FABRIC CUTTING OPTIMIZATION APPLICATION

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Abstract

Under increasingly competitive conditions, it has become inevitable for businesses to produce better quality products at lower cost so that they can maintain their marketplace. In today's conditions where the competition has reached an international dimension, producing quality products with less cost provides serious advantages to businesses. Enterprises manufacturing in the textile sector have to compete not only with domestic businesses but also with countries where the textile industry such as Pakistan, Egypt, Bangladesh, Indonesia is developing. In particular, the denim sector is making small pieces of long-lived fabrics for customer orders and selling them to customers. Because of getting more first quality products from same amount of fabric is decreasing wastage and increasing profitability this will achieve significant advantages to companies.

Keywords: textile, denim, facric cutting, optimization, software

Introduction to Fabric Production

The operations for fabric production in denim mills and the machines where these processes are applied are almost identical. Production orders for each order are arranged and the fabric passes through a certain route and the production is completed. Different processes are applied on the fabric at every stage of production. A wide range of paints and chemicals are used when these processes are applied. Each process has its own production conditions. Speed, temperature and the amount of chemical to be applied are very important for the production phase. If these conditions are not provided correctly, defects are appeared in fabric production and the fabric is wasted. The final stages of the production processes are quality control, cutting and packaging processes. Orders are usually long-term and are not suitable for the customer to carry in one piece. Therefore, the fabric is cut into smaller pieces in the cutting stage and shipped to the customers.

Quality Control in Fabric Production

The fabrics that have been produced are passed through the quality control stage before they are sent to the customer. After physical and chemical tests, the quality control of fabrics is examined in quality control machines. This is done by an operator. There is a software on the machines that can enter these quality control results. This software communicates with meter meters on the machine via serial port or Ethernet and displays the fabric quantity instantly in software. Operators taking into account customer requests and cut the fabric from a certain point according to their own initiative and start the quality control of the next roll after packaging. In the meantime, because the quality control machine can not see all the fabric attached to the cutting point immediately after a break that causes this piece to be wasted. Since quality control and cutting is done at the same time, this kind of waste is inevitable. In addition, since the whole of the fabric is not evaluated, it is possible to obtain more 1. Quality fabrics by making much better cuts than the different points and this method is wasted too much.

Fabric Defect Map

Quality control and cutting operations on the same machine, cause too much waste because of the defects that can come after cutting is not known. With this method we recommend, firstly all the fabric will be checked defects without cutting. In this way, which meter is located on the fabric which error will be recorded in the system. Table 1 shows the error map of a 1041, 82 meter fabric.

Defect	Start	Length	Point
Width variation	1033,89	0	1
Crack	1023,47	0	4
Less size	1009,13	0	1
Hand mark	991,44	5,75	24
Lashing	983,66	0	1
Lashing	960,81	0	1
Lashing	953,7	0	1
Belt mark	929,15	0	4
Width variation	901,43	0	1
Width variation	880,14	0	1
Miss pick	867,48	0	1
Width variation	862,47	0	2
Rubbing mark	832,04	4,66	20
Crack	830,02	0	4
Width variation	825,62	0	1
Width variation	823,54	0	1
Width variation	800,09	0	1
Knots	797,66	0	3
Width variation	778,85	0	1
Width variation	762,6	0	1
Width variation	746,82	0	4
Width variation	722,33	0	1
Miss pick	717,28	0	1
Knots	704,67	0	1
Knots	701,6	0	1
Width variation	646,3	0	1
Width variation	631,92	0	1
Poly contaminatio n	573,44	0	4
Width variation	570,53	0	1
Width variation	507,72	0	1
Splice Cut	495,62	0	4
Width variation	492,2	0	1
Miss pick	408,44	0	1
Width variation	398,01	0	2
Knots	390,14	0	1
Width variation	379,55	0	1
Width variation	321,4	0	1
Width variation	307,29	0	1
Width variation	300,21	0	1
Knots	297,52	0	2
Weft slub	272,32	0	1
Weft slub	269,52	0	4
Belt mark	262,66	0	4
Belt mark	240,4	0	4
2 - Belt mark	238,58	0	4
Defect	**Start**	**Length**	**Point**
Width variation	234,75	0	1
Belt mark	211,44	0	4
Clip mark	206,16	0	3
Miss pick	200,03	0	1
Hard size	186,17	0	4
Weft slub	166,84	0	1
Belt mark	152,72	0	4
Hard size	148,36	0	4
Belt mark	145,55	0	4
Hard size	140,47	0	4
Width variation	128,08	0	1
Width variation	102,78	0	1
Clip mark	88,68	0	4
Width variation	83,51	0	1
Width variation	68,17	0	1
Weft slub	57,85	0	1
Belt mark	54,41	0	4
Knots	51,43	0	1
Weft slub	39,2	0	1
Width variation	29,63	0	1
Weft slub	6,93	0	1
Weft slub	5,44	0	1
Weft slub	2,4	0	1

