# Forecasting Model of Shrinkage in Circular Knitted Fabric Using Decision Tree Analysis

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***Abstract*— Controlling and ensuring product quality are significant in any production department, especially in the textile and clothing industry. Ensuring fabric shrinkage meets customer requirements constitutes a critical factor in evaluating product quality in the knitted fabric production process. However, fabric shrinkage depends on the order's specifications, such as loop length, fabric weight, material composition, longitudinal density, and transverse density. This complexity makes it challenging to control and ensure the fabric quality according to customer requirements. This study will describe the characteristics of each specification factor and explore its influence on fabric shrinkage. Finally, data mining techniques develop a forecasting model based on input parameters. The prediction model results will support production managers in estimating and promptly adjusting process parameters to achieve the expected quality levels.**

***Index Terms* — data mining, knitted production, quality assurance, textile industries.**

## I. INTRODUCTION

The textile and clothing industry plays a vital role in the economy. Product quality is a significant mission in every manufacturing or service sector [1]. Quality of product not only drives market demand but also fosters customer satisfaction, ultimately securing customer loyalty. The success or failure of any organization hinges significantly on the quality it delivers. This principle applies to the knitting sector, which has an intricate manufacturing process. For these reasons, quality control tools are increasingly popular in the textile and clothing industries, aiming to enhance product quality [2]. The primary objective of most quality control and improvement tools is to reduce variation during product manufacturing and meet predetermined specifications. Quality improvement efforts depend on a solid understanding of the quality characteristics relevant to a product. Moreover, quality characteristics depend on specific attributes or features of a product. Organizations can make informed decisions and implement targeted improvements by focusing on these characteristics.

In the knitting sector, knitted products adhere to desirable quality standards, which can be objectively measured [3]. In producing knitted fabric, ensuring that the finished fabric meets the specification requirements set by the customer is a critical factor in determining its quality. In practice, after analyzing the composition of fibers, yarn count, yarn density, and other machinery and technological factors, the challenge of post-knitting shrinkage in fabric consistently requires attention during the production process [4]. Therefore, fabric shrinkage has become an increasingly important parameter that needs careful control in a knitting factory. However, fabric shrinkage is primarily determined after production, which consumes significant time and resources. Additionally, this process requires specialized skills and tangible fabric samples. Therefore, predicting fabric shrinkage before production would be valuable for businesses. It allows better control of product quality, enhances production process efficiency, and reduces effort and costs compared to the current method of post-production shrinkage determination.

This study develops a forecasting model for fabric shrinkage based on input parameters using data mining techniques. The prediction model results will support production managers' estimates and promptly adjust process parameters to achieve the expected quality levels.

## II. LITERATURE REVIEW

### A. Knitted fabric and previous research

Knitted fabric is made from one or more yarns by forming yarn loops and linking these loops together [5]. The smallest specification unit in knitted fabric is the yarn loop, which has a curved shape, as shown in Fig. 1. To create fabric, yarn loops are often interconnected according to specific rules. Depending on how the yarn loops are linked within the fabric, knitted fabrics are classified into two main groups: warp knit fabrics and weft knit fabrics.

Knitted fabrics exhibit excellent stretch and elasticity. When subjected to force, the fabric's stretch surpasses the processed yarn, as the stretch graph depicts. The fabric surface is airy, soft, and spongy, with the added benefit of efficiently retaining heat without impeding the metabolic exchange between the body and the surrounding environment. Additionally, knitted fabric boasts good permeability, promotes clothing hygiene, provides a comfortable wearing experience, minimizes wrinkles, and is

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easy to maintain. However, its most significant drawback is its tendency to curl at the edges and slip.

In the production process of knitted fabric, ensuring that it adheres to the fabric specifications defined by the customer stands out as a crucial factor influencing the overall quality of the fabric [6]. The quality of knitted fabrics is influenced by changes in raw material composition and input specifications. Numerous prior studies have investigated these effects.

