# Reducing Screen Printing Lead Time by Implementing TQM: A Quality Control Circle Approach

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## Abstract

Total lead time of complete readymade garments depends on the sum of individual processing lead time such as spinning, knitting, dyeing, finishing, all over printing, cutting, screen printing, embroidery, sewing, washing, packaging etc. In this work, process of receiving of input to delivery of output of Screen Printing Industry is studied. Quality Control Circle approach is used to find out the possible causes for which print delay of quality printing happens. Total Quality Management tools are applied to modify the working process which results significant reduction of lead time inside the factory which is applicable for all screen printing processes of RMG sector. Effect of reducing printing lead time is calculated in terms of monetary value for validation of the implementation of developed model.

**Key Words:** Screen Printing, Quality Control Circle, Lead Time, TQM

## 1. Introduction:

In this competitive business era, selling price need to be kept minimum to earn the competitive business advantage. Following cost leadership strategy in the global market, to be successful in business there is no other alternative other than reducing overall operating cost. Operating cost can be controlled by maintaining minimum lead time, reducing excess manpower, developing scientific management production process etc. Larger lead time is a costly exercise, generally regards this as primary evil from managerial point of view. Delivering the buyers order within the committed lead time plays a vital role to establish a long term business relationship with the buyers. Therefore, only by reducing the lead time of individual processing unit the total lead time of readymade garments can be reduced. The objective of this research work is to develop an ideal model for screen printing industry production process which ensures minimum lead time, man power effective utilization and scientific production process. Modified screen printing process of developed model is applied to Thanbee Print World Ltd. and cost benefit analysis is calculated to verify the developed model. Reducing lead time by modified screen printing process also results a reduction of operating cost of the industry.

## 2. Literature Review:

Based on the data of Emirati airline companies, there is a positive relationship between TQM and the organizational performance (OP), reached to a decision by (Androwis, Sweis et al. 2018). TQM implementation improves customer satisfaction, the economy of an organization, and superior management of workers within companies (Malik, Banerjee et al. 2018). The nine constructs of TQM implementation are Top management commitment & involvement, Policy deployment with process control & improvement, Research and development, training & education, maintaining

suppliers' empowerment & relationship, customer relationship, employee empowerment & involvement, and evaluation & assessment, which can be implemented by the industries of Nepal to get benefit from TQM implementation described by (Pradhan 2017). Productivity has been improved as total alters and rejections have been considerably reduced after implementing the proposed TQM framework, reported by (Syduzzaman, Biswas et al. 2016). Bangladeshi textile and apparel sector must be able to adopt TQM to help them meet global challenges in the long run concluded by (Syduzzaman, Islam et al. 2016). Quality Circle programs adaptation lead to improvement in employment productivity rate and absenteeism described by (Marks, Mirvis et al. 1986) How and why Japanese Quality Control circle worked to improve competitiveness in the Japanese industries showed by (Watanabe 1991). The percentage of eyes with achieved refractive outcomes within 0.5 di-opter significantly increased from 63.2% to 80.8% after successful implementation of QC Circles (Lin, Chang et al. 2017). Human behaviour sensing and visualization technologies support QC circle activities (Okuma, Fukuhara et al. 2017). The importance of establishing the quality circle in a production firm in order to resolve some of the issues in terms of the quality of the technological process is depicted by (Blaga and Jozsef 2014). Total Quality Management (TQM) keeps vital role in improving productivity, product quality and reduces manufacturing cost by reducing rework and scrap stated by (Syduzzaman, Rahman et al. 2014). A study confirms the effectiveness of quality circles in improving quality of work-life and job satisfaction of nurses working in Emergency Medical Services, and offers their application as a management method that can be used by EMS managers (Hosseinabadi, Karampourian et al. 2013). Systematic review of the application of quality improvement methodologies from the manufacturing industry to surgical healthcare done by (Nicolay, Purkayastha et al. 2012)

