production. Industrial Engineers involvement and risk assessment during sample development can assist proper planning.

### **Capacity Planning in a Bangladeshi Sweater Factory**

Finalizing the capacity needed to make the best use of it. For which there is no alternative of an effective capacity planning. Preparation for production need to be ensured prior production with smooth raw materials supply to have best planning and to ensure execution of the planning. Any time inconvenience can arise within production due to changes in raw materials lot, machine mal function or power disruption. Contingency plans should be prepared not to lose production and to ensure best use of capacity. Facts which assist in capacity planning for a sweater factory, are described below:

- a. Demand Forecasting:** Factors such as seasonal trends, customer preferences, and market dynamics are considered to anticipate future demand for different types of sweaters.
- b. Production Capacity Assessment:** Assessing the production capacity involves evaluating the capabilities of machinery, workforce, and infrastructure. This assessment helps identify any bottlenecks and optimize production processes for maximum efficiency.
- c. Resource Allocation:** Efficient resource allocation is crucial for maximizing the capacity utilization of Bangladeshi sweater factories. This includes optimizing the utilization of machinery, workforce, raw materials, and production floor space [12].
- d. Technology Adoption:** Adopting modern technology and automation solutions can enhance the capacity planning process in sweater factories. This includes investing in advanced knitting machines, computer-aided design (CAD) software, and production management systems [13].
- e. Skill Development:** Capacity planning in Bangladeshi sweater factories also involves investing in the skill development of the workforce. Training programs aimed at enhancing technical skills and productivity contribute to improved capacity utilization and overall performance.
- f. Supply Chain Integration and Collaboration:** Uninterrupted, timely and correct delivery of all supplies, especially raw materials will ensure smooth production process, thus increases productivity. Stores, SCD and production team need to be integrated to forecast raw materials correctly, select trustworthy supplier and forward order in time.
- g. Quality Control and Continuous Improvement:** In sweater production, quality is very important in each stage to ensure best production in shortest possible



time and to reduce wastage. When wastage is less, reproduction requirement reduces, productivity increases.

**h. Sustainable Practices:** Integrating sustainable practices into capacity planning is increasingly important for Bangladeshi sweater factories. This includes energy-efficient production processes, waste reduction initiatives, and compliance with environmental regulations.

**Research Identified Gaps**

In global consideration sweater is considered as flat knit product. In Bangladesh flat knit or sweater is considered as a part of knitwear production. BGMEA, BKMEA or Bangladesh Government passing rules and regulations similar to all knitwear products. Whereas flat knit or sweater production process is completely different from circular knit or jersey. Flat knit or sweater production is the combination of textiles division and RMG division. Government made duty free acceptance on wastage for textiles and RMG differently, which not applied for flat knit. Flat knit factories can utilize accepted level of duty-free wastage limit only for the RMG division of knitwear.

Again, different government organizations cannot support factories properly as they do not understand difference between flat knit and circular knit production. They consider both in same category and make rules common.

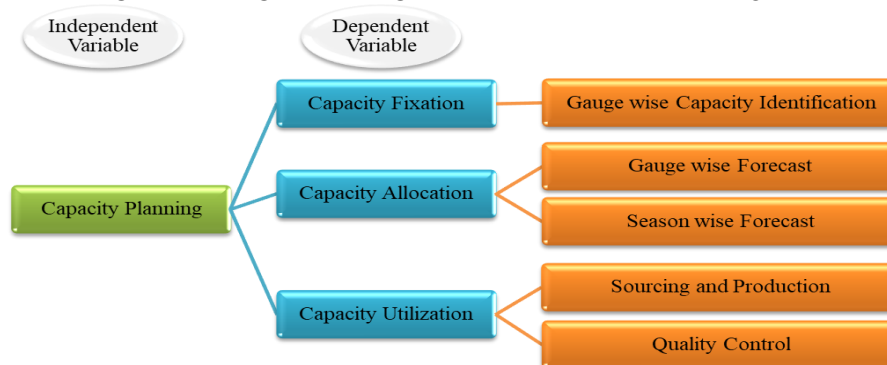
In sweater production many of the section workers like linking, trimming, mending

sewing, iron etc. are paid on piece rate basis. That means per piece rate for production process is declared before production. Workers earn money for the number of garments he completes his process of work. That gives an opportunity of earning calculation to each worker based on his/ her production. Many workers are reluctant to join in work when he/ she ensures good amount of earning as per his/ her need. Absenteeism rate in sweater factories is often higher and mostly unpredictable.

