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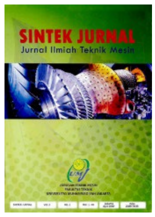

OPTIMIZATION ANALYSIS OF PRODUCTION CAPACITY ON TRIMMING PROCESS FOR PASSENGER VEHICLE WITH A LEARNING CURVE APPROACH (CASE STUDY: CAR OS)

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ABSTRACT

The primary goal of this research to optimizing the production process capacity is expected to answer basic problems of how steps taken by the manufacturing industry to produce effective output. This study used a technique Research Design case study, namely in the automotive manufacturing industry in the process of assembling a car OS in the Trimming Process PT. XYZ. This study refers to the technique of quantitative research methods of data collection by interview and sampling cycle time by using stopwach. There are 5 models used in this research is, a) Learning Curve Approach, b) Time study c) The model of productivity to measure productivity Actual and after the application of the standard time Productivity Model, d) Efficiency and Efectivity Model. Results of this study found a) Learning Curve Effect on the curve for each station, the end effect of learning curve for operators learning process average in the assembly process units to 11 – 16 with learning rate between 88% - 94% for each stations, b) Standard time for assembly process OS is 215.17 minutes/units with the effective capacity 5.18 units / hour, c) Estimate the productivity level obtained when applying the standard time is 5.18 higher than the actual productivity is 2.45, d) the level of efficiency that can be achieved in the application of standard time is 4.7%, e) Identification of factors that affect the speed of the operator skill then found five factors that according to the operator (the respondents) that affect their work, the machine does not automatically chosen 95% of respondents, many elements of the work carried out by manual as much as 85% and 80% respectively of respondents choose the layout, engine support and salaries / wages are still not standard than othersame industry.

Keywords: optimization; learning curve; time study; productivity; efeciency; effectivity.

1. INTRODUCTION

In the manufacturing industry, many companies not only produce different products in one location [1], but also produce the same types of products at different locations. For example in the automotive industry, many well-known automotive manufacturers to develop their business in developing countries [2]. Although the materials and products have the same standards, but sometimes there are differences in the level of automation technology used. In countries with high levels of technology may be 75% using automated equipment, but the developing countries could be just 25% use automated equipment. Indonesia is the largest automotive market in Southeast Asia after Thailand. Various brand car sales increased more than 50% annually (Gaikindo, 2014). According to the Ministry of Industry (Ministry of Industry), during 2013-2014 therewere at least five agents brand holder

(APM), which expanded its production capacity with a total investment commitment of approximately US $ 3 billion to US $ 4 billion in Indonesia.

However in the assembly process are still using low-tech equipment, almost 75% still manually process. But it is an effect on the ability of producers to meet the increasing consumer request. Manufacturers of motor vehicles reasoned slow delivery of orders due to limited production capacity. It is, to be a challenge for automotive manufacturers in the future. Company vehicles are required to solve the problem of delays in production using suitable methods such as increasing production volume. Therefore in planning a production company needs to maximize the working hours so that theproductivity of the workforce can be increased as well as the effective capacity will be achieved.

Optimize production capacity is important for the company. One of them with the optimization of working time in activities produksidengan operator learning curve approach.. The primary goal of this research to optimizing the production process capacity is expected to answer basic problems of how steps taken by the manufacturing industry to produce effective output.

Several studies developed methods to use its application from, learning curve analysis to Operation Planning [3]. This learning curve is used to measure progress and is widely used in various industries. Essentially [4], empirical evidence suggests that learning can occur at any type or level of production and that learning includes more than design changes and worker proficiency gains. The learning effect can also be affected by changes in work methods and have an impact on production time reduction [5].

The dimensions of the learning process involved in an activity in capacity expansion and identifying the direct and indirect influence of Labor on the production learning curve were examined by [6]. On this basis, they propose solutions to manage the learning curve in capacity expansion abroad and conclude with measures that have the potential to significantly reduce wastage time and add capacity.

