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Study of Lean facility Layout in Garment Manufacturing Process: Focusing Sewing Section of Men's Shirt

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ABSTRACT

Facility layout is a settlement of machine, storage areas or work areas within the confines of a physical structure to increase the production rate. It is estimated that 20% to 40% production cost can be reduced by proper arrangement of machine, storage areas or work areas. By developing a good layout arrangement it can be possible to reduced bottlenecks in moving people or material, minimize material handling cost, reduced hazards to personnel, utilize labor efficiency, trim down idle time, make the most of available space effectively and efficiently and provide flexibility. Many researches have been done to get optimum arrangement of layout design. Here we specially perform Time Study, Learning curve, Waste identification of the line to get optimum target, and output, capacity of operator and to find the optimum arrangement of man, machine, and material of the production line.

Keywords: Facility layout, Learning curve, Time study.

1. Introduction

In current world the garments industries is led by fashion and gives emphasis on the use of modern technology. In modern civilized world the clothing industries has created a great application particularly in the emerging countries due to the increasing labor wage in developed countries, the apparel manufacturing has been transferring from the high pay developed countries to low pay developing countries. By purpose of low labor cost of Bangladesh before now gets a foremost position in this sector. This sector contributes about three-fourth of the national export earnings of Bangladesh. Garments sectors are one of the leading job sources to the employee of the country. The working environment of garments are not satisfactory, the industries are ran in such an environment that they are the victim of low labor utilization low labor productivity, high WIP, excessive manufacturing lead times, huge amount of waste and higher manufacturing cost. Garment Industries in developing countries are low intensive on labor productivity than other issues like sourcing of raw material and minimizing delivery cost because of the availability of cheap labor and its result is low labor productivity than developed countries. For example, efforts are very reasonable in Bangladesh but the productivity is poor among other developing countries [1]. Many Industries want higher productivity from labor without paying standard wage and incentives but they become fail to improve productivity because it is not a motivating factor to the workers. Even today the garments of developing countries are familiar to work with similar styles but numbers of styles are increasing rapidly with the revolution of fashion world. This becomes the new challenge for the garments industries. The garment industries are accustomed to work with same style and large volume product. But nowadays due to small order quantities and complex designs, the garment industry has to produce multiple styles even within a day; this needs higher flexibility in volume and style change over [2].In developing countries it is seen that they have rarely used modern technology and lean application because they maintain the traditional way to run the organization. Majority of them don't know the benefit of lean application and the also have no sufficient knowledge about lean tools and they also hesitate to employ industrial engineer as well as textile engineer with handsome amount of money and facilities. Such kind of traditional motive is one of the major obstacles for the garments industries in developing countries to strive with the rising challenges and also for attaining higher efficiency with work friendly environment.

2. Literature view

Lean Manufacturing is not exclusively new. This term derives from the Toyota Production System or Just, Henry Ford and other predecessors. Eli Whitney is most prominent as the originator of the cotton gin. Nevertheless, the gin was an insignificant achievement compared to his perfection of substitutable parts. Whitney established this about 1799 when he took a agreement from the U.S. Army for the manufacture of 10,000 muskets at the extraordinarily low price of $13.40 each. For the next 100 years manufacturers predominantly alarmed themselves with specific technologies. Throughout this time our scheme of engineering drawings settled, modern machine tools were completed and large scale processes such as the Bessemer process for making steel held the center of courtesy [3].Frederick W. Taylor [4] instigated to look at separate workers and work methods. The outcome was Time Study and standardized work. He called his concepts Scientific Management. Taylor was a provocative figure. The idea of applying science to management was comprehensive but Taylor simply

