IMPROVING PRODUCTIVITY OF APPAREL MANUFACTURING SYSTEM USING VALUE STREAM MAPPING AND PRODUCTION CONTROL TOOLS FOCUSING ON PRINTING SECTION

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Abstract

Traditional printing works in maximum garment industries are facing different problems like low productivity, longer production lead time, high rework and rejection, low flexibility, lower quality product, high non-value added work etc. In this study these different problems were identified by using numerous effective production control tools like process analysis, layout of work station, motion and time study, work standardization etc. The encouraging results after implementing these tools give the way to go forward and thrust to reach at the end point. Some key benefits of this implementation are decrease in sample rejection level by 70%, reduction of work level for repairing works by 80%. Value stream mapping has been used to identify the most bottleneck process. Eliminating bottleneck process results in reduction of excess motion and non-value added works by 50%. As a result, total processing time for final output is decreased. After the implementation of these tools effectively, the result shows a significant improvement of the production than before.

Index Terms: *Value stream mapping, Production control tools, Process analysis, Motion study, Time study.*

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1. INTRODUCTION

In this paper, a study was conducted in the printing section under a garment manufacturing company. From textile industry fabric comes to printing section for being the output of sewing section. So, printing section plays a vital role for apparel industries. Printing section involve different types of critical work like expose work, color mixing according to recipe, die work, drying and curing work etc. This study introduces general procedures for promoting improvement and production layout as a means of production design.

1.1 Background

Due to the increasing labor wage in developed countries, the apparel manufacturing has been migrating from the high wage developed world to low wage developing countries. Garment industries in developing countries are more focused on sourcing of raw material and minimizing delivery cost than labor productivity because of the availability of cheap labor. Due to this, labor productivity is lower in developing countries than in the developed ones. Now the worry is about labor productivity and making production flexible; because the fashion industry is highly volatile and if the orders are not fulfilled on time, the fear for losing business is real. In some cases it has been observed that, in developing countries the garment industries are run as family business lacking skilled personnel as well as capital to implement new technologies for improving productivity and flexibility.

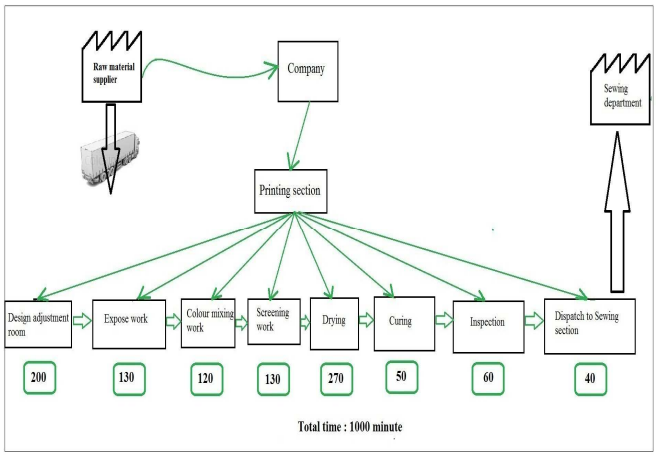

Fig-1: CVSM of supplier to sewing department.

Because of this, industries have been running in a traditional way for years and are rigid to change. They are happy as long as they are sustaining their business. They don't have much confidence and will towards innovation over old processes. Now the time has come to struggle with global market

demand and niche market in garment industries if they want to run it further. The best way to cope with all these challenges is the implementation of production control tools. This will serve our purpose of flexibility and save a lot of money by reducing production lead time, reducing the inventory, increasing productivity, training operators for multiple works, and by reducing rework.

2. VALUE STREAM MAPPING

VSM is a mapping tool that maps not only material flows but also information flows that signal and control the material flows. This enhanced visual representation facilitates the identification of the value-adding steps in a Value Stream and elimination of the non-value adding steps, or wastes. Using VSM, many OEM's and their top-tier suppliers have changed their existing facility layouts, as well as existing systems for material handling, inventory control, purchasing and scheduling, to reduce the total throughput times of orders and current levels of work-in-process (WIP) inventories [10]. Time study has performed for 500 fabrics for the analysis of CVSM and FVSM. Analysis of Current State Map (CVSM) of printing section is shown in figure 1.

Table-1: Cycle time in minutes for departments of printing section.

