Garment Sewing Process Delay Problem: Worker Performance Efficiency Improvement in a Philippine Garment Company

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Abstract. Work simplification results to operational efficiency as most labor-intensive enterprise utilize it for improving each process done in the production. Productivity can be obtained through utilization of the available resources, a factor for a speed production of goods. In this study, workers experienced delays on the sewing process of sleepwear garments due to technical and assorting issues. These problems cause 21-25% product defects on needle machines incurring PhP. 47,000 total income loss per 1,000 pieces of garments. Through work sampling, creating a standard operational breakdown could serve as a basis for the worker performance in eliminating the unnecessary hand and body movements, which workers' performance are considerably 85% efficient. Recommendations such as progressive flow process, operational breakdown through process simplification, and addition of a new production processes (i.e. cut strings for hanger loops, attach logo and before side seam) for the continuous flow of production is expected to improve the whole sewing process by 21.93%.

Keywords: work simplification, productivity, efficiency, methods engineering, work sampling

1. INTRODUCTION

Worker performance is the ability of the worker to execute a series of tasks given by the company in order to produce a product. With proper utilization of the available resources and doing each process right the first time with less cost, workers tend to perform the job efficiently and produces quality products through right movements and techniques needed to finish the job at a shorter period of time. In this way, the capacity of the worker to perform each assigned task appropriately helps increase productivity and their improvements to perform each task efficiently. Efficiency is achieved when each worker performs a specific task with correct movements that allows each worker to finish the task with less interruptions and delays in production. In addition, the efficiency improvement and proper management can also be a factor to an efficient performance by implementing a "single-tasking" activities and an open communication between the worker and the management.

For most garment manufacturing industries, every process and movements done in the operations are the most important elements needed for a rapid production of quality goods. Efficiency improvement plays a major role in the operations of garments industries wherein non-value adding activities are being identified and considered to be the causes of delays. The elimination of these delaying factors is beneficial to a smooth and consistent performance of the workers that leads to a faster production and higher profitability.

This study shows the effects of the improvements and changes made on the sewing process of a Philippine Garment Company through the application of methods engineering and operations research. Through these processes, each movement are being identified, timed and translated into a mathematical equation as basis for determining the optimal process needed to attain the efficiency of the workers when performing each task of the production. This study also serves as basis for maximizing the profit of the company while minimizing the cost spent and for each worker to perform efficiently. This will also help each worker's performance to have an efficient way of doing appropriate practices of each task needed for the production.

1.1 Problem Statement

The workers play a vital role in the production of goods to a certain garments company; however, the delays experienced by the workers during the production of sleepwear garments on the sewing process creates technical and assorting issues which leads to a range of 21-25% product defects on needle machines, incurring PhP 47,000 total income loss for every 1,000 pieces of garments. Daily reports show that workers commit 15-25% rejected outputs at the end line production daily caused by the defects acquired during the sewing process that were considered to be inefficient.

1.2 Objectives of the Study

The main objective of this study is to create at least 10% improvement on the performance efficiency done by the workers in the production of sleepwear garments in a Philippine garment company through elimination of non-value adding activities, addition of significant processes and combination of similar processes.

Specifically, this study aims to:

1. Create a standard time for each process that helps the workers finish the task and produce the desired outputs before its deadline.
2. Measure the actual time of producing the sleepwear garments to eliminate the non-value adding activities done by the workers using snapback timing method.
3. Determine the efficiency of the workers in doing each task through work sampling.
4. Evaluate each worker performance through management by objectives.
5. Calculate the maximum profit through linear programming - maximization method.

1.3 Scope and Limitations of the Study

This study is subject to the following conditions:

1. This study considered the production time of each worker including overtime shifts.
2. This study will not be considering the selling price of the product for cost-benefit analysis due to confidentiality imposed by the company towards money.
3. The data being considered are based on actual observations and calculations for each process.
4. This study will only be considering twenty (20) observations for each process due to limited time allotment for the actual time study.

