Identification of Standard Times to Determine Production Capacity: A Case Study

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Abstract

PT XYZ is one of the companies in Bandung engaged in the textile industry. The company's principal product is a plain T-shirt. The issue at PT XYZ is that the production capacity of plain T-shirts is not clearly defined, resulting in inconsistency and inaccuracy in production time. This, in turn, leads to delivery times that do not align with the agreed customer expectations. This research employs a quantitative methodology with a time study approach, to calculate the standard time, determine the production capacity of plain T-shirts, and formulate recommendations to enhance production capacity. The total standard time for each production process can be identified. The standard time is divided by the number of operators, resulting in the system cycle time. The system cycle time for the production of plain T-shirt A allows for the calculation of a capacity of 86 units per hour, while plain T-shirt B has a capacity of 101 units per hour. The research findings indicate that the total standard time required to produce one unit of plain T-shirt A is 398,54 seconds, and 412,63 seconds for plain T-shirt B. The production capacity of plain T-shirt A is 689 units per day, while that of plain T-shirt B is 810 units per day. Recommendations to increase capacity can be made in two ways: by adding operators or by increasing working hours.

Keywords: standard times, production capacity, time study

1. Introduction

PT XYZ is a company that operates within the textile industry. The company is headquartered in Bandung City, Indonesia, and has been in operation since August 2008. The company produces a variety of garments, including plain T-shirts, long-sleeved T-shirts, shirts, and hoodies, in accordance with customer requests. The textile industry's most widely produced item is the plain T-shirt, with a total production exceeding 40,000 units between November 2023 and February 2024. Consequently, this research focuses on the production of plain T-shirts.

The issue at PT XYZ is the lack of clarity regarding the production capacity for plain T-shirts. This lack of transparency leads to uncertainty and inaccuracy in production time, resulting in orders being delivered outside of the agreed timeframe. Additionally, the company is aiming to increase its production capacity to 1,000 units per day, a goal that was not met in March 2024. During that period, the company fulfilled only 16,536 requests out of the 19,466 requests it received. Timely delivery is a key determinant of customer satisfaction, with positive and negative implications [1]. This statement is in accordance with the company supervisor's interview with the customer, which revealed that uncertainty and inaccuracy in production time result in a decline in customer trust and satisfaction with the company's production services. This, in turn, leads customers to seek alternative production services. In the 2022 period, five customers utilized the company's services for the production of plain T-shirts. In the 2023 period, there was a 20% decline in the utilization of the company's services, with the number of customers reducing from five to four. During the 2024 period, only two customers continued to employ the company's services.

The first step to improving productivity is to know the standard time [2]. In light of the issues pertaining to the ambiguity and imprecision of production timeframes, it is imperative to employ the time study methodology for the assessment of work time. This method is one of the methods used for optimizing the production process [3]. Without the data obtained through time measurement, the company is unable to ascertain the operational capacity of the facility or to make informed projections regarding delivery dates and costs [4]. A time study is a direct and intensive observation measurement technique. It involves recording the times and conditions under which a task is performed and subsequently analysing the data collected in order to ascertain the execution time at a well-defined performance level [5].

Determining the standard time will help production scheduling to meet demand without overburdening the workforce [6]. Time studies will also help in finding improvement ideas that will create a new system that is more efficient and can increase productivity [7]. Based on the statements, time study is expected to help in determining the production capacity of plain T-shirts, scheduling production properly in order to increase the productivity of the company that is expected to increase the production capacity of plain T-shirts.

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2. Methods

The objective of work measurement is to ascertain the standard time required to complete a given task. This is defined as the time needed for a typical worker to complete a task in the most optimal work system. The techniques utilized for work measurement can be classified into two distinct categories: direct work measurement and indirect work measurement [8]. This research employs direct measurement of work time, specifically time study. This method is particularly well-suited to tasks that are both brief and repetitive in nature [9].
Once an observation has been made, the next step is to test the uniformity of the data. The purpose of this test is twofold: firstly, to ascertain whether the data is uniform; and secondly, to identify any instances where the data is too extreme [10].
The subsequent phase is to undertake a data sufficient test. This is a statistical examination of the measured data, which is sufficient to describe the overall population. The data subjected to this test will yield a conclusion of N' ≤ N if the data is sufficient for the desired level of confidence and degree of accuracy. The calculation can be performed using equation (1) [11].