The learning curve is considered an effective tool for monitoring the performance of workers exposed to new tasks [7]. The Learning curve provides a mathematical representation of the learning process that occurs when repetition of a task occurs. Initially this curve was aimed at observing cost reductions due to repetitive procedures in production plants. Since then, the Learning curve has been used to estimate the time required to complete the production process and the reduction of production costs as learning progresses, as well as to assign workers to tasks based on their performance profile. The effect of task disruption on worker performance was also modeled with modifications to the learning curve Anzanello tried to present the state of the art in the literature on learning and forgetting curves, describing existing models, their limitations, and reported applications.

Heoretic analyses that incorporate learning of production are usually deterministic: costs are posed to decrease the known deterministic force as cumulative production increases [8], proposes 1earning: a curve model that incorporates random variation in a decreasing cost function, they consider discrete-time Dynamic Programming formulations, monopolistic production planning when costs follow a learning curve. This Model was later expanded to allow for random variation in the learning process.

Work experience in production can be shown with cumulative production volume from year to tahunt or from month to bullae [9], so that when the cumulative production volume increased to double, then the work experience also increased to double. If we do something, of course, the time taken at the first work to be longer than the work performed second, or even third [10, 11], fourth and so on. With repetition, the time required will be shorter and will heading towards improvement. This phenomenon is called the learning curve.

2. METHODS

Type of this research is quantitative research in the field of expertise of manufacturing systems. In this study, we used a technique Research Design case study (Yin, 1996) which raised the automotive manufacturing industry as a topic of discussion by focusing research on the calculation of capacity optimization of production processes. which are developed based on quantitative research methods because in this study used data sourced directly from the company that became the object of research and Method Analysis of the data obtained by doing interviews and observation.

The data used in this study are primary and secondary data. Primary data from this study is assembly cycle time in OS's Trimming process on. While the secondary data in this study is based documents PT. XYZ.

Data collected by direct observation with using Stop watch technique as calculators, interviewing and collect tof documents related to production.

3. RESULT AND DISCUSSION

3.1 Learning curve Effect

Learning curve effect is described by a curve showing the process of learning by operator in each workstation on the assembly for car OS in Triming Process.

The data used to describe this curve is the cycle time performed by operators at each work station. Cycle time at the work station is a combination of several elements of the operator work done from the first unit (Prototype).

Table 1. Cycle Time Data

No.	PT	T1	T2	T3	T4	C1	C2	F1	F2	F3
1	43,34	55,34	74,05	100,33	65,60	42,48	43,01	46,48	44,01	44,01
2	38,44	51,33	63,35	89,33	57,01	40,05	41,46	42,57	40,32	40,32
3	34,50	41,6	54,56	75,20	55,56	38,20	37,05	40,16	37,48	38,48
4	30,31	40,73	43,50	61,20	50,32	36,25	35,06	39,08	35,08	36,08
5	27,70	39,7	40,33	52,46	38,15	33,33	33,51	37,25	34,05	34,05
6	26,06	38,06	37,53	47,35	35,15	30,10	30,16	34,03	30,10	30,10
7	22,25	31,2	33,40	43,20	32,05	28,56	28,10	30,33	27,16	27,16
8	19,19	30,27	30,25	41,19	29,55	25,41	25,59	28,19	25,50	25,50
9	16,50	28,5	28,15	38,41	25,23	23,22	25,17	26,20	24,50	24,50
10	16,21	28,21	26,01	34,05	23,07	22,03	23,51	23,33	23,21	23,21
11	14,33	26,33	25,44	29,57	21,53	21,57	23,35	21,44	23,01	22,57
12	14,01	26,01	22,49	25,33	20,49	21,20	21,44	20,48	22,36	22,36
13	13,30	25,3	20,55	22,03	20,22	20,33	21,23	20,32	22,14	22,14

In determining the effect of a learning curve Pre Trimming station does not have a lot of work elements, activities undertaken in preparation for entering the station is trimiming 1. Elements activities include checking and making holes for the nuts to be in preparati for the process at the station Trimming 1.

Based on the table 1 shows reduction in process cycle time yangdilakukan by the operator, it can be illustrated on the curve figure 1.