2. LITERATURE REVIEW

Based on the study of Ofreneo (2012), the Philippine Garments Industry grew through the quota system implementation. However, the industry has continuously been losing its competitiveness in the global market due to the lack of strategic industrial policies that are being implemented in a local organization. Also, the on-going relationship of the Philippines and the United States through free trade policies aims to export all American products in the Philippines is considered as one of the major causes of the crisis encountered by most industries in the country as most of the garments manufactured in the country depend on the approved designs by customers in the United States through a made-to-order system. Productivity improvement has been implemented to such industries in order to achieve transformation, diversification and simplification (Ahmed et. al. 2013). The sudden drop of employees working in this industry impacted the amount of time needed for the worker to produce each product before its deadline. To provide a solution on this problem, methods engineering could help simplify the work done by the workers and improve each process done in the production.

The study done by Morshed and Palash (2014) focused mainly on the imbalances occurring in the production that causes longer overall line cycle time and bottlenecks in the production. These bottlenecks were eliminated through the use of benchmarking and balancing the workload of each workstation by creating a variation from the current to the proposed processes that would allow each worker to perform each process continuously with no waiting time needed. Considering the manpower, work hours and the standard minute value as basis for line balancing, the labor productivity and line efficiency have been improved from 40 and 44 to 50 and 53 respectively. In addition, the total manpower needed per line decreased from 27 to 24 each day and target per hour has been balanced to 180 outputs with 80% efficiency. As a result, lesser time has been consumed in hitting the customer demand and 3 workers were transferred to a different line of production. Similarly, based on the study conducted by Nunesca and Amorado (2015), lean manufacturing tools can be incorporated in line balancing in order to reduce production times and to eliminate non-value adding activities. The use of qualitative and quantitative research approaches can increase the productivity of each worker and standardize each process cycle times. The reduction of standard minute value can also be determined through time study, taking into consideration the capacity of the workers can produce in a day. Consequently, manpower can be utilized to produce the demand each day (Nabi et al. 2015).

For Karim and Rahman (2012), in order to utilize the manpower available in an assembly line of production, lean manufacturing tools such as Pareto Analysis, Ishikawa Diagram and 5S or work-place organization must be used in order to determine the wastes in the sewing production at a garment industry in Bangladesh. Some wastes and failures in production that were identified from these tools were waiting time, rejected garments due to inefficiency of the workers and overproduction. Once these wastes were eliminated, an increase in productivity can be achieved and profit can be maximized at a least period of time. Through linear programming, the maximization of profit can be determined with a consideration of the available resources that is useful to produce the desired outputs (Vakilifard et al. 2013). The demanded outputs can be produced continuously with modified step by step processes that are being performed simultaneously. Proper allocation of raw materials is vital for fast and efficient production which significantly contributes in the performance of each worker (Wang et al. 2014). Job performance, ergonomically, indicates the efficiency of a worker to perform the task at a high skill level considering the working conditions and the standards set by the organization. The physical efforts exerted for each task greatly affect worker performance satisfaction from the management (Kahya 2007).

3. METHODOLOGY

Preliminary data gathering was conducted by the researchers to have an indication of the current production rate. Based from the observation, 14 workers were 85% productive out of 16 production hours (960 minutes). Otherwise, they were unproductive that includes two allowable 15-minute break time. Figure 1 shows the breakdown of the observations conducted.

Work sampling technique was utilized to determine the number of observations needed in the study. The total productive and unproductive rates for each worker, the maximum error of 0.05 were considered that resulted to a total of 196 observations for each process in the production.

