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Impact of Work Study on Productivity: A Study on Athletic Shirt Manufacturing Process in the Apparel Industry

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***Abstract*— Bangladesh has gone through an unprecedented growth of export-oriented garment industries. The growth rate is spectacular if seen from the view point that development in any other sector of Industry was sluggish and of basic textile sector, in particular, was negative and had been a source of drain on our resources. Production of clothing items is rather a very complex job under a lot of pressure points. Added to the particular complexity and unique features of garment production there is the lack of appropriate management techniques. Apparel industries in this country are said to be not competitive because of a host of reasons.**

***Index Terms*— Athletic shirt, manufacturing process and Apparel Industry**

I. INTRODUCTION

Many experts speculate with rationale that with the withdrawal of quota protection, apparel factories may find them in a deep hole unless some breakthrough takes place in the following areas: 1) Shortening of lead time. 2) Effecting substantial improvement in productivity & quality 3) Improvement of infrastructure & 4) Existence of due political stability & 5) Improvement of compliance status.A number of measures should be undertaken to substantially improve productivity. The first & foremost measure to be implemented is introduction of work study principles in the apparel industries. Work study is a management technique that determines standard time required to complete a job and discovers the best method to accomplish the job in the easiest and cheapest way. As manual work abounds in the apparel industry, work study is the only way to stipulate a time frame to complete each job. Work study also species the night method of doing the job. Thus it helps enhance productivity to the desired level. This article also describes how work study principles can be applied to the apparel industries for improvement of productivity.

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II. WORK STUDY-THE MAGIC TOOL OF IMPROVING PRODUCTIVITY

Most of the Bangladeshi apparel industries are not really productive which is compensated by off the clock work. Some factories work more than 14 hours per day to achieve production & shipment target. This situation cannot continue for long as foreign buyers have become very sensitive to violation of local laws & their code of conduct. .So Bangladesh apparel industries have no other choice but to improve productivity in a substantial way. We may cite an example. A factory does not know work study method and produces Shelf Camies (ladies knitwear)@200 pcs per hour and only 1600 pcs in a day of 8 working hours by implying 24 machines in a production line. But in order to effect shipment in time it needs to produce the item@ 300 pcs per hour or 2400 pcs per day of 8 working hours. Conventional consideration in this country to produce 2400 pcs per day is to raise working hours from 8 to 12 hours instead of improving productivity from 200 pcs per hour to 300 pcs per hour by designing proper lay-out & balancing the line. The method that extends a helping hand in improving productivity in such cases is the work study method which is also coined as Time and Motion study. Work study is a component of management science & it was developed by the well-known American scientist F. w. Taylor, generally known as father of modem management science.

III. WHAT IS WORK STUDY?

It is a scientific method which ensures measurement of work content of a job & takes recourse to better method of doing it & thus realizes the best utilization of human, machinery & other resources of an organization. In a nutshell, this is a science of setting up standard time of a job (work measurement) & discovering the best and the easiest way of performing that job. Thus the job of work study is to investigate how a work is being done, whether there is any defect in doing it & to improve the method of working of the job so that productivity improves per unit time, per unit worker or per unit machine. Work study also must determine standard time by which a qualified worker can accomplish the job within that standard time

Thus we may define work study in the following way: Work study is the systematic method of examining existing ways of

doing a job so as to improve productivity & to set up standard time for each job.

Systematic feature of work study: Work study as a method is systematic in nature. It succeeds because it is systematic in studying the problems & also systematic in developing the coveted solution.

Comprehensiveness of work study: Work study is a very thorough process in investigating problems in production floor & it is also comprehensive in determining solution of such problems. As work study is involved in rigorous study of problems & thorough working out of solutions, it is a time consuming matter. Production manager or floor manager or supervisor cannot devote enough time to dedicate to such systematic & thorough study.Thus work-study is a full time duty. This is the reason why an enterprise needs to allocate a full department for work study matter. Garment industries must have a separate & independent work-study department.

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IV. The Objectives of Work Study

1. Simplify or modify the operation to reduce unnecessary work.
2. Increase production and productivity.
3. Setting time standards.
4. Reduce cost by most effective usage of inputs.
5. Improvement of conditions, which involve an element of excessive fatigue or danger.
6. Improve quality.
7. Evaluation of human work.
8. Reduction of the inefficient time and increasing the productivity.

