Effects of Worker Fatigue on Product Quality: A Case Study in Apparel Industry

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Abstract—Improving product quality is one of the main concerns of any manufacturing industry. There are many factors in apparel industries which are responsible poor product quality and defective items. Unskilled workers, physical fatigue from manual works of extended working hours, misplacement of worker at workstation, lack of training, absence of engineering knowledge and engineering management are few factors directly related to product quality. In this work effects of work fatigue on product quality is studied and analysed for stitching, finishing and fabric departments of an apparel industry. During the investigation attention is concentrated on how work fatigue influences product quality. It is found that defect rate varies with time. Defect rate increases gradually until lunch break. Similar fashion is observed after the lunch break also. Among the three departments defect rate in stitching department is higher than fabric and finishing departments. Finally few suggestions are proposed to reduce quantity of fatigue related defective items.

Index Terms— Product quality, Apparel industry, Work fatigue, Fatigue factor, Potential intervention, Defect rate, Manual activity

1 Introduction

FATIGUE can be represented as a single phenomenon or discrete variable, but it is probably more appropriate to view it as a continuous dimension, that is experienced as a subjective internal feeling. Fatigue is both ubiquitous symptom and is difficult to define. From a physiological perspective weakness is a diminished ability of rested muscle to exert maximal force, whilst fatigue is a loss of maximal force-generating capacity that develops during muscular activity. A major goal of global market is low cost, high quality and on-time delivery. In the apparel industry, demands are customer driven, companies are being made more responsible for good working conditions on the floor by government regulations, tight labor markets and recognition of the value of a good employee. To meet these demands, apparel manufacturers must find a manufacturing method that meets or exceeds quality standards while decreasing costs through optimizing manufacturing productivity, efficiency and safety. Design of successful working method helps to utilize the human capabilities with job demands. A mismatch of this interface can increase expenses, thus affecting the net profit by causing human operators to make mental mistakes, work inefficiently, or work beyond their physical capabilities to the point of injury. Work fatigue research has been employed where work is highly repetitive and more manual activities are involved.

Fatigue has a major impact on product quality. Workplace conditions for which fatigue is a major symptom such as depression or anxiety accounted for only a small part of the productivity losses. Fatigue reduced work performance mainly by interfering with concentration and increasing the time needed to accomplish tasks. There is a clear relationship between quality and productivity. Generally, when quality increases, increased in productivity, because waste is eliminated. The amount of inputs required to produce outputs is reduced. It is the operation manager's task to provide the facilities, tools and desire or motivation to do so. To take a place in the global market there is no way to produce good quality of product.

The objectives of the study are as follows: To identify defective rate due to fatigue in different sections of an apparel industry, to classify in defective items in different time interval during working hours, analyze the change in defective rate during the working hours and to design the potential interventions to reduce fatigue and/or improve product quality.

2 Literature Review

Many works have done on the effect of fatigue on productivity in the working hours. However no works is done on the effect fatigue on product quality. Human fatigue is one of the important factor which affects product quality directly. So far several works are reported in the literature of human fatigue. Study the effects of shift work on different dimensions of perceived fatigue, as well as to study if fatigue changes over an entire shift life. Fatigue was rated at the end of each shift. Reaction time tests were also carried out at the end of each shift. The result showed that the reported fatigue was primarily expressed in terms of sleepiness and to some extend also in term of lack of energy and lack of motivation. These dimensions also discriminated most between work shifts, where the highest level of fatigue were reported during the night shift. Longer reaction times coincided with increasing ratings of the mental aspects of fatigue. However no work is conducted to investigate how product quality is affected due to fatigue in apparel industries. Several research groups have developed models for estimating the work-related fatigue associated with shift

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workers duty schedules. The prevalence of shiftwork has substantially increased in most industrialized economies in the last three decades, largely due to changes in customer demands and community expectations, combined with the arrival of global competition. Consequently, employees in many industries are now required to work extended shifts and/or to work shifts that are outside the standard 9-to-5, Monday-to-Friday work week. The sleep loss and body clock disruption associated with these work demands may lead to increased levels of work-related fatigue, which manifests as reduced alertness, impaired neurobehavioral performance, increased sleepiness, and/or greater risk of injury and accident. However, several research groups have developed fatigue models designed to quantify the impact of shiftwork schedules on employees' levels of sleepiness, alertness, and/or performance. Most early fatigue models shared a common feature: they required actual or estimated sleep times as one of several inputs. This requirement was reasonable for researchers estimating the effects of fatigue in laboratory- based studies, but it posed difficulties for organizations wishing to estimate the effects of fatigue in workplace settings. [1]