Sr. No.	Department	Cycle time (minute)	Percentages
01	Design adjustment	200	20%
02	Expose work	130	13%
03	Colour mixing work	120	12%
04	Screening work	130	13%
05	Drying	270	27%
06	Curing	50	5%
07	Inspection	60	6%
08	Dispatch	40	4%

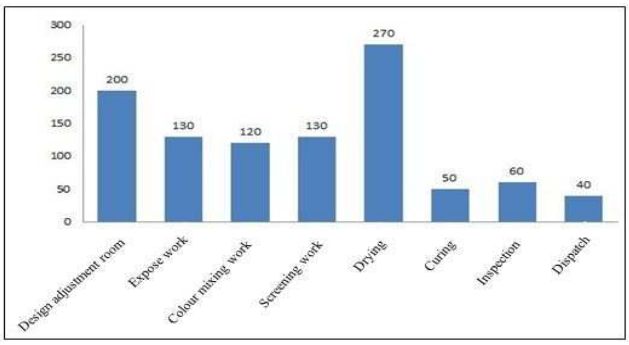

Chart-1: Cycle time in minutes for departments of printing section.

From The Graph it is clear that the cycle time required for drying department is 270 minute which is highest.

The traditional transportation systems of fabric for drying from working table to air circulation medium included the following steps:
(i) First, a worker separates the fabrics which are attached with table using gum.
(ii) Another worker brings a stick which is used to carry the fabrics.
(iii) Then the fabrics are put on the stick and after that stick are carried out to the air circulation medium.
(iv) Fabrics are kept under air circulation medium more than 80 minutes for drying. This drying time can be varied due to some reasons such as weather, air circulation system; colour combination etc.
(v) After completing the required time another worker takes the sticks with fabrics from drying area and delivers the fabrics for inspection.

There are some problems in traditional transportation of fabrics. The Problems are [3]:
(i) Need extra time to separate fabrics from table.
(ii) Need lot of manual equipment to carry the fabrics.
(iii) Need extra workers.
(iv) More waiting time
(v) Underutilization of man, equipment and time.
(vi) Material flow is not smooth.

Table-2: Components with their Cycle time in minutes for drying department.

Sr. No.	Components	Cycle time (minutes)
01	Picking fabric from working table	70
02	Bringing stick to keep fabric on it & Carrying it to the air circulation medium	110
03	Keeping fabric under air circulation medium	90

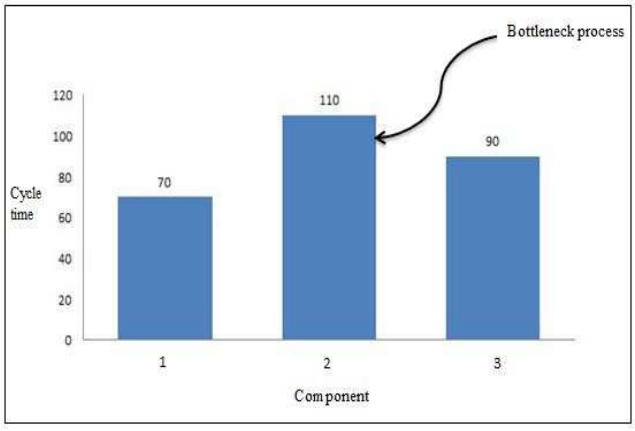

Chart-2: Cycle time in minutes for components of drying department.

So from above graph it can be said that component 2 acts as a bottleneck component which causes more time to finish drying process. The drawbacks can be eliminated by using conveyor system instead of traditional transportation of fabrics from working table to air circulation medium. Conveyor system will also increase production rate as well as overall efficiency. It will reduce non value added time. Number of worker needed to accomplish the task can also be reduced by implementing conveyor system for transportation of fabrics.

A U shaped conveyor system will be established upon the working bed for transportation of fabrics. The designed conveyor for this purpose is shown in figure 2. This conveyor consist a lot of hanger to carry the fabrics. After completing the screening work fabrics will be put on to the hanger. Then hangers will move toward air circulation medium following the path of conveyor system. Sequentially empty hanker will come upon the bed and after that same procedure will be repeated. The working procedure of conveyor is shown in figure 3.

