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Ways to Reduce Product Cost by Optimizing the Structure of Fibers in Spinning Enterprises

Yusupov Saidvali Shukrullaevich

Abstract— This article describes how to reduce production costs by optimizing the content of the fiber mixture in spinning mills. Also, the composition of the fiber mixture includes a mathematical model for reducing the cost of type 1 fiber, based on methods of reducing the cost of production.

Index Terms— textile factories, spinning mills, fiber mixes, product cost, mix content, fiber strength, fiber length, yarn.

1 Introduction

IT is well-known that the textile products produced today in the developed countries are of high quality and are in demand. One of the main reasons for this is the availability of high-tech, high-skilled workers and a wide range of opportunities to reduce product costs. Therefore, their products are competitive and export-oriented.

In this regard, the President, Sh.Mirziyoev said, "Today, 40% of the cotton fiber grown in the country is processed, the rest is exported abroad. The calculations show that if we export yarn, not raw materials, we will export 1.4 times more products than fiber. If we sell cotton as a finished product, the export volume will increase 6 times "[1].

With the global demand for natural fibers today, the light industry in Uzbekistan has a great potential not only in the global market for being a major supplier of cotton, but also as a major textile exporter. One of such opportunities is to reduce the cost of production while ensuring quality.

The share of the cost of raw materials in the cost of production of textile enterprises is 65-75%. That is why it is important to develop an enterprise development strategy to explore ways to maximize profits by reducing costs and reducing costs [22].

2 Literature review

Theoretical and methodological foundations of strategic management have been studied in the works of foreign scholars such as I.Ansoff [3], M.Porter, G.Mintsberg [4], J.B. Quinn, S.Goshal, R.Rumelt [5], and V. Quint [6], and developed the concept of strategic management.

CIS scientists A.M. Aronov [7], O.S. Vikhansky [8], V.A. Goremykin [9], O.A. Bogomolov, V.S. Efremov [10], A.T. Zub [11], N.K. Kruglova, M.I.Kruglov, The theoretical and methodological issues of strategic management have been studied in works of N.N. Trenyov and R.A. Fatkhutdinov.

Improving the competitiveness of the national economy of Uzbekistan, improving the theoretical and practical aspects of strategic management, as well as theoretical and methodological foundations for the development of the textile industry, which is one of the leading sectors of light industry. Shodmonova U.A.[12], Nasyrkhodjaeva [13], N.N.Yuldashev [14], N.Q.Yuldoshev [21], Ergashxodjaeva Sh.J. [18], K.S.Kyvyakin, B.O.Tursunov [15;16;17;18;19;20;21] and many other scientists.

3 Analysis and discussion of results

The cost of raw materials is particularly high in spinning factories, which are the leading sectors of the textile industry, and depend on the correct determination of the composition of the fiber mixture in the production of products. If the optimization of fiber mixes at the spinning mills requires a reduction in the cost of the fiber mixes on the one hand, the quality of the fiber mixes on the other hand should be at the level of the plan. Determining the composition of the fiber mixture is a labor-intensive process. Because of the composition and composition of the fiber, the selection of cotton fiber, the length of the cut, the length of the staple, and so on must be taken into account.

In addition, the solution of the problem can be improved by taking into consideration the physical and chemical properties of the materials used in the mixing of fibers, such as cotton lavender, viscose, staples and other fibers. Based on the aforementioned, optimization of the composition of the fiber mixtures becomes a multidimensional problem, and of course, it is necessary to build a mathematical model of the problem. The main requirement for the optimization of the structure of the designed fiber mixes is the reduction of the cost of raw materials, since 80-90% of the cost of the finished product in the spinning enterprises is the cost of raw materials. The cost of raw materials is reflected in the value of the unit weight of the mixture, the percentage of fiber content from the yarn, and the cost of raw materials in yarn.

It is advisable to use a linear programming method for optimization of fiber mix content in spinning enterprises. In the first step we enter the symbols.

Index of fiber mixture (i = 1, n), relative value of fiber in type Xi, length of fiber of type I - fiber, strength of fiber - type Pi, i - type of fiber, type Wi - i. of cotton yarn, Rn - length of planned break, Pn - planned strength, Sn - rate of planned contamination, Wn - percentage of cotton yarn, 1 kg of Ci type fiber, Cn - plan b is 1 kg.