## 3. Proposed Methodology:

Quality Control Circle is a concept to improve the quality by identifying problems and generating possible scopes of solutions in the working area of the circles. At first, details study of screen printing is done by creating SIPOC diagram of the printing process. Through brainstorming tool root causes of print delay are identified which causes an increase in lead time. Then, cause and effect diagram is created relating the effect - print delay and the causes of print delay dividing into man, machine, material and method types. Sub causes are also listed in the categories. Matrix is formed to prioritize among the different causes are critical to customers. Numerical data is collected and check sheet is created daily. Histogram and cumulative percentage are created to see the graphical representation of the collected data. Later, Pareto chart is drawn by Minitab software to identify the implementation priorities. 4W-1H analysis techniques are followed to find the potential solution for implementation. Finally, benefit cost is analysed of the implementation to validate the potential solutions. At last, post implementation Pareto chart is drawn to understand the causes for delay are withdrawn from the root or not? Thus, standardize and sustainable screen printing lead time reduction methodology is developed.

## 4. Problem description:

Dulal Brothers Ltd. (DBL) group is a vertically integrated knit garments manufacturing & exporting composite industry. The group started its business in 1991. Thanbee Print World Ltd. is one of the sister concerns for screen printing process of DBL Group which is hundred percent export oriented project. The factory has manual printing tables, manual printing machines, auto circular machines, auto oval machines, silicon printing machines etc. for carry out different types of printing such as Rubber, Pigment, Discharge, Puff, Plastisol, Foil, Crack, Gel, High-Density,

Reflective, Barn out, Dark in the glow, Metallic, Flock, etc. The input of this factory is come from the cutting section and the output printed panels are also delivered to cutting section of the group. SIPOC diagram is created to relate the supplier to customer of Thanbee Print World Ltd. (TPWL). From the customer – cutting sewing section's data analysis it is found that due to delay in screen printing at TPWL difficulties are arising to meet the overall lead time for complete garments provided by the buyers.

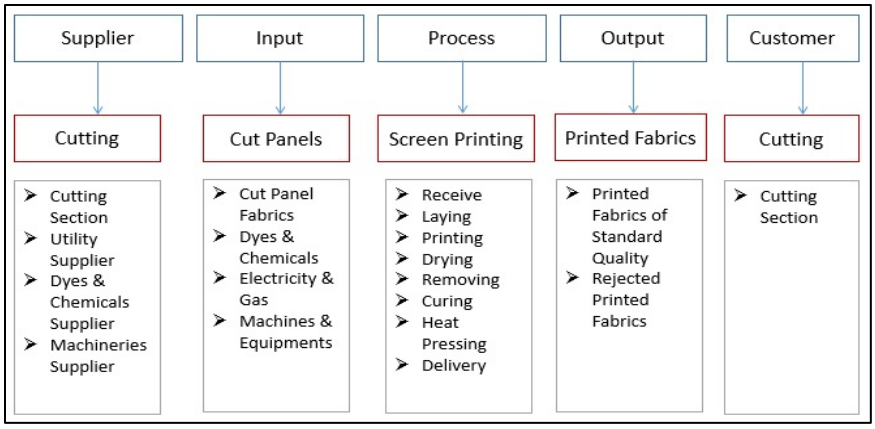


Figure 1. SIPOC diagram of Thanbee Print World Ltd.