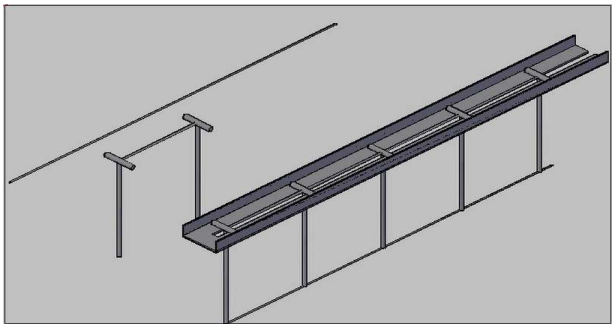

Fig-2: Designed conveyor for drying process.

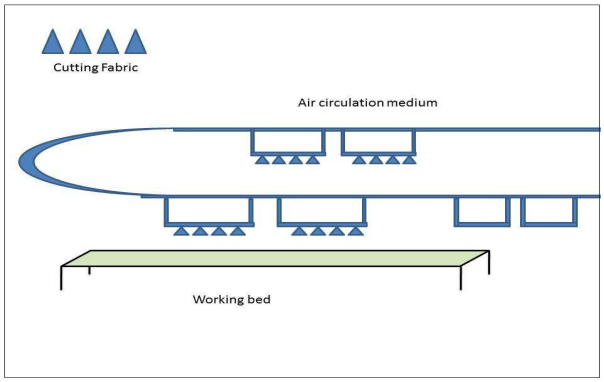

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Fig-3: Working procedure of designed conveyor.

The following graph shows the comparison of Current State Map (CVSM) and Future State Map (FVSM) for component of drying department.

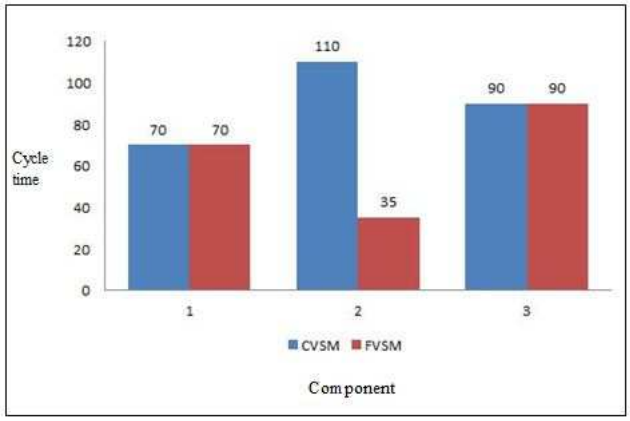

Chart-3: Comparison of CVSM and FVSM for component of drying department.

So the total processing time for drying section is came from 270 to 195 minutes by introducing conveyor system for transportation of fabrics which can be easily observed from above graph.

3. PROCESS ANALYSIS

Processes are units of divided work which form a series of work. Purposes of process analysis are [1]:
(i) To clearly define the order of the processes.
(ii) To clearly define the manufacturing method.
(iii) To make further improvements in each process.
(iv) To provide basic information on improving the performance.
(v) To provide basic information on production design.
(vi) To provide teaching materials for workers and sub-contractor.

For process analysis here a special sign is used (Fig-4).

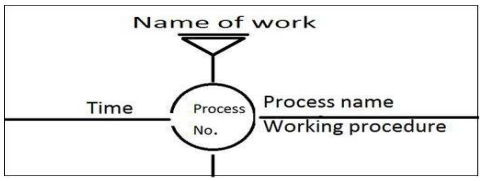

Fig-4: Sign used for process analysis.

Process analysis diagram is shown in figure 5. At first work begin with expose work. Expose is the work to produce die which is the vital equipment of printing work. Process 1 includes adjustment of art design which is sent from buyer. After completing adjustment of design a film is produced with the help of printer which is process 2. In process 3 die is made with combining film and frame with pressing mechanism. After expose work, color related work is carried out. Color composition is one of the most important tasks for printing