V. Components of Work Study

It has two components

1. Method Study
2. Work Measurement

A. Method study

Is the systematic recording and critical examination of ways of doing things in order to make improvements. Method study is the systematic recording & critical analysis of ways of doing a job so as to make improvements. It analyzes how a work is being done currently to find out ways to improve so that productivity increases. Method study discovers suitable and easier method of work so that the task can be completed quickly.

The Objectives of method study

1. Simplify the task or eliminate it.
2. Eliminate unnecessary motions.
3. Reduce inherent work content.
4. Engineer the operation.

The Basic procedure of method study

1. Select - the job to be studied
2. Record - by collecting data or direct observation
3. Examine - by challenging purpose, place, sequence & method of work
4. Develop - new method, drawing on contributions of those concerned
5. Evaluate - results of different alternative solutions
6. Define - new method & present it
7. Install - new method & train persons in applying it

B. Work Measurement

Productivity as a whole depends upon how quickly a job can be accomplished in unit time. The lesser the time required the higher the efficiency or productivity. So it is essential to establish Standard 'Time to produce unit product or service. If a company cannot determine Standard time for a unit of its product or service, it cannot decide the following:

1. It cannot decide upon production cost and as a result cannot establish price value of its product or service. If a company does not know work content (Standard Time) of an apparel, so it will be unable to quote right price (FOB) for the garment item.
2. The efficiency & productivity of the company cannot be determined.
3. The company cannot set incentive chart.
4. Hourly or daily production target cannot be set:
5. The efficiency of operators cannot be determined.
6. Production target for each operator cannot be established.
7. Production or shipment plan cannot be properly chalked out..

C. TIME STUDY

Time study is a technique of work measurement for recording time of doing a certain job or its elements carried out under certain conditions at defined rate of performance. In RMG industry, there are some considering factors on which time are studied.

1. **Process Cycle or operation cycle:** Most of the works conducted on a mass scale have a repetitive nature. For example, a worker in an apparel industry performs her job again and again. She takes a bundle of cut pats, opens the bundle, takes a part from it, position it to the machine, completes sewing, ties up the bundle, keep it aside & takes another bundle. This process continues all long. The series of movements from taking a part from a bundle, fitting it, putting to the needle, sewing the part and disposing the part to the bundle of sewn parts is called a process cycle.
2. **Qualified worker:** A qualified worker is a person who has the right skill, knowledge, motivation and other attributes to accomplish a job up to satisfactory level of quality, quantity and safety.
3. **Observed Time:** An operator in an apparel industry performs one or more processes. The time she requires to complete her job as determined by a work study officer by observing her time with the aid of a stop watch is called observed time.
4. **Rating:** Different workers perform their job with different efficiencies. Some workers are clever, they learn their job quickly and attain a very high efficiency. Some others may be mediocre and many

others may be lenient to learn or may be dull. Thus workers widely vary in their performance. Thus rating is the measure of speed with which an operator works. Rating is the speed of an operator doing a job relative to the observer's idea of standard pace of work. Rating is thus a comparison of the rate of work observed by a work study executive with the idea of some standard level of working in his mind. The standard rate is the average rate with which qualified workers are assumed to be able to work provided they are motivated to do the job & if right method of work is applied. Such rate of work is called as standard rating. This standard rate corresponds to 100 in the rating scale. This is called standard rating, because it is assumed that majority of the qualified workers will be able to achieve such rate of working. If appropriate allowance is provided a worker can retain standard performance over the whole of working hours.

There are several rating scales in use. British Standard Scale 100 BSI which is also known as 0-100 scale. The advantage of this scale is that 0 designates no activity while 100 represents standard rating which is normal for an average qualified worker. The details of the scale are given below.

Rating	Description
0	No activity or movement
50	Very slow clumsy movement
75	Speedy, purposeful but unhurried movement
100	Speedy, business like movement of a qualified motivated worker
125	Very speedy movement, operator shows higher degree of effort dexterity and coordination higher than that of an average Qualified worker
150	Exceptionally fast movement which cannot be retained for the whole of the working time.

5. **Basic Time:** Basic time is the time required by a qualified operator to complete a job had she worked at standard performance (or at 100 % rating). Basic time is obtained by multiplying observed time with the rating of the worker. Thus Basic time = Observed Time X rating of the operator.

Example: 1: For example, an operator attaches top-center to the left front. Her observed time shows 28Seconds. Work study executive considers her of 80% rating. Calculate Basic time of the operation.

