Investigation of Causes for Out-Of-Tolerance Defects to Improve the Quality of Products in the Garment Industry

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ABSTRACT

This article is inspired by the quality improvement in a manufacturing enterprise through a practical study. Traditionally operated garment industries are facing problems like high rework and rejection. The out-of-tolerance defect in garment manufacturing was selected to study which factors directly contribute towards high rework and rejection in an apparel industry. Apparel manufacturers need to improve their operations to ensure first time right quality. This paper discusses the apparel manufacturing by minimizing out-of-tolerance defects that usually occur in the production process. The study explores effect of three factors, shape of the module, style and size of the women's briefs on the out-of-tolerance defects. Secondary data were collected from October 2014 to December 2014. Descriptive analysis and Two-way ANOVA methods were used to analyze the data. The study revealed that the styles of the women's briefs and shapes of the module significantly affect the out-of-tolerance defect. However the sizes of women's briefs would not provide significant effect on the out-of tolerance. Further U-shape modules performed better than Zig-Zag modules since it has improved communication among employees and the better material flow. More U-shape modules should be established since it reduces direct labour cost and out-of-tolerance defects. The Boy short style provides significant effect on the out-of-tolerance defects than those of other styles of women's briefs. Therefore it is necessary to have a quality assurance method at initial stage for style of Boy short. The recommendations proposed here would help the company to reduce its losses due to the out-of-tolerance defects.

KEYWORDS: Out-of-tolerance, Defect, Quality, Garment Industry

INTRODUCTION

In a rapidly changing global economy industries usually focus on profit margin, customer demand for high quality product and improved productivity. Nevertheless, one of the burning issues faced by industries is that such objectives are badly undermined by failures like the need for rework and rejection of products. The production process is complex and it needs to flow according to the correct and efficient practices to ensure the quality of the final product. Extra time is wasted for correcting any defects and so valuable human time is lost to readjust the defects. Materials (fabrics, threads, elastic and lace) are lost when defective products have to be discarded. Different types of defects occur in garment industries. As the out-of-tolerance defect badly affects the final quality of products, it was selected as a study area from among several other defects, such as uncut thread and appearance out.

In this paper, the sewing section of a garment factory is studied where women's briefs are produced. The main objective of the present study is to identify the causes for out-of-tolerance defects and to propose recommendations for reducing it in a garment industry.

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LITERATURE REVIEW

DMAIC (Define, Measure, Analyze, Improve, and Control) methodology is the best practice to improve the quality of the final products. The specific process can be developed for every work flow to minimize the defects in garment industry (Kumar & Naidu, 2009).

TQM (Total Quality Management) is a method to improve the quality of products in garmentindustries (Rahman and Maud, 2011). Six attributes had been identified for successful implementation of TQM program. Those are the customer focus, process focus, prevention verses inspection, employee empowerment, compensation, fact-based decision making and receptiveness to feedback. TQM process reduced the percentage of defects, while increasing the percentage of efficiency.

RESEARCH PROBLEM

This research is based on identifying causes for out-of-tolerance (Measurement out) defects in women's briefs. The factory always tries to get the best quality product at first time through (FTT). However, in reality, more than twenty types of defects have identified by quality checkers occurred at the floor level. The out-of-tolerance is one of the significant defects that badly affect the final quality of the products. It has seven sub-categories (Front / Back Crotch Width / Front / Back Rise / Leg and Back / Front Coverage). Different kinds of causes affect the out-of-tolerance defects in the plant. The company is currently interested in to know how size of women's briefs, style of women's briefs and shape of the modules would effect on this defect. Therefore this study was designed in order to meet the demand made by the company.

METHODOLOGY

Recheck quantities from each category (size, style and shape of the modules) were collected for three months from September to December in 2014. Descriptive analysis was carried out to identify major areas under each of the three categories that lead to produce out-of-tolerance defects. Further the two-way analysis of variance (ANOVA) was conducted with 3 replications to identify causes that significantly affected to produce the out-of-tolerance defects. Finally Turkey multiple comparison test was applied to appropriate places to determine which means are differ from others. Based on the results recommendations could be provided to minimize the out-of-tolerance defect. Through this investigation, the process may be smoothened and it would help the company to reduce its losses due to out-of-tolerance defects.

The factors investigated for out-of-tolerance defects are described as follows.