Fatigue due to prolonged task performance is a common phenomenon in our everyday lives. When people become fatigued, they usually experience difficulties in maintaining task performance at an adequate level. This can have major consequences: for example, in a recent study by Campagne et al. (2004) in which subject were required to drive a car (in a simulator) for about 3 hours, it was found that with increasing fatigue, performance deteriorated. Driving errors such as large speed variations and even running of the road became increasingly frequent. The effects of mental fatigue on behavior are due to reduced action monitoring as indexed by the error related negativity. Subjects clearly exhibited impaired action monitoring and response preparation when they became fatigued. The observation that this impairment can be alleviated by increasing rewards, suggest that mental fatigue involves an effort/reward imbalance. Continuous task performance over such a prolonged period of time requires an increase in effort of subjects to keep performance at adequate levels. When the observed rewards become insufficient, subjects disengage from the task, feeling fatigued. When rewards are increased at the end of the task, effort and reward are once again balanced, resulting in better performance. The observation that subjects differed in the way they improved their performance after the motivation, suggests that performance under conditions of mental fatigue involves adaptive strategy changes to keep performance at acceptable levels. [2]

A self-rating scale was developed to measure the severity of fatigue. Two-hundred and seventy-four (274) new registrations on a general practice list completed a 14 items fatigue scale. Tests of internal consistency and principal components analyses were performed on both sets of data. Aim was to produce a short, easy to administer scale which was both reliable and valid. Many synonyms are used to describe fatigue. It has been suggested that the shorter the scale the less reliable and valid it becomes, however, the revised 11-item scale was found to be both reliable and valid, despite its brevity. Items were chosen for their simplicity and unambiguousness. Like most symptoms, fatigue is better viewed as a dimension as opposed to a category and response options were chosen accordingly, to accommodate two different scoring methods. The principle components analyses provided good evidence for the distinction made between the two constructs, physical and mental fatigue. To date, a total fatigue score has been obtained by adding up all the items. However, the analyses demonstrate that it would probably be more useful to have two scores, one for physical fatigue and one for mental fatigue. In a brief, easy to administer self-rating fatigue scale was developed. The intended purpose of the scale is the assessment of symptom severity, the detection of fatigue cases in epidemiological studies and as a valid estimator of change. It is recommended, however, that the scale is not used alone to detect cases, but should be used as an adjunct to a thorough clinical assessment. The scale has good face validity, and reasonable discriminant validity. Although evidence of validity as an estimator of change has been established in an open-treatment trial further evidence could be obtained by using the scale before and after treatment in a controlled trial. [3]

Fatigue conceptualized as a reduction in physical and mental capacity which reduces strength, speed and reaction time. It has a negative impact on product quality by increasing errors. It is frequently advocated that humans are unreliable and less consistent compare to machines, they are primarily responsible for lowering product quality. Physical, psychological, mental and sensory fatigue factors adversely affect operator/worker performance. [4]

3 Proposed Work/ Model

The study will be carried out in an apparel industry in Bangladesh. After choosing a product, the processed will be identified where more manual activities are involved. Then whole working time will be divided into 20 intervals of 30 minutes each. Data from different sections such as stitching and finishing will be collected. The factors related to product quality due to fatigue will be identified. All items will be checked to classify defect types and quantities. Finally percentage of defective items due to fatigue will be determined and compared with other factors and average defective items at different times and in different sections. Results will show section-wise variation in defective rate in a particular time and explanations. Based on the findings, possible interventions will be determined to reduce defective rate due to fatigue. While improving productivity it should be kept in mind to keep product quality in a standard manner. Generally fatigue is associated where manual activities are more involved. Out of total loss, fatigue factors losses play an important role. Many models and methods exist to analyze fatigue loss. In this study, a new model is developed which can be used to identify real fatigue problems and quantity associated with work fatigue.