work. In process 4 color composition work is done according to color pattern. Additional work 5 and 6 are needed for further processing. Gum and tape are sent everywhere of working bed where printing will be carried out. Cutting part is then set on working bed with the help of gum and tape. In process 7 the main value added work is carried out with combining the output of process 3 and process 6.After process 7, decision making stage is come out. In this stage the color on cutting fabric is examined with buyer requirement. If it seems that the color is perfect than it goes for further processing as primary sample and if not then the process 4, 5, 6 would be carried out according to the way described earlier. After getting primary sample, it sends for curing operation which is process 8. After final inspection, final sample is come out in process 9. After getting final sample it sent to buyer for approval. Buyer can reject final sample in two ways, one for misalignment as well as error of design adjustment and another is for error in color mixing. It will be awkward for company if buyer reject final sample for error in design adjustment. Because then the whole process from 1 to 9 would be carried out according to the way described earlier. If buyer reject final sample for the reason of color mixing then process 4 to 9 would be carried out. If buyer approve final sample then it goes for bulk production. In process analysis time study has performed for 72 fabrics for sampling wok and 250 fabrics for bulk production. So, after process analysis it can be said that the process of design adjustment is more sensitive than any other process. Hence more attention should give for design adjustment to reduce sample rejection rate. With proper concerning on design adjustment and color activity, it is shown that the sample rejection rate can be reduced up to 70%.

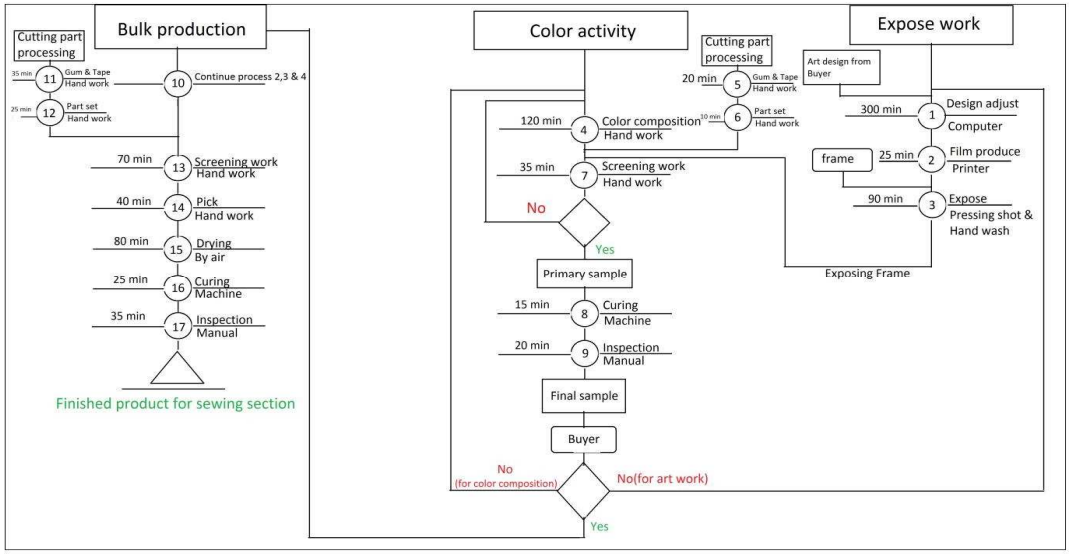

Fig-5: Process analysis

4. LAYOUT

In developing a layout for an operations system we seek the optimum allocation of space to the components of the production process [7]. The need for layout planning arises both in the process of designing new facilities and in redesigning existing facilities. Layout refers to the configuration of departments, work centers, and equipment, with particular emphasis on movement of work (customers and materials) through the system [6].

4.1 Building Layout

During observation of different process of printing section it has been noticed that the orientation of work stations are not good enough. For these reason excess motion and extra works are needed [2]. Type of existing work stations on different floor is shown in figure 6. In ground floor only screening work of all over printing is carried out. First floor consist design adjustment room of piece by piece and all over printing. It also consist an expose room for sampling work of both types of printing. This floor is also used for the bulk production of piece by piece printing. A cutting work of all over printing output and repair work of piece by piece printing are carried out on first floor. Second floor consist expose room of all over printing. And also bulk production, curing and inspection of piece by piece printing are carried out there. In third floor only bulk production of piece by piece printing is carried out. In fourth floor sampling work of both type of printing and bulk production of piece by piece printing are carried out.

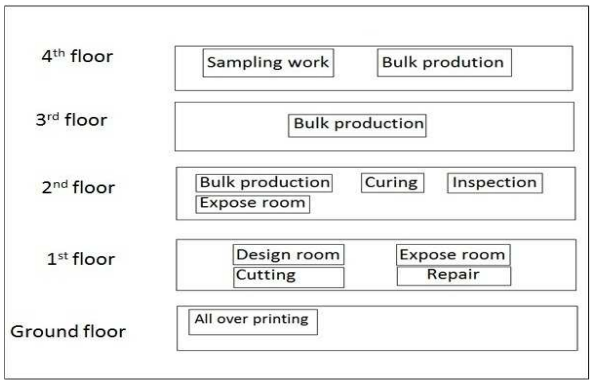

Fig-6: Workstations in different floor for present layout.