Style of Women's Briefs

Different types of women's briefs are available in the production floor. These briefs are different from each other based on shape, lace and elastic. One type of women's brief has different colors.

Size of the Women's Briefs:

Basically four types of sizes are sewn under each style in the Linea clothing plant. (XS - Extra small,S- Small, M - Medium and L - Large)

Shape of the Module

1) U – Shaped module

There is a team leader, who always supports the team members to continue the operations without any backing down from the process. There is no quality leader so the team member needs to check the quality of the briefs before it is handed over to the next team member (self-ownership) and hence it reduces direct labour cost. Also one team member needs to carry out two sewing operations.

2) Zig-Zag module (Dancing module)

This module has approximately eighteen to twenty machines. A team leader works in the module as in the U-shaped

module but a Quality Leader is also available in this module, who gives some instructions to team members and is involved in several activities to improve quality in the module. Each team member has a unique operation.

DATA COLLECTION AND ANALYSIS

It was found from the analysis that the waist defect (27.51%) and the leg defect (27.14%) occurred mostly in the plant during the three month period. The highest percentage of out-of-tolerance defects were found in the Zig-zag module (68.58%) than in the U-shape module (31.42%) when the two modules were considered. Based on the analysis for style it was revealed that the highest percentage of out-of-tolerance defects was found in the Boy short style (33.79%) during this study period among all styles.

Analysis of Styles and Sizes of Women's Briefs

The analysis of out-of-tolerance defects may be influenced by two factors style and size of the women's briefs is summarized in Table 1.

Table 1: Summary of two-way ANOVA for Out-Of-Tolerance Defects along with Two Factors Style and Size

	Method	Test	p-value	Decision
Residual Analysis	Shapiro-Wilk	Normality	0.244	H_{00} is accepted
	Levene's	Variance	0.067	H_{01} is accepted
Two –Way ANOVA		Main effect for Style	0.025	H_{02} is rejected
		Main effect for Size	0.371	H_{03} is accepted
		Interaction among Style and Size	0.588	H_{04} is accepted

The null hypotheses associated with each of the above tests were mention below.

H_{00}: Data follows normal distribution.
H_{01}: Error variances are equally distributed over the groups.
H_{02}: There is no difference among the mean defects of styles of women's briefs.
H_{03}: There is no difference among the mean defects of sizes of women's briefs.
H_{04}: There is no interaction between styles and sizes of women's briefs for out-of-tolerance defect.

According to two-way ANOVA, the null hypotheses (H_{02}) for main effect of style was rejected at predetermine level of significance 0.05. Therefore it can be concluded that there is a significant difference among the mean out-of-tolerance defects of styles of women's briefs.

However there is no sufficient evidence to reject null hypothesis (H_{03}) for main effect of size at 5% level of significance. This concludes that there is no significant difference among the mean out-of-tolerance defects of sizes of women's briefs. Also it was revealed that there is no significant interaction between styles and sizes of women's briefs for the out-of-tolerance defects at 5% level of significance.

Residual analysis shows that the p-value for the Shapiro-Wilk test (0.244) is greater than 0.05 and so the defects are normally distributed. The p-value for Levene's test indicates that (0.067>0.05) error variances are equally distributed over the groups.

Analysis of Sizes of Women's Briefs and Shapes of the Module

The analysis of out-of-tolerance defects may be influenced by two factors, shape of the module and size of the women's briefs was summarized in Table 2.

The null hypotheses associated with each of the tests conducted in Table 2 were mention below.

H_{00}: Data follows normal distribution.

H_{01}: Error variances are equally distributed over the groups.
H_{02}: There is no difference among the mean defects of sizes of women's briefs.
H_{03}: There is no difference among the mean defects of shapes of module.
H_{04}: There is no interaction between shapes of the module and sizes of women's briefs for out-of-tolerance defect.

Table 2: Summary of two-way ANOVA for Out-Of-Tolerance Defects along with Two Factors Shape and Size

	Method	Test	P-value	Decision
Residual Analysis	Shapiro-Wilk	Normality	0.66	H_{00} is accepted
	Levene's	Variance	0.317	H_{01} is accepted
Two way ANOVA		Main effect for size	0.082	H_{02} is accepted
		Main effect for shape	0.001	H_{03} is rejected
		Interaction among shape of the modules and Size of the women's briefs	0.678	H_{04} is accepted

According to two-way ANOVA, there is no sufficient evidence to reject null hypothesis (H_{02}) for main effect of size at predetermine level of significance 0.05. Therefore it can be concluded that there is no significant difference among the mean out-of-tolerance defects of sizes of women's briefs.

