A Sustainable and Economic Approach towards Shoulder Tape Joining in T-Shirt

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Abstract

This paper specifically discusses the utilization of shoulder tape in t-shirts, which helps reduce production time and lessens fabric wastage. In recent times, apparel manufacturing industries are constantly trying to reduce their fabric waste and use them to ensure sustainability. Therefore, fabric consumption and production time become a prime concern in maintaining efficiency. In the sewing section, the excess motion with the least capacity of the marker tape cutting takes a high pick-up and dispatches time, leading to higher labor costs and fabric waste. Incorporating shoulder tape fabric fabricated from the piping cutting machine helps us to strengthen the shoulder seams. However, the pick-up and dispatching period have also been calculated prior to the body motion. Therefore, it relieves the factory owners from the problem of lower production margins and helps to set up more outstanding production planning. We propose a slitting-cutting machine to have the tape directly through the piping method, which can be set up with the sewing machine over the auto-cutter machine to increase the capacity. Piping will economically help us reduce waste more efficiently and thus for achieving sustainability. Analyzing a factory's production data as a case study, we have found out how much we can save with this method and considered the proper utilization of the plan that can easily be visible in the stages of production. Therefore, this paper will help us to find a new way of

sustainability as to how the piping method of tape cutting can surely lessen the production time and waste but can also bring us more profit.

Keywords
Apparel Manufacturing, Shoulder Tape, Piping Machine, Waste Management, Sustainability and Textile Technologies.

1. Introduction
As the world's second-biggest clothing exporter, Bangladesh earns 83% of its earnings from the RMG sector (Asad et al. 2022). Day by day, this industry is getting highly competitive as the demand for sustainable apparel has been increasing, and market competition is becoming much more competitive than ever. Consequently, customer demand has been unpredictable, as the product lifecycle is becoming short, the environment is changing, and of course, the opportunities to entry in this industry are shrinking dramatically. Despite being in a superior position in this industry for years, it still does face some massive challenges due to its inadequate incentives, unfavorable trade policies, high transportation costs, longer lead time, deficient raw materials, and many more constraints (Islam et al. 2013). Low production cost has been a point of strength for Bangladesh to sustain itself in this highly competitive market (Ahmed 2009). Therefore, it has become a great matter of concern for industrialists to think of strategies to increase their efficiency and maintain a lower production cost at the same time. However, the production cost jumps with a rise in the quality of the product (Morris et al. 2009). Increased efficiency can provide us not only with quality products but also keep the production cost lower. The RMG sector of Bangladesh has gained less efficiency than its competitors. Therefore, production time and cost have become a great concern, leaving an option for applying innovation.

Knit garments with shoulder tape have contributed a lot to the emerging fashion trends controlled by consumers. The shoulder tapes are added to strengthen the shoulder seam and have the added benefit of increased aesthetics of the garment. On the sewing floor, shoulder tape that is cut with the marker process keeps the least capacity due to its excess motion which results in a high pickup & dispatches time as well as a high cost of labor and fabric wastage. Factory owners have been suffering from a lower production margin as it takes more time to estimate and set up the shoulder tape in place with a marker. In this process, shoulder tape has been cut along the horizontal grain line by an auto-cutter machine. The sewing line is a sequential formation where sewing workstations are placed on the sewing floor to produce an output. Materials flow from the back to the front in a straight single-line layout (Nabi et al. 2015; Syduzzaman and Golder 2015). Thus, it takes more time to complete the production process and produces more fabric waste. A slitting-cutting machine is used to replace the auto-cutter machine to increase the shoulder tape capacity on the sewing floor. Shoulder tape length has been considered an area of improvement to increase production. The slitting process has also been proposed for economic reasons both within and outside the business as it takes less time to process shoulder tape, resulting in significantly low fabric wastage. It is a unique concept for increasing shoulder tape capacity. Shoulder tap cutting using a marker is an industry baseline that is compared with the proposed process. Metrics that are typically considered and measured can be quality, time, and cost.

1.1 Objectives
In this experiment, our objective was to introduce an innovative technique to mobilize production in the sewing section and measure its impact on quality, time, and cost. Also, this research mainly focuses on achieving social, economic, and environmental sustainability by reducing waste, time of production, and production costs. We have studied an experiment that has been practiced in the industry and provided us with some fruitful outcomes to implement throughout the industry. This process dramatically reduces fabric wastage and makes it economical and sustainable. As it saves time and enhances productivity and efficiency, it is going to show a new dimension in the field of textiles.