Due to the physical fatigue of worker, there will have an effect on product quality. To calculate the amount of fatigue factors

defect rate of a particular areas where manual activities are more, the following steps has been followed. By checking and counting every pieces, total number of defective items are found where fatigue related factors and other factors both are involved. Then total number of defective items are categorized. Defects related to fatigue and other factors are the two categories. Then check both fatigue and other factors and their respective quantity. Is the factors really related to fatigue? If no, then identify fatigue related factors and come back to previous step. And the process will be continued. If the answer is yes, then proceed to the next step. After identifying the fatigue factors from previous step, the defect rate is calculated. And it plays an important role to the total number of defective items. After that feasibility of defect rate is checked/or tested. If defect rate is reasonable then go to the next step where this will be compared with other factors. If no, then identify new fatigue related factors and/or change the process where manual activities are more and related to work fatigue. And come back to step two. And the process will be continued. Then comparison are made between work fatigue related factors and other factors. The definite fatigue related factors from previous step are found. Both defects amount and rate are found from total number of defective items. Finally average defective rate in the whole working hour **are** calculated. The rate is calculated at different time intervals in a whole working hour.

4 Data Collection

In this study the assumptions are as follows: Continuous flow of material through the assembly line, defects due to fatigue are analyzed and others defects are used for comparison, there is an effect on defect rates due to worker fatigue varying in working environment and working procedure with different time interval of working hours is considered and no effect of fatigue of data collector in collecting whole day data. The study is carried out on a woven out ware apparel manufacturing industry. The effects of fatigue on product quality may vary company to company. For this study one woven jacket is considered. Those factors are considered whose are related to work related fatigue. Factors results nonconformity of product quality, where rework is mandatory. By controlling these factors rework can be minimize and better productivity and product quality can be achieved.

Eleven fatigue factors are considered in the stitching department. They are as follows:

Pleat- A double or multiple fold in a garment.

Uncut thread: The excess thread which should not be include in a garment.

Open seam: Where the threads in the seam have ruptured leaving a hole in the stitch line.

Needle mark: Needle holes exists without stitch on garment.

Raw edge: Unfinished or cut edge of a garment.

Point up down: Stitching end points are not in same position.

Misplacement: Part(s) are placed in a wrong position.

Down stitch: Stitch dropped down from stitching line.

Symmetry: Uniformity of parts to their own position.

Uneven stitch: Uneven distance between the stitches of a garment operation.

Join stitch: Two or more stitches in a seam where one stitch is allowed.

Four fatigue factors considered in the finishing department. They are as follows:

Pressing zone: Here poor ironing, shiny mark, crease mark and wrong shape of the garments are considered.

Accessories zone: Here missing, wrong placement of the accessories, wrong accessories and damage accessories to the body are considered.

Spot zone: Here oil mark, dirty mark, chalk mark and ink spot are considered.

Packaging zone: Here sizes mistake, purchase order mistake, poly mistake and carton mistakes are considered.

5 Data Analysis

By utilizing maximum performance of worker at the assembly line, the productivity status of an assembly line can be improved and also product quality should be ensured. There has an important effect of fatigue on product quality in the stitching and finishing departments. To control product quality it should have taken right potential interventions to reduce fatigue. In this study the effects of fatigue is observed in the stitching and finishing departments. Here the whole working time is divided into 20 intervals 30 minutes each and data are collected in the whole working time interval.

5.1 Stitching Department

In this study to produce jacket machineries are as follows: single needle lock stitch, over lock, double needle lock stitch, punch and snap button machines. Here eleven fatigue factors defect rates are observed. For this study stitching department is divided into five sections. The sections and related operations are given below-

Hood make: Here the operations are hood padding katcha, hood overlock, hood faceing tuck, hood zipper joint, hood make and hood rulling.

Front part: Here the operations are front yoke join, facing join, front yoke top stitch, front part join and kacha

Back part and central processing unit (CPU): Here the operations are back yoke join, back yoke top stitch, show stitch with padding, collar, box plate, appulate and bone make.

Lining part: Here the operations are facing join, patch join, label join, loop join, front facing join, shoulder join, sleeve join and side-seam join.

Assembly part: In this zone complete collar, hood, front part, back part, sleeve, lining part, zipper, other associated parts and accessories are assembled here.