$$N' = \left(\frac{\frac{k}{s} \times \sqrt{N \times \sum X_i^2 - (\sum X_i)^2}}{\sum X_i} \right)^2 \quad (1)$$

The next step is to ascertain the rating factor, which is a comparative instrument utilized to normalize the allocated time for workers to complete their assigned tasks [11]. Ratings are made using the Westinghouse method and the objective method. Westinghouse method is one of the rating methods that directs the assessment to four factors that are considered to determine the reasonableness or unreasonableness of work, namely skill, effort, working conditions, and consistency [8]. The objective method is a rating method that considers two factors: work speed and work difficulty. The two factors are considered together in order to determine the rating factor that will allow the completion of the task within the standard time frame [12].
The next step is to determine the allowance, defined as the duration encompassing a time lag in a routine operational activity [13]. The allowances given are allowances for personal needs, allowances for fatigue, and allowances for unavoidable obstacles. The allowance for personal needs, according to Sutalaksana's table, the allowance for men is 2%-2.5%, and for women 2.5%-5%, while according to the International Labor Organization the allowance for men is 5% and for women 7%. [4,8]. The allowance for fatigue was determined using Sutalaksana's table and the International Labor Organization (ILO) table [8,14]. An allowance for unavoidable obstacles/contingency allowance, usually 5%, is given. [15].
The next step is to calculate the standard time. The standard time is defined as the time required to complete a given task or activity by a reasonable workforce under normal circumstances. The calculation can be completed using equations (2) and (3) [16].

$$\text{Normal Time} = \text{Cycle Time} \times \text{Rating Factor} \quad (2)$$

$$\text{Standard Time} = \text{Normal Time} + (\text{Normal Time} \times \text{Allowance}) \quad (3)$$

The longest standard time (system cycle time) can be used to determine production capacity [14]. The final step is to determine the number of operator requirements and overtime requirements to achieve production targets.

3. Results and Discussion

3.1. Cycle Time

Cycle time is defined as the average result of each operation, obtained after 30 observations on operators selected from each department involved in the manufacture of plain T-shirts A and plain T-shirts B. Table 1 illustrates the cycle time of each operation in the manufacture of plain T-shirt A, while Table 2 depicts the cycle time of each operation in the manufacture of plain T-shirt B. Additionally, Tables 1 and 2 present the output of each operation.

Table 1. Cycle Time of Plain T-shirt Product A

Department	Operation	Cycle Time (seconds)	Output (unit)
A-1	Shoulder seam	36,933	1
A-2	Overdeck Neck	13,433	1
A-3	Shoulder Chain	26,067	1
A-4	Side seam	80,833	1
A-5	Overdeck hem	25,233	1
A-6	Discard Thread	77,333	1
	Stack and Tie	168,800	5

Table 2. Cycle Time of Plain T-shirt Product B

Department	Operation	Cycle Time (seconds)	Output (unit)
A-1	Shoulder seam	36,467	1
A-2	Overdeck Neck	13,900	1
A-3	Shoulder Chain	25,533	1
A-4	Side seam	56,867	1
A-5	Overdeck hem	25,300	1
A-6	Discard Thread	77,867	1
A-7	Steam	77,333	5
A-6	Packing	46,200	1

3.2. Data Sufficient and Uniformity Test

The objective of the data uniformity test is to ascertain that the observed data does not exceed the upper control limit (UCL) or fall below the lower control limit (LCL). The results of the data sufficiency and uniformity tests for plain T-shirts A and B are presented in Tables 3 and 4, respectively. The results of the calculations demonstrate that the observed data does not exceed the control limits, indicating that the data is uniform. Additionally, the results indicate that N is greater than N', which further supports the conclusion that the data is sufficient.

Table 3. The Data Sufficiency and Uniformity Tests for Plain T-Shirts A

Operation	Average of the averages	Standard Deviation	Standard Deviation of Subgroups	UCL	LCL	N	N'
Shoulder seam	36,933	4,209	1,719	42,089	31,778	30,000	20,091
Overdeck Neck	13,433	1,478	0,603	15,244	11,623	30,000	18,728
Shoulder Chain	26,067	2,778	1,134	29,470	22,664	30,000	17,572
Side seam	80,833	9,473	3,867	92,435	69,232	30,000	21,240
Overdeck hem	25,233	3,081	1,258	29,007	21,459	30,000	23,065
Discard Thread	77,333	9,473	3,868	88,936	65,731	30,000	23,210
Stack and Tie	168,800	22,851	9,329	196,787	140,813	30,000	28,344