Sweater being a premium product demands higher quality requirements. Unskilled workers in various sections of works can destroy a product. Again, issues raised for quality complains, restrict potential high value product orders in the factory. Factory depends on low value products orders and loses profitability. Which effects reputation of the factory as well as the industry.

**Conceptual Framework**

The conceptual framework of the research is based on the relationship that exist between capacity fixation, allocation and utilization by effective capacity planning. Here the independent variable is the capacity planning and the dependent variables are capacity fixation, allocation and utilization. Two dependent variables, capacity fixation and allocation are based on season and gauge wise capacity. Whereas the last dependent variable of capacity utilization is illustrated based on production and quality control. The framework is shown in below Figure:7.



**Figure 7.** Conceptual Framework of this Research

## Methodology

**Research Design:** Research design illustrates the overall data collection process [14]. Researcher used descriptive design using Starlight Sweaters Limited as a case study. Here a mixed-methods approach mixing quantitative and qualitative techniques to gather comprehensive data process selected.

**Study Area:** The study area in this research is Starlight Sweater Limited; located at Vogra, Gazipur, the densest RMG factory location in the country. This factory selected as it is of the first sweater factory of Labib Group, the largest sweater manufacturer in the world.

**Study Population:** In this research the population included the Starlight Sweaters Limited all employees including workers, staffs and management, factory stakeholders, both suppliers and buyers. In this case the estimated population was 1650 people, where 1500 skilled and experienced (minimum 3 years' experience) are from factory employees and rest 150 are from stakeholders.

**Sampling Procedures:** In this research, random sampling technique applied. This is the technique in which all Starlight Sweaters Limited employees had equal chance of being selected. However, the vital sections were given little more priority in selection to ensure key areas are covered well. For the suppliers and buyers only available suppliers and buyers during the research period were considered. This helped the researcher to obtain the insight information on the sweater business in all aspects from production team, suppliers and buyers. The sample size was obtained by using the [15] formula given a finite population and the degree of precision (reliability) desired by the study.

$$[15] \text{ states; } n = \frac{N}{1+N(\delta)^2}$$

Where;  $n$ = the sample size,  $N$  is the known population of the study and  $\delta$  permissible error (considered 0.03 or 3%).

$$\text{Thus } n = \frac{1650}{1+1650(0.03)^2} = 473$$

From the population of 1650, a sample of 473 were used to conduct the study which account for 29% of the total population. More focus given to the vital operational sections, touching all operations. All small or big operational or supporting sections were considered in the sampling process.

### **Data Collection methods and procedures:**

To determine the capacity of the factory and to ensure effective planning for identified capacity, both primary and secondary data were collected by using self-administered questionnaires to sample of the population which in this study were Starlight Sweaters Limited all employees including workers, staffs and management: factory stakeholders, both suppliers and buyers.

### **Data Validity and Reliability**

**Data validity:** Validity as the certainty that a test measures what it was designed to measure [16]. This research measured all four types of validity namely construct, content, face and criterion validity. Construct validity was measured by ensuring that the correct tools used for measures. Content validity was measured by ensuring that the all part of the subject measured, face validity was measured by ensuring that we included only the people who is well skilled. Data collection was limited to quick process in order to minimize data distortion from major events.

**Data reliability:** To ensure reliability, the researcher ensured following steps:

1. Ensured data sources are reliable. As factory personnel having sufficient experience were the sources of data, the data were authentic.
2. Evaluated the data. All data were evaluated during collection to ensure reliability.
3. Comparison. Similar data from different floors but same sections were compared to each other to ensure reliability.
4. Citation. Finally reliable data were cited in the research.



## Data Analysis, Management and Presentation

Here, statistical data were collected from different sections of work processes in different dates and floors. Collected data were analyzed to generate the intended objective. The analysis included tables, charts, correlation analysis as well as regression analysis to determine the productivity of different sections on different kinds of sweaters.