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overlooked the behavioral sciences. In accumulation, he had a strange attitude towards factory workers [5]. Frank Gilbreth (Cheaper by the Dozen) added Motion Study and invented Process registering. Process charts fixated care on all work elements including those non-value added elements which generally occur between the "official" elements. Starting about 1910, Ford and his right-hand-man, Charles E. Sorensen, shaped the first inclusive Manufacturing Strategy. They took all the elements of a manufacturing system-- people, machines, tooling, and products-- and organized them in a nonstop system for manufacturing the Model T automobile. Ford was so unbelievably successful he rapidly became one of the world's richest men and placed the world on wheels. Ford is painstaking by many to be the first expert of Just in Time and Lean Manufacturing. Ford's success stimulated many others to copy his methods. But maximum of those who copied did not recognize the basics. Ford assembly lines were frequently engaged for products and processes that were inapt for them. At Toyota Motor Company, Shigeo Shingo and Taichii Ohno initiated to integrate Ford production and additional techniques into a method called Toyota Production System or Just in Time [6]. They documented the inventory. The Toyota people also familiar with the Ford system had contradictions and shortcomings, predominantly with respect to employees. With General Douglas MacArthur actively encouraging labor unions in the occupation years, Ford's punitive boldness and demeaning job structures were unworkable in post-war Japan. They were also impracticable in the American context, but that would not be apparent for some years. America's "Greatest Generation" carried over arrogances from the Great Depression that made the system work in spite of its defects. Toyota shortly exposed that factory workers had distant more to subsidize than just muscle power. This sighting perhaps created in the Quality Circle movement. Ishikawa, Deming, and Juran all completed main contributions to the quality movement. In this manner, small production runs started by Toyota became a advantage relatively than a burden, as it was able to reply much more rapidly to changes in demand by quickly substituting production from one model to another [8].Toyota didn't depend on the economies of measure production like American companies. It somewhat developed a culture, organization and operating system that uncompromisingly followed the elimination of waste, variability and inflexibility. To achieve this, it focused its operating system on responding to demand and nothing else. This in turn means it has to be flexible; when there are changes in demand, the operating system is a steady workforce that is required to be much more skilled and much more flexible than those inmost mass production systems. Over time, all these elements were associated into a new method to operations that shaped the foundation of lean or Toyota production System.

3. Methodology

To achieve optimum productivity by balancing the production line well here we performed Time study, Motion study, Root cause analysis Learning Curve as a part of our research work. By doing this we become able to know the actual capacity of the worker, the improvement of operators performance with time, the actual allowance time of the worker, the person who is actually responsible for the defects of the part, the reasons behind the dissimilarity of motion and so on. All of these helps to fix better scheduling, balancing line according to the operators capacity and operation sequence, reducing workers waiting time, speed up to the production line, to fix actual allowable allowance of time. By doing this, stitching operations will be standardized and production targets for each operation will be fixed. Furthermore, batch processing is transformed into single piece movement by the allegation of new layout. This will serve the purpose of WIP reduction. For the ease of operator movement between machines, sitting operations were converted into standing. The worker multi-skilling is achieved by the concept of assembly line balancing. As in cellular manufacturing the numbers of operators are less than the number of operations (machines), one operator has to perform at least three to four operations. This will help to increase operator skill. Finally, flexibility in production is achieved by reduced WIP and multi-skilled operators, who can work on multiple styles immediately.

3.1 Root Cause Analysis

The principle of root cause analysis is to sock at the root of a crisis by pronouncement and influential its root causes. Root cause analysis is "a group of problem solving methods intended at identifying the root causes of problems or measures or so on [7]. The carry out of root cause analysis is predicated on the certainty that problems are greatest solved by attempting to exact or reduce root causes, as opposed to simply addressing the directly observable symptoms."Our essential rule is the only way to explain a complicated problem is to determine its root causes. Various major problems are founded by analyzing root causes that are shown in Table 1.

Table 1: Major problem In Sewing Section

SL. Name	Problem Name
1	Skipped Stitch
2	Broken Stitch
3	Loose Tension
4	Uneven Stitch
5	Run Off Stitch
6	Slanted
7	High/Low
8	Puckering
9	Crooked
10	Overlap
11	Incomplete

12	Visible Joint
13	Wrong SPI
14	Spot
15	Oil Mark
16	Twisting
17	Label Mistake
18	Visible Top Stitch
19	Color Bone Make Uneven
20	Color Shading

By applying root cause Analysis method majority of this problem can be reduced in a significant amount which will give flexibility to balancing a line well as well as to ensure optimum productivity with defect free units and it will save huge amount of production time.

