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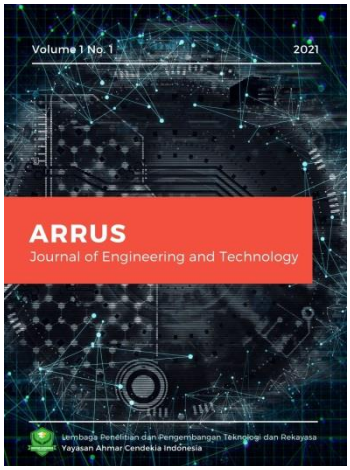

*Corresponding author: Syed Tam Husain, Faculty of Commerce, Van Lang University, Ho Chi Minh City, 70000, Vietnam

E-mail: tam.husain@vlu.edu.vn

RESEARCH ARTICLE

Application of Industrial Engineering Technique for Better Productivity in Garment Industry

Nguyen Viet Tinh, Syed Tam Husain*, & Nguyen Van Thanh

Faculty of Commerce, Van Lang University, Ho Chi Minh City, 70000, Vietnam

Abstract: In recent years, with the strong development of the industry, it has created a competitive market. To be able to stand and survive requires businesses to create their own charisma based on the products they create must have the quality, cost and speed quickly. To do that requires businesses to have proper production strategies. Especially for the garment industry, which has a lot of waste in the production process that needs to be eliminated. This study focuses on the construction of standard time sets and standard activities to help eliminate wasted time on hand movements and time spent by workers. The result ca be used to develop the standard operation procedures of the production process.

Keywords: Garment industry, standard operation, waste reduction.

1. Introduction

Time-based research is a technique used to estimate the standard time that allows one step to be completed in a certain way at the normal pace of an average and trained workman. This technique is based on measuring the content of work performed in a certain way, with reasonable compensation for fatigue and personal problems, as well as factors Unforeseen occurrences can occur during production processes that are beyond the control of the worker.

Determination of time limits is the process of measuring and forecasting the production time required to create a unit of product or semi-finished product. In the apparel industry, the required production time is called the norm time. Factors influencing the time scale are product defect, worker time, downtime for adjustment, effects on labor conditions as well as worker psychological status. It can be said that the design of time-normative measures is the heart of the production department. Because when working methods work, workers can solve real problems. Time norms will tell us how much time it will take to produce a product, determine the cost of producing that product, and determine the price correct for that product. With time limits, we can roughly estimate how long it takes for a customer to deliver which is necessary for the production planning and division of labor, as well as the comparison and selection of effective product methods such as the purchase of new machines, the number of production servers, the determination of reasonable work and the assessment of worker productivity.

2. Literature Review

The Institute of Industrial Engineers defined time study as, "A work measurement technique consisting of careful time measurement of the task with a time measuring instrument, adjusted for any observed variance from normal effort or pace and to allow adequate time for such items as foreign elements, unavoidable or machine delays, rest to overcome fatigue, and personal needs." Time study is most popular and used method for

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line balancing and solving bottlenecks. One problem of time study is the Hawthorne Effect where it is found that employees change their behavior when they know that their being measured (Jannat et al., 2009).

Balance is an important factor. In traditional performance measurement approach, the most important goal of evaluation is performance measurement while modern approach has focused on evaluated growth and development capacity (Norton, 1999). Drucker (1954) argued that one potential solution was to introduce "balanced" sets of measures. Market standings, innovation, productivity, physical and financial resources, profitability, manager performance and development, worker performance and attitude, and public responsibility are appropriate performance criteria (Neely, 2005). Modern evaluation system results in satisfaction improvement, efficiency improvement, and finally improvement in effectiveness of organizational activities (Nabi et al., 2015; Jung et al., 2020).

