Reprint **ISSN 1997-2571 (Web Version)**

Journal of Innovation & Development Strategy (JIDS)

(J. Innov. Dev. Strategy)

Volume: 5 **Issue: 2** **August 2011**

J. Innov. Dev. Strategy 5(2): 29-33 (August 2011)

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http://ggfagro.com/ejournals/current issues

JIDS** issn 1997-2571, HQ:19-10 central place, saskatoon, saskatchewan, s7n 2s2, Canada

ISSN-1997-2571 (Online)
J. Innov. Dev. Strategy 5(2):29-33(August 2011)

A STATISTICAL APPROACH: ELIMINATION OF STRIPPING PROCESS FROM DYEING PROCESS

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Accepted for publication on 13 August 2011

ABSTRACT

Islam MA, Moin CJ, Mahabubuzzaman AKM (2011) A statistical approach: elimination of stripping process from dyeing process. *J. Innov. Dev. Strategy* 5(2), 29-33.

In order to coloration of textile goods especially knit fabric in Bangladesh dyeing and its corrective process stripping is obvious. As any corrective action involves extra cost, the stripping process should be eliminated from the dyeing industry. The elimination is possible after finding the cause and necessity of the process. When the coloration goes wrong for reactive dyeing the necessities of stripping arise. This paper finds a cause of stripping is shifts rather than the personnel and even the process. The statistical tool two way ANOVA implications determine F-critical and F-calculate to find out the causes and variances determine the intensity of the causes. The use of statistical theory makes the research trustworthy and logical.

Key words: *reactive dyeing, shift, personnel, F-critical*

INTRODUCTION

The development of readymade garments industries is flourishing towards the excellence with the continual and incredible supports from its backward linkage industries and become the leading revenue earner for Bangladesh. About 78% of the foreign revenue is earned by this sector (bgmea.com.bd), so it is one of the prime interests for Bangladesh. Different backward linkage industries like spinning, weaving, knitting, dyeing, printing and accessories industries are supporting the readymade industries by supplying raw materials (banglapedia.org). Among the different backward linkages, dyeing industry, color the fabrics which add the highest proportion of value to the RMG. Among the woven and knit fabrics the later one is dyed largely in Bangladesh. Largest proportion of those knit fabric are cotton and dyed with reactive dyes. When there is some color matching problem regarding the shade of the desired fabric and it cannot be corrected by other parameters present the last but mandatory process of stripping comes into action. The dyeing factories runs 24hrs a day and different dyeing process is run by the prior formulation of some skilled personnel. The stripping process is undesirable and just as a repairing process which subsequently reduces the profit margin. The statistical tools such as- Two-way ANOVA may be fruitful to find the liabilities of stripping. Some general information of reactive dyeing, stripping and Two-way ANOVA is illustrated as follows:

Reactive dyeing:

The fabric is prepared that means the impurities, oil, dirt etc are removed by some mechanical and chemical action also the natural color of cotton is also removed to produce white ground that is essential for coloration. The chemicals used are Caustic Soda, Hydrogen Peroxide, Sequestering agent, Wetting agent, enzymes, acids etc. The preparation process goes on a machine on elevated temperature for about an hour. After that the coloration process begins. Dyeing of fabric with reactive dyes involves mainly three steps: 1. Exhaustion of dyes in presence of a lot of electrolytes, 2. Fixation of dyes with the fibre in alkaline condition and 3. Washing off unfixed dyes from the fiber, (Shore 1995; Broadbent 2001; and Christie 1999).

The Stripping process:

In dyeing with reactive dyes continuous assessment and critical control must be achieved to match the desired color on the fabric. A large amount of fabric is dyed on machines; if something is not good then the required color cannot be imparted on that fabric. In that case the removal of that unwanted color is essential. As mentioned earlier reactive dyes react with the fibre, it's very difficult to remove color from fabric. The only way left is stripping (Smith 1987). The process is done on the dyeing machine. Here a strong reducing agent called Hydrose is mainly used, which is mainly Sodium Hydro Sulphite. This type of stripping is called reductive stripping because it is a reducing agent (Carr 1995). The chemical is used along with Caustic Soda and Wetting agent at elevated temperature which is mainly the temperature at which the dyeing was done (Oğulata and Balci, 2007). The color is removed but there is also some problem of strength loss and absorbency.

Two-Way ANOVA:

Analysis of variance or ANOVA is one of the most used ways to find out the variations between population means. ANOVA mainly measures the sources of variation (Walpole 2007). The F distribution is also used for testing whether two or more sample means came from the same or equal populations. This technique is called analysis of variance or ANOVA.