3.2 Learning Curve

A learning curve is a graphical representation of the increase of learning (vertical axis) with experience (horizontal axis). Learning curve is an industrial tool which has direct and indirect relationship with line balancing as well as facility layout [9]. Learning curves are mathematical models used to estimate efficiencies gained when an activity is repeated. The “learning effect” was first noted in the 1920s in linking with aircraft production. Learning curves draw from historic building practice to decide expected reductions in labor and materials costs. Expected reductions can be determined from the labor and materials content of the manufactured item, plus the number of repetitions of the initial production run. Cost estimate need to reflect the observed characteristic that costs will vary in proportion to the quantity produced. Now a days, learning curves are considered as an important tool or formula in garments industries for better scheduling, line balancing, capacity planning, etc. All of these ensure optimum productivity of the industries. The underlying view behind learning curves is that when people individually or collectively repeat an activity, there tends to be a gain in efficiency. Generally, this depicts the form of a decrease time required for doing the activity. Because cost is generally related to time or labor hours consumed, learning curves are very important in industrial cost analysis. A key idea underlying the theory is that every time the production quantity couples, we can expected a more or less fixed percentage decrease in the strength required to build a single unit (the Crawford theory), or in the average time required to build a group of units (the wright theory). These reductions occur not in big jumps, but more or less smoothly as production continue. Learning tends will be “lost” when there is a break in repetitions of the activity, or a change in the nature of the activity. The usual use of learning curves is to assessment the labor time and thereby cost of labor of a manufactured item that is made in significant quantities. Besides learning curve is used for designing of the manufacturing work force, and valuing costs of production when same tasks are repeated. Here we work with learning curves at some specific operation of a line in a garments industries and comparing these curves with ideal curve. Here we work with learning curves at some specific operation of a line in a garments industries and comparing these curves with ideal curve. The curve from the practical experience are shown in Fig.1

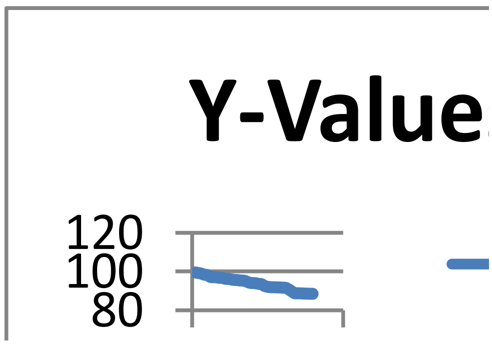

Fig.1 The curve obtained from the practical experience**.**

3.3 Waste Identification

We know that generally there are seven wastes are found in the working areas. In our research we found that all of these waste are not equally present and rise as a vital waste in one working areas. By this way we have identified some of the major waste which consists on our research areas, these are:

- Worker’s waiting for raw material, information and machinery.
- Defective parts made by the operators.
- Unnecessary transportation.
- Over processing.

Excess idle time of the operators can also be considered as a waste. Here we perform experiment over two types of waste like waiting time and idle time. Major waste in the existing line are shown in Fig.2.

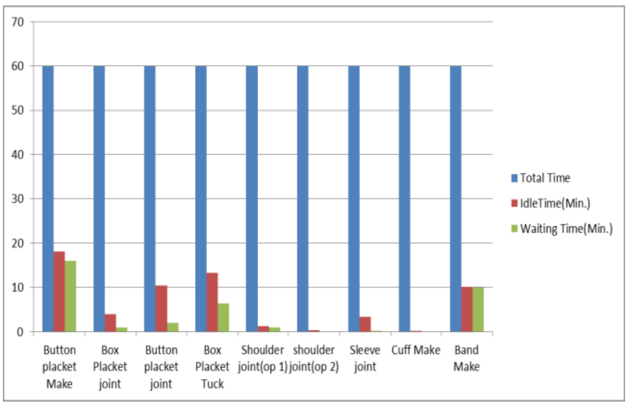

Fig.2 Major waste in the existing line (total time versus waiting & Idle time)