Yusupov Saidvali Shukrullaevich
Customs Institute of the State Customs Committee
Associate Professor, Department of "Economic Sciences" (PhD)
E-mail: saidvaliusupov@mail.ru

1. To reduce the cost of fiber of 1 type in the fiber mixture. $L(X) = \sum C_i \cdot X_i \to min$

2. On increasing the stiffness of the fiber type in the fiber mixture. $L(X) = \sum P_i \cdot X_i \to max$

3. On increasing the length of the fiber type in the fiber mixture. $L(X) = \sum R_i \cdot X_i \to max$

4. To reduce the degree of fiber contamination in the fiber mixture. $L(X) = \sum S_i \cdot X_i \to min$

5. Increasing the percentage of yarn by fiber type in the fiber mixture. $L(X) = \sum W_i \cdot X_i \to max$

To achieve these objectives, the following boundary conditions should be observed:

Tensile strength $\sum W_i \cdot X_i \geq W_n$, break length $\sum R_i \cdot X_i \geq R_n$, pollution rate бўйича $\sum S_i \cdot X_i \leq S_n$,% of yarn output kal $\sum W_i \cdot X_i \geq W_n$, by product cost $\sum C_i \cdot X_i \leq C_n$, by the component completeity condition $\sum X_i = 1$, relative value of components in fiber mixture $X_i \leq \lambda_i$, while the variables are not negative X_i≥0.

Using a linear programming method to optimize fiber mixture content, we construct an economical mathematical model for the optimization of the composition of the fiber mixtures for specific conditions. Let four different types of cotton fiber come to the factory [3]:

Table 1

Technical and economic indicators of fiber

Cotton grade	Fiber Type Index	Wholesale cost of 1 ton of cotton, mln. soum (Ci)	Percentage of yarn yarn	Fiber staple length mm (Li)	The length of the fiber break cH, (Ri)
I	1	27,3	85,7	28,6	4,5
II	2	25,5	84,2	27,2	4,15
III	3	20,5	85,1	26,5	4,06
IV	4	14,3	83,4	27	3,51
Plan			Till to86	Above to 27,3	Above to 4,2

Source: The author's work on the basis of data from the Association "Uztukimachisanoat".

At the same time, it is necessary to determine the composition of the fiber mixture so that its feasibility studies are not worse than planned and the cost is minimal. The purpose is to reduce the cost of a unit of fiber mass and will look as follows.

$$27{,}3X_1 + 25{,}5X_2 + 20{,}5X_3 + 14{,}3X_4 \to min$$

The boundary conditions are as follows:

1. By the complexity of the mixture.

$$X_1 + X_2 + X_3 + X_4 = 1$$

2. By fiber length of staple.

$$28{,}6X_1 + 27{,}2X_2 + 26{,}5X_3 + 27X_4 \geq 27{,}3$$

3. By the length of the fiber break.

$$4{,}54X_1 + 4{,}15X_2 + 4{,}06X_3 + 3{,}51X_4 \geq 4{,}2$$

4. Percentage of cotton fiber by yarn.

$$85{,}7X_1 + 84{,}2X_2 + 85{,}1X_3 + 83{,}4X_4 \leq 86$$

5. The condition of the variables is not negative.

$$X_1, X_2, X_3, X_4 \geq 0$$

When the above-mentioned economic mathematical model is solved by the simplex method algorithm, 1 t of fiber mixture has a minimum value of 21.9 m. It corresponds to the following vectors:.

$$X = (X_1; X_2; X_3; X_4) = (0{,}4198; 0{,}5313; 0; 0{,}0489)$$

The economic conclusion is that if fiber mixture contains 41.98% of 1st grade cotton, 53.13% of the second grade and 4.89% of the fourth grade, 1 t of fiber is of minimal value. 21.9 million for the mixture. soums. This is 2.24 million US dollars more than the Uztex Tashkent J.V. In other words, the cost of the compound will be reduced by 10% (we used statistical data from Uzteks Tashkent during the research). In addition to providing the minimum cost of the raw cotton blend at the enterprise, it can be optimized for preserving high physical mechanical properties. We take the fiber length of the fiber as an indicator for the target function. In this case, the economic mathematical model will look like this.

$$L(X) = 4{,}54X_1 + 4{,}15X_2 + 4{,}06X_3 + 3{,}51X_4 \to max$$

The boundary conditions are as follows:

$$X_1 + X_2 + X_3 + X_4 = 1$$
$$85{,}7X_1 + 84{,}2X_2 + 85{,}1X_3 + 83{,}4X_4 \leq 86$$
$$28{,}6X_1 + 27{,}2X_2 + 26{,}5X_3 + 27X_4 \geq 27{,}3$$
$$27{,}3X_1 + 25{,}5X_2 + 20{,}5X_3 + 14{,}3X_4 = 21{,}9$$
$$X_1, X_2, X_3, X_4 \geq 0$$

By solving this problem, we will increase the fiber mixing length to 4,282 sH and the value of the fiber mix will remain minimal. In addition to these parameters, many additional indicators, such as fiber stiffness, contamination, and the percentage of individual components in the fiber, are needed in the production environment, which requires many options.