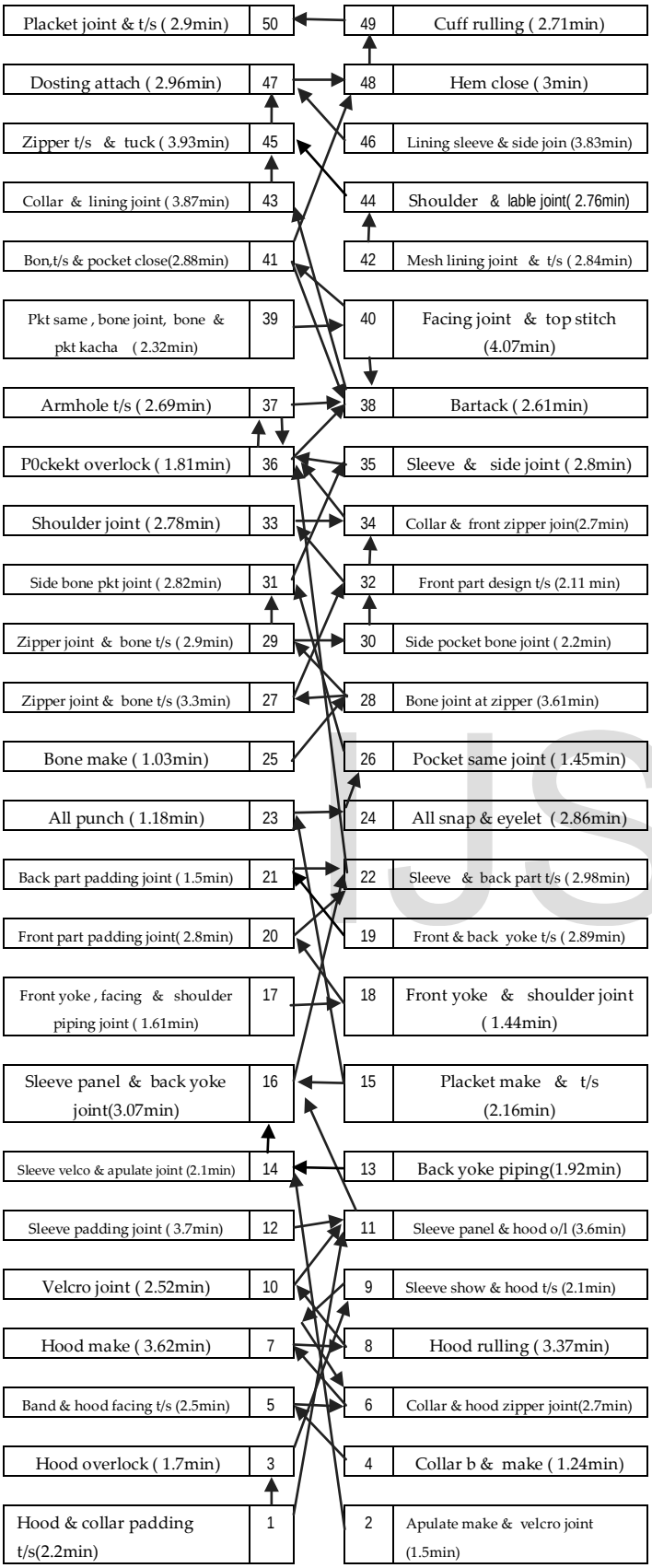

Figure 1 Layout of the assembly line

In figure 1 layout of the assembly line is shown where total standard minute value is 130.6 for machine operators. Input of this jacket parts are coming from cutting department as bundles. In this layout 50 work stations are shown. Out of them 15 work stations are direct input and they are 1,2,4,9,12,13,15, 17,19,21,25,26,39,42 and 46 number workstations, which are shown in figure. Material flow along the stitching line is shown by arrow with moving directions. In the material flow, sometimes material comes from one or more sources and distribute in the same way.

In figure 2 the stitching department's average defective rates in five different zones are shown and the average fatigue factors defect rate is calculated 27.26%.

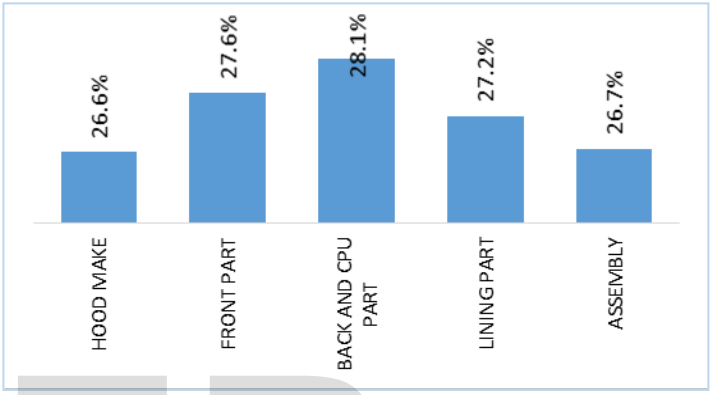

Figure 2: Average defect rates in stitching department

In the stitching department, 3 days average fatigue factor's defective rates are given in figure 3. Average defect rates are different in the whole working hour with respect total fatigue factors defect.