3.4 Time Study

The time study is conducted in a selected certain line whose product is Men's Formal Shirt because operations differ from style to style and it is difficult to correlate all these operations of individual styles. After that, at least two or three operators were selected for each operation so that the difference in timing can be cross checked from the experiential data of these two operators. To get better results, each operation time is taken for at least 5 cycles. Once time study is made by collecting raw data the performance rating is given to each operator and actual time is calculated for particular operation. Finally the Personal Fatigue and Delay (PFD) component is added on the calculated time and the operation time is identical. While conducting time study some parameters are kept fixed (for example machine speed, stitches per inch, type of machine used etc.) to get consistent results. The PFD factor is taken as 12%-15% of total time depending on the types of operation. This PFD is a little bit higher than normal industry standard; it is taken higher considering the standing operation and operator's movement inside the cell. Performance rating is also taken as the average of the performance of the 5 cycles.

3.5 SAM/SMV

Standard Allowed Minute (SAM) is used to measure task of a garment. SAM widely used by production people and industrial engineers in the garment manufacturing industry. SAM value plays a very important role for the estimation of cost of making a garment.

Standard Minute Value (SMV) = NT (1+ AF)

Normal Time (NT) = (Average Cycle Time) x (Rating Factor)

Process Target = 60/SMV

Operation Name	Machine Name	Cycle time	21.00	22.67	18.76	21.01	21.10	Allowance	Avg. cycle time	Avg. Rating
Collar Make	SNLS	Rating	1	0.97	1.05	1	1	13%	20.908	1.004

SMV = NT (1+AF)

= 20.908*1.004(1+13%)

=23.29/60 = 0.40

So, the process target = 60/0.40 = 150

3.6 Proposed Layout

From our experiment we become able to identify the problem or obstacle, the operator's capacity, the root cause of the defect and the major waste of the of the existing production line layout. By considering these problem we can proposed a significant layout for the production line with a view to solving the existing problem and for getting higher productivity as well as optimum productivity. Here we proposing cellular U-Shaped layout by considering the problem of the existing layout of the production line. In figure we have showed the proposed layout for the output section and the other two sections like make and output section will be arranged similarly according to the capacity of the operators, sequence of the operations and the types of machines. Proposed layout is shown in Fig.3.

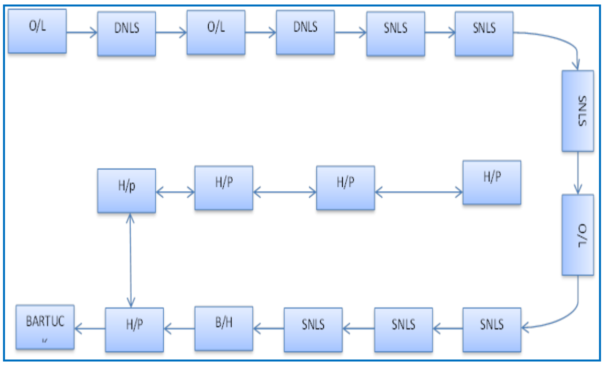

Fig.3 The proposed layout (output section)

Present capacity of the existing manufacturing systems which are summarized in table.2