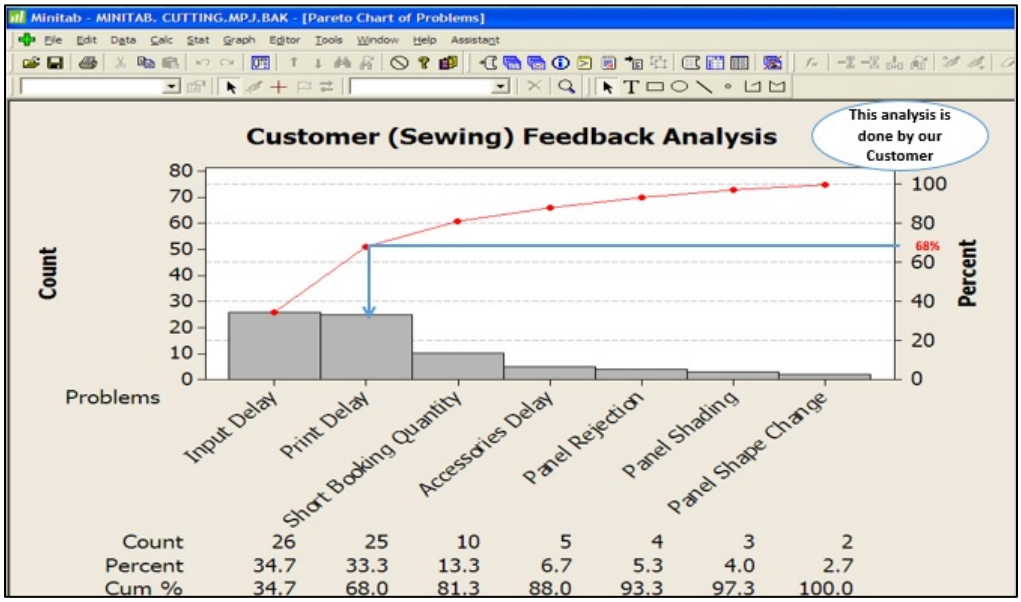


Figure 2. Pareto analysis to understand the customer requirements

The root causes are identified and the cause effect diagram is drawn to create potential solutions of print delay. Man, Machine, Material, Method and Environment are taken as sub causes.