After completing capacity analysis [7] of each floor we propose a new layout besides the existence layout of workstations for each floor of 5 stored building. Type of workstations on different floor in proposed layout is shown in figure 7. Where in ground floor, expose room and screening work of all over printing both will come together. Because of sufficient space curing, inspection, repair work of piece by piece printing and also cutting work of all over printing will come together on first floor. In second and third floor only bulk production of piece by piece printing will be carried out. Fourth floor will be accomplished with design room and sampling work of both type of printing. Fourth floor also consist an expose room which will be used for sampling work of both type of printing and it will be also used for the bulk production of piece by piece printing.

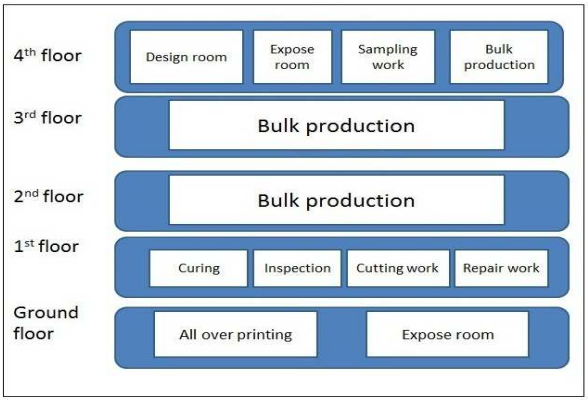

Fig-7: Workstations in different floor for proposed layout.

The results after implementing the proposed layout are:
(i) It minimizes the effort of workers to carry the exposed die for sampling work.
(ii) It remedies the difficulties for workers of lifting exposed die.
(iii) It reduces extra motions and it also form a linear flow of material by eliminating circular flow between different floor.
(iv) It also reduces non-value added work by reducing extra motion.
(v) It minimizes the distance between adjacent workstation and increase worker reliability.

4.2 Curing Process Analysis

In curing process for existing layout operators require extra motion for picking and disposing fabrics from working table because of backward movement [2]. Some operators are waiting beside the input table during idle time. Input and output box are not efficiently distributed. More operators required for this process. The existing layout of curing process is shown in figure 8.

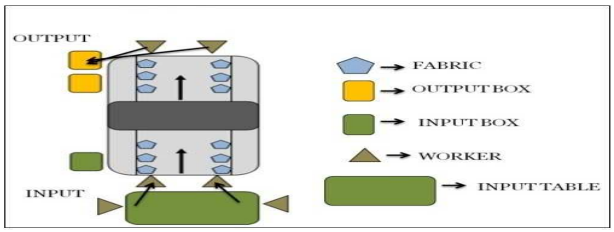

Fig-8: Existing layout of curing process.

It is shown that a smooth production flow is achieved with minimum interruptions after implementing the suggested layout [3] for curing process. It also causes better working condition, less processing time and fewer workers to accomplish the task. The proposed layout for curing process is shown in figure 9.

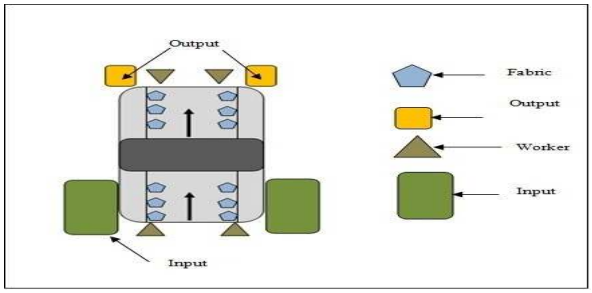

Fig-9: Proposed layout of curing process.

4.3 Inspection System Layout

In existing layout of inspection involved larger processing time. Works cannot be distributed properly among workers because of incorrect layout of inspection system. That's why extra workers are needed for inspection. Because of communication gap it causes less flexibility for workers [4]. The existing layout for inspection system is shown in figure 10.

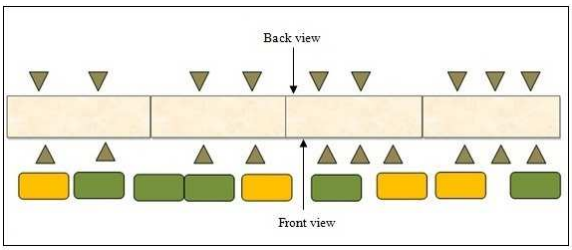

Fig-10: Existing layout of inspection system.