Table 2

SL.	Operation	Manpower	M/C	SMV(Min)	Present Capacity
1	FRONT JOINT	1	O/L	.35	173
2	FRONT JOINT THREAD CUT	1	H/P	.18	325
3	SHOLDER TOP STITCH	1	DNLS	0.43	139
4	SLEEVE JOINT	1	O/L	o.3o	190
5	SLEEVE JOINT THREAD CUT	1	H/P	0.1	348
6	ARMHOLL	2	DNLS	0.45	270
7	ARMHOLL THREAD CUT	1	H/P	0.23	261
8	COLLER BODY MATCH	1	H/P	0.30	202
9	COLLER JOINT	1	SNLS	0.29	208
10	COLLAR HALA MARK	1	H/P	0.18	326
11	COLLAR TOP STITCH	1	SNLS	0.4	147
12	COLLAR TOP STITCH THREAD CUT	1	H/P	0.25	244
13	CIRE LABEL JOINT	1	SNLS	0.23	261
14	SIDE JOINT	2	O/L	0.71	170
15	SIDE JOINT THRED CUT	3	H/P	0.62	291

16	SAFETY STITCH	2	SNLS	0.51	234
17	CUFF+BODY MATCH	2	H/P	0.33	368
18	CUFF JOINT	2	SNLS	0.62	192
19	CUFF JOINT THREAD CUT	1	H/P	0.34	186
20	HEM	1	SNLS	0.67	89
21	HEM THREAD CUT	2	H/P	0.47	254
22	BUTTON HOLE	2	B/H	0.78	175

4. Result and Discussion

By considering the international demand and the rapid growth of garments in Asian country especially in Bangladesh, the lean facility layout can be a powerful tool of lean manufacturing. In the sewing floor of a RMG industry, to ensure a perfect environment must implement various layout tools to obtain the benefits of lean manufacturing as well as lean facility layout. Lean facility layout has a great influence in garments sectors. As the lean manufacturing reduces wastes that do not add any value to the product, it supports to reduce the manufacturing cost and increase productivity by increasing the labor utilization. Minimize manufacturing cost, increase productivity, maximize interest is the main motto of every manufacturing industries. If the labor utilization increases, a factory can save a handsome amount of cost annually; this will help the factory to exist in the competitive business world. In our research we are enabled to practically work in a garments where we observed the practical environment of a garments especially the practical environment of the sewing floor and we have conducted our research on sewing line by applying some useful lean techniques like Lean facility layout, Seven waste, Learning curve, Root cause analysis, SAM calculation. By these kinds of experiments we become able to know more about layout, the problems of a line, capacity of workers, learning rate of workers.

5. Conclusions and future works

The research is performed based on the practical experiment by using some lean techniques, find out the barriers of the existing line and try to solve these obstacles by applying right techniques right place. The authors feel that these objectives have been accomplished. The sewing floor of a ready-made garment industry is an ideal environment to introduced lean manufacturing tools as well as lean facility layout. From our research we become able to realize that the proper arrangement of layout has a great influence at the improvement of factory performance like better utilization of workers, higher productivity, smooth flow of task, reduce waste, balancing operators capacity and so on.

This research is limited to the only sewing section of the garments industry, but the lean facility layout can be studied and implemented in other areas of the shop floor of the garments like finishing, cutting, warehouse. In cutting section we can save a significant amount of fabrics by arranging the marker ‘layout significantly. Allowance is taken as workers fatigue, motion variation, machinery problem and the factory maintain a standard without calculation but the allowance may vary with the types of fabrics. The line balancing is made as per manual calculation and assuming every operator knows at least three to four operations of individual cells, but operators may not essentially know this much operation confidently. This may cause imbalance of the line so while selecting operator for the particular cell it is necessary to check whether the operator is suitable for that work or not because the cell will perform best if all the group members have the same skill level. If it is not maintain then it will be very difficult to balance line. Performance rating of operators and helper has no mathematical equation; it is measured during time when cycle time is taken. This measurement may not be 100% correct because it is difficult to identify the performance of man. . In organization, manager need better knowledge about the capacity of the workers, problems in the line, future challenges. To gain these he should use the lean tools in the organization and also should try to improve the application of these tools. In this research the lean facility layout is experimented and tried to implement to improve productivity but this can be possible more significant by implementing group incentives and reward system. In this way we can use some motivation theory given by Gant and Gilbert, Taylor, Merrick, Henry Fayal and so on.

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