Answer: Observed Time: 28". Rating of the operator 80%, so her basic time= Observed time x her rating=28"x 80% 28" x 0.8. = 22.4 second

Three operators are doing the same job. Their ratings are respectively the following 75, 100& 120

Operator	Observed time	Operator rating	Basic Time
Julie	16" sec	75 %	16 x 75 % =12
Jesmin	12" sec	100%	12 x 100 %= 12"
Kariman	10" sec	120 %	12 x 120 %=12"

Thus whatever may be the rating of different operators for the same job, the Basic Time of that operation will be the same.Different rating of operators for the same operation.

6. **Standard time:**

Standard time of an operator is the time which a qualified operator should take to accomplish it if the she works at standard performance (at the rating of 100) and provided she takes extra time allowed to her as allowance. If time is counted in second it is called Standard time (or Standard Second) but if time is calculated in minutes, Standard time is referred to as Standard Minute or Standard Minute Value (SMV) In case of jackets or garments which take standard time to the tune of more than 2,000 seconds standard time may be calculated as Standard Minute or SMV. Standard time of an operation is also a constant value though different operators may take different observed time due to their different rating or efficiencies and if the allowance rate is fixed throughout the enterprise. Allowance is calculated on Basic time.

Operator	Observed time	Operator rating	Basic Time	Allowance @ 15%	Standard Time
Julie	16" sec	75 %	16 x 75 % =12"	1.8"	13.8"
Jesmin	12" sec	100%	12 x 100 %= 12"	1.8"	13.8"
Kariman	10" sec	120 %	12 x 120 %=12"	1.8"	13.8"

This table shows that two operators were observed to have taken different time to complete the same job due to their different efficiencies. But the Basic & Standard Time for the operation are constant.

Example: The same operator was allowed to have an allowance time @20 %.Calculate her Standard time

Answer: Standard time = Basic Time +Allowance Time = 2.7"+ 20% 2.7+2.7" x 20%=2.7+0.54=3.24

Thus Standard time of the operation is 3.24 second.

7. **Allowance Time:** A worker cannot and does not work continuously throughout her full working hours. She has to open a bundle, tie it up, go to lavatory, take out bobbin case, replace a blunt needle, talk to the supervisor or line inspector, a small rest to recover from fatigue, etc. She cannot avoid doing all these things, because they are beyond her control. She needs some time for her own personal needs. This is why workers are entitled to some type of extra time for these types of circumstances. This type of time allowed to operators for some unavoidable but non-performing task is called allowance. The allowance time ranges from 15-25 %. Allowance time is taken into account during setting up of Standard Time.

Types of allowances: There are different types of allowances, namely

a) Relaxation allowance,

b). Contingency allowance

c). Machine delay allowance,

d). Style change allowance

e). Special allowance, etc.

Relaxation allowance: It is the time allowed to an operator to attend to personal needs and cover from fatigue. Fatigue is a mental or physical exhaustion developed in a worker due to continuous work. It is assumed that a small rest or pressure in work lessens fatigue and as a result the person is re-energized.

There are two types of relaxation allowances:

1). Fixed relaxation allowance &

2). Variable relaxation allowance.

Fixed Relaxation Allowance: Fixed allowance comprises time allowed for personal needs and for basic fatigue. Time allowed for personal needs is around 5-7 %

Variable allowance: Variable allowance is added to take into account a poor working condition leading to higher stress and fatigue.

2). Contingency allowance: There are some factories which encounter frequent minor interruptions. They cover them by a contingency allowance.

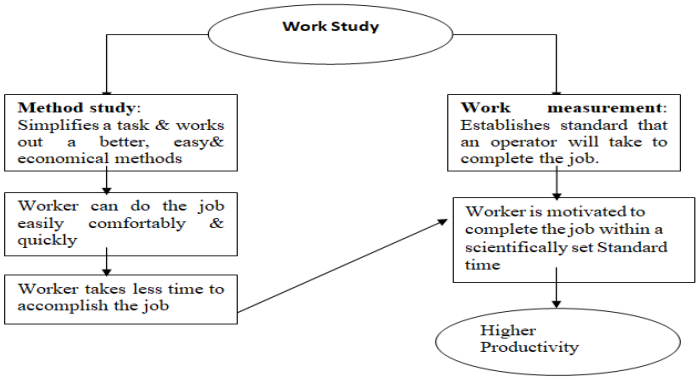
3). Machine Delay Allowance: This is the time allowed for delay due to machine maintenance. Allowance time varies with the complexity of the machine. Some typical machine delay allowances are shown below for reference:

S/L	Type of machine	Allowance Rate in %
1	1-needle lock stitcher	9%
2	2-needle lock stitcher	14%
3	1-needle 3-thread over lock	7%
4	2-needle 4-thread over lock	9 %
5	2-needle 5-thread over lock	11 %

4). Style Change Allowance: Allowance time is permitted where frequent style changes occur.