Suggested layout for inspection system is shown in figure 11. By implementing suggested layout for inspection system it is shown that work can be easily distributed among worker and it also reduce the number of worker needed to accomplish the inspection work. It also increases reliability by reducing communication gap among worker.

The improvement of the existing layout of curing and inspection system results reduction of non-value added work by 50%.

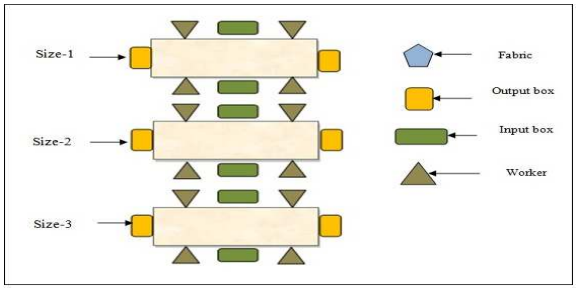

Fig-11: Proposed layout of inspection system.

5. WORK STUDY

Work study is a generic term for those techniques, method study and work measurement which are used in the examination of human work in all its contexts. And which lead systematically to the investigation of all the factors which affect the efficiency and economy of the situation being reviewed, in order to effect improvement. Work study forms the basis for work system design. The purpose of work design is to identify the most effective means of achieving necessary function [9].

5.1 Delivery Section

After the drying section the fabric goes to the inspection section. In this section fabrics are inspected by workers to maintain the quality and find out the defects. If any error in colour combination or any other defect is found during inspection then those fabric goes to repair section to repair the defects. Product without defect goes to delivery section to deliver the output toward sewing section.

The procedures followed for deliver the output are:

(i) After completing the inspection, fabrics put on a basket according to their size.
(ii) Then the baskets are sent to the delivery section.
(iii) In delivery section a worker transfer all fabrics into a sack.
(iv) Then a worker tied the bundle.
(v) Then it stored to deliver for sewing section.

Problems involved in traditional delivery system of final output are [3]:
(i) Needs extra time to transfer the fabrics from basket.
(ii) Need extra worker.
(iii) The quality of the fabric may be hampered.

These problems can be eliminated by introducing a lift system which will carry the final output for sewing section just after the inspection stage. By introducing lift system for deliver the output reduce the time needed for transportation and also reduce the number worker needed to accomplish the task. By the utilization of gravity it also increases flexibility for worker [5].

5.2 Repair Work

Repair work means doing the job over again, because it wasn't right the first time. Set up procedure of the fabric has identified as the main cause for repair work. The steps involved to set a fabric on working table are:
(i) At first a worker sweeps the working bed by gum.
(ii) Then a worker distributes the Tape.
(iii) Then a worker distributes the fabric.
(iv) Then a worker attached the tape and fabric on the table.

After two or three cycle of printing, it is necessary to clean the table for next cycle. In this situation it produces a lot of dirt due to gum and tape. When it is cleaned it may be present in the air with small amount which may be fall in the fabric in next cycle and then it causes poor printing quality. For these reason repairs work is needed to improve the printing quality of the fabrics. It is shown that using of wax instead of gum and tape on working table results reduction of repair work by 80%.

6. SUMMARY AND CONCLUSIONS

The research consists of conducting time and motion study of printing operations. By doing this, printing operations will be standardized and production targets for each operation will be fixed. Secondly, working condition and space utilization are improved and also processing time, number of workers decrease by the implication of new layout. In the research, the unit layout has been implemented to increase the productivity. Similarly, the sitting operations have been converted into standing operations for better movement of operators in between the machines, from the perspective of work balancing and uniform work load

distribution. Finally, flexibility in production is achieved by reduced work in progress and complexity in material flow.

7. RECOMMENDATION FOR FUTURE RESEARCH

In this research, only the printing operations are standardized due to time limitation. But this work can be extended for other operations like stitching, storing etc. This will minimize the duplication of work and it is easier to calculate standard time of new style by reallocation of some operations over existing. In this research conveyer system with hanger has been suggested for drying process, but it is necessary to be reviewed some other way also which will be profitable for long period. It is also important to be reviewed some other material instead of wax for table to reduce repair work more effectively.

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