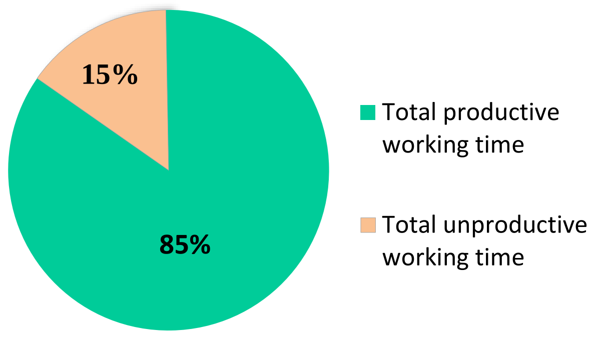

Figure 1. Proportion of Working Hours

3.1 Nomenclatures

Linear programming is a technique used to determine the maximum profit or to minimize the cost of production in a certain company. This is also used to generate the optimal solution that would help increase the company's profit and can be obtained through a linear program stated below:

$$\text{Maximize } 10000X1 + 10000X2 + 1000X3 + 10000X4 + 10000X5 + 10000X6$$

Subject to

$$\begin{aligned}
0.58X1 &\le 4400\\
0.58X2 &\le 4400\\
0.58X3 &\le 4400\\
0.58X4 &\le 4400\\
0.58X5 &\le 4400\\
0.58X6 &\le 4400\\
0.50X1 &\le 4400\\
0.50X2 &\le 4400\\
0.50X3 &\le 4400\\
0.50X4 &\le 4400\\
0.50X5 &\le 4400\\
0.50X6 &\le 4400\\
2.80X1 &\le 2400\\
2.80X2 &\le 2400\\
2.80X3 &\le 2400\\
2.80X4 &\le 2400\\
2.80X5 &\le 2400\\
2.80X6 &\le 2400\\
2X1 &\le 2400\\
2X2 &\le 2400\\
2X3 &\le 2400\\
2X4 &\le 2400\\
2X5 &\le 2400\\
2X6 &\le 2400\\
2.80X1 &\le 2400
\end{aligned}$$

$2.80X2 \leq 2400$
$2.80X3 \leq 2400$
$2.80X4 \leq 2400$
$2.80X5 \leq 2400$
$2.80X6 \leq 2400$
$1.20X1 \leq 3400$
$1.20X2 \leq 3400$
$1.20X3 \leq 3400$
$1.20X4 \leq 3400$
$1.20X5 \leq 3400$
$1.20X6 \leq 3400$
$1.50X1 \leq 3400$
$1.50X2 \leq 3400$
$1.50X3 \leq 3400$
$1.50X4 \leq 3400$
$1.50X5 \leq 3400$
$1.50X6 \leq 3400$
$4X1 \leq 2400$
$4X2 \leq 2400$
$4X3 \leq 2400$
$4X4 \leq 2400$
$4X5 \leq 2400$
$4X6 \leq 2400$
$1.80X1 \leq 3400$
$1.80X2 \leq 3400$
$1.80X3 \leq 3400$
$1.80X4 \leq 3400$
$1.80X5 \leq 3400$
$1.80X6 \leq 3400$
$2.20X1 \leq 2400$
$2.20X2 \leq 2400$
$2.20X3 \leq 2400$
$2.20X4 \leq 2400$
$2.20X5 \leq 2400$
$2.20X6 \leq 2400$
$0.80X1 \leq 4400$
$0.80X2 \leq 4400$
$0.80X3 \leq 4400$
$0.80X4 \leq 4400$
$0.80X5 \leq 4400$
$0.80X6 \leq 4400$
$0.80X1 \leq 4400$
$0.80X2 \leq 4400$
$0.80X3 \leq 4400$
$0.80X4 \leq 4400$
$0.80X5 \leq 4400$
$0.80X6 \leq 4400$
$0.73X1 \leq 4400$
$0.73X2 \leq 4400$
$0.73X3 \leq 4400$
$0.73X4 \leq 4400$
$0.73X5 \leq 4400$
$0.73X6 \leq 4400$

$$X_1, X_2, X_3, X_4, X_5, X_6 \geq 0$$

The objective function constitutes the total profit (in Philippine Pesos) that the company earns each month for one design of garment. The decision variables are the number of outputs needed for the company to produce monthly in order to achieve the maximum profit earned. On the other hand, the constraints consist of the total number of outputs being produced each month considering each process (a total of 13) done by the workers in the production. Through Lindo software, this would easily calculate the number of outputs needed to produce each month in order to attain the maximum profit.