Table 4. The Data Sufficiency and Uniformity Tests for Plain T-Shirts B

Operation	Average of the averages	Standard Deviation	Standard Deviation of Subgroups	UCL	LCL	N	N'
Shoulder seam	36,467	3,309	1,351	40,519	32,414	30,000	12,732
Overdeck Neck	13,900	1,062	0,434	15,201	12,599	30,000	9,026
Shoulder Chain	25,533	2,315	0,945	28,369	22,698	30,000	12,718
Side seam	56,867	4,547	1,856	62,435	51,298	30,000	9,887
Overdeck hem	25,300	2,718	1,110	28,629	21,971	30,000	17,856
Discard Thread	77,867	5,144	2,100	84,167	71,566	30,000	6,751
Steam	77,333	7,937	3,240	87,054	67,613	30,000	16,290
Packing	46,200	4,012	1,638	51,114	41,286	30,000	11,664

3.3. Rating Factor

The rating factor is determined through a process that considers the results of the gauge assessment and the supervisor's assessment of the operator's performance. The purpose of the rating factor is to normalize the cycle

time in instances where it is perceived that the operator is working at an excessive or insufficient pace during the observation period. In this study, two rating methods are employed: the Westinghouse method (P_1) and the objective method (P_2). The Westinghouse method employs a four-factor evaluation system to assess work speed, encompassing skill, effort, condition, and consistency. The objective method assesses work speed in conjunction with work difficulty. The latter is determined by a number of factors, including the limbs used, foot pedals, hand use, eye-hand coordination, equipment, and load weight. The Westinghouse system of rating for plain T-shirt A operators can be observed in Tables 5 and 6 for plain T-shirt B. Table 7 provides a description of the calculation for P_2.

Table 5. Westinghouse System of Rating - Plain T-shirt A

No.	Operation	Skills		Effort		Conditions	Consistency		P_1
1	Shoulder seam	B2	0,08	E2	-0,08	E	-0,03	D	0,00	0,97
2	Overdeck Neck	C2	0,03	E2	-0,08	E	-0,03	C	0,01	0,93
3	Shoulder Chain	B2	0,08	E2	-0,08	E	-0,03	D	0,00	0,97
4	Side seam	B2	0,08	E2	-0,08	E	-0,03	E	-0,02	0,95
5	Overdeck hem	C2	0,03	E2	-0,08	E	-0,03	D	0,00	0,92
6	Discard Thread	E1	-0,05	F2	-0,17	E	-0,03	E	-0,02	0,73
7	Stack and Tie	E1	-0,05	F2	-0,17	E	-0,03	F	-0,04	0,71

Table 6. Westinghouse System of Rating - Plain T-shirt B

No.	Operation	Skills		Effort		Conditions		Consistency		P_1
1	Shoulder seam	B2	0,08	E2	-0,08	E	-0,03	D	0,00	0,97
2	Overdeck Neck	C2	0,03	E2	-0,08	E	-0,03	B	0,03	0,95
3	Shoulder Chain	B2	0,08	E2	-0,08	E	-0,03	C	0,01	0,98
4	Side seam	B2	0,08	E2	-0,08	E	-0,03	D	0,00	0,97
5	Overdeck hem	C2	0,03	E2	-0,08	E	-0,03	D	0,00	0,92
6	Discard Thread	E1	-0,05	F2	-0,17	E	-0,03	E	-0,02	0,73
7	Stack and Tie	E1	-0,05	F2	-0,17	E	-0,03	E	-0,02	0,73
8	Steam	B2	0,08	E2	-0,08	E	-0,03	D	0,00	0,97
9	Packing	B2	0,08	E2	-0,08	E	-0,03	D	0,00	0,97