5. Special allowance: Some times, special time is given as start time allowance, shut down allowance, cleaning allowance, etc. because time is wasted at start time or change of work shift. These times are covered by special allowance.

VI. TECHNIQUES OF WORK STUDY



VII. PROCESS DESIGN FOR ATHLETIC SHIRT IN THE APPAREL INDUSTRY

Athletic shirt is one of the easiest and simple garment taken here as a sample to show how to design processes for manufacture of the item. The list of processes in sequence is given below for reference. It is made from one piece tubular fabric.

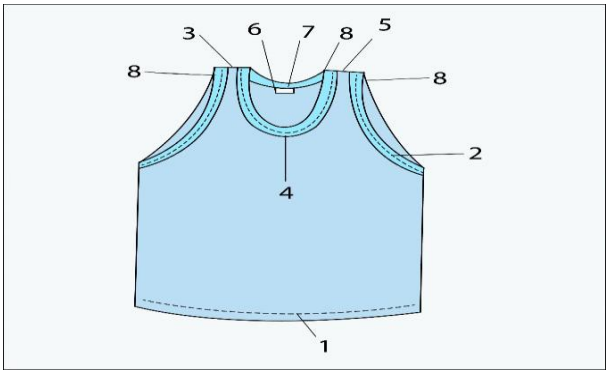


Fig: 1: (Athletic Shirt)

List of processes to produce athletic shirts: Standard time has been gathered from time study.

SI	Name of operations	Machine required	Standard time in sec	Operator Allocation
1	Hem bottom	1-Needle Overclock Machine	9”	Operator # 1
2	Bind Arm holes	2-Needle Flatbed Interlock m/c	7”	Operator # 2
3	Seam Right Shoulder	4-needle Feed of the arm m/c	11”	Operator # 3
4	Bind neck	2- needle Flatbed Interlock m/c	12”	Operator # 4
5	Seam left Shoulder	4-ncedle Feed off the arm m/c	11”	Operator # 5
6	Cut & Fold Label	Auto Label Cutting Folding m/c	4”	Operator # 6
7	Attach label	1- needle Lock stich m/c	10”	Operator # 7
8	Bar tack shoulder & neck	Bar tack m/c	14”	Operator # 8
		Total Standard Time	78 ”	

The process design chart shows that there are 8 production operations required for manufacture of Athletic shirt and 8 operators will do those operation taking 78 seconds according to traditional system. Operator no 8^{th} taking highest time 14 second while operator no 4^{th} takes lowest time 4 second in the production line. It means operator no 4^{th} is doing 3 pieces of her job when 8^{th} operator do one piece of her job. As it is a chain work so ultimate garment production depends on the production of process no 8.

Actual production per hour= $\frac{3600}{14}$ = 257 pcs/hour
1 hour = 1×60×60=3600 second, 14 = highest process time

VIII. OPERATOR ALLOCATION & CONSTRUCTION OF PITCH DIAGRAM

The process design chart shows that there are 8 production operations required for manufacture of Athletic shirt and time study reveals that the 8 operations together take 78 seconds. In order to make a balanced lay-out right number of operators must be allocated to these 8 operations. Untrained Supervisors tend to allocate operators based on guess work and in a case like this; the trend is to allocate one operator each for each of the operations. But a balanced lay-out demands scientific Methods and right calculations. To allocate right number of operators the following steps must be taken:
(1). Calculate average process time,
(2). Compare average process time with each operation time.
Now let us calculate Average Process Time = Total Standard Time / Total Process Number = 78 /8 =9.75 and compare each operation time with this value. This leads us to the following operator allocation shown in the table below.
List of operations to produce Athletic Shirt and work allocation:

SI	Name of operations	Machine required	Standard time in sec	Operator Allocation
1	Hem bottom	1-Needle Over clock Machine	9”	Operator # 1
2	Bind Arm holes	2-Needle Flatbed Interlock m/c	7”	Operator # 2
3	Seam Right Shoulder	4-needle Feed of the arm m/c	11”	Operator # 3
4	Bind neck	2- needle Flatbed Interlock m/c	12”	Operator # 4
5	Seam left Shoulder	4-ncedle Feed off the arm m/c	11”	Operator # 5
6	Cut & Fold Label	Auto Label Cutting Folding m/c	4”	Operator # 2
7	Attach label	1- needle Lock stich m/c	10”	Operator # 6
8	Bar tack shoulder & neck	Bar tack m/c	14”	Operator # 7, 8
		Total Standard Time	78 ”	

The work/ operator allocation shows that Operation # 2 & 6 should be allotted to preferably one operator, say, Operator # 2. On the other hand Operation #8having the highest standard time among the operations should be divided among two operators, say, Operator # 7 and 8. Later we shall see how the work distribution facilitated balancing the production line and lay-out.