Table 1: Defect Map

When the defect map is examined, it is seen that there are different defects in the fabric at many different points. Defects can be examined in two parts as point and continuous. The beginning and end points of point defects are the same. Continuous defects start and

continue at a certain point. If the defect map is not subtracted, it is inevitable that any errors that may occur after the point where the operator intersects are unknown. However, since the pre-cut defect map will give detailed information about the fabric, the cutting process can be done more planned.

Materials and Methods in Cutting Optimization

Customers want small pieces to make their orders easier to carry on production lines. The weight of square meters is about 400 grams / square meter and the approximate weight of the 1.5-meter-wide 1000-meter fabric (1.5 meters * 1000 meters) * 400 grams / square meter = 600 kg. It is impossible for such a heavy ball to be transported and processed by human beings. For this reason, the enterprises want fabric in certain quantities according to their own conditions. Produced fabrics are divided into qualities according to certain criteria. Qualification can be different for each customer. The following figure shows the cutting parameters that can be used during quality determination operations.

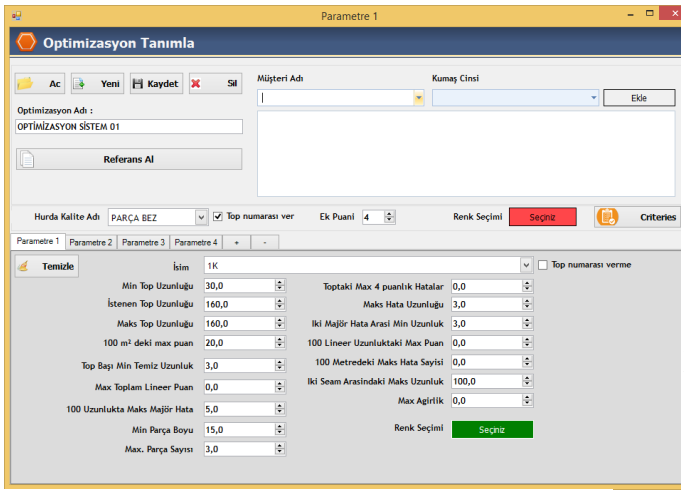

Figure 1: *Optimization cutting parameters*

Min. Ball length: The shortest ball length that the customer wants.
Desired ball length: Customer's specific length
Max. ball length: The maximum length that the customer can accept.
Max. Score in 100 m2: The maximum demerit point of the ball in 100m2.
Roll head min. clean length: The minimum length of the piece at the beginning and at the end of each cut without defect.
Max. Total linear score: Demerit points are calculated for 100 m2. The linear score is calculated according to the length of the roll.
The maximum number of errors in 100 meters: The maximum number of major defects in the 100 meter fabric. Depending on the fabric length, the number may vary. For example, for a 75 meter cannon, there may be a maximum of 3 major defects.
Max. Number of pieces: Maximum number of additional pieces.
Min piece length: Minimum quantity of additional rolls.
Max 4 points defect number in the roll: The maximum number of defect points per roll that can be cut is 4 points.
Max defect length: The longest continuous defect meter that the roll can receive.
Distance between two major defects: The minimum length of the major defects between each other is kept.
The maximum score in 100 meters:The maximum linear score that a 100 meter roll can take. It is calculated in proportion to its quantity of roll.
Max length between added pieces: It is the maximum length difference between the additional pieces.
Max weight: The maximum weight that the fabric can be.