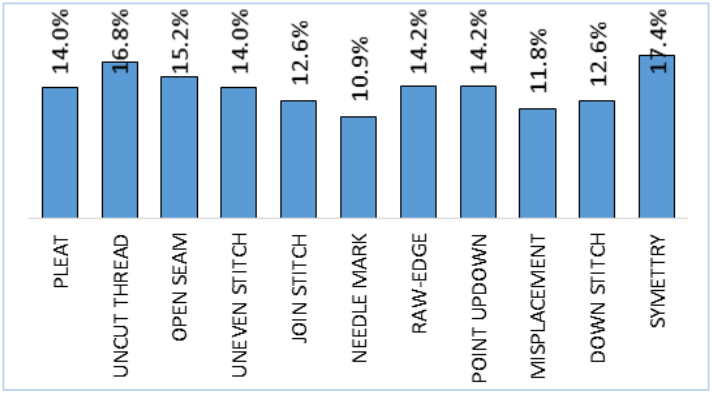

Figure: 3 Fatigue factor's defect rates in stitching section

In figure 4 the stitching department's fatigue factors and their average defective rates in five different zones are shown and the average fatigue factors defect rate is calculated 11.6%.
Maximum defect rate is found in the high risk fatigue area, assembly zone and lowest in the low risk fatigue zone, hood make. Risk is depends on more manual and complex job nature.

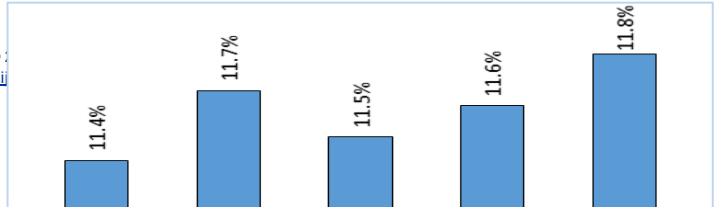

Figure: 4 Zonewise average defect rates in stitching section

From figure 5 it is observed that defect rates varies with respect to time. In the morning time especially in the first and second hour very less amount of defects are found. With the increasing of time, defect rate increases. From first five hours, three hours defects are gradually increases where in the 4th and 5th hour defect rate is remarkable. After lunch break the nature of the curve is different. Again defects rate is high in the 6th and 7th working hour. After that again it behaves downward means defects rate is low. In these hours productivity is also get higher with better quality. But after the normal working hours, in the extended working hours the fatigue factors defective items are found more than previous one or two hour. Again the defect rate is higher. In a word, in the stitching department, in the particular time intervals defect rate is comparatively higher. In this study, ten working hours are considered where in the 4th,5th,6th,7th,9th and 10th hours defect rate is high than other working hours.

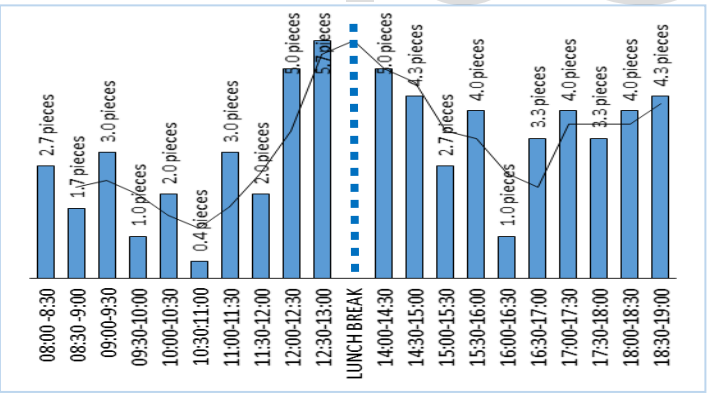

Figure: 5 Change in defective rate in the different time interval in the stitching department

From table 1, stitching department's data are summarized here. The study is carried out on an out ware jacket. The section is divided into five different sections and they are as follows: hood make, front part, back part and CPU (central processing unit or parts section) part, lining part and assembly. And fatigue factor's defect rates are shown in the table. The defect rates are very closer. Higher defect rate 11.8% is found in the assembly portion where lowest defect rate 11.4% is found in the hode make portion. Three days Average total defective rate is 27.24%, whereas fatigue factors proportion is 11.6%. Here one thing can be noted that the lowest defect rate is found in the low risk of fatigue area which is hood make. Very few operations are exist there. And in the high risk of fatigue area, defect rate is higher.