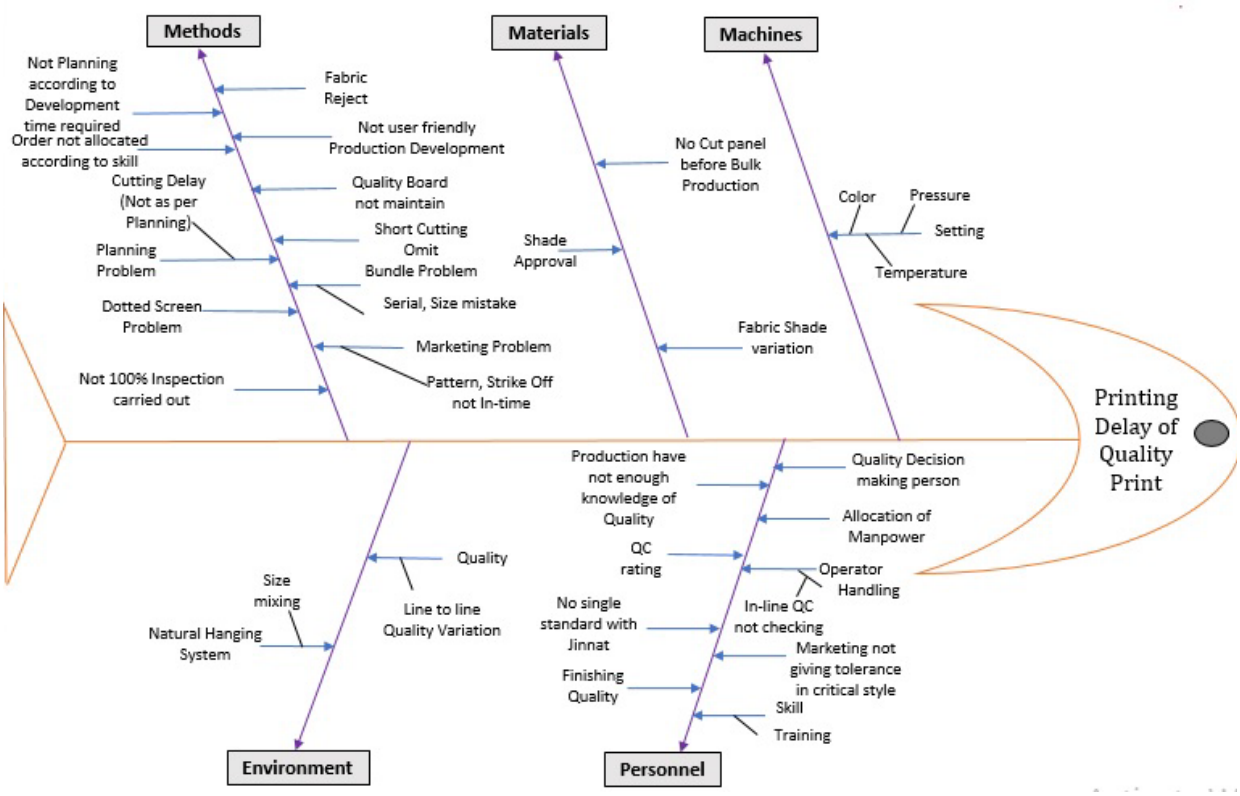


Figure 3. Cause effect diagram for printing delay of quality print

To prioritize the root causes which are critical to the customer matrix is created by giving the appropriate scores. If the solution implementation is of highest difficulty level scored 1 and the lowest difficult level scored 9. Again after implementation for the best result the rating is 9 and lowest result the score is given 1. By multiplying the scores of result and implementation difficulty level printing delay causes are ranked to be solved.

Table 1. Priority Matrix critical causes to customer

| Key Points | Causes | Implement Difficulties | Result | Score | Position |
|---|---|---|---|---|---|
| Cut Panel Replacement | Fabric Reject | 8 | 9 | 72 | 2nd |
| | Print Reject | 7 | 9 | 63 | 4th |
| | Size, Serial Mistake | 9 | 9 | 81 | 1st |
| | Size mixing at natural hanging | 9 | 9 | 81 | 1st |
| Single Checking | Skill of Quality Controllers | 5 | 9 | 45 | 2nd |
| | Rating of Quality Controllers | 8 | 8 | 64 | 3rd |
| | Not allocating according to criticality | 5 | 5 | 25 | 3rd |
| | Quality checking after Finishing - not available | 9 | 9 | 81 | 1st |
| Quick Quality Decision | No Senior person to give Quality Decisions | 9 | 9 | 81 | 1st |
| | Marketing not giving tolerance in critical styles | 5 | 5 | 25 | 3rd |
| Team Work | Production Vs. Quality Personnel | 6 | 8 | 48 | 2nd |
| | Finishing Rectify | 5 | 7 | 35 | 3rd |
| Scientific Management | Work study personnel not available | 9 | 9 | 81 | 1st |
| | Production Target and Overtime not selected scientifically | 7 | 9 | 63 | 4th |

Data collected of the first ranked causes to understand the practical scenario. Later checks sheet, histogram data are drawn –

Table 2. Check sheet for data collection

| Key Points | Causes | Defects Check Sheet | | Total |
|---|---|---|---|---|
| Cut Panel Replacement | Fabric Reject | 𝍸 | 4 | 40 |
| | Print Reject | 𝍸 𝍸 𝍸 | 21 | |
| | Size, Serial Mistake | 𝍸 | 9 | |
| | Size mixing at natural hanging | 𝍸 | 6 | |
| Single Checking | Skill of Quality Controllers | 𝍸 | 7 | 50 |
| | Rating of Quality Controllers | 𝍸 | 3 | |
| | Not allocating according to criticality | 𝍸 𝍸 | 11 | |
| | Quality checking after Finishing - not available | 𝍸 𝍸 𝍸 𝍸 | 29 | |
| Quick Quality Decision | No Senior person to give Quality Decisions | 𝍸 𝍸 | 10 | 15 |
| | Marketing not giving tolerance in critical styles | 𝍸 | 5 | |
| Team Work | Production Vs. Quality Personnel | 𝍸 | 5 | 10 |
| | Finishing Rectify | 𝍸 | 5 | |
| Scientific Management | Work study personnel not available | 𝍸 𝍸 𝍸 𝍸 | 19 | 35 |
| | Production Target and Overtime not selected scientifically | 𝍸 𝍸 | 16 | |