ANOVA requires the following conditions:

-The sampled populations follow the normal distribution.
-The samples are independent
-The populations have equal standard deviations.

Sometimes there are other causes of variation. The two-factor ANOVA test determines whether there is a significant difference between the treatment effects and whether there is a difference in the blocking effect (a second treatment variable).

Sum of square due to block, $SSB = r S (X_b - X_G)^2$

Where r is the number of blocks
X_b is the sample mean of block b
X_G is the overall or grand mean

The procedure is same like other hypothesis testing; the five step hypothesis testing is also done here, unlike the one way approach the error element is tried to reduce by defining it more precisely as blocks which is liable for the reason for variation. The data are arranged and if the fulfill the conditions of ANOVA testing they are calculated and arranged in the ANOVA table as stated as Table-1. By calculating the F-value for treatment as well as blocks the critical values are tested with them to finalize the decision of accepting or rejecting the null hypothesis. The variation may be found for treatment or block or for the both (Lind 2005).

Table 1. Two-way ANOVA Table

Source of Variation	Sum of Squares	Degree of Freedom	Mean Square	F
Treatments (k)	SST	k-1	SST/(k-1)=MST	$\frac{MST}{MSE}$
Blocks (b)	SSB	b-1	SSB/(b-1) =MSB	$\frac{MSB}{MSE}$
Error	SSE (TSS – SST – SSB)	(k-1)(b-1)	SSE/(n-k) =MSE	
Total	TSS	n-1		

SIGNIFICANCE OF THE WORK

The existence of Bangladeshi garments industry largely depends upon the amenable profit margin. In recent years due some reasons like world recession the profit level, increase of labor wages it faces the lowest profit proportions, so now it is necessary to concentrate on the processing system to eliminate any unwanted costs. The more precise planning and operating of industries can save a lot of money. In dyeing industries non-value adding chemical process not only affects the earnings but also creates environmental hazards. As mentioned earlier stripping is unwanted sometimes essential process to be done. The stripping is done when the dyeing is faulty so the costing of first dyeing is added to waste plus the cost of the stripping process. The cost of dyeing and stripping is mentioned (Table 2). The calculation of Table 2 shows the expenses for stripping cost as well as the importance of elimination of this process.

Table 2. The cost of dyeing and stripping

Factory Name	Avg. Dyeing (for dark shade) in TK/kg	Stripping in TK/kg	Cost due to correction process (Stripping) in TK/kg
Factory A	120	30	150
Factory B	135	35	170
Factory C	140	35	175
Factory D	130	40	170
Factory E	125	35	160
Average cost	130	35	165

Note: Generally the dark shades are needed to do stripping and the light to medium shades are converted into other necessary shades

In addition, beside of the matter of money, there are some more facts that are related with the stripping process. The following are the effects of that process:

1. The chemical action reduce the strength of fabric, makes the fabric harsh as well as the absorbency of that fabric is reduced, re-dyeing becomes difficult.
2. As the process takes another full dyeing cycle plus the time for stripping so the schedule of the factory is hampered as well as the lead time.
3. The rework process increase the amount of effluents in the ETP, discharged water's BOD and COD is increased which is harmful for the environment.

So, considering all above mentioned causes the attempt to reduce stripping process is very essential.

METHODOLOGY

1. Dyeing and stripping cost were collected from five exporting oriented composite knit garment factories (A, B, C, D, and E) and recorded in the Table 2.
2. Among the factories the frequencies of stripping in A was collected for 52 weeks and the data are tabulated according to personnel and shift wise (Table 3).
3. The data are tested for normality with Kolmogorov-Smirnov test (Boes *et al.* 1974; DeGroot 1991) by Minitab® 16.1.1 software.
4. Data distribution plot also checked by Minitab® 16.1.1 software.
5. Finally the data were subjected to Two-way ANOVA, which was performed by MS Excel.