2. Literature Review
Knitwear garments have been booming over the past years as the biggest export earner in the readymade garment industry in Bangladesh. Thus, the industry is focusing more on the efficient and economic production process of knitted garments. There is a huge number of studies conducted on the efficient and economical production of knitted garments. Efficiency is a term that can be defined as the ratio of the useful work (output) performed by a person, line, company, factory, etc. using resources such as time, materials, or labor well as to the total input taken in.

Productivity can be measured in terms of the rate of output per unit of input in industry and can be designated as the effectiveness of the productive effort.

A study focused on designing Production lines & operational time minimization for increasing productivity in ready-made garment factories for knitted fabrics in Egypt (El-Tahan and AbuEl-Nasr 2014). Another study was found on the effect of community identity on investment behavior in the knitted garment industry in India. The paper documented very large and systematic differences in both levels of capital stock and capital intensity (Banerjee and Munshi 2004). Another study investigated the manufacturing sector of Apparel/ Clothing in Turkey in terms of energy consumption to enhance the efficient production of the entire knitted garments wear production chain (Çay 2018). To increase production, research has been carried out in Bangladesh on the following aspects such as technological adaptation, modern machines, sewing lines, multi-skilled operators, defects and sewing parameters, etc. So, it is believed that this research has a touch of innovation as well as it will play a leading role (Choudhary et al. 2018; Joshi and Singh 2010; Kılıç 2019; Wang et al. 2022). Hence, the present study is unique in terms of content and it is expected to play a leading role in the development of the textile industry. Substantially, shoulder tapes are an essential part of the T-shirt and the shoulder tape-cutting method has been revealed as a point of research considering a better option to cut the shoulder tape. Not many studies have been done on the development of the shoulder tape-cutting method. Therefore, this experiment is significant in proposing a new usage of piping that is extremely beneficial for reducing cost and production time.

3. Methods

In this experiment, we have analyzed some case studies based on some order information and relevant data from Cotton Field BD Ltd. Shoulder tape fabric has been cut by using a piping/slitting machine. This device has been adjusted on the sewing machine and the garments are set up in the machine and then the sewn shoulder tape on the shoulder attachment. Pickup and dispatching time has been calculated for defining the required body motion. Then fabric consumption for shoulder tape (*Equation 1*)and cutting time are also calculated for a cost comparison. Further processes were executed according to the buyer's requirements to get the final products. The information on the orders of the fabric sample has been given in Table 1 and the essential parameters are described in Table 2.

$$Consumption\ per\ shoulder\ tape\ (in\ kg) = \frac{Tape\ length \times Fabric\ Dia \times Fabric\ GSM}{Tape\ Quantity \times 1550 \times 1000 \times 2.54} \quad (1)$$

Table 1. Order information

Fabric type	Tape width	Sewing machine	Total Ply	Lays	Total order/ month
Single jersey Knit	0.9 cm	10 lines	1297	25	12,00,000

Table 2. Parameter values

Parameters	Measurements
Tape length	40 cm
Tape width	0.9 cm
Fabrics GSM	160
Fabrics Dia	68 cm

4. Data Collection and Results

The data and the results for each order have been illustrated in the tables below. In this experiment, we took 4 orders as our sample to evaluate our hypothesis. In Table 3, it denotes the number of total plies according to specific orders. Table 4 and Table 5 have shown a clear comparison between the conventional processes on total consumption through the marker process and the newly conducted piping method. Consequently, the Table 6 and Table 7 have

made it clear that this new process can save much cost as well as time. Therefore, the tables specified the justification for our information and the results that we are expecting for.

4.1 Numerical Results

Table 3. Calculation of total ply(s) per order

Order No.	Total Quantity	Marker Pcs	Total Ply
350-0851A	27894	15	1860
400-0098	145238	8	18155
520-0388	40236	31	1298
350-0854A	18524	14	1324

Table 4. The new method (Piping Machine)

Order No.	Tape Quantity In 1 Ply	Tape Consumption Per Quantity	Total Tape Consumption
350-0851A	191	0.000576	16.14
400-0098	191	0.000576	84.06
520-0388	191	0.000576	23.29
350-0854A	191	0.000576	10.72

Table 5. Conventional method (Marker Process)

Order No.	Consumption With Tape In 1 Ply	Consumption Without Tape In 1 Ply	Fabrics Needed In 1 Ply	Total Fabrics Needed For Tape
350-0851A	1.18	1.17	0.01	18.60
400-0098	3.94	3.92	0.02	363.10
520-0388	2.55	2.52	0.03	38.94
350-0854A			0.02	26.48