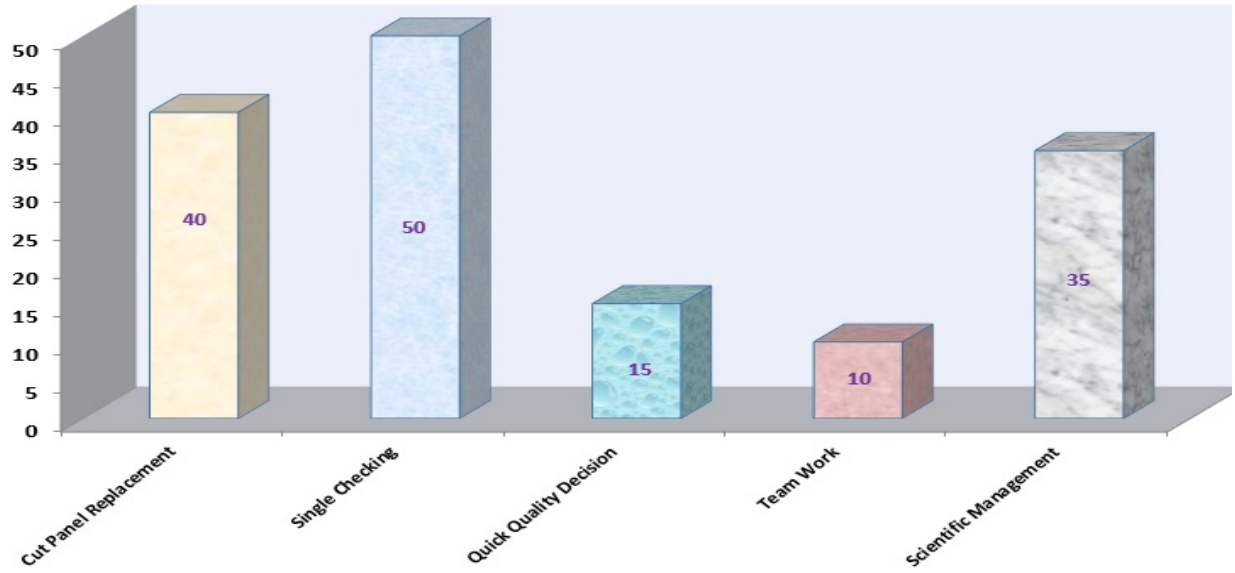


Figure 4. Histogram for causes of printing delay

Minitab software is used to draw Pareto chart for determining vital causes to be prioritized and solved. 4W-1H analysis is done to find out potential solution of the prioritized causes.