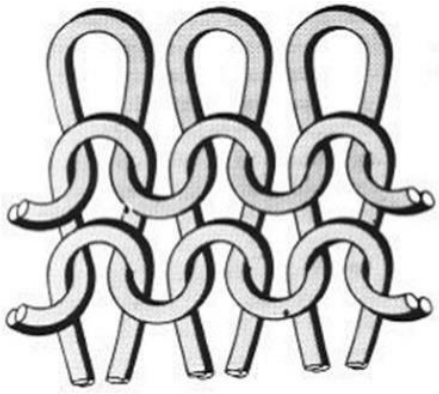

Fig. 1. Structure of knitted fabric

Ref. [7] investigated how different input parameters, including yarn count, yarn tension, tightness factor, stitch length, fabric weight per unit area, and machine speed, impact knitted fabric's spirality. Fabric spirality was found to increase as stitch length, the number of feeders, yarn count, and twists per unit length in constituent yarn increased. Ref. [8] researched the effect of yarn's characteristics and the characteristics and conditions of technological processes that influence knitwear's geometrical and dimensional stability. Furthermore, Ref. [9] investigated how the proportion of fibers affects knitted fabric. The findings revealed that incorporating Lycra into single jersey knitted fabric leads to increased course density, fabric thickness, and knitted fabric recovery while fabric width, porosity, and extension decrease. Previous research has demonstrated that various input specifications and production processes influence the quality requirements of knitted fabric.

In knitting, fabric shrinkage is one of the most important parameters that need careful control [10]. The shrinkage of knitted fabric is defined as the change in size after knitting. This change results in a reduction in both the fabric's length and width. To determine the fabric shrinkage after knitting, the ASTM D3774 standard is applied. The shrinkage of the fabric is determined according to Equation (1).

$$R\ (\%) = \frac{|L_1 - L_0|}{L_0}\ x\ 100\% \quad \text{.....(1)}$$

Where

$R$ (%) : the percentage of fabric shrinkage

$L_0$ : the original size of the fabric in the setting process

$L_1$: the size of the fabric after taking it out of the machine.

The causes of shrinkage can be divided into construction shrinkage and processing shrinkage [11]. This means that the structural parameters of the fabric influence fabric shrinkage and are also influenced by the forces acting on it during dyeing and other finishing processes. In this paper, only the fabric shrinkage after knitting is considered based on the effects of input materials (shrinkage construction), not other finishing processes (bleaching, dyeing, washing, etc).

*B. List of input parameters and production processes in knitting manufacturing*

The shrinkage of fabric after knitting is influenced by factors at two levels, as outlined below:

- Micro level: This pertains to the molecular structure of fibers. It is affected by fiber type, chemical/amorphous structure, and the chemical treatment method in fiber.
- Macroscopic level: at this level, yarn and fabric structure are crucial in fabric shrinkage. Setting specifications during knitting impacts fabric shrinkage. Additionally, fiber structure and fabric structure significantly influence frictional behavior, which, to some extent, affects the deformation properties of fibers when the fabric undergoes deformation.

In this paper, a list of input parameters and production processes will be measured, collected, and applied for forecasting model of shrinkage in knitted fabric, including:

*1) Loop length*

In technological design, when the specifications for knitting type, yarn type, and yarn count are known, the loop length is determined based on the value of the yarn loop modulus [12]. When the yarn ring modulus of the fabric is small, the fabric structure becomes tight and resistant to deformation. However, if the impact on the knitted fabric is significant enough to cause deformation, the tight structure can lead to increased friction at the connection points, gradually mitigating the deformation.

Conversely, when the loop length modulus of the fabric is large, the fabric structure becomes quite loose. The elastic force and friction components at the connection points are minimal, making them insufficient to withstand external impacts. As a result, the fabric is prone to deformation.

*2) Yarn density*

Yarn density in knitted fabric refers to the arrangement and concentration of yarn loops within a given area. This specification plays a crucial role in determining the fabric's quality, appearance, and performance [13]. The density correlation coefficient of a fabric remains approximately constant when the fabric reaches a state of relative equilibrium. This coefficient significantly influences the dimensional stability of the weft fabric during its use.