Table 1: Fatigue and other factors data in stitching department:

Stitching department's five zones	Checked quantity (pieces)	Factor's Defect quantity (pieces)		Total defect (%)	Factor's defect rate (%)	
		Others	Fatigue		Others	Fatigue
Hode make	1145	250	188	26.6	15.2	11.4
Front part	1603	255	187	27.6	15.9	11.7
Back & CPU	1625	270	187	28.1	16.6	11.5
Lining part	1610	251	187	27.2	15.6	11.6
Assembly	1586	236	187	26.7	14.9	11.8

Factors results higher ensure nonconformity of product quality, where rework is mandatory. By controlling these factors rework can be minimize and better productivity and product quality can be achieved. In the stitching department, if the segments are more the better result will come, but for this study to avoid complexity it is divided into five portions only. Finally it can be said that the result may vary company to company. The study is carried out for 3 consecutive days and the average defect rates are considered here. The more the days are studied, the accuracy of the study will increase. Data analysis for stitching department should accurate to get exact result. Because for the grater result of that particular product, same stitched garment is analyzed in the finishing department.

5.2 FINISHING DEPARTMENT

Fatigue factors defects are observed in the finishing department also. The four sections and their functions with importance are described as follows:

Pressing zone: In apparel manufacturing, this is the most important zone. The main appearance of a garment comes out through this zone. Some fatigue and non-fatigue both type of defect's effects are found here.

Accessories zone: Major indications are made visible in this section. These are color, sizes, price tag, fabric type, flag label, brand patch etc. Any mistake creates problem of wrong product. Out of them some mistakes are fatigue oriented and rest of them are other factors oriented.

Spot zone: Without movement and/or transportation it's not possible to make a garment. Most of the apparel making machine contain oil for proper functioning of the machine. In respect of Bangladesh it is very quiet possible to make outwear garments without marking, some factories achieved oil free or very less oil problem. Chalk or other marking is mandatory, unfortunately sometimes these are treated as spot

problem. Ink mark is also often found. Strict control can minimized these spot problem in finishing department.

Packaging zone: Some mistakes are also found in the packaging section. Sizes mistake, P.O. (purchase order) mistake, poly mistake and carton mistakes are the factors who are oriented to work fatigue.

In figure 6 the finishing department's average defective rates in four different zones are shown and the average defect rate is calculated 22.0%.

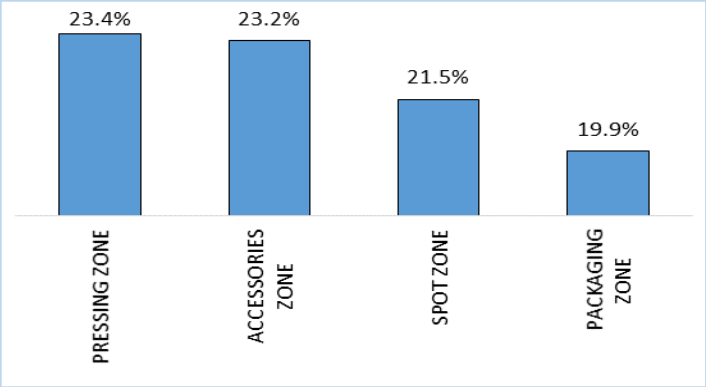

Figure 6: Average defect rates in finishing department

In figure 7 the finishing department's fatigue factors and their average defective rates in four different zones are shown and the average fatigue factors defect rate is calculated 7.6%.

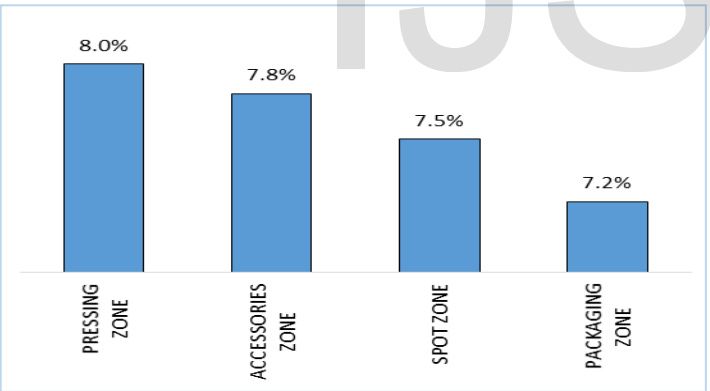

Figure 7: Fatigue factors defect rates in finishing department

From figure 8 it is observed that defect rates varies with respect to time. Same as stitching department, in the finishing department's fatigue effects are observed. The nature is same but quantities and defect rate is different. In this study, ten working hours are also considered in finishing department where in the 4th,5th,6th,7th,9th and 10th hours defect rate is high than other working hours. In the particular time intervals deviations of defective rate are found. The high risk fatigue area in finishing department is pressing zone. In this study, most significant result is found in this zone.