3. Methodology

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3.1. Research Process

The research process of the paper is shown in Figure 1:

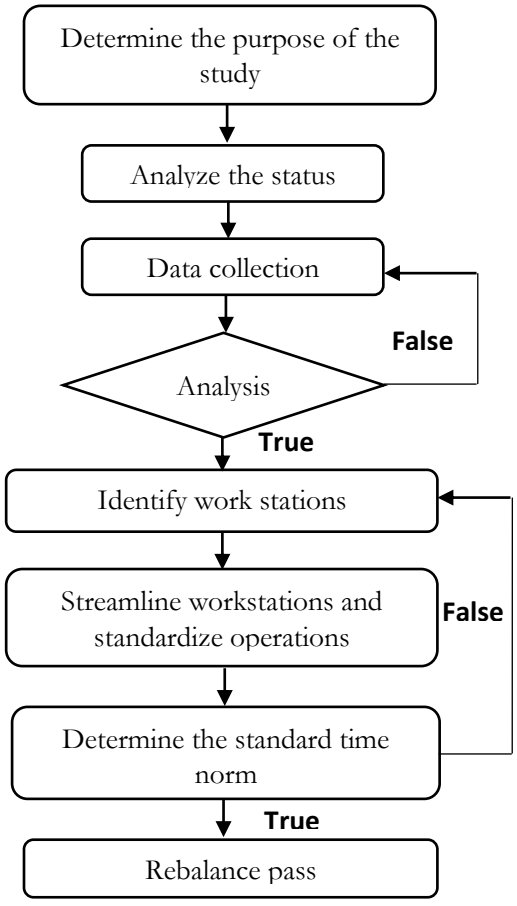

Figure 1: Research process

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3.2. Standard Time Set Development

The standard time set is developed through 8 steps as follows:

Step 1: Determine the purpose of the study. This involves the ultimate use of research results, including the degree of accuracy as well as the reliability required of standard time.

Step 2: Carry out an action analysis to determine the standard work methods and conditions, and whether the worker performs the correct operation. It is necessary to ensure that the work of the workers is standardized and homogeneous before hitting the clock, studying the time.

Step 3: Select a worker to conduct a time study if more than one worker performs the same procedure.

Step 4: Record all information about: workers, products, equipment, requirements on product quality as well as working conditions.

Step 5: Properly divide the activities into many small components.

Step 6: Record the time each worker worked on each component during the operation.

Step 7: For each operational component, calculate the average observation time, then multiply by the factor evaluating the worker's performance will be the standard time.

$$Standard\ time = Average\ time\ of\ observation * Performance\ evaluation\ coefficient \quad (1)$$

Step 8: Determine the clearing factor for various delays according to the company's standards or conduct independent research in order to correctly construct the compensation factors.

$$Time\ norm = standard\ time + sum\ of\ offset \quad (2)$$

Where: The sum of the offset includes personal compensation, fatigue, ...

$$Standard\ time:\ NT = OT * \frac{R}{100} \quad (3)$$

Where: OT is the time of observation and R is performance completed.

Step 9: Determine the actual standard time required for the stages of production using the formula:

$$Actual\ Standard\ Time = Standard\ Time * (1 + Coefficient) \quad (4)$$

$$ST = NT * (1 + A) \quad (5)$$

3.3. Production Process Balancing

Step 1: Identify the tasks that must be performed to complete a separate product.
Step 2: Determine the sequence of work to be done.
Step 3: Draw a workflow diagram.
Step 4: Estimate the time of work:
Calculate cycle time (T_{CK}).

$$Cycle\ time = \frac{Actual\ production\ time\ in\ the\ period}{Quantity\ to\ produce\ in\ the\ period} \quad (6)$$

Calculate the minimum number of production areas

$$Minimum\ area\ number = \frac{Time\ to\ complete\ the\ product}{Cycle\ time} \quad (7)$$

Efficiency of use (machinery or labor).

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$$Efficiency = \frac{Number\ of\ minimum\ production\ areas}{Number\ of\ actual\ production\ areas} * 10 \quad (8)$$

4. Case Study

In this session, the proposed method is applied to a real-world case study to demonstrate its usability. The case study is performed in phases: first processing input data and putting it into process simulation to find hidden problems, then propose a rebalancing solution.

4.1. Analysis of Input Data

Determine the actual production time of each workstation in the workflow as the basis for improvement, we proceed to pre-press, collect the actual production time of each workstation in accordance with the way. The actual layout is as shown in Table 1.