- To enhance the density correlation coefficient, consider using coarser fibers or smaller loop lengths.
- When yarn density increases, the shrink loops lie close to each other, resulting in greater fabric shrinkage. In contrast, reducing yarn density leads to longer yarn loop lengths, increasing the fabric width.

In knitted fabric, yarn density is classified into two sub-specifications, including vertical yarn density and horizontal yarn density.

*3) Knitting type*

Knitted fabrics come in various types, each with distinct characteristics. Fabric shrinkage is influenced by the knitting type employed during knitting machines [14]. Numerous

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studies have compared different knitting types regarding their impact on fabric shrinkage. Single jersey and 1x1 Interlock fabrics exhibit horizontal shrinkage, primarily due to the influence of loop length and fabric density. In contrast, Rib 1x1 fabrics experience minimal horizontal shrinkage.

*4) Fiber component materials*

The degree of shrinkage in textile materials primarily depends on the hydrophilic nature of the fibers—that is, their ability to absorb water [15]. When fibers in a fabric have high water absorption capacity, they tend to expand after soaking, resulting in an increase in diameter and a shortening of length, ultimately causing shrinkage.

- Natural fibers such as cotton, hemp, and viscose fall into the hydrophilic category, exhibiting greater shrinkage than synthetic fibers like polyester and acrylic. For instance, the diameter of cotton fibers can increase by up to 20%, and swelling-induced shrinkage can account for up to 2% of the total fabric shrinkage. Rayon fibers, being even more hydrophilic than cotton, swell significantly and experience higher shrinkage, reaching 9-10%.
- In contrast, fabrics made from synthetic fibers exhibit minimal swelling when wet, making them less prone to shrinkage.

*5) Fabric weight*

In knitted fabric orders, customers often consider control of two technological parameters on the finished fabric, including yarn length ($mm$) and fabric weight ($g/m^2$). The customer's fabric weight requirements will change a large number of knitting parameters, leading to changes in the size of the fabric when coming off the machine. Depending on the fabric weight order, it is necessary to change the stitching cam settings, yarn input tension, and number of threads to ensure that the raw fabric size reaches a certain allowable shrinkage level when coming off the machine.

### *C. Data mining in quality management*

In textile industries, quality management is increasingly important, becoming an essential and indispensable task for increasing businesses' competition. Some traditional quality assurance tools, including Six Sigma (6σ), designed for Six Sigma (DFSS) or Kaizen, encourage data-driven improvement decision-making. In addition, with advances in process automation and computer systems, data from manufacturing processes is becoming increasingly convenient to collect [16]. Although traditional data analytics tools have been used successfully in improving product quality and manufacturing processes, with the rapidly changing market and customer needs, quality assurance processes need to adopt better tools to exploit the large volumes of data collected through industrial computer systems [17]. Quality management should extend beyond merely detecting defects and suggesting corrective actions. Predicting quality defects before production begins is essential, allowing for adjustments to technical parameter settings.

However, one significant consideration when applying data mining in actual knitting production is that researchers and managers must understand quality tasks within the production process. This understanding is essential for selecting appropriate techniques and methods in data mining to generate valuable insights for evaluating and improving product quality. One key aspect is determining relevant input quality parameters and their impact on the final output product.

### *D. Decision trees technique in Data mining*

Ref. [18] found that manufacturing enterprises increasingly adopt hybrid models. These models integrate new data processing techniques from data mining and artificial intelligence into production systems to enhance quality and improve performance.

Data mining is extracting potentially valuable information from extensive data stored in data warehouses [19]. To gain knowledge from existing databases, various data mining techniques have been developed, including data classification, data clustering, association rule mining, regression, and genetic algorithms. Among these, decision trees stand out as powerful and practical tools for classification and prediction.