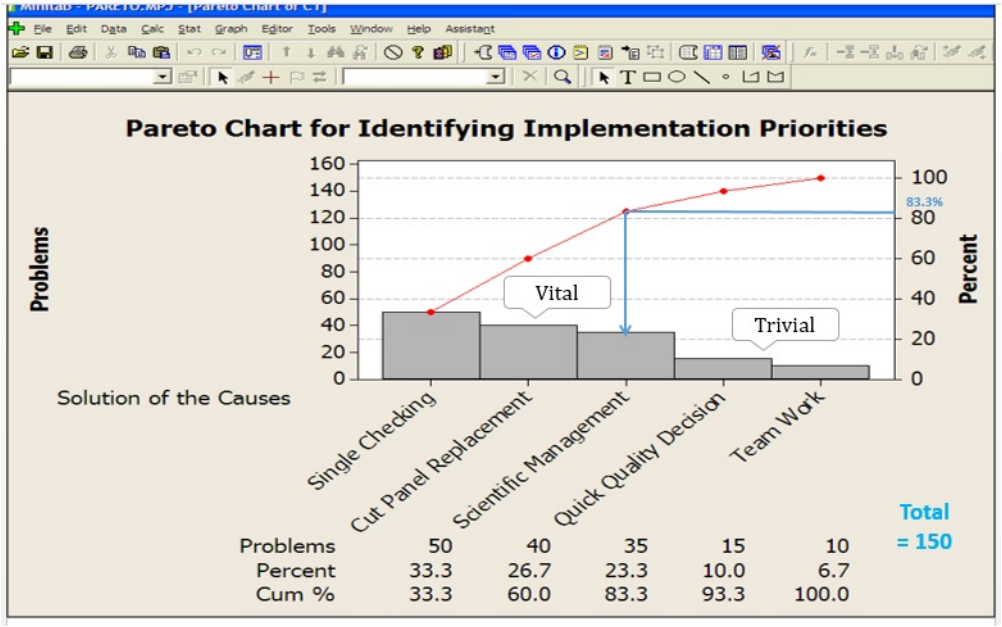


Figure 5. Pareto chart for identifying implementation priority

Table 3. 4W-1H analysis to determine the solution

| 4 W – 1H Questions | Solutions | | |
|---|---|---|---|
| What is the Problem?? | Double Checking | Rejected Cut Panels | No Standard time and Scientific Target is maintain |
| Where the Problem Is?? | At Thanbee Print World Ltd. & Garments section | From Garments & at Thanbee Print World Limited | At Thanbee Print World Limited |
| Why the Problem is happening ?? | Quality Standard not followed at TPWL | Fabric Reject, Print Reject, Size & Bundle Mistake | Work Study Team is not Available |
| Who is responsible?? | QC team and Quality Department | QC team and Quality Department | QC team and Thanbee Print World Management |
| How to solve the Problem?? | Complete Standard is maintain at Single Check Point – Thanbee Print World Ltd. | Extra Cut Panels are provided from Cutting Section for Cut Panel Replacement | Establishing Work Study Department, Setting Scientific working Target |

## 5. Result and Discussion:

**Solution 1:** On previous process, same fabric of 1.5% problems were checked at 3 workstations which is the prime reason for increased lead time of screen printing. Training programs weekly for Quality Personnel & Production Staffs are arranged at regular basis for upgrading the standard of Quality Checking and high Quality Production. The jobs are allocating to effective personnel according to the criticality of the work. The proposed modified process eliminates 1 workstation to quality check are shown graphically below –

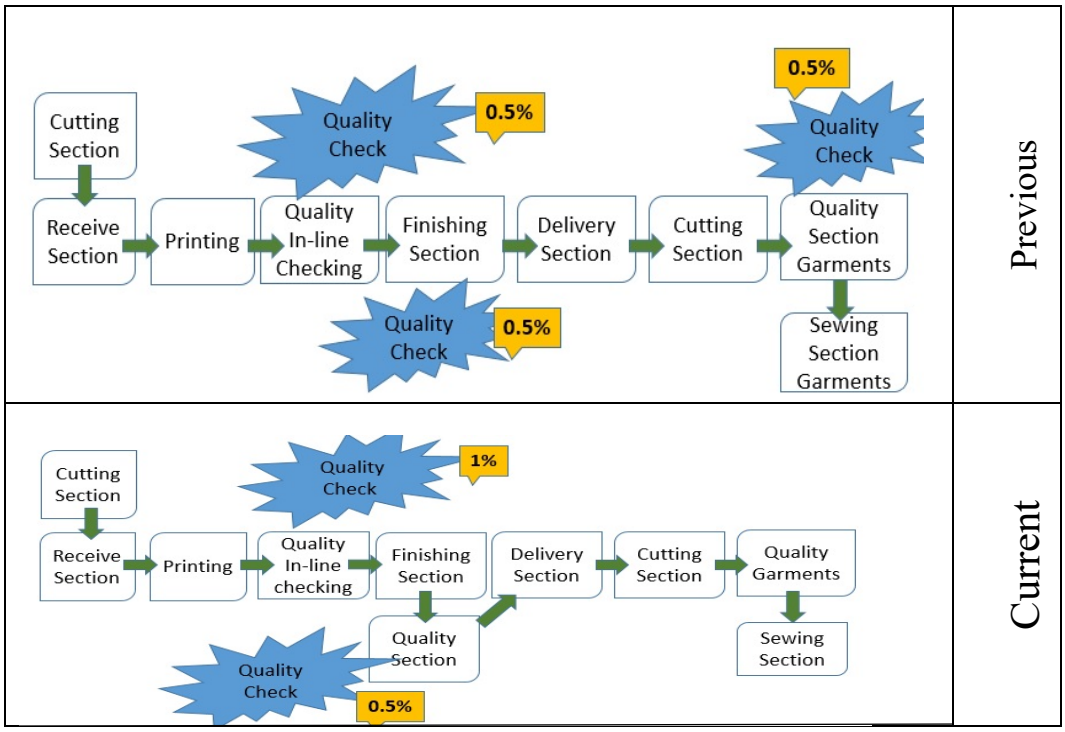


Figure 6. Graphical representation of previous and current screen printing process

**Previous System: (Manpower)**
Quality Department Printing = 36
Finishing Section Printing = 50
Quality Section Garments = 20
Total = 106 Persons

**Current System: (Manpower)**
Quality Department Printing = 76
Finishing Section Printing = 0
Quality Section Garments = 0
Total = 76 Persons

**Cost Savings at Current System:**
Manpower Reduction = (106 - 76) = 30 Persons
Average Salary of a Quality Controller
= $150
Savings = $150 x 30 x 12
**Yearly Savings = $54,000 per year.**

Reduced Manpower are not downsized. They are transferred to other Sections.