Table 1: Actual production time

Number	Stage name	Time manipulation (s)	Time Garments (s)	Total time (s)	Construction standard time (s)	Stage
1	XEN XQ LA 2 + EP NHIET	43.64	0	43.64	47	1
2	LAY DAU LA 2 + TAY HANG	33.51	0	33.51	28.3	2
3	UI LA 2 + CHAN CO	36.51	0	36.51	30.8	3
4	UI MOI KEO LA 2 + UI MOI MS	40.31	0	40.31	39.9	4
5	MAY LON LA 2	8.9	8.8	17.7	24	5
5A	MAY BOC CHAN CO	8.22	12.14	20.36	17.2	6
6	CHAN CO DUONG THANG	6.76	33.71	40.47	37.5	7
7	MAY CAP LA 3	15.6	23.7	39.3	31.4	8
7A	LUOC LA 2	2.85	3.5	6.35	6	9
8	XEP LY TS + GAN DAY	20.13	20.47	40.6	40.3	10
9	MAY CUON DO	15.78	26	41.78	38.5	11
10	DIEU LA 2 GAN BALEM	13.52	22.29	35.81	39.6	12
11	CUON NEP NUT	5.4	15.88	21.28	20	13
11A	MAY NEP KHUY	4.24	10.11	14.35	21.9	14
12	MAY LON MS	6.36	22.86	29.22	24	15
12A	BOC MS	11.05	7.46	18.51	20.6	16
13	DIEU MS	3.72	30.86	34.58	30.8	17
14	UI MS TRA + XQ TUI + DUOI DO	42.07	0	42.07	34.3	18
15	TRA TUI	10.65	26.23	36.88	31	19
16	MAY CUON TRU NHO	12.5	29.06	41.56	33.3	20
17,18	MAY TRU LON	8.94	21.06	30	36.8	21,22
19	GOT SUA DO + LAY DAU TRU	40.71	0	40.71	39	23
20	THUA KHUY NEP	5.36	35.06	40.42	48.3	24
21	ĐINH NUT NEP	4.26	21.25	25.51	33.8	25
22	MAY CUON VAI CON	7.44	26.44	33.88	36.5	26
23	TRA TAY VS	8.88	17.88	26.76	45.4	27
24	DIEU VONG TAY	28.41	23.08	51.49	41.5	28
25	CUON SUON	35.69	21.78	57.47	43	29,30
26	TRA CO	11.47	30	41.47	38.7	31
27	MI CO CAU DAU	29.77	15.17	44.94	39.2	32

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Number	Stage name	Time manipulation (s)	Time Garments (s)	Total time (s)	Construction standard time (s)	Stage
28,29	TRA MS XEP 1 LY	13.95	26.62	40.57	57.3	33,34
30,31	MAY CUON LAI BAU + LUOC NHAN SUONG	10.18	31.66	41.84	41	35,36
32	THUA KHUY CC + MS	8.75	11.59	20.34	22.5	37
32A	ĐINH NUT CC + LA 2 + MS	6.25	20.43	26.68	25	38
	Total production time			1118.9	954.4	

With the worker's time minus lunch time is 31200 seconds and the rated power is 700 products per day. The company's target time, day goal yield that needs to be:

$$\text{Productivity line} = \frac{31200*32}{954.40} = 1046 \text{ (products/day)}$$

$$\text{Current demand} = \frac{31200}{1046} = 29.83 \text{ (s)}$$

Parameters to evaluate the current line:

$$\text{Target Source} = \frac{1118.90}{29.83} = 37.51 \approx 38 \text{ (stations)}$$

$$\text{Balance pass rate} = \frac{1118.90}{32*57.47} = 51.23 \text{ (\%)}$$

4.2. Production Process Simulation

4.2.1. Stage Function Distribution

The distributions of the functions of each stage are collected and analyzed using the built-in Input Analyzer tool in Arena 14 software, shown in Table 2.