A decision tree is a structured hierarchical tree used to classify objects based on a series of rules in data mining. Object attributes can have various data types, including binary, nominal, ordinal, and numerical values. However, the classification attribute must have either binary or ordinal data type. A decision tree is a hierarchical structure that resembles a tree, as shown in Fig. 2. Each internal node corresponds to an attribute in this structure. At the same time, branches represent the possible values of that attribute. The leaf nodes, on the other hand, signify decision outcomes. At the very top of the tree, we find the root node [20]. Decision trees are commonly employed for classification tasks. To classify an instance, we begin at the root and traverse the branches until we reach a leaf node.

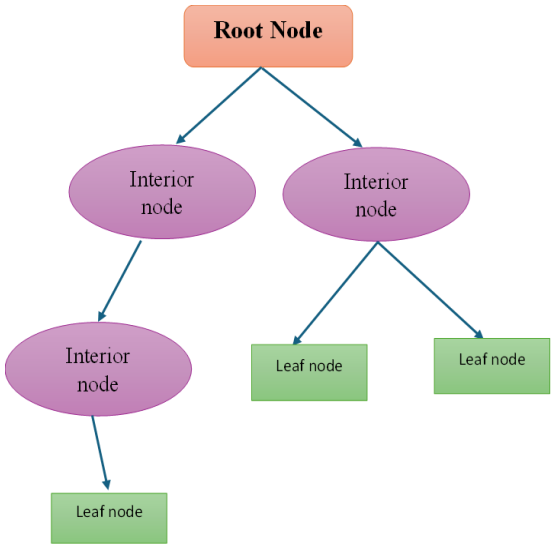


Fig. 2. Basic structure of decision tree

In decision trees, one of the critical functions is *Entropy*. The Entropy function is associated with Boolean classification, where the proportion $p^+$ of positive objects varies between 0 and 1. Entropy, denoted as $H(S)$, quantifies the uncertainty within a dataset $S$. If the dataset contains $c$

distinct groups of objects, the entropy is calculated as Equation (2).

$$H(S) = -\sum_{i=1}^{c} p_i \log_2(p_i) \text{.....(2)}$$

The decision trees are capable of managing missing values and qualitative data, and users can readily comprehend them thanks to their user-friendly graphical representation.

## III. PROPOSED APPROACH FOR FORECASTING FABRIC SHRINKAGE

In knitting production, estimating fabric shrinkage is challenging due to its dependence on various input material parameters and technical specifications. This section represents the proposed method for predicting fabric shrinkage in knitting. This approach relies on input specifications, and the prediction is facilitated by a decision tree constructed using historical observations.

### *A. Identification of knitting order's input specifications*

The input parameters for knitting orders can be classified into six types of specifications: loop length, vertical yarn density, horizontal yarn density, knitting type, fiber component, and fabric weight. Among these factors, loop length, vertical and horizontal yarn density, and fabric weight are numerical data, while knitting type and fiber component fall into the categorical data. The most suitable approach for representing the value of these specifications is to utilize categorical variables. In this step, five experts with technical management experience in the knitting company, two from the quality management department, one from the manufacturing department, and two from the R&D department, are selected to become members of a panel to classify these quantitative factors into categorical data. The classification of five factors is represented in categorical data in Table I.

TABLE I. THE CLASSIFICATION OF QUANTITATIVE FACTORS IN CATEGORICAL DATA

| **Level** | **Loop length ($l_{mm}$)** | **Level** | **Fabric weight (W)** |
|---|---|---|---|
| Very low | $l \leq 2.394$ | Very light | $W \leq 276.6$ |
| Low | $2.394 < l \leq 3.402$ | Light | $276.6 < W \leq 391.2$ |
| Medium | $3.402 < l \leq 4.086$ | Medium | $391.2 < W \leq 505.8$ |
| High | $4.086 < l \leq 4.650$ | Heavy | $505.8 < W \leq 620.4$ |
| Very high | $l > 4.650$ | Very heavy | $W > 620.4$ |
| **Level** | **Vertical yarn density ($P_{d/10cm}$)** | **Level** | **Horizontal yarn density ($P_{n/10cm}$)** |
| Very low | $P_d \leq 194.4$ | Very low | $P_n \leq 92$ |
| Low | $194.4 < P_d \leq 363.2$ | Low | $92 < P_n \leq 177.6$ |
| Medium | $363.2 < P_d \leq 447.6$ | Medium | $177.6 < P_n \leq 218.4$ |
| High | $447.6 < P_d \leq 532$ | High | $218.4 < P_n \leq 259.2$ |
| Very high | $P_d > 532$ | Very high | $P_n > 259.2$ |
| **Level** | | **Fabric shrinkage (H %)** | |
| Very low | | $H \leq 9{,}8$ | |
| Low | | $9.8 < H \leq 12.6$ | |
| Medium | | $12.6 < H \leq 15.4$ | |
| High | | $15.4 < H \leq 18.2$ | |
| Very high | | $H > 18.2$ | |