**Solution 2:** The cutting part has screen printing on it are sent to TPWL with 1.5% extra panels with different grading. When there is a size mistake, without printing the panel is removed and replaced by same grading extra panel provided and bundle is fulfilled. In previous process, if there is a rejection of printed panel, other panels (back/front, two sleeves) were thrown away as wastage. But modified process provides full bundle, so there is no need to waste the good panels.

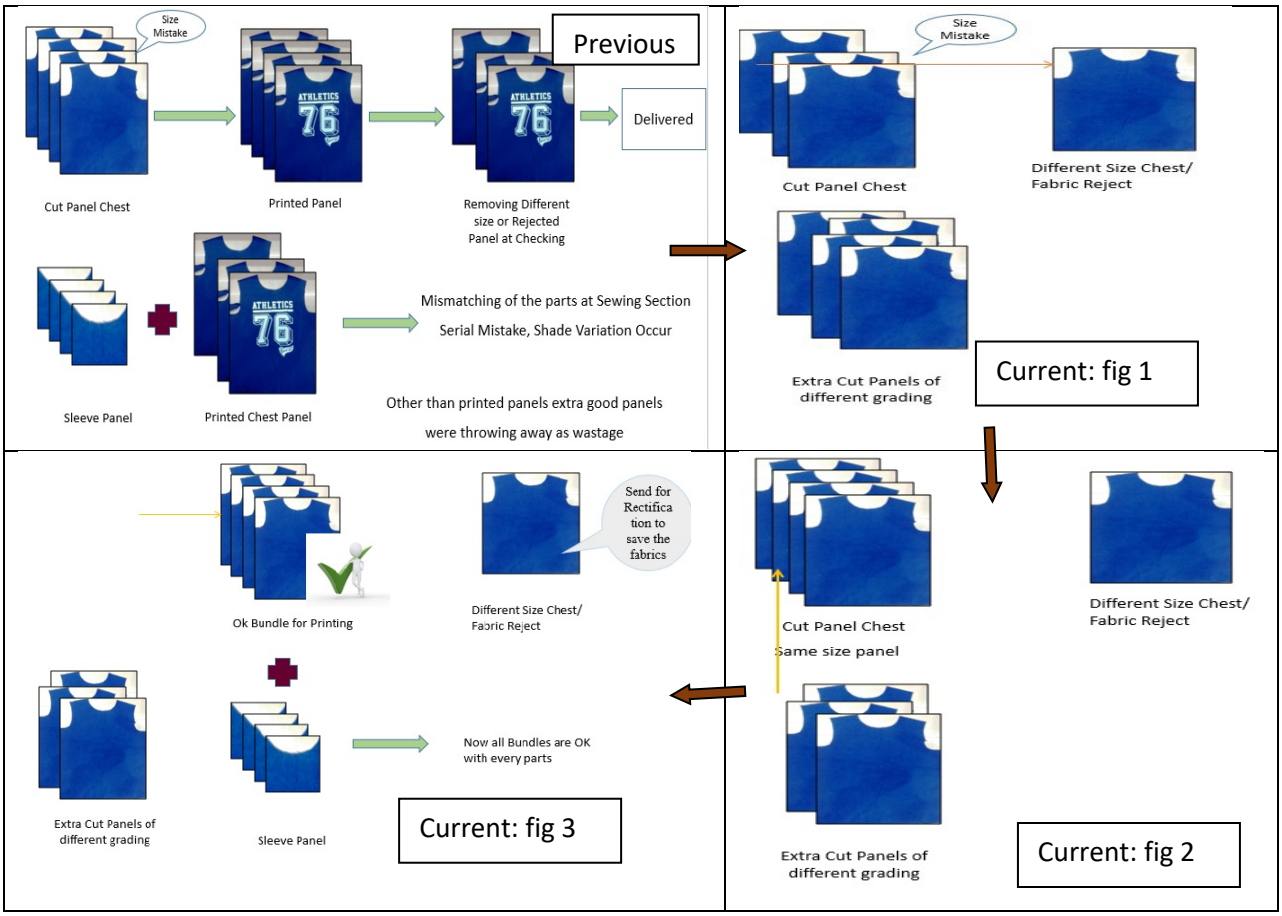


Figure 7. Graphical representation of previous and current screen printing process

Average Parts in a Complete Garment = 4 (Front, Back, 2 Sleeves)

Average Production Front part= 12,00,000 pieces per month

Rejection percentage = 1.5% of 12,00,000 = 18,000 pieces

So, at previous system these 18,000 complete garments need to be cut again. Previously 1 piece rejection at print factory caused a loss of another extra 3 pieces of parts than this present system.

Therefore, Savings of fabrics per month = 18000* 3 = 54,000 parts.

1 Kg fabrics = 20 parts of fabrics

So, 54,000 pieces = 2700 Kg per month are saved.

1 Kg price on average = 7.5 USD

Monthly Savings = 2700*$7.5 = $20, 250

**Yearly Savings = $20,250 * 12 = 243,000 USD**

**Solution 3:** At previous process, hourly target and daily target were given without any base. Overtime (OT) was extensively high with very low amount of production comparative to regular time. Work study manager is assigned to establish work study department at Printing. Work study executives are working to set the production targets scientifically according to different styles. In case of fulfilling targets the production personnel are inspired with

incentives weekly. A competitive environment is developed after every weekly production meeting caused increasing Productivity. Production Loss Time is decreasing gradually.