Table 6. Fabric savings in kg

Order No.	Total Fabrics Saved	Fabrics Saved Per 1000 Ply
350-0851A	2.46	0.09
400-0098	279.04	1.92
520-0388	15.65	0.39
350-0854A	15.76	0.85

Table 7. Cost savings in taka

Savings in Extra Production	Savings in Extra Cutting	Fabric Savings (In Marker Vs Piping Cut)	Total
151,250	429,000	7,562,500	8,142,750

4.2 Graphical Results

The proposed piping system utilizes the production time & fabric wastages. From the industry data depicted in Figure 1 and Figure 2, it is clear that the new method saved as much as 15.37 grams per ply and 1.92 grams per garment just by reducing the wastage caused by the conventional method. As a result, the proposed piping process has a vast amount of financial value for the organization, referring to total savings of 8142750 takas per year for about 1200000 pcs of orders per month. About 93% (*Figure 3*) of the cost savings come from the reduction of fabric wastage. When the process will be practiced more in the industry, more improvements might come out for the development of the process. Overall, this experimental process shows that the proposed piping system is economical for garment shoulder tape attachment. It is easily applicable to other industries by installing piping facilities, and the industry should implement it and should share it with the concerned person for implementing it into the industry.

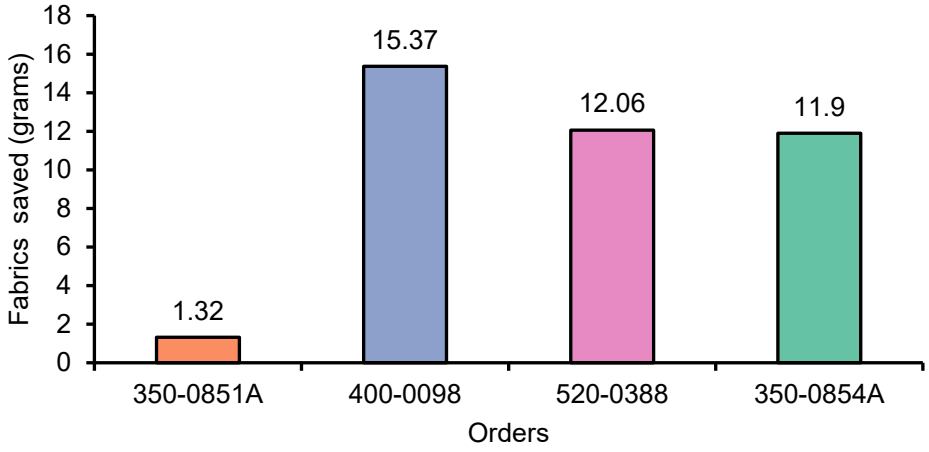

Figure 1. Fabrics saved per ply in grams

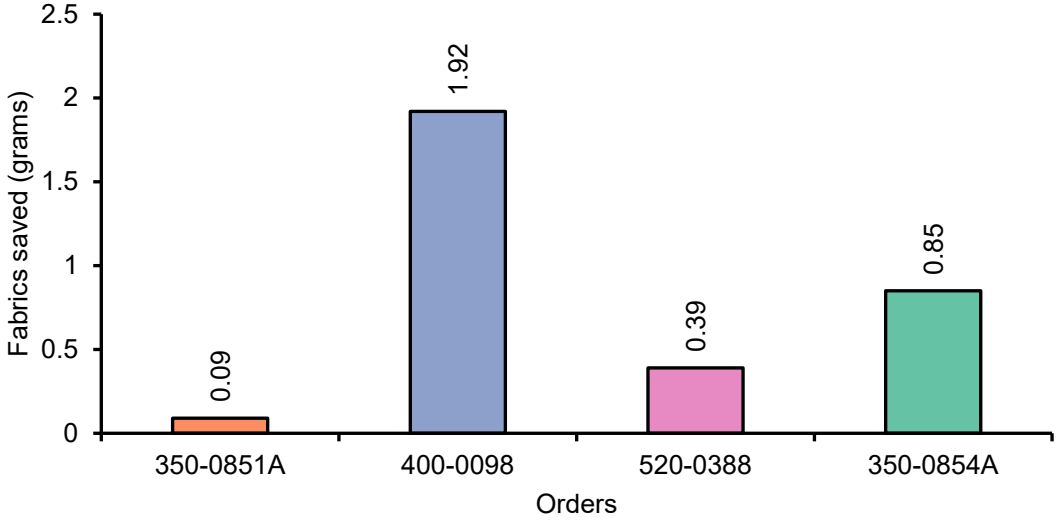

Figure 2. Fabrics saved per garment in grams

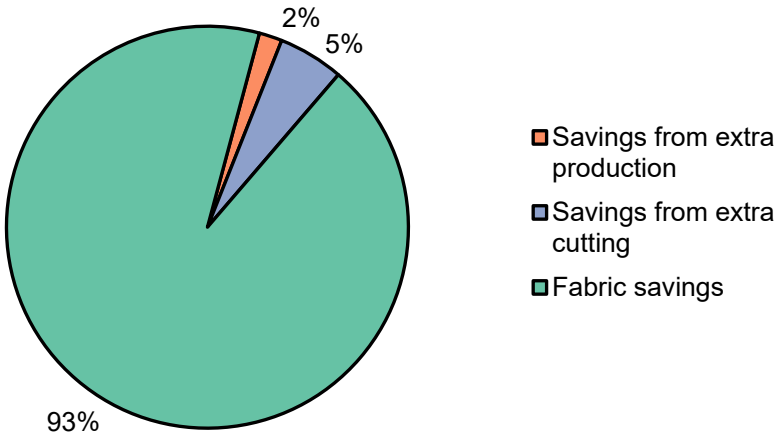

Figure 3. Savings per year in taka

5. Conclusion

The whole world is currently moving towards sustainability and reducing waste. This research paves the way for achieving sustainability in shoulder tape joining by reducing in-line waste and utilizing raw materials most efficiently. However, the production time has also been a great concern in terms of the lead time issues. This piping method can be a significant change in curtailing production. The production time directly impacts the lead time of foreign and even domestic orders as well. Therefore, less production time results in more production in other words. Aside from all these things, this study provides us with some significant results in production cost reduction. Therefore, this process is validated by the case study run in the industry and this process can make us benefitted in so many ways, especially in achieving sustainable goals to lessen the environmental impacts of the textiles industry.

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Biographies

Habibur Rahman Anik is a diligent engineering honors student from the Bangladesh University of Textiles with the proven presentation, research, and communication skills. A man with good listening skills can take instructions from all levels and build good working relationships with colleagues. Keeping a creative mind and always up for new challenges, he is always ready to work well under pressure and adhere to strict deadlines. His favorite activity is finding a problem, analyzing it adequately, and looking for an appropriate solution for it. His research activities include the area of Operations Research & Management, Quality Management, Sustainable Textiles, Bio Materials, and Renewable Energy.