**Ethical Consideration:** This study intended to implement two ethical considerations; thus, the consent of participants to mean that respondents accepted willingly to participate in the study were given the questionnaires but those who rejected were not given. Also, the study considered respondents' privacy; thus, the information provided by respondents were

treated as confidential and for academic purposes only [17].

## Findings and Discussion

### Preliminary Data Analysis

**Response Rate:** The sample population which was supposed to respond on questionnaires were 473. The fully responded and returned questionnaires were 429 indicating a response rate of 90.7%.

**Gender of Respondents:** In Table 1 indicates that, 58.97% of the respondents were male and 41.03% were female. This entails that Starlight Sweaters Limited factory is predominated by male than female, though the female ratio is not identically behind. Males are the people engaged mostly in this operation than females.

**Table 1.** Gender Distribution of Respondents

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Male	253	58.97	58.97	38.9
Female	176	41.03	41.03	100.0
Total	429	100.0	100.0	

**Age of Respondents:** The researcher was also interested to determine age of respondents in order to establish the age category of the Starlight Sweaters Limited employees and stake holders. Findings from

the field as shown in Table 2 show that, 7.7% are aged below 25 years, 46.6% aged between 25-29 years, 22.9% aged between 30-39 years, 13.7% aged 40-49 years and 9.2% aged above 50 years.

**Table 2.** Age of Respondents

Age	Frequency	Percent	Valid Percent	Cumulative Percent
20- 25 years	129	30.07	30.07	30.07
25-29 years	219	51.05	51.05	81.12
30-39 years	43	10.02	10.02	91.14
40-49 years	30	6.99	6.99	98.13
above 50 years	8	1.87	1.87	100.0
Total	429	100.00	100.00	

**Education Level of Respondents:** Educational assessment taken for factory workers and senior staffs, management

along with stakeholders which are shown in Table:3 and Table: 4.

**Table 3.** Education Level of Factory Workers

Education level	Frequency	Percent	Valid Percent	Cumulative Percent
Below SSC	177	50.43	50.43	50.43
SSC	127	36.18	36.18	86.61
HSC	43	12.25	12.25	98.86
Bachelor's degree	4	1.14	1.14	100.00
Total	351	100.00	100.00	

**Table 4.** Education Level of Senior Staffs, Management Team and Stake Holders

Education level	Frequency	Percent	Valid Percent	Cumulative Percent
HSC	2	2.56	2.56	2.56
Diploma	12	15.38	15.38	17.94
Bachelor's degree	53	67.96	67.96	85.90
Masters	11	14.10	14.10	100.0
Total	78	100.0	100.0	

**Working Experience of Respondents:**

Finding from the field as indicated in Table: 5 shows that 18.88% have been in the business for less than 2 years, 30.07% have

been in the business for the period between 2-5 years and maximum in 51.05% have been in the business for the period ranging between 6-10 years.

**Table 5.** Years of Experience of Starlight Sweaters Limited Employees

Years of experience	Frequency	Percent	Valid Percent	Cumulative Percent
Less than 2 years	81	18.88	18.88	18.88
2-5 years	129	30.07	30.07	48.95
6-10 years	219	51.05	51.05	100.0
Total	429	100.0	100.0	

**Detailed Data Analysis:** All quantitative data were analyzed using statistical techniques such as descriptive statistics, correlation analysis, and regression analysis. Researcher used thematic analysis to analyze qualitative data from interviews and open-ended survey responses [18]. Findings from quantitative and qualitative analyses triangulated to validate results and to identify patterns.

**Factor Analysis for the Research:** The dependent variables under this research are Capacity Fixation, Capacity Allocation and Capacity Utilization for Starlight Sweaters Limited, with its factors respectively Gauge and

Season wise Capacity Identification, Gauge & Season wise Capacity forecast, Sourcing and production, with quality control. The factor analysis for the dependent variables were analyzed in order to establish the significance of its components.