4. RESULTS AND DISCUSSION

4.1. Normal and Standard Time

Normal time is the time accumulated by a worker in finishing a specific task without exerting any extra effort and is working at a normal pace. The assumption set by the company for the worker to perform each task was obtained using the formula:

$$\boldsymbol{NT = Elemental\ Average\ x\ PF} \quad (1)$$

Where:

NT = Normal Time
E.A. = Elemental Average in minutes
PF = Performance Rating Factor

Standard time is the amount of time exerted by the worker in performing the job considering 7% personal allowances and 4% fatigue allowances set by the company to finish a certain task. These times were calculated using the formula:

$$\boldsymbol{ST = Normal\ Time\ x\ (1 + ALL)} \quad (2)$$

Where:

ST = Standard Time in minutes
ALL = Allowance Percentage

Table 1. Present Normal and Standard Time

PROCESS	E.A.	PF	NT	ALL.	ST
1	0.52	1	0.52	0.057	0.58
2	0.45	1	0.45	0.043	0.50
3	2.52	1	2.52	0.277	2.80
4	0.75	1	0.75	0.083	2.00
5	1.80	1	1.80	0.198	2.80
6	1.08	1	1.08	0.119	1.20
7	1.35	1	1.35	0.385	1.50
8	3.60	1	3.60	0.396	4.00
9	1.62	1	1.62	0.178	1.80
10	1.98	1	1.98	0.218	2.20
11	0.72	1	0.72	0.079	0.80
12	0.72	1	0.72	0.079	0.80
13	0.66	1	0.66	0.073	0.73
Total			**17.77**		**21.71**

Table 1 shows the perceived time done by a worker for each process working at a normal pace and calculated normal and standard time for each process.

4.2 Efficiency

A worker who produces more outputs each day is considered to be efficient. The efficiency of a worker also considers the overall performance of all workers on each line within a working shift. It is computed using the formula:

$$\boldsymbol{Efficiency} = \frac{(\boldsymbol{Output\ x\ ST})}{(\boldsymbol{WH\ x\ n\ x\ 60})} \quad (3)$$

Where:

ST = Standard Time (in minutes)
WH = Working Hours
n = Number of workers on each line

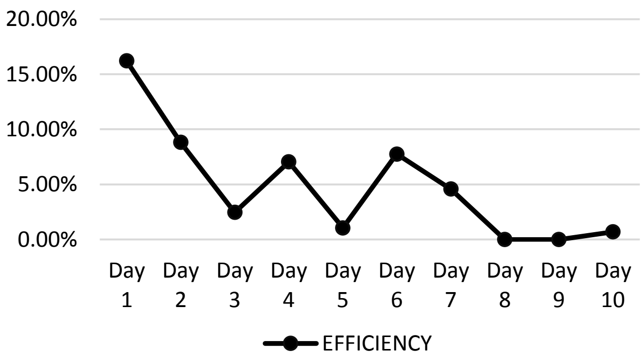

Figure 2. Sewing Efficiency of Workers

Figure 2 shows the efficiency of all 14 workers working in the production line each day considering the ratio of the standard time of production and the accumulated outputs each day over the total minutes attended by all the workers involved in the production.

4.3 Maximization of Profit

Considering the nomenclatures in determining the maximum profit of the company, Lindo displayed the following values of the profit and the decision variables:

```
LP OPTIMUM FOUND AT STEP      6

       OBJECTIVE FUNCTION VALUE

       1)      0.3060000E+08

 VARIABLE         VALUE          REDUCED COST
       X1        600.000000          0.000000
       X2        600.000000          0.000000
       X3        600.000000          0.000000
       X4        600.000000          0.000000
       X5        600.000000          0.000000
       X6        600.000000          0.000000
```

Figure 3. Maximum Profit using Lindo

Figure 3 also shows that the company needs to produce a minimum of 600 garments each month considering a minimum purchase order of 150 garments every week in order to attain the maximum profit of 306 million pesos (PhP 306,000,000) in six (6) months.