Table 2.: Distribution functions

Number	Stage name	Distribution function
1	XEN XQ LA 2 + EP NHIET	42 + 4.91 * BETA(1.23, 1.77)
2	LAY DAU LA 2 + TAY HANG	31 + 5 * BETA(0.887, 0.881)
3	UI LA 2 + CHAN CO	TRIA(32, 36.6, 41)
4	UI MOI KEO LA 2 + UI MOI MS	37 + 8 * BETA(1.31, 1.85)
5	MAY LON LA 2	TRIA(14.1, 18.9, 21)
5A	MAY BOC CHAN CO	TRIA(18, 21.6, 24)
6	CHAN CO DUONG THANG	37 + ERLA(1.28, 3)
7	MAY CAP LA 3	36.3 + 5.58 * BETA(1.36, 1.13)
7A	LUOC LA 2	TRIA(5, 6.47, 7.56)
8	XEP LY TS + GAN DAY	39 + 8 * BETA(1.61, 1.16)
9	MAY CUON DO	TRIA(42, 45.5, 47)
10	DIEU LA 2 GAN BALEM	34 + 2.92 * BETA(1.25, 1.37)
11	CUON NEP NUT	18 + 5 * BETA(2.71, 1.94)
11A	MAY NEP KHUY	12 + 4 * BETA(1.43, 1.28)
12	MAY LON MS	TRIA(28, 32.9, 35)

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Number	Stage name	Distribution function
12A	BOC MS	18 + 2.98 * BETA(1.17, 1.66)
13	DIEU MS	34 + 3 * BETA(0.89, 1.61)
14	UI MS TRA + XQ TUI + DUOI DO	TRIA(39.1, 43, 44)
15	TRA TUI	34 + 3.97 * BETA(1.65, 2.13)
16	MAY CUON TRU NHO	TRIA(40, 45.8, 47.9)
17,18	MAY TRU LON	27.1 + 2.9 * BETA(2.29, 1.37)
19	GOT SUA DO + LAY DAU TRU	35 + 10 * BETA(1.63, 1.23)
20	THUA KHUY NEP	42.1 + 4.31 * BETA(1.35, 1.13)
21	ĐINH NUT NEP	TRIA(24, 24.9, 29)
22	MAY CUON VAI CON	TRIA(28, 32.9, 35)
23	TRA TAY VS	TRIA(24, 25.8, 27.7)
24	DIEU VONG TAY	UNIF(37.4, 43.6)
25	CUON SUON	TRIA(35, 38.5, 43)
26	TRA CO	TRIA(40.1, 42.7, 44.7)
27	MI CO CAU DAU	TRIA(34, 34.9, 37)
28,29	TRA MS XEP 1 LY	UNIF(39, 46)
30,31	MAY CUON LAI BAU + LUOC NHAN SUONG	TRIA(37, 41.5, 46)
32	THUA KHUY CC + MS	17 + 6.98 * BETA(1.35, 1.47)
32A	ĐINH NUT CC + LA 2 + MS	TRIA(22.1, 28.3, 31)

4.2.2. Simulation Results

The simulation of the actual sewing process in the sewing line can show the bottlenecks and waiting time in the process. Based on the men's shirt manufacturing process and the company's collected data, we can build a logical model that we can set up a logical model on the Arena software. The model is set up for 10 days and every working day for 8 hours. After running the model, the actual productivity of the sewing line was 455 products per day.

4.2.3. Results after applying standard time norm

The result of normalization is that after standardization of the working procedure, determination of the coefficients of compensation is necessary. The constructed standard time norm is compared to the current standard time being applied in the company (Table 3).

Table 3: Standard time norm and standard times are being applied

Number	Stage name	Construction standard time norm	Standard times are being applied at the company
1	XEN XQ LA 2 + EP NHIET	50.34	47.00
2	LAY DAU LA 2 + TAY HANG	38.66	28.30