**Factor Analysis for Gauge Wise Capacity Identification:** The factor gauge wise capacity identification is analyzed to identify the capacity of this factory for machine-based production. Knitting and linking are 2 machine-based production, where machines are different for different gauges. Rest other machine-based operation like sewing are done with common

machines for all gauges. Therefore, researcher analyzed gauge wise production capacity of

knitting machines and linking machines. Findings are shown in Table: 6:

**Table 6.** Knitting and Linking Production Capacity as Per Gauge in Starlight Sweaters Limited

Machine Number	Gauge	Knitting			Linking					
		Daily Work min	Daily Capacity (in min)	Monthly Capacity (in min)	Average SMV	Monthly Prod Capacity (in number)	Daily Work min	Average PPM	Daily Prod Capacity (in number)	Monthly Prod Capacity (in number)
540	12/14 Gauge	1,200	648,000	18,144,000	80	226,820	600	24	7,200	180,000
200	5/7 Gauge		240,000	6,720,000	45	149,333		32	6,400	160,000
102	7 Gauge		122,400	3,427,200	70	48,960		32	1,280	32,000
97	1.5/3 Gauge		116,400	3,259,200	60	54,320		36	2,160	54,000
<b>939</b>	<b>All in Total</b>		<b>1,126,800</b>	<b>31,550,400</b>		<b>479,433</b>		<b>124</b>	<b>17,040</b>	<b>426,000</b>
<b>Total</b>										

This capacity will differ with the change of SMV (Standard Minute Value). This capacity is considered as monthly 28 days operation with 10 hours duty in a day in 2 shifts. If we make percentage of production capacity, we will find from the table 42% capacity is for lighter gauge (12/14) and 58% capacity for heavier gauge (5/7, 7 and 1.5/3) available for knitting in factory.

Linking production per month considered 25 days' work for 1 shift. Percentage wise lighter and heavier gauge production capacity is 42% and 58% respectively.

Although other vital sections operations are common for all gauge, those sections capacity identification is also important within this factor. Here also considered 25 days' work per month in 1 shift, which shown in Table: 7 below.

**Table 7.** Vital Sections Production Capacity in Starlight Sweaters Limited

Man	Section	Daily Work min	Average PPM	Daily Prod Capacity (in number)	Monthly Prod Capacity (in number)
220	Trimming	600	80	17,600	440,000
160	Mending		110	17,600	440,000
44	Sewing		400	17,600	440,000
18	Washing		950	17,100	427,500
100	Iron		175	17,500	437,500
150	PQC		120	18,000	450,000
100	Packing		180	18,000	450,000

**Factor Analysis for Gauge Wise Forecast:** Knitting is the costliest part of production and required jacquard machines are not manageable in short time. Capacity forecast

as per knitting capacity is most important. Factory production capacity for knitting and linking is 42% for lighter and 58% for heavier products, factory could manage

production considering lower SMV for knitting and lower PPM (Productivity Per Man/ Machine) for linking in lighter

products. Table: 8 below shows the gauge wise export result of Starlight Sweaters Limited in last 4 years.

**Table 8.** Gauge Wise Export Data

Gauge	Export Data Per Year					
	2020	2021	2022	2023	Average	Average %
12/14 Gauge	2,888,000	2,812,000	2,733,000	2,647,000	2,770,000	49%
5/7 Gauge	1,812,000	1,876,000	1,884,000	1,773,000	1,836,250	32%
7 Gauge	510,000	525,000	533,000	496,000	516,000	9%
1.5/3 Gauge	575,000	580,000	98,000	549,000	575,500	10%
<b>Total</b>	<b>5,785,000</b>	<b>5,793,000</b>	<b>5,748,000</b>	<b>5,465,000</b>	<b>5,697,750</b>	

**Factor Analysis for Season Wise Forecast:** Sweater being a seasonal product, order fluctuates in each season. Considering last 4

years demand since Covid-19 situation, factory seasonal exports are as shown below in table 9

**Table 9.** Season Wise Export Data

Gauge	Export Data Per Year						Delivery Months
	2020	2021	2022	2023	Average	Average %	
Spring	1,123,000	1,147,000	1,226,000	1,088,000	1,146,000	20%	NOV-FEB
Summer	637,000	643,000	674,000	597,000	637,750	11%	MAR-APR
Autumn	879,000	902,000	936,000	892,000	902,250	16%	MAY-JUN
Winter	3,146,000	3,101,000	2,912,000	2,888,000	3,011,750	53%	JUL-OCT
<b>Total</b>	<b>5,785,000</b>	<b>5,793,000</b>	<b>5,748,000</b>	<b>5,465,000</b>	<b>5,697,750</b>		