IX. CONSTRUCTION OF PITCH DIAGRAM OF ATHLETIC SHIRT

We already have a work allocation table showing each process, machine requirement, standard time for each process and work allocation to operators. Now we see that there are 8 operations and the number of operators that have been engaged for the operations are also 8 though the allocation has been made in an intelligent manner. At this stage we are in a position to draw pitch diagram for the athletic shirt

How to Construct Pitch Diagram

1. Draw X-axis & set operators along Abscissa (X-Axis) in Fig-2 below:
2. Set Process Time of each operator along Ordinate (Y-Axis);
3. Join the points & a curve has originated in Fig-2
4. Draw Basic Pitch Line (BPT=Total Standard Time /Number of operators) =9.75 sec.
5. Draw Upper Control Limit (UCL= BPT/0.85) = 11.47 sec;
6. Draw Lower Control Limit (LCL=2 BPT – UCL) = 8.03 sec;
7. Calculation of Organizational Efficiency = (BPT x 100)/ Bottle- neck time = (9.75 X 100/12) x100 = 81.25%

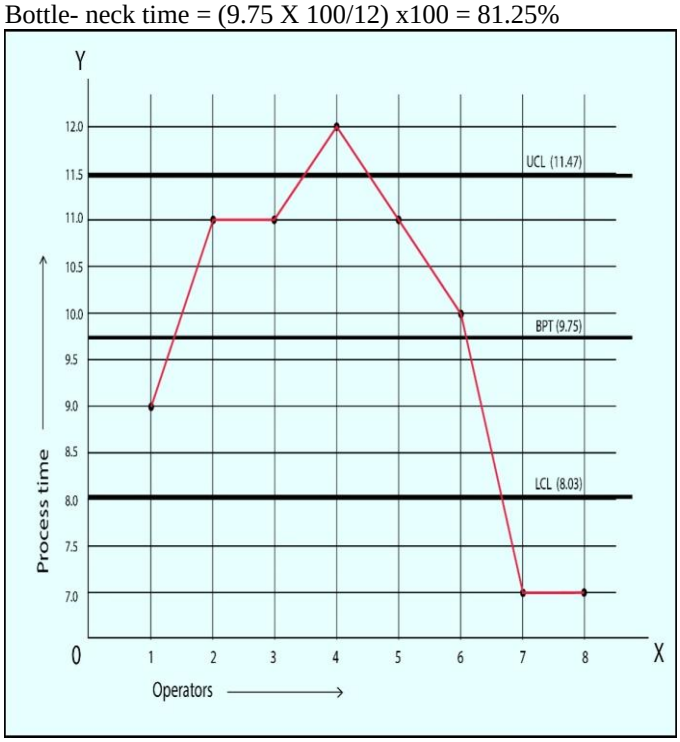


Fig: 2 (Pitch Diagram)

1. Production target per hour with 8 operators = (No of Operator × Working hour in sec × Standard efficiency)÷ Standard time
   = (8 × 1 ×60 ×60 × .85)/78 =313 pcs/hour
   No of workers= 8
   Working hour = 1 hour
   Standard efficiency = 85%
   Standard time = 78 second
2. Bottle neck time as shown in pitch diagram is 12 sec, so production per hour 3600/12 = 300 pcs/hour. This is actual productivity of this athletic production line.

The Pitch Diagram shows that the most of the operations are within UCL & LCL except Op. # 4 &7and 8. But these points are beyond UCL & LCL by around 1/2 second. We have to assign very intelligent operator for process no 4. Thus the Pitch diagram may be considered as balanced.

X. CONCLUSION

From that production line of the apparel industry, here we see that work study fix standard time for each process and proper allocation of the work among the workers. In reality it is difficult to equally distribute work among them as garment manufacturing is a chain work, and we cannot break a particular process until it is done so upper control and lower control limit are created. If we able to keep workers within this limit then the production line will be balanced. We have seen that, in conventional system, athletic shirt productivity was 257 pcs/hour and after implementing various techniques of work study productivity is 300 pcs/hour. Thus, work study impacts in a productive manner on the process of garment manufacturing in the Apparel Industry.

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