Upon analyzing the six specifications influencing fabric shrinkage, the data collection process examines historical orders to determine the fabric size difference ratio. Historical data is collected from the ERP system. Data preprocessing will be applied during data collection to handle missing values and remove outliers, ensuring accuracy and consistency for the input data set. Subsequently, a model is developed to predict fabric shrinkage after knitting. The observed data set S can be shown in Table II.

TABLE II. THE EXAMPLE OF OBSERVED DATA SET

| Order ID | Loop length | Vertical yarn density | Horizontal yarn density | Knitting type | Fiber component | Fabric weight | H% |
|---|---|---|---|---|---|---|---|
| 1 | Low | Low | Very low | Interlock | CO 30/1 | Heavy | Low |
| 2 | | | | | | | |
| ⋮ | | | | | | | |
| n | | | | | | | |

### *B. Building the decision tree from the historical data*

The process of creating a decision tree from a training dataset is known as tree induction. It involves the following steps:

- Compute the Entropy for the entire dataset using *Equation (2).*
- For each attribute in the dataset:
  - Calculate the entropy for all categorical values associated with that attribute.
  - Determine the information gain for the current attribute.

Information gain measures how effective an attribute is in classifying data. It represents the expected reduction in entropy achieved by dividing the objects based on that attribute with the equation:

$$Gain\ (S, A) = H(S) - \sum_{v \in value\ A} \frac{|S_v|}{|S|} H(S_v) \text{..... (3)}$$

From ERP system, 449 historical data are collected, the value of fabric shrinkage is determined as very high: 9, high: 106, medium: 145, low: 119 and very low: 70. The entropy of dataset $S$ will be:

$$\begin{aligned} H(S) = &-\frac{9}{449}\log_2\frac{9}{449} - \frac{106}{449}\log_2\frac{106}{449} - \frac{145}{449}\log_2\frac{145}{449} \\ &- \frac{119}{449}\log_2\frac{119}{449} - \frac{70}{449}\log_2\frac{70}{449} \\ &= 2.057099839 \end{aligned}$$

The information gain for the remaining attributes is calculated to expand the decision tree based on Equation (3). For example, the loop length property is determined as follows:

$$\begin{aligned} G(S, loop\ length) = &\ 2.057099839 \\ &- \left(\frac{139}{449} \times 0.864453 + \frac{95}{449} \times 1.478241\right. \\ &+ \frac{104}{449} \times 1.375336 + \frac{52}{449} \times\ 1.851026 \\ &\left. + \frac{59}{449} \times 1.88709388\right) = 0.695811 \end{aligned}$$

The gain information for six objective attributes is shown in Table III.

The loop length is the attribute with the highest gain value (0.695811), so it will be the first attribute in the decision tree. In practical production, manufacturers must always strike a balance between two factors: the length of the yarn loop and the width of the knitted fabric. Input factors

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mutually influence each other and directly and indirectly affect fabric shrinkage during the production process.