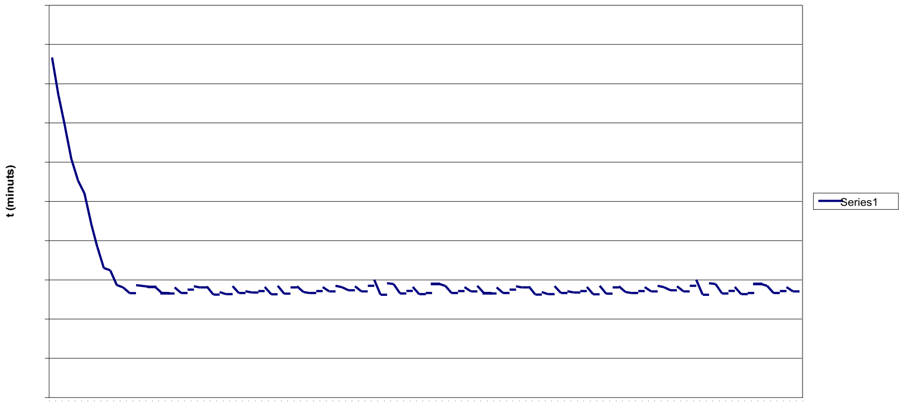

Figure 1. Learning Curve Effect for Pre Trimming Station

For the planning of the learning progress of operators in the assembly process car OS in Triming Process companies use the percentage level of learning (learning rate) based on the guidance of Rodney Stewart and Richard Wyskida are considered suitable for this process because 75% done with the manual and 25% by automation, but in practice it is difficult to perform constant improvement learning progress or remain as planned [10, 11].

Examples:
Learning rate (LR) to the station PT is as follows:
a =43.34 minutes (the processing time for first unit)Y =38.44 minutes (the processing time for 2nd unit) X = 2 (number of units cumulative)

So b is:
$Yn = a\ X^b$
$38{,}44 = 43{,}34\ (2)^b$
$(2)^b = 38{,}44 / 43{,}34$
$(2)^b = 0{,}8869$
$b = \log 0{,}8869 / \log 2$
$b = -0{,}1732$

and b price can be obtained from the learning level (LR) by substituting the price of b to the following equation:
$b = \log LR / \log 2 - 0{,}1732$
$= \log LR / \log 2 \log LR$
$= -0{,}1732 \times \log 2 \log LR$
$= -0{,}1200$
LR = **0,89 (89%)**

Table 2. Operator Learning rate for All Station in Triming Process

Num	Work station	LR
1	Pre Triming	89 %
2	Triming 1	94 %
3	Triming 2	90 %
4	Triming 3	88 %
5	Triming 4	91 %
6	Chasis 1	94 %
7	Chasis 2	94 %
8	Final 1	93 %
9	Final 2	94 %
10	Final 3	94 %

3.2 Time Measurement

At this time measurement takes some time samples were taken randomly at a car assembly processes OS. Data taken as many as 50 samples at each work station. In measuring this time, several stages are carried out, namely:

Normal Time (Nt)

Measurement of normal time using the adjustment factor (Rating Factor) according westing house system table rating. Based on sample cycle time of the observations obtained by the normal time following.

Example:
Calculation of normal time (Nt) to the work station Pre Triming.

Adjustment Factors

Skill (Good = C1)	= + 0.06
Conditions (Good = C)	= + 0.02
Effort (Good = C1)	= + 0.05
Consistency (Good = C)	= +001 +
Total *RF*	= 0.14

For the adjustment factor (RF) at each work station can be seen in the following table 4.

Table 4. Adjustment Factor for Each Work Station

Work Station	Factor								Amount
	Skill		Effort		Condition		Consistency		
PT	C1	0.06	C1	0.05	C	0.02	C	0.01	0.14
T1	C1	0.06	C1	0.05	C	0.02	C	0.01	0.14
T2	C1	0.06	C1	0.05	C	0.02	C	0.01	0.14
T3	C1	0.06	C1	0.05	C	0.02	C	0.01	0.14
T4	C1	0.06	C1	0.05	C	0.02	C	0.01	0.14
C1	C1	0.08	B2	0.05	C	0.02	C	0.01	0.16
C2	C1	0.08	B2	0.05	C	0.02	C	0.01	0.16
F1	C1	0.06	C1	0.05	C	0.02	C	0.01	0.14
F2	C1	0.06	C1	0.05	C	0.02	C	0.01	0.14
F3	C1	0.06	C1	0.05	C	0.02	C	0.01	0.14

From the results of the adjustment factors are used to determine the normal time and the normal timework station assembly process. The equation used is:

Nt = X + *RF*

Example:
The normal time for the station PT (Pre Triming) :

Nr = 13.78 + 1.14
= **15.71 minutes**

For normal time each work station and the normal time overall assembly process can be seen in the following table 5.