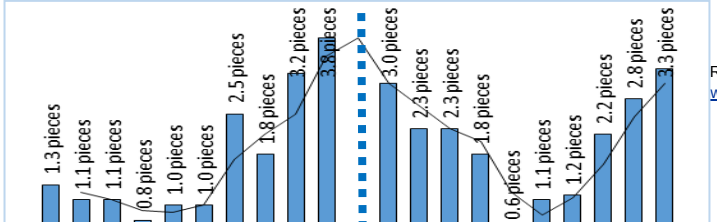

Figure: 8 Change in defective rate quantities in the different time interval in finishing department

From table 2, finishing department's data are summarized here. The study is carried out on an out ware jacket what is completed in the stitching department. Fatigue factor's defect rates are shown in the table. The whole section is divided into four different sections and they are as follows: pressing, accessories, spot and packing zones. And fatigue factor's defect rates are shown in the table. The defect rates are different than each other. Higher rate 8.0% is found in pressing zone where lowest 7.2% is found in the packing zone. Same as stitching department, factors results higher ensure nonconformity of product quality, where rework is mandatory. By controlling these factors rework can be minimize and better productivity and product quality can be achieved. The result may vary company to company. The study is carried out for 3 consecutive days and the average defect rates are considered in this department. Data analysis for finishing department is just after stitching department. Because for the gretter result of that particular product, same stitched garment is analyzed in the finishing department.

Table 2: Fatigue and other factors data in finishing department

6 Potential Interventions

Finishing department's four zones	Checked quantity (pieces)	Factor's Defect quantity (pieces)		Total defect (%)	Factor's defect rate (%)	
		Others	Fatigue		Others	Fatigue
Pressing	1597	247	127	23.4	15.5	8.0
Accessories	1592	246	124	23.2	15.5	7.8
Spot	1592	222	120	21.5	13.9	7.5
Packing	1154	147	83	19.9	12.7	7.2

The potential interventions for stitching and finishing departments are as follows:

- Restrict shift work, especially night shift, to essential tasks and projects.
- Schedule low risk work during high fatigue periods, e.g. end of shift and others relevant hours (Specially in hood making in stitching and accessories zone in finishing department).

- Ensure adequate supervision during high fatigue working hours and his/her respective operation(s).
- Develop contingency plans in case employees become fatigued, rotating employees through job tasks so that fatigued employees are replaced regularly and manage fatigue.
- Enforce strict controls and procedures when performing respective work during high fatigue periods.
- Rotate employees through different tasks to prevent mental fatigue from performing repetitive work.
- Develop and implement rosters that reduce the risk of excessive sleep deprivation and fatigue.
- Limit the duration of shifts and eliminate or reduce the need to work overtime or be on-call.
- Ensure breaks between shifts allow for sufficient rest and recovery as well as commuting between work and home.
- Check that secondary employment does not affect the ability to obtain adequate rest.
- Provide information to employees on how they can manage both work and non-work related fatigue.
- Monitor and take account of your workers' previous hours and days, e.g. last shift was night or else.
- Maintain time of day work is being performed and arrange work so that high risk tasks are scheduled at the times when workers are performing at their best, outside body clock low points
- If possible arrange vehicle for worker transportation, it reduces work fatigue.
- When designing work have to consider safety, criticality and have regular breaks.
- Recovering or preparing for work every time when starting work.
- Providing right environment for work not like sleepy, sweetness, noisy and overheated environment (e.g. Ironing zone in the finishing department)
- Making of eco-friendly environment for work to reduce physical and mental fatigue.
- To reduce mental fatigue provide television, prayer room, award etc.
- Make the operation standard and standard operation procedure (SOP) should be clear to worker. Excessive work causes low performance, result fatigue and lowering product quality.
- In the case of extended hours of work, **e**nsure sufficient cover for workers who are on annual or sick leave. If overtime is necessary, plan for it so workers can schedule their activities around it. Standards are based on eight hour days.
- Maintain working time schedule and minimize early morning starts before 6 am.