TABLE III. THE INFORMATION GAIN FOR OBJECTIVE ATTRIBUTES.

| Objective attributes | Gain information |
|---|---|
| Loop length | 0.695811 |
| Vertical yarn density | 0.329420 |
| Horizontal yarn density | 0.083064 |
| Knitting type | 0.060456 |
| Fiber component | 0.209680 |
| Fabric weight | 0.034621 |

After selecting the root node-based loop length attribute, we compute the information gain scores for the remaining attributes. Our research employed Weka software to construct the final decision tree efficiently. The output of final decision tree is described in the rule ***"IF.....AND.....THEN....."***. For example, some rules are generated from historical data, such as:

- **IF** Loop length is "Low" **OR** "Medium"
  **AND** Fiber component is "CM 20/1"
  **AND** Fabric weight is "Medium" **THEN** Fabric shrinkage is "Medium"
- **IF** Loop length is "Low" **OR** "Medium"
  **AND** Fiber component is "CM 20/1"
  **AND** Fabric weight is "Very light" **OR** "Light" **OR** "Heavy" **OR** "Very heavy" **THEN** Fabric shrinkage is "High"
- **IF** Loop length is "Low"
  **AND** Fiber component is "CVC 26/1"
  **AND** Vertical yarn density is "High" **THEN** Fabric shrinkage is "Very high"
- **IF** Loop length is "Low"
  **AND** Fiber component is "TR 30/1" **THEN** Fabric shrinkage is "High"
- **IF** Loop length is "Medium"
  **AND** Fiber component is "CM 26/1"
  **AND** Fabric weight is "Heavy" **THEN** Fabric shrinkage is "High"
- **IF** Loop length is "Medium"
  **AND** Fiber component is "CO 20/1"
  **AND** Horizontal yarn density is "Very low "
  **AND** Knitting type is "Beeheave Pique" **OR** " Single Jersey**"** **OR** "Rib1:1" **OR** "Interlock" **THEN** Fabric shrinkage is "Medium"
- **IF** Loop length is "Medium"
  **AND** Fiber component is "CO 20/1"
  **AND** Horizontal yarn density is "Very low "
  **AND** Knitting type is "Diamond Pique" **THEN** Fabric shrinkage is "High"
- **IF** Loop length is "High"
  **AND** Vertical yarn density is "Medium"
  **AND** Knitting type is "Single Jersey"
  **AND** Fiber component is "CM 20/1" **OR** "CM 26/1" **OR** "CO 30/1" **OR** "CVC 26/1" **OR** "TC 30/1" **OR** "TR 30/1" **THEN** Fabric shrinkage is "Medium"
- **IF** Loop length is "Very high"
  **AND** Fiber component is "TC 30/1"
  **AND** Horizontal yarn density is "Very low" **OR** "Medium" **OR** "High" **OR** "Very high" **THEN** Fabric shrinkage is "Very low"
- **IF** Loop length is "Very low" **THEN** Fabric shrinkage is "High"

The summary of the model performance is shown in Table IV. Based on the analysis of 449 data points, the model achieves an accuracy of 79.06%. However, accuracy becomes particularly valuable when dealing with symmetric data sets, where the True positive rate (TPR) and False positive rate (FPR) exhibit similar values. In such scenarios, it is essential to take into account the model's performance metrics for individual classes.

TABLE IV. THE SUMMARY OF THE MODEL.

| | | |
|---|---|---|
| Correctly classification instances | | 79.06% |
| Incorrectly classification instances | | 20.94% |
| **Detailed accuracy by class** | | |
| Class | True positive rate | False positive rate |
| Very low | 0.829 | 0.053 |
| Low | 0.765 | 0.073 |
| Medium | 0.876 | 0.082 |
| High | 0.717 | 0.058 |
| Very high | 0.333 | 0.011 |

The True Positive Rate (TPR) index represents the count of correctly predicted cases. A higher TPR index indicates better model performance. For the given model, the accuracy in classifying "Medium" and "Very low" instances surpasses that of the other classes.

### *C. Application of generating logical IF-THEN rules from the results of the decision tree*

Production managers could predict the fabric shrinkage by utilizing decision trees when receiving a new order and considering the customer's requirements. Subsequently, production managers can devise suitable production strategies while ensuring product quality throughout manufacturing.