Table 4. Comparison of overtime after implementation of work study

| Line Name | January OT (hours) | March OT (hours) | Line Name | January OT (hours) | March OT (hours) | Line Name | January OT (hours) | March OT (hours) |
|---|---|---|---|---|---|---|---|---|
| A1 | 83 | 50 | F1 | 80 | 75 | Auto-2 Night | 71 | 28 |
| A2 | 95 | 63 | F2 | 83 | 75 | Auto-3 Day | 88 | 59 |
| B1 | 103 | 99 | G1 | 71 | 64 | Auto-3 Night | 66 | 39 |
| B2 | 96 | 83 | G2 | 79 | 74 | Auto-4 Day | 81 | 60 |
| C1 | 109 | 97 | H1 | 71 | 62 | Auto-4 Night | 73 | 30 |
| C2 | 92 | 87 | H2 | 80 | 75 | Auto Oval Day | 105 | 66 |
| D1 | 72 | 54 | I1 | 114 | 69 | Auto Oval Night | 67 | 7 |
| D2 | 73 | 69 | Auto-1 Day | 80 | 60 | Manual | 149 | 46 |
| E1 | 89 | 77 | Auto-1 Night | 69 | 37 | **Total** | **2414** | **1759** |
| E2 | 98 | 93 | Auto-2 Day | 79 | 60 | **Difference** | **655** | |

Average Manpower per Line = 20

Over Time Decreased = 2414 – 1759 = 655 hours

Average Overtime payment = $0.5/ hour

Cost Saving = 20 *655 hours/Line *$0.5/ hour = 6,550 USD per month

Expenditure due to salary of Work Study Executives = 2 x $250 = 500 USD per month

Salary of work study manager = 800 USD per month

**Yearly Savings = ($6550 – $1300) x 12 = 63, 000 USD**

## 6. Conclusion:

Successful implementation of the research work in Thanbee Print World Limited reduced the Lead time of screen printing. Rejection percentage reduced at a substantial amount. Total operating cost also came down. Wastage is minimized. Team efforts between departments increased at a significant way. Customer supplier relationship is improved, thus cultural imperatives for quality is established. The application of implemented project is not limited to particular factory rather all the business units with similar production process.

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