7 Result And Discussion

Fatigue study of worker is a very significant way to design the work assembly line. In the stitching and finishing departments work fatigue nature is similar. In the 4^{th}, 5^{th}, 6^{th}, 7^{th}, 9^{th} and 10^{th} hours comparatively defects rates are higher than other hours in stitching and finishing departments. Hence, every apparel industry should control fatigue factors to increasing productivity and product quality in the assembly line. The study presents the results of work fatigue effects on product quality and suggests potential interventions to reduce fatigue. Major fatigue factors and other factors effects are both studied here. Here department and its elements fatigue factors defect, other factors defect quantity and defect rate, fatigue factors versus average defect quantity, nature of defect with explanation in the whole working hour and, nature of defect in particular time interval with explanation and potentials interventions to control fatigue are studied.

Finally for stitching department defect quantities with respect to time increases in the 4^{th}, 5^{th}, 6^{th}, 7^{th}, 9^{th} and 10^{th} hour due to work fatigue. For this study total 8069 pieces checked and 2198 pieces defect quantity is found. Out of 2198 pieces, in 936 pieces fatigue factors are involved and 1262 other factors. Finally potential interventions are suggested to reduce fatigue to enhance performance of productivity and product quality. Same nature is found in finishing department but quantities and rate are different. In the finishing department total 5935 pieces checked and 1316 pieces defect quantity is found. Out of 1316 pieces, in 454 pieces fatigue factors are involved and 862 other factors. Finally potential interventions are suggested to reduce fatigue to enhance finishing product quality.

From table 3, in the stitching department average total defect rate is 27.2%, where fatigue factors proportion is 11.6%. And in the finishing department average total defect rate is 22.00%, where fatigue factors proportion is 7.7%. Higher defect rate is found in stitching department. In both depratments, defect rate is higher where should be less within tolerance. The defect rates and its tolerance may vary company to company. The study is carried out on a specific woven out ware jacket. The greater the frequency, the greater the rework. As a result nonconformity of product quality and performance. By controlling fatigue factors rework can be minimize and better productivity and product quality can be achieved.

Table 3: Fatigue and other factors data in stitching and finishing department

Respective Departments	Total defects (%)	Other factor's defect rate (%)	Fatigue factor's defect rate (%)
Stitching	27.2	15.6	11.6
Finishing	22.0	14.4	7.6

8 Conclusion

Because of increasing competition and demand of apparel

product in the global market, it is very important for apparel companies maintaining the demand and deadline of shipment and with providing good quality of product. But in the most companies no way of improving technique has been employed both productivity and quality. In most of the assembly line of apparel in Bangladesh, fatigue is not considered for lowering product quality. Because of their ignorance and lack of knowledge on work related fatigue's effect and its severity. The study is carried out for the purpose of the study of the effects of work fatigue on product quality in apparel industry. Aim to identify defective rate due to fatigue in different sections, classify defective items with different time intervals during working hours, analyze the change and design of potential interventions to reduce fatigue and/or improve product quality. It is clear that work related fatigue has a big negative impact on product quality. Potential interventions can be taken to reduce fatigue to increase quality level. The results may vary section wise and company to company. By selecting proper interventions fatigue can be reduced at a remarkable level. As a result reduced quality related faults. It is also noted that product quality loss/defects due to fatigue can be reduced in a certain limit. After that the changes can be ignored. It is obvious that utilization in assembly line can improve and quality fault can be reduced by design of potential interventions of that particular section. From the above results it is clear that a promising result can be obtained by studying the effect of worker fatigue on product quality. By improving source of physical fatigue such as lighting, ventilation, sufficient space allocation, keeping lower label of noise, worker's physical fatigue can be reduce to an extent. But it incurs some additional cost to the product. But the main goal of any company is not only to provide service but also profit. In the other way quality means increased cost. If the additional cost is very high compare to the design of potential interventions, it is not wise to expense to develop the environment of workplace. But for a long run obviously it will bring profit to any organizations.

The study is limited to work fatigue and its effects on product quality. It is necessary to examine the relationship between product quality and increased relevant cost which incurs for ventilation, multi operation training, keeping low label of noise, ventilation and others. A future study can be carried out to find the profitability comparing the improvement of product quality and increased quality related cost.

ACKNOWLEDGMENT

I would like thank to Epyllion Style Limited, under Epyllion Group. It has been considered today as one of the biggest conglomerates with substantial establishment of its backward linkage of all kinds of knit garments, textile, wet processing & garments accessories. An important garments manufacturer for a number of renowned brand apprels of Europe, USA, Asia and Africa. It is situated at Vawal Mirzapur, Gazipur Sadar, Gazipur-1703 (Web: www.epylliongroup.com).

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