Abir Hassan is an undergraduate student at the Bangladesh University of Textiles. His research interests include nanotechnology, materials science, machine learning, and sustainability in textiles. He is actively engaged in research activities and seeking challenges in his field.

Sazid Elahi is serving as Assistant Professor at BUTEX. Having a great interest in research and teaching-learning, he joined as a faculty member at the department of Apparel Engineering under the faculty of Fashion Design and Apparel Engineering to contribute as a stakeholder to Bangladesh's textile and apparel sector. From the department of Apparel Engineering, he is pursuing an M.SC. in Textile Engineering. He received his B.SC. in Textile Engineering with the highest grade in his class in 2018 from the Fashion Design and Apparel Engineering faculty's department of Apparel Engineering. In addition to his academic prowess, he is currently diligently engaged in research activities. His current research interest includes Plasma Finish in Clothing, Circular Fashion and Economy, macroeconomic Taxation System, Bangladesh's RMG Industry, Labor Law & Human Rights, and Measurement of carbon capture and emissions and clean energy in the RMG sector.

Mohammad Ishaque is now a lecturer at BUFT. He is a scholar with the potential to serve as a mentor in the classroom and on campus and to make it big for academic and research brilliance at the national and international levels. Previously, he has done so many works related to the industry with denim and quality, and his point of research interest has been concentrated on Sustainable Textiles and Development.

Rony Kumar Shil has completed his Bachelor's in Textile Engineering from the Bangladesh University of Textiles. Currently, he is serving in Cotton Fields BD Ltd., which is a concern of Mondol Group.

Atashee Dey Rishti is one of the meritorious students in her class. Her excellence at the undergraduate level amazes her mentors and teachers. Critical thinking, problem-solving, and analyzing the problem in-depth have been her strengths. Her field of research interest includes Textile technology and sustainable development.

Sumaiya Tabassum,is an engineering student from Bangladesh University of Textiles.She is always up for new challenges, loves to analyze problems and solve them gradually. A competent, resourceful, and ambitious individual, with an inherent interest in research work and studies. Demonstrated ability to comprehend the main objectives of each study, and determine correlating research procedures. Highly proficient in conducting comprehensive literature reviews.Her research interest includes Sustainable Textiles & Development, Medical Textiles, nanotechnology,Eco friendly Textile Material, Waste Management.