Table 7. Objective Rating of Plain T-shirt B

No.	Operation	Used limbs		Pedal		Hand Usage		Eye & Hand Coordination		Equipment		Load Weight		P_2
1	Shoulder seam	C	2	F	0	H2	18	K	4	P	2	B-1	2	1,28
2	Overdeck Neck	C	2	F	0	H2	18	K	4	P	2	B-1	2	1,28
3	Shoulder Chain	C	2	F	0	H2	18	K	4	P	2	B-1	2	1,28
4	Side seam	C	2	F	0	H2	18	K	4	P	2	B-1	2	1,28
5	Overdeck hem	C	2	F	0	H2	18	K	4	P	2	B-1	2	1,28
6	Discard Thread	C	2	F	0	H1	0	J	2	N	0	B-1	2	1,06
7	Stack and Tie	C	2	F	0	H2	18	I	0	N	0	B-1	2	1,22
8	Steam	C	2	F	0	H1	0	I	0	N	0	B-2	5	1,07
9	Packing	C	2	F	0	H2	18	I	0	N	0	B-1	2	1,22

The final rating factor (P) is calculated after the P_1 and P_2 values have been obtained. The P value obtained will be used to calculate the normal time. Calculation result P values on plain T-shirt A can be seen in Table 8 and P values on plain T-shirt B can be seen in Table 9.

Table 8. The Final Rating Factor of Plain T-Shirt A

No.	Operation	P_1	P_2	P ($P_1 \times P_2$)
1	Shoulder seam	0,97	1,28	1,24
2	Overdeck Neck	0,93	1,28	1,19
3	Shoulder Chain	0,97	1,28	1,24
4	Side seam	0,95	1,28	1,22
5	Overdeck hem	0,92	1,28	1,18
6	Discard Thread	0,73	1,06	0,77
7	Stack and Tie	0,71	1,22	0,87

Table 9. The Final Rating Factor of Plain T-Shirt B

No.	Operation	P_1	P_2	P ($P_1 \times P_2$)
1	Shoulder seam	0,97	1,28	1,24
2	Overdeck Neck	0,95	1,28	1,22
3	Shoulder Chain	0,98	1,28	1,25
4	Side seam	0,97	1,28	1,24
5	Overdeck hem	0,92	1,28	1,18
6	Discard Thread	0,73	1,06	0,77
7	Steam	0,73	1,07	0,78
8	Packing	0,97	1,22	1,18

3.4. Allowances

The allowance is provided to operators as a period of rest and recuperation, which may be utilized for activities outside of the immediate operational scope. These activities may include, but are not limited to, consumption of beverages, visits to the restroom, informal discourse with colleagues, recuperation from fatigue, guidance from superiors, transitions between tasks, and other similar activities. The duration of these allowances is determined based on the guidelines outlined in [8]) with reference to the International Labor Organization table in [14], An allowance of 5% is made for unavoidable obstacles. The allowances for the manufacture of plain T-shirt A and plain T-shirt B are presented in Table 10. The allowances detailed in Table 10 encompass allowances for personal necessities, fatigue mitigation, and unavoidable impediments.

Table 10. Allowances

No.	Work Elements	Allowances
1	Shoulder seam	27,5%
2	Overdeck Neck	27,5%
3	Shoulder Chain	27,5%
4	Side seam	27,5%
5	Overdeck hem	27,5%
6	Discard Thread	29,0%
7	Stack and Tie	30,0%
8	Steam	30,0%
9	Packing	30,0%

3.5. Standard Time

The term standard time refers to a normal time frame that has been adjusted to account for certain allowances. The standard time derived from this study will be utilized to ascertain the available production capacity of the company. The outcomes of the standard time calculations for plain shirts A and plain shirts B can be found in Tables 11 and 12, respectively. The cycle time presented in Table 9 has been standardized to seconds per unit.

Table 11. Standard time of Plain T-shirt A

No.	Operations	Cycle Time (sec/unit)	Normal Time (sec/unit)	Standard Time (sec/unit)
1	Shoulder seam	36,93	45,86	58,47
2	Overdeck Neck	13,43	15,99	20,39
3	Shoulder Chain	26,07	32,36	41,26
4	Side seam	80,83	98,29	125,32
5	Overdeck hem	25,23	29,71	37,89
6	Discard Thread	77,33	59,84	77,19
7	Stack and Tie	33,76	29,24	38,02
	Total	293,59	311,3	398,54

Table 12. Standard time of Plain T-shirt B

No.	Operations	Cycle Time (sec/unit)	Normal Time (sec/unit)	Standard Time (sec/unit)
1	Shoulder seam	36,47	45,28	57,73
2	Overdeck Neck	13,90	16,90	21,55
3	Shoulder Chain	25,53	32,03	40,84
4	Side seam	56,87	70,61	90,02
5	Overdeck hem	25,30	29,79	37,99
6	Discard Thread	77,87	60,25	77,73
7	Steam	15,47	12,08	15,71
8	Packing	46,20	54,67	71,08
	Total	293,59	297,60	321,61

3.6. Production Capacity

The capacity to produce plain T-shirt A and plain T-shirt B can be determined by identifying the department with the longest standard time, which is subsequently divided by the number of operators to yield the system cycle time. The capacity can be observed in Tables 13 and 14. The production capacity of plain T-shirt A is determined by Department A-4, while the production capacity for plain T-shirt B is determined by Department A-7.