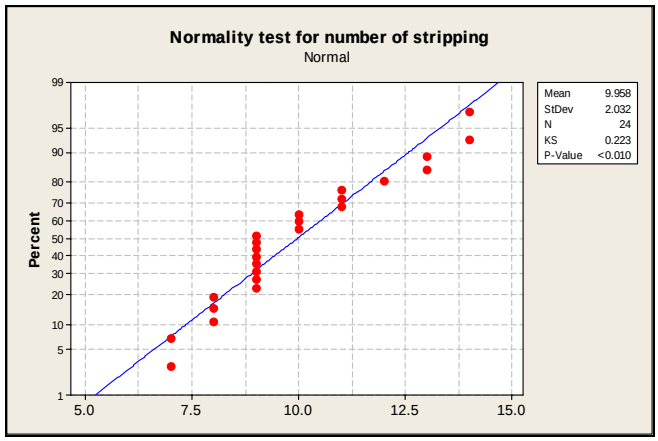
DATA AND ANALYSIS

The 52 weeks data for stripping process of factory A is summarized as follows:
Table 3. 52 weeks data for stripping process per shift per person

Personnel	Shift-Morning	Shift-Evening	Shift-Night
Mr. A	9	8	11
Mr. B	9	9	12
Mr. C	9	7	13
Mr. D	8	9	11
Mr. E	10	8	14
Mr. F	9	7	11
Mr. G	9	10	13
Mr. H	10	9	14

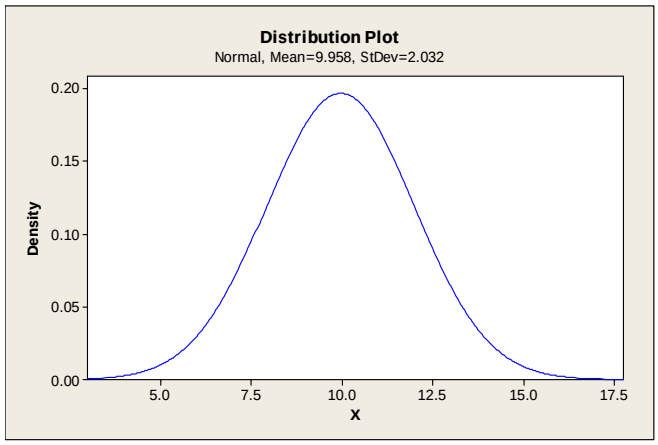
The data for stripping process are tested for normality with Kolmogorov-Smirnov test by Minitab® 16.1.1 software.

The output graph which shows that the data follows the normal distribution and illustrated as follows:



Graph 1. Normality graph

From the above graph the data showed normality, also from the mean=9.958 and standard deviation =2.032 the distribution plot is as follows:



Graph 2. Distribution plot

As the data follows the normal distribution now it can be tested to measure the variation.
The two-way ANOVA analysis was done by MS Excel with the add-on named Data-analysis. This gave the following output:

Table 4. Two-way ANOVA analysis for stripping process

SUMMARY	Count	Sum	Average	Variance
Mr. A	3	28	9.333333	2.333333
Mr. B	3	30	10	3
Mr. C	3	29	9.666667	9.333333
Mr. D	3	28	9.333333	2.333333
Mr. E	3	32	10.66667	9.333333
Mr. F	3	27	9	4
Mr. G	3	32	10.66667	4.333333
Mr. H	3	33	11	7
Shift-Morning	8	73	9.125	0.410714
Shift -Evening	8	67	8.375	1.125
Shift -Night	8	99	12.375	1.696429

ANOVA Table

Source of Variation	SS	df	MS	F calculated	P-value	F critical
Personnel	11.625	7	1.660714	2.113636	0.110539	2.764199
Shifts	72.33333	2	36.16667	46.0303	6.98E-07	3.738892
Error	11	14	0.785714			
Total	94.95833	23				

The ANOVA table shows the average number of stripping process is not depended upon the performance of the personnel as the F-critical is greater than F-calculated. When it comes to the shift-wise the F-critical is less than F-calculated, that means there is a difference in average number of stripping for different shifts not for personnel.

DISCUSSION

From the data analysis the ANOVA table indicates that there is a shift-wise variation in the number of stripping so it is clear that one of the three shifts is more liable for having more stripping that is things go wrong in a particular shift. The shift wise variance guided to that the more stripping occurs in night shift, next evening and minimum occur in morning shift. So the worker and the personnel should be motivated more to be careful at those shifts. More precise control should be established and more regulations should be applied for those shifts. Incentives can be offered for working in those shifts but no one can attend frequently on those shifts for incentive. If the mentioned measures can be taken the number of stripping may be reduced significantly.

CONCLUSION

Statistics is a powerful tool to measure different variations and their reasons in a industry. ANOVA is just one aspect of the whole picture. Though the outcome of this work is not so tremendous but it can be commenced to use the statistics in every steps of textile industry. This type of work can find out the causes of enormous problems and their simple solutions. The elimination of stripping process will contribute to maintain the quality of fabric also.

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