From table: 9 we find, average 53% products exported only in 4 months (July-October) for the winter products.

important for timely production and to achieve maximum productivity [19]. Raw materials types with lead time needed to collect these materials are shown in following table 10:

**Factor Analysis for Sourcing and Production:** Sourcing of raw materials is very

**Table 10.** Lead Time for Sourcing Raw Materials

Type	Material/ Source	Lead Time	Remarks
Yarn	Local	30-45 days	Need colour approval to order
	Imported	60-90 days	
Accessories	Labels	30-90 days	Need labels, material and wash approval to order

	Packing Materials	07-30 days	Need folding, poly/ carton size approval to order
<b>Attachments</b>	Local	30-45 days	Need materials type, design and colour approval to order
	Imported	60-90 days	

From Table: 10 we get idea for lead time and from remarks we can find approval needed to be acquired prior to order each material.

**Factor Analysis for Quality Control:** Quality control system works in 2 parts:

**Quality Assurance:** This is a proactive process of making SOP, ensuring execution of that SOP and monitoring effectiveness of SOP through Quality Management System. The more effective the quality assurance is, the less

mistakes will happen and the more productivity will be achieved.

**Quality Control:** This is a reactive process of ensuring quality standard through different layers of inspection. This is basically identification of mistaken products. The more products would be identified with mistakes, the more will be rework and the less would be productivity.

Difference of quality assurance and control can be understood by following figure:8.



**Figure 8.** Quality Assurance and Quality Control

**Correlation Analysis:** After analysing of all factors from dependent variables, we find relationship of capacity between different operations based on gauges, especially for

machine-based operations i.e. knitting and linking, where other operations are also related. Relationship between the factors and effect on each other shown in the following table: 11:

**Table 11.** Correlation Analysis Amongst Variables and Factors

Variable	Capacity Fixation	Capacity Identification		Capacity Utilization	
	Factor	Gauge wise Capacity Identification	Gauge wise forecast	Season wise forecast	Sourcing and Production
Relation/Effect	Machine based	Need to forecast	Season wise	Sourcing ahead of	Quality Control can

	productivity fixed	as per fixed capacity	forecast is must to maintain balance amongst gauge wise capacity	lead time can create opportunity for advance production	decrease rework
<b>Adjustments</b>	Can be adjusted man-based productions with required manpower	Gauge wise capacity can be adjusted adjusting average SMV and PPM	Seasonal effects can be adjusted through advance production	Advance production in low season, for additional capacity needed for winter, makes balance on capacity	Effective quality control increases productivity, thus capacity

## Results

**Capacity Fixation:** The research paper analysed and identified the fixed capacity of Starlight Sweaters Limited for machine-based production, focusing on knitting and linking operations. The factory's production capacity identified as 42% for lighter and 58% for heavier gauge products.

**Forecasting:** The research paper delved into gauge-wise and season-wise forecasting for the factory's sweater production. A detailed analysis was done on the historical export data and seasonal demand trends to predict and optimize production planning.

**Sourcing and Production:** The paper outlined lead times for sourcing raw materials like yarn, accessories, and attachments, highlighting the importance of advanced sourcing to facilitate timely production and maximize productivity.

**Quality Control:** Quality control methods like, quality assurance and quality control were discussed, focusing need of quality management practices to increase efficiency and reduce rework.

## Conclusion

Capacity planning is a complex process in the Bangladeshi sweater industry. By implementing appropriate strategies, sweater factories can optimize capacity utilization and improve overall efficiency. This research paper contributes to the understanding of capacity planning in context of Bangladeshi sweater factories to provides practical recommendations.

Good planning would assist in effective capacity utilization, [20] reduce wastages and increase profitability. Effective planning will guide factory to avoid system losses, which will result more productivity for factory and more income for workers. Effective time planning will reduce extra time works, thus resulting more free time for workers ensuring better social life.

Well organized capacity planning will ensure smooth timely production with best quality. Therefore, the reputation of the factory will be increasing gradually. Grabbing different market demands would be easier for marketing team. Which would assist to overcome seasonal demand crisis and ensure order from all around

the globe to help factory production in all season symmetrically. Factory can ensure best quality and can offer better price; all reputed brands will focus to work with this factory. Which would result better reputation for the factory, for the industry as well as for the country.