Table 13. Production Capacity of Plain T-shirt A

Department	Operations	Standard Time (sec/unit)	Operator	System Cycle Time	Capacity (unit/hour)	Capacity (units/hour)
A-1	Shoulder seam	58,47	2	29,23	123	985
A-2	Overdeck Neck	20,39	1	20,39	176	1.412
A-3	Shoulder Chain	41,26	2	20,63	174	1.395
A-4	Side seam	125,32	3	41,77	86	689
A-5	Overdeck hem	37,89	2	18,94	190	1.520
A-6	Discard Thread Stack and Tie	115,21	7	16,46	218	1.749

Table 14. Production Capacity of Plain T-shirt B

Department	Operations	Standard Time (sec/unit)	Operator	System Cycle Time	Capacity (unit/hour)	Capacity (units/hour)
A-1	Shoulder seam	57,73	2	28,86	124	997
A-2	Overdeck Neck	21,55	1	21,55	167	1.336
A-3	Shoulder Chain	40,84	2	20,42	176	1.410
A-4	Side seam	90,02	3	30,01	119	959
A-5	Overdeck hem	37,99	2	18,99	189	1.516
A-6	Discard Thread Packing	148,8	5	29,76	120	967
A-7	Steam	71,08	2	35,54	101	810

3.7. Increase Capacity to Achieve Targets

The calculation of the number of operator requirements and the need for overtime is carried out with the objective of determining the capacity increase required to achieve the production target. This is done by considering the number of units produced per day, which in this case is 1,000. Table 13 and Table 14 indicate that two departments, namely Department A-1 and A-4, fail to meet the target for the production of plain T-shirts A. Similarly, four departments, specifically A-1, A-4, A-6, and A-7, fall short of the target for the production of plain T-shirts B. The requisite number of standard operators for the production of plain T-shirts A and B can be found in Tables 15 and 16, respectively. The necessary overtime requirements are presented in Tables 17 and 18.

Table 15. Number of Standard Operators – Plain T-shirt A

Department	Number of Operators	Production Target/Day (unit)	Normal Working Hours	Standard Time (sec/unit)	Standard operators	Operator Shortage
A-1	2	1.000	8	58,47	3	1
A-4	3	1.000	8	125,32	5	2

Table 16. Number of Standard Operators – Plain T-shirt B

Department	Number of Operators	Production Target/Day	Normal Working Hours	Standard Time (sec/unit)	Standard operators	Operator Shortage
A-1	2	1.000	8	57,73	3	1
A-4	3	1.000	8	90,02	4	1
A-6	5	1.000	8	148,8	6	1
A-7	2	1.000	8	59,07	3	1

Table 17. Overtime Requirement - Plain T-shirt A

Department	Capacity/Day (unit)	Production Target/Day (unit)	Overtime (Hour)
A-1	985	1.000	0,12
A-4	689	1.000	3,61

Table 18. Overtime Requirement - Plain T-shirt B

Department	Capacity/Day (unit)	Production Target/Day (unit)	Overtime (Hour)
A-1	997	1.000	0,02
A-4	959	1.000	0,34
A-6	967	1.000	0,27
A-7	810	1.000	1,88

4. Conclusion

The research findings indicate that the total standard time required to produce one unit of plain T-shirt A is 398.54 seconds, or 6.64 minutes, and the total standard time to produce one unit of plain T-shirt B is 412.63 seconds, or 6.87 minutes. The company's capacity to produce plain T-shirt A in a single day is 689 units, while the capacity to produce plain B shirts is 810 units. To enhance production, two primary recommendations can be proposed: increasing the number of operators and extending the working hours through overtime. In addition, recommendations can be provided. It is imperative that the company enhance its supervision of employees to ensure that they do not engage in activities that are not related to work during working hours. These activities include chatting, using gadgets, smoking, and walking around.

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