Table 5. Normal Time For Each Work Station

Work Station	Average	PR	Nt
PT	13.78	1.14	15.71
T1	18.04	1.14	20.57
T2	18.12	1.14	20.66
T3	19.13	1.14	21.81
T4	18.41	1.14	20.99
C1	19.55	1.16	22.68
C2	19.40	1.16	22.51
F1	18.14	1.14	20.68
F2	16.25	1.14	18.52
F3	18.36	1.14	20.93
Total		205.06	

From the table 5 can be determined the normal time for the high overall assembly process are 205.06 minutes/unit.

Standard Time

Measure of standard time is the result of multiplying the percentage of Allowance Factor,Factors determined as follows:

For 1 Shiff:
Personal needs = 10 minutes
Delay Time = 5 minutes
Fatigue = 5 minutes +
Total = 20 minutes

The effective time of production for 1 shift
= Working time - average downtime Plan per shift
= 9.10 hours- 2.02 hours
= 7.08 hours
= 424.8 minutes

Allowance
= 20/424.8 x 100%
= 4.7 %

Standard time process can be determined by the equation:
St = Nt x (1+*Allowance Factor*)
= 205.06 x (1 + 4.7%)
= 215.17 minutes/unit

Productivity

For calculating the level productivity of the assembly process car OS we use operator's work hours as a input. Calculation level of productivity before and after implementation the standra time can be calculated as follows table 6.

Table 6. Comparison for Operator Productivity

	Input man hour in a mount (hour)	**Total output a mount (unit/hour)**	**Productivity**
Actual	296.62	726.7	2.45
Effective	296.62	1536.5	5.18

From the table 6 we can calculated level of efficiency of output generated as follows:

Efficiency =Actual output / Effective Capacity

= 2.45 / 5.18
= 0.47
= 47 %

Identification of factors that affect the speed and performance of the operator

To identify the factors that affect the speed and performance of the operator, then we disseminate the questionnaire containing statements prepared under the framework of productivity and literature from various sources that relate with anything can influence performance of a worker to do their job.

Each factors in the questionnaires are the factors that affect the speed and performance of the operator at the car OS's assembly process. These factors are engine factors / tools, work environment factors, human factors and motivational factors.

From the results of processing the respondent's data, there are four categories of items selected with a factor of more than 80% of the respondents in table 7.

Table 7. Priority Factors

No.	Question	%
B2.	Production machines are not automatic	95
B3.	Many elements of the work is done manually	85
A2.	The space for the operator is less extensive	80
B6.	Age of machinery / production equipment that is old	80
C2.	Salary received inadequate	80

4. CONCLUSION

From this research can be concluded as follows: Effect Learning Curve depicted on the curve learning curve for each station, the operator stops the learning process mean to the process of assembling the unit to 11 - 16 and will not happen again the significant progress of learners with learning levels of operator (learning rate) for each operator to be between 88% - 94%, from the level of learning outcomes operator is still not reach the level expected by the company that is 80%. For the calculation of the standard time in the assembly process by using the OS cars leeway level 20 minutes or 4.7% of the effective time used to process berakitan is 215.17 minutes / unit, then the effective capacity that can be produced is 5.18 units /hour.

The resulting productivity of hours worked by the operator and the production capacity resulting in the actual process that is 2.45, whereas estimates of productivity that can be generated using standard time 215.17 minutes / unit is 5.18. The level of efficiency that can be obtained using standard time the process was 47%.. From the hail identification of factors that affect the speed and performance of the work of the operators obtained from questionnaires distributed to several factors that should be an important concern by companies that percentage is ≥ 80% are: Factors machinery/equipment, the production machine automation and yet there are still many elements of the work is done manually. Factors Work Environment, which is the space for a less extensive operator so that the operator is less flexibility in doing his job. Motivation factors, such as salaries according to the operator is still not balanced by the jobs they do ndard Time Measurement.

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