However the null hypothesis (H_{03}) for main effect of shape was rejected at 5% level of significance. Therefore it can be concluded that there is a significant difference among the mean defects of shapes of the module. Also it was revealed that there is no significant interaction between shapes and sizes of women's briefs for the out-of-tolerance defects at 5% level of significance.

Residual analysis shows that the p-value for the Shapiro-Wilk test (0.66) is greater than 0.05 and so the defects are normally distributed. The p-value for Levene's test indicates that (0.3175>0.05) error variances are equally distributed over the groups.

Analysis of Styles of Women's Briefs and Shapes of the Module

The analysis of out-of-tolerance defects may be influenced by two factors, shapes of the module and styles of the women's briefs was summarized in Table 3.

Table 3: Summary of two-way ANOVA for Out-Of-Tolerance Defects along with Two Factors Shape and Style

	Method	Test	P-value	Decision
Residual Analysis	Shapiro - Wilk	Normality	0.281	H_{00} is accepted
	Levene's	Variance	0.095	H_{01} is accepted
Two way ANOVA		Main effect for style	0.018	H_{02} is rejected
		Main effect for Shape	0.002	H_{03} is rejected
		Interaction among shape of the modules and Style of the women's briefs	0.213	H_{04} is accepted

The null hypotheses associated with each of the above tests were mention below.

H_{00}: Data follow a normal distribution.
H_{01}: Error variances are equally distributed over the groups.
H_{02}: There is no difference among the mean defects of styles of women's briefs.
H_{03}: There is no difference among the mean defects of shapes of module.

H_{04}: There is no interaction effect between shape of the module and style of women's briefs for out-of-tolerance defect.

According to two-way ANOVA, the null hypotheses (H_{02}) for main effect of style was rejected at predetermine level of significance 0.05. Therefore it can be concluded that there is a significant difference among the mean out-of-tolerance defects of styles of women's briefs.

In addition to that the null hypothesis (H_{03}) for main effect of shape was rejected at 5% level of significance. This concludes that that there is a significant difference among the mean out-of-tolerance defects of shapes of the module. Also it was revealed that there is no significant interaction between styles of women's briefs and shapes of the modules for the out-of-tolerance defects at 5% level of significance.

Residual analysis shows that the p-value for the Shapiro-Wilk test (0.281) is greater than 0.05 and so the defects are normally distributed. The p-value for Levene's test indicates that (0.095>0.05) error variances are equally distributed over the groups.

Since there was a difference among the mean defects of styles of women's briefs, Turkey multiple comparison test was applied. The test concludes that there is significant difference between mean defects of Boy short and those of other styles of women's briefs.

RESULTS & DISCUSSION

The Boy short style shows highest percentage of defects compared to those of other styles sewing in the plant. The standard material flow will reduce the quality problem at initial level when considering the Boy short style.

In addition to that there is a significant difference among mean defects of shapes of the module. The U- Module is suitable for sewing lines since this shape produce less defects in contrast with the Zig-zag module.

According to the two-way ANOVA results, the styles of the women's briefs and shapes of the module were significantly affecting the out-of-tolerance defects. Some measures should be taken against these factors to minimize the out-of-tolerance defects in the plant.

CONCLUSION

This study explores effect of three factors, size of women's briefs, style of women's briefs and shape of the modules on the out- of-tolerance defects. It was revealed that styles of women's briefs and shapes of the module significantly affect the out-of-tolerance defects whereas sizes of women's briefs were not.

The employees work in U-shape modules performed better than work in Zig-Zag modules since it has improved communication between employees, self-ownership and the better material flow.

The Boy short style provides significant effect on the out-of-tolerance defects than those of other styles of women's briefs. Therefore it is necessary to have a quality assurance method at initial stage for style of Boy short. In addition to that standard work process (Heat seal operation, cutting, bundling etc.) should be introduced for Boy short style of the women's briefs in the plant. The suggestions proposed here would help the company to reduce its losses due to out-of-tolerance defects.

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