It is known that while optimizing the composition of the fiber mix at the spinning mills, certain types of fiber are identified in the bush and are the value of the components' components in the mixture. Therefore, it is desirable to determine the percentage of fiber involved in determining the composition of the fiber mixture in batches, which turns from linear programming to a finite number of programming tasks.

When expressing the economic mathematical model of the fiber mixture in the form of an integer programming problem, we add the symbols to the linear programming method:

Yi is the amount of raw material of type i in the

mixture (i = 1, n), Qi is the weight of the fiber of the type i in one batch, Ai is the maximum value of the type i fiber in the mixture, and the amount of fiber that can be decomposed simultaneously in the compounding unit. .

Using the aforementioned symbols, we can summarize the problem of programming the entire fiber mix in the following form. Target function:

$$L(X) = \sum Q_i \cdot C_i \cdot Y_i \to max$$

To achieve these objectives, the following boundary conditions must be met.

1. By the degree of strength of the fiber of the i type per bale.

$$(\sum Q_i \cdot P_i \cdot Y_i)/(\sum Q_i \cdot Y_i) \geq P_g$$

2. By the degree of length of fiber mass of type i in one batch.

$$(\sum Q_i \cdot R_i \cdot Y_i)/(\sum Q_i \cdot Y_i) \geq R_g$$

3. By the degree of pollution of the fiber of the i type per bale.

$$(\sum Q_i \cdot S_i \cdot Y_i)/(\sum Q_i \cdot Y_i) \leq S_g$$

4. The length of the mass of the fiber of the type i in one batch.

$$L_{min} \leq (\sum Q_i \cdot L_i \cdot Y_i)/(\sum Q_i \cdot Y_i) \leq L_{max}$$

5. Condition of the length of the fiber of the type i in the mixture by the maximum participation value. $Y_i \leq A_i$

6. It is essential to determine the amount of fiber that can be stored in vibrating units. $\sum Q_i \cdot Y_i = M$

7. It is essential that variables are not negative and result in an integer. $Y_i \geq 0$

We will make mathematical changes to the above statements and write as follows.

1. $\sum Q_i \cdot P_i \cdot Y_i \geq P_g \sum Q_i \cdot Y_i$ $\sum Q_i \cdot P_i \cdot Y_i - P_g \sum Q_i \cdot Y_i \geq 0$

$\sum Q_i \cdot Y_i \cdot (P_i - P_g) \geq 0$

2. $\sum Q_i \cdot R_i \cdot Y_i \geq R_g \sum Q_i \cdot Y_i$ $\sum Q_i \cdot R_i \cdot Y_i - R_g \sum Q_i \cdot Y_i \geq 0$

$\sum Q_i \cdot Y_i \cdot (R_i - R_g) \geq 0$

3. $\sum Q_i \cdot S_i \cdot Y_i \leq S_n \sum Q_i \cdot Y_i$ $\sum Q_i \cdot S_i \cdot Y_i - S_n \sum Q_i \cdot Y_i \leq 0$

$\sum Q_i \cdot Y_i \cdot (S_i - S_n) \leq 0$

4. $\sum Q_i \cdot L_i \cdot Y_i \geq L_{min} \sum Q_i \cdot Y_i$ $\sum Q_i \cdot L_i \cdot Y_i - L_{min} \sum Q_i \cdot Y_i \geq 0$

$\sum Q_i \cdot Y_i \cdot (L_i - L_{min}) \geq 0$ $\sum Q_i \cdot L_i \cdot Y_i \leq L_{max} \sum Q_i \cdot Y_i$

$\sum Q_i \cdot L_i \cdot Y_i - L_{max} \sum Q_i \cdot Y_i \leq 0$

5. $Y_i \leq A_i$ 6. $\sum Q_i \cdot Y_i = M$ 7. $Y_i \geq 0$ and the whole number.

Optimization of the composition of the given fiber mixture is considered as a whole programming problem and can be solved using Gamori's algorithm 1, depending on the physical and mechanical properties of the yarn produced by the enterprise.

4 Conclussions

As a result of the above analysis, we can conclude:

- export of finished textile products, instead of selling semi-finished textile products, can be increased up to 6 times;
- Professional development of textile enterprises and attraction of modern technologies is one of the key factors in increasing profitability of enterprises and products;
- to create a mathematical model to reduce the cost of 1 type of fiber in the fiber mixture, using the linear programming method to reduce the cost of products by up to 10%;
- Providing the minimum cost of raw cotton mixtures at the enterprise, it is also possible to optimize the storage of high physical mechanical properties.

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