COMPARATIVE ANALYSIS OF MAN POWER, PRODUCTIVITY, AND OUTPUT IN THE SHORT AND LONG CONVEYOR CONVEYOR USING MICRO MOTION (CASE STUDY: PT. EDS MANUFACTURING INDONESIA)

Marisa Dosma Sitanggang  
Mercu Buana University, