QUALITY CONTROL IN TEXTILE: AN ATTRIBUTE AGREEMENT ANALYSIS

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ABSTRACT
When determining the production quality, it is usually necessary to control the product. In some manufacturing operations, these controls can be made automatically. However, some manufacturing operations require visual inspection. In textile manufacturing, visual inspection is usually required to determine the product quality. It is very important that the operators performing these inspections make the right decision and be consistent. In this study, an example of attribute agreement analysis is shared for quality control operators of a textile company manufacturing fabric.

Keywords: Quality, quality control, attribute agreement, textile.

1. INTRODUCTION

There are many players in the textile manufacturing sector, like many other sectors. This means intense competition. In a competitive environment, customer satisfaction becomes even more important. Customers' needs and expectations also increase over time. In order to be sustainable, businesses must satisfy customers both in terms of product variety and cost. In a sense, quality means meeting customer needs and expectations.

Textile is a multi-stage and labour-intensive manufacturing. In addition, product variety is constantly increasing due to changing fashion and customer expectations. A production that is already risky in terms of quality defects becomes even more risky with the increase in product variety. Because the changing manufacturing conditions due to the differences of the products cause various defects to occur during the manufacturing processes. These defects are determined by the quality control operators during the quality control processes of the products.

The effects of defects are not the same. Some defects can be fixed, some cannot. Depending on the contracts with the customers, some defects may be accepted by the customer while others may not. The products can be reprocessed in order to eliminate the defects that occur on the product. If it is not possible to eliminate the defect, these products are either divided into second quality or become waste by losing their quality. There may be differences between businesses, but there are dozens of different quality defects in an integrated textile business. It is very important for quality control operators to accurately identify these defects.
In this sense, agreement analysis emerges as a useful tool. Especially in Six Sigma studies, both quantitative and qualitative agreement analyses are used. Murphy et al. (2009) stated that measurement systems analysis is a useful way to determine where variability in processes

originates [1]. Qualitative agreement analysis is also a useful tool, especially for systems with visual inspections.

Marques et al. (2018), in their study, reduced the errors of operators who control errors in a company that produces electronic circuits. In the study, they determined the training need using attribute agreement analysis. In this direction, they organized training for operators and determined that operator errors were reduced [2]. According to Yadav et al. (2019) reduced production errors with the Six Sigma method in a company that produces glass for automobiles. They performed attribute agreement analysis as part of the study. Thus, they determined that the operators' controls were reliable [3]. Aust and Pons (2022) conducted an agreement analysis for operators working in aircraft engine maintenance processes in their study. As a result of the study, which was based on the engine defects that should be detected in maintenance operations, they determined that operator performances should be improved [4]. In the literature, no similar study has been found for the textile sector.

In this study, a small attribute agreement analysis is designed and applied to determine the agreement of the operators performing the inspection process in the quality control unit of an integrated textile business. The aim of the study is to make preliminary preparations for a more comprehensive design. In the second part of the study, the research methodology is explained. In the third section, the results of the analysis are given. In the last section, conclusions are interpreted.

2. RESEARCH METHODOLOGY

Textile manufacturing begins with the transformation of natural or synthetic fibres into yarn. Although there are sometimes differences in the workflow, raw fabric is obtained by weaving or knitting. Then the raw fabric is dyed, and the manufacturing process is completed with finishing processes. After manufacturing, the quality control of the finished fabric is carried out. Finally, the packed fabric rolls are directed to the warehouse for shipping to the customer.

Quality control processes consist of tests with devices, technical analyses and operations based on visual inspections. Different operators can perform visual inspection operations in a business. These operators need to be consistent both with each other and with themselves. In addition, the decisions made should be in accordance with the customer decisions. In the study, an attribute agreement analysis is recommended to ensure this harmony. Agreement analysis is mostly done for independent products. However, there are long-length products in fabric manufacturing.

The steps of the attribute agreement analysis designed for fabric manufacturing are shown in Figure-1. After a fabric is selected in the study, the foreman first inspects this fabric and identifies defects as a reference. Then, two operators take turns inspecting the fabric and identifying defects. After a certain period after this inspection, the same fabric is inspected again by the operators and the detected defects are recorded again. Finally, the obtained data is analysed.

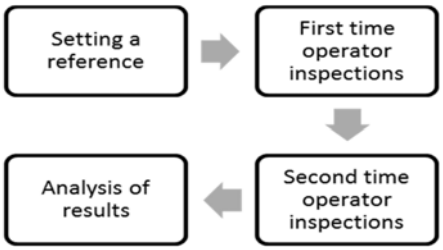

Figure 1. The steps of the attribute agreement analysis

3. RESULTS

The data obtained during the inspections are analysed in Minitab software. Figure-2 shows the agreement of the operators within themselves and with the reference. The agreement of operator A in the two inspections is 80%, while the agreement of operator B is 70%. In the agreement of the operators with the reference, both operators are 60% consistent. In other words, they agreed with the reference in 6 out of 10 defects.

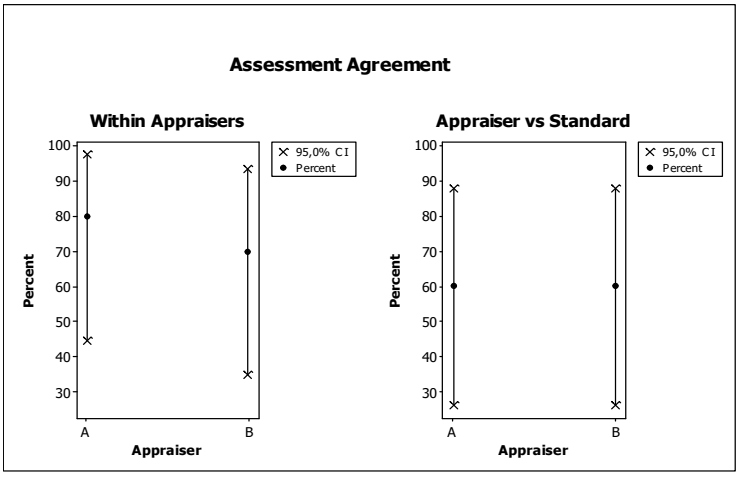

Figure 2. The result of attribute agreement analysis

Table-1 shows the agreement of the operators with the reference in all inspections. In only 3 of the 10 defects, the operators were able to make the same decision as the reference in both controls. This is a very low rate. Kappa statistic remained at the level of 0.41. Therefore, it is clear that operators need training.

Table 1. The result of analysis for operators vs reference

Assessment Agreement				
# Inspected	**# Matched**	**Percent**	**95% CI**	
10	3	30,00	(6,67; 65,25)	
# Matched: All appraisers' assessments agree with the known standard.				
Fleiss' Kappa Statistics				
Response	**Kappa**	**SE Kappa**	**Z**	**P (vs > 0)**
No	0,4147	0,1581	2,6225	0,0044
Yes	0,4147	0,1581	2,6225	0,0044

4. CONCLUSION

For customer satisfaction, it is necessary to provide the level of quality that will meet customer expectations. In some productions, quality control must be done visually. Textile manufacturing is one such. In visual inspections, the decisions of the operators are very important. Operators should be able to take the same decision at different times, similarly, different operators should be able to make consistent decisions with each other, and these decisions should also be compatible with the standard.

In this study, a small attribute agreement analysis is designed and applied to determine the agreement of the operators performing the inspection process in the quality control unit of an integrated textile business. As a result, although the agreement of the operators is sufficient in itself, their agreement with each other and especially with the standard is not enough. Therefore, it has been determined that operators need training.

With the results obtained from here, it was decided to design a more comprehensive agreement analysis. In the design to be made, more defect types can be decided with more operators. The number of experiments can be increased.

5. REFERENCES

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