All the parameters shown in Figure 1 may vary on customer basis. It is very difficult to analyze these parameters by people. It can take a lot of time for a person who is qualified to produce a maximum of 1. Quality fabric that meets these criteria. Even so, it is very difficult for the software to produce the result that it can produce. People-oriented systems increase the personnel dependencies of enterprises as they are in people's initiatives. In the absence of qualified personnel, it can cause serious problems. However, with the software to be used, a 7x24 stable system can be created and a system can be established that provides human independent and better results. For example, if we want to cut the fabric with the defect map given in Table 1 according to the parameters in Figure 1, a result can be obtained from the software in seconds.

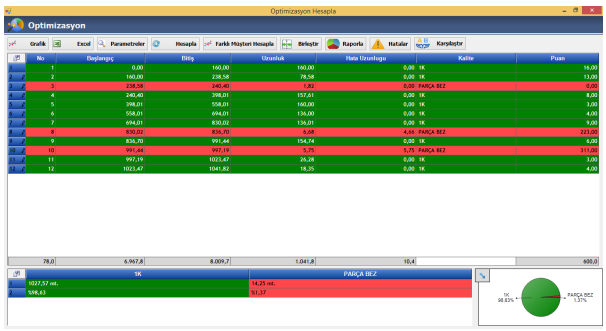

Figure 2: *Optimization cutting plan.*

As shown in Figure 2, the first quality fabric of 98,63% was obtained.
Many companies make quality classifications according to the international system of 4 points.

4 Points Fabric Quality Detection System

In determining the fabric quality, most enterprises use 4 points quality system according to the demands of customers. According to this system, each defect has a penalty point. Longitudinal defects take penalty points according to their lengths according to the table below. Also, the defects are divided into two groups as minor and major according to their level. Major defects are more critical level defects.

Length(inch)	Point
0 - 3	1
3 - 6	2
6 - 9	3
9+	4 point for each meter

Table 2: 4 points error system

For each fabric cut, defects are collected. Taking into account the square meter length of the cut fabric is calculated in 100 square meters. These points are called demerit points. Although it varies in terms of enterprise, demerit scores between 16-20 are generally classified as first quality fabric.

Fabric Cutting Process

The fabric with the fault map subtracked and the cut plan created is now ready for cutting. The fabric to be cut is connected to the cutting machine. With the software to be used, the operator is informed about the fabric. Overlook defects in the defect map section can be entered by the operator in the cutting section. Re-optimization can be performed according to these defects. The operator completes the customer requests by cutting from the points proposed by the optimization system. Thus, a maximum of 1. Quality fabric will be obtained. The following figure shows the cut-off screen of the fabric that has been planed in Figure 2.

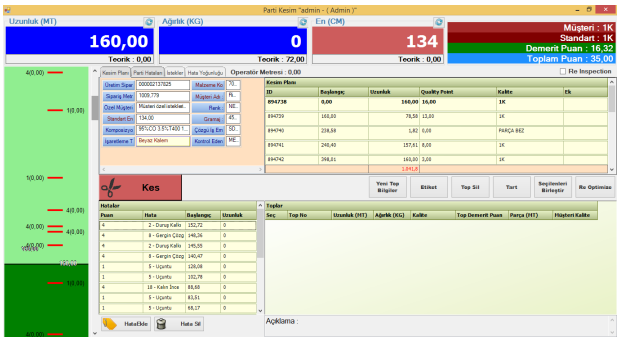

Figure 3: *Cutting screen*

Discussion and Conclusion

Monthly production capacities which are millions of meters of enterprises in the first quality fabric production can achieve a very small improvement even thousands of dollars will make a profit. The dependency on the designed and realized system and the personnel doing this work is reduced. At the same time, more first quality fabric is obtained. The increase in the amount of first quality fabric obtained by this system can reach approximately %1 in total. An increase of %1 for an enterprise with a monthly production of millions of meters is a very serious amount. Thanks to this application, the profitability of enterprises is increased and competitive power is supported.

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