## Recommendations

The researcher recommends execution of effective capacity planning in every sweater factory. Challenges sorted out in this research would help all factories to visualize and to plan in advance. Besides, the strategies suggested would help to overcome those challenges and to make effective plan for best capacity utilization. Therefore, the researcher also recommends to accept this research paper as a method of study by BGMEA, BKMEA.

## References

- [1]. Ferdous, S., 2019, "A Review of the Readymade Garments Industry of Bangladesh: Origin, Growth, Challenges, and Prospects." *Journal of Asian Business Strategy*, 9(2), 51-61.
- [2]. Hossain, M. S., & Hossain, M. M., 2020, "Sustainability in Textile and Apparel Industry: A Case Study on Bangladesh Perspective." *Journal of Textile Science and Engineering*, 10(3), 1-7.
- [3]. Nahmias, S., 2015, "Production and Operations Analysis." Waveland Press.
- [4]. Operation Management by Chase Jacobs, Aquilano & Agarwal., Tata Mc Graw Hill, 11th edition, 2006.
- [5]. Production and Operations Management by Chary - (Tata Mc Graw -Hill, 1997 9th ed.)
- [6]. Production and Operation Management by EVERETT E ADAM, Jr. RONALD J. EBERT, 13th Edition, PHI Learning Private Limited, New Delhi
- [7]. Goldratt, E. M., 1984, "The Goal: A Process of Ongoing Improvement." North River Press.
- [8]. Haque, M. E., & Uddin, M. N., 2019, "Production Capacity Evaluation and Optimization

## Conflict of Interest

This research did not disclose any conflict of interest that might have influenced the results or recommendations provided. It focused on providing an objective analysis and practical recommendations to optimize capacity planning in Bangladeshi sweater factories. However, it is important to note that Starlight Sweaters Limited, the focus of this research work, is a prominent player in the Bangladeshi sweater industry and known for its high reputation and extensive experience. As such, there may be a potential conflict of interest in promoting the strategies and recommendations outlined in this research to benefit all other factories. It's essential for stakeholders, policymakers, and factory management to critically evaluate and adapt these recommendations based on their specific contexts and goals to ensure unbiased decision-making.

- of an Apparel Industry: A Case Study in Bangladesh." *International Journal of Supply Chain Management*, 8(6), 722-730.
- [9]. Gross, D., & Harris, C. M., 1998, "Fundamentals of Queueing Theory." John Wiley & Sons.
- [10]. Hasan, M., & Uddin, M. N. 2020, "An Analysis of Forecasting Techniques for Textile and Apparel Industry: A Case Study in Bangladesh." *Global Journal of Researches in Engineering: F Industrial Engineering*, 20(3), 1-10.
- [11]. Law, A. M., & Kelton, W. D., 2000, "Simulation Modeling and Analysis." McGraw-Hill.
- [12]. Makridakis, S., Wheelwright, S. C., & Hyndman, R. J., 1998)., "Forecasting: Methods and Applications." John Wiley & Sons.
- [13]. Uddin, M. N., & Hossain, M. A., 2018, "Technology Adoption in the Apparel Industry: A Case Study on Bangladesh Perspective." *European Journal of Business and Management*, 10(23), 77-86.

- [14]. Kothari, C., 2004, *Research Methodology, Methods and Techniques*. New Delhi: New Age International Publishers.
- [15]. Yamane, T., 1967, "Statistics: An Introductory Analysis." Harper & Row.
- [16]. Drost, E. A., 2011, Validity and Reliability in Social Science Research. *Education Research and Perspectives*, Vol.38, No.1, pp 105-121.
- [17]. Sekaran, U., & Bougie, R., 2016, "Research Methods for Business: A Skill Building Approach." John Wiley & Sons.
- [18]. Miles, M. B., et al. 2013, "Qualitative Data Analysis: A Methods Sourcebook." Sage Publications.
- [19]. Rahman, M. A., & Islam, M. N., 2018, "Optimization of Resources Utilization in Apparel Industry: A Case.
- [20]. Silvestre, B. S., & Ramirez, R. 2012, "Capacity Utilization and Productivity Measurement: A Study in Bangladesh." *Journal of Textile Science and Engineering*, 8(3), 1-5.