5. CONCLUSIONS

The proposed method on this study states the addition of the new processes needed to produce the desired output. Combining some processes from the present methods were also considered on the proposed method since these processes can be done by a single worker in a timely manner. Re-arranging the proper flow of production also resulted to a shorter time in performing each process without having to affect the availability of the workers needed to perform the job.

Through this study, the company's set standards for each process can also be improved since lesser time can be implemented to finish such tasks. The proposed standard time can also be major factor in increasing the profitability of the company at lesser time and for the workers to maintain their efficiency in doing each process. Therefore, profit can be maximized through utilization of workers given that standards are set and resulting to the attainment of desired outputs.

6. RECOMMENDATIONS

6.1 Process Improvement and Cycle Time Redu ction

Through Time Study, improvements were made by eliminating the non-value adding activities and normal time were obtained through observed time and performance rating factor. These factors were used to determine the proposed standard times for each process. The addition of two more processes for quality requirements and the combination of two process were also recommended in order to maintain a fast but yet, efficient production among workers.

Table 3. Proposed Normal and Standard Time

PROCESS	E.A.	PF	NT	ALL.	ST
1	0.14	1	0.14	0.015	0.16
2	0.66	1	0.66	0.073	0.73
3	0.34	1	0.34	0.037	0.36
4	0.98	1	0.98	0.108	1.09
5	1.68	1	1.68	0.185	1.68
6	0.94	1	0.94	0.103	1.04
7	1.51	1	1.51	0.166	1.68
8	0.70	1	0.70	0.077	0.78
9	2.63	1	2.63	0.289	2.91
10	1.47	1	1.47	0.162	1.63
11	0.66	1	0.66	0.073	0.73
12	0.83	1	0.83	0.091	2.13
13	0.45	1	0.45	0.050	0.50
14	0.45	1	0.45	0.050	0.50
15	0.93	1	0.93	0.102	1.03
Total			**14.37**		**16.95**

Table 3 presents the proposed normal time that were obtained through observed time and the performance rating factor which were used to distinguish the proposed standard times. The addition of two (2) more processes and the combination of two processes were also proposed in order to maintain a fast but yet, efficient production among workers. A total of 21.93% improvement was made on the total process cycle time that can be used for the production of other designs of manufactured in the operations. Finally, a total of fifteen (15) processes should be performed by the workers in order to produce the garment considering the proposed processing time and to meet the quality standards set by the client for the design.

6.2 Cost-Benefit Analysis

After generating improvements on the processes being done by the workers in the production of garments, significant drop on its cost has been made as compared to the existing process. The analysis on production cost was measured to serve as basis for implementation of the proposed processes.

Present Cost of Labor Production

$$440 \ min \ x \ \frac{Php.58.25}{hour} \ x \ \frac{hour}{60 \ min} = \boldsymbol{Php.427.17}$$

Proposed Cost of Labor Production

$$(440 - 4.76)min \ x \ \frac{Php.58.25}{hour} \ x \ \frac{hour}{60 \ min} = \boldsymbol{Php.422.55}$$

Cost Savings = PhP4.62

Each worker is required to work 60 hours per week within 6 working days of a given week. Analyzing the proposed method, the company would save 4.76 minutes for every production of garment which can lead to a total savings of PhP4.62 for every piece of garment (i.e. 600 garments = PhP 2,772 savings each month). Thus, there is no significant effect on the total savings even when there is an addition of two new processes. The cost savings can also be utilized and spent for other expenses of the company.

6.3. Recommendation for Future Studies

Future research should be considered that can work and focus on the utilization of each worker taking into account the number of garment designs available for production. Through Time and Motion Study and Linear Programming, this would analyze the efficiency and capacity of the worker to perform such tasks given the number of working hours and the number of outputs a worker can produce for a specific design using the available resources in production. The consideration of the selling price and the demand of garment being manufactured can also be supportive figures that can be considered in forecasting the production of garments. Lastly, the applicability of Time and Motion Study and Linear Programming to other industries can be a great help in maintaining the efficiency of worker in production.

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