For example, when analyzing the specification requirements from a new order, a rule can be extracted from the model fix with requirements, such as IF "loop length" is "*Medium*" AND "fiber component" is "*CO 20/1*" AND "horizontal yarn density" is "*very low*" AND " knitting type" is "*Single jersey*" THEN "fabric shrinkage" will be " *Medium*". Based on this rule, the production manager could be forecasted that the average of fabric shrinkage ranges between 12.6 to 15.4%. Moreover, in another case, when specifications in the production process change, the level of fabric shrinkage also differs. IF "loop length" is "*High*" AND "fiber component" is "*CO 20/1*" AND "horizontal yarn density" is "*very low*" AND " knitting type" is "*Single jersey*" THEN "fabric shrinkage" will be "Low". In this case, simply by adjusting the yarn loop length requirement, fabric shrinkage will decrease.

It can be proven that the process specifications affect each other and directly and indirectly influence the shrinkage of the fabric during the production process. When the yarn loop length increases, the knitting density will immediately change, affecting the fabric shrinkage.

## IV. DISCUSSION

The results obtained from 449 data show that the model's accuracy is 79.06%. This accuracy can be accepted in actual production planning or adjusting technological parameters in the knitted fabric production line. The prediction results from the decision tree can provide manufacturers with a fundamental for estimating the shrinkage of the fabric before production. For the problem of forecasting the shrinkage of the fabric, the decision tree method gives the prediction result as 1 class (a range of shrinkage). In the production context, the prediction of the shrinkage of the fabric can be somewhat accurate because actual production always has an allowable error range. Therefore, the decision tree is very suitable because it provides the prediction result in classes, that is, specific shrinkage ranges. Due to its simple and intuitive structure, the fabric shrinkage prediction results in this study are a valuable tool for understanding and interpreting a set of input order specifications at the same time. The production manager can easily track the change in the shrinkage level of the finished fabric when an input parameter is changed by tracking different ***IF...THEN....*** rules.

The rules created from the model not only support manager manufacturers in predicting fabric shrinkage but also serve as a standard for adjusting production parameters to suit customer shrinkage requirements. For instance, with a comparison of 2 below rules

- **IF** Loop length is "Low" **OR** "Medium"
  **AND** Fiber component is "CM 20/1"
  **AND** Fabric weight is "Medium" **THEN** Fabric shrinkage is "Medium"
- **IF** Loop length is "Low" **OR** "Medium"
  **AND** Fiber component is "CM 20/1"
  **AND** Fabric weight is "Very light" **OR** "Light" **OR** "Heavy" **OR** "Very heavy" **THEN** Fabric shrinkage is "High"

If the production manager wants to reduce the shrinkage of the fabric after production, in that case, they only need to adjust the fabric weight parameter to the "Medium" level to reduce the shrinkage of the fabric.

## V. CONCLUSION

Product quality stands as a pivotal determinant for consumers when making purchasing decisions. Quality management constitutes a focal area of interest for textile and clothing manufacturing enterprises. In the knitting industry, fabric shrinkage after knitting is a crucial parameter that companies should control effectively. It significantly impacts various aspects, including fabric width beyond the final product's loom, durability, elasticity, and comfort. Accurate determination of fabric shrinkage post-knitting enables businesses to enhance product quality, providing economic benefits. However, nowadays, textile enterprises assess fabric shrinkage mainly based on experience. It is time-consuming, consumes a lot of effort and resources, and directly affects the quality of the fabric.

Based on the urgency of determining fabric shrinkage after knitting and acknowledging the limitations of previous related studies, this research aims to construct a forecasting model for predicting post-knitting fabric shrinkage based on input material properties, including loop length, vertical yarn density, horizontal yarn density, knitting type, fiber component, and fabric weight. The results from the decision trees technique will support production managers in devising suitable production strategies while ensuring product quality throughout the manufacturing process. The goal is to assist businesses in adjusting and optimizing production processes to enhance production efficiency, exercise better control over product quality, and conserve resources. Ultimately, this will lead to improved enterprise productivity and increased profits.

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