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Number	Stage name	Construction standard time norm	Standard times are being applied at the company
3	UI LA 2 + CHAN CO	42.12	30.80
4	UI MOI KEO LA 2 + UI MOI MS	46.50	39.90
5	MAY LON LA 2	21.39	24.00
5A	MAY BOC CHAN CO	24.28	17.20
6	CHAN CO DUONG THANG	51.08	37.50
7	MAY CAP LA 3	47.49	31.40
7A	LUOC LA 2	7.46	6.00
8	XEP LY TS + GAN DAY	52.74	40.30
9	MAY CUON DO	52.90	38.50
10	DIEU LA 2 GAN BALEM	44.50	39.60
11	CUON NEP NUT	27.64	20.00
11A	MAY NEP KHUY	18.64	21.90
12	MAY LON MS	35.31	24.00
12A	BOC MS	23.30	20.60
13	DIEU MS	39.71	30.80
14	UI MS TRA + XQ TUI + DUOI DO	48.53	34.30
15	TRA TUI	47.90	31.00
16	MAY CUON TRU NHO	56.83	33.30
17,18	MAY TRU LON	37.21	36.80
19	GOT SUA DO + LAY DAU TRU	46.96	39.00
20	THUA KHUY NEP	53.73	48.30
21	ĐINH NUT NEP	30.86	33.80
22	MAY CUON VAI CON	41.94	36.50
23	TRA TAY VS	33.24	45.40
24	DIEU VONG TAY	53.37	41.50
25	CUON SUON	49.59	43.00
26	TRA CO	54.34	48.70
27	MI CO CAU DAU	45.92	39.20
28,29	TRA MS XEP 1 LY	62.12	57.30
30,31	MAY CUON LAI BAU + LUOC NHAN SUONG	55.81	41.00
32	THUA KHUY CC + MS	24.60	22.50
32A	ĐINH NUT CC + LA 2 + MS	32.27	25.00
	Total	1377.33	954.40

4.2.4. Production process rebalancing

After constructing a set of standard time, we proceed to rebalance the flow, where the method used to balance the flow is the method of increased utilization. Result after rebalancing is summarized as follows:

Table 4: Summary of work assignments in the production area on the line

Stage	1	2	3	4	5	6	7	8	Total
Actual area number	5	2	9	1	4	2	7	3	33

Parameters to evaluate after line balancing:

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Efficient use of machinery and equipment= $\frac{31}{33}$ *100 = 93.94 (%)

Balanced pass rate = $\frac{1377.33}{33*62.12}$ = 67.19 (%)

Maximum capacity = $\frac{31200}{62.12}$ = 502 (product/day)

After re-weighing the line, the line-by-line ratio was 67.19%, an increase of 15.96% compared to the line-before-line rebalancing, while the yield was 502 products per day. As the construction time limit is higher than that of the company, the improvement of 47 products compared to the actual sewing lines indicates that the balance between the stations is improved compared to that of the company balance the company's line.

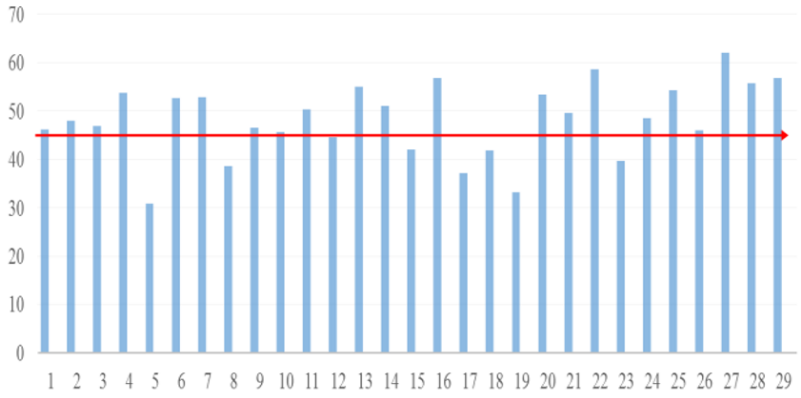

Figure 2: Timeline of work done after balance

5. Conclusion

This study focused on standardized operations and the construction of time sets by conducting analyzes and eliminating surplus, streamlining workstations, and standardizing worker operations, the time taken for each task from which the calculation defines the standard time and rebalance the line. The result is a shorter lead time to help businesses make more accurate production schedules and a 15.96% increase in line balancing, contributing to increased product yields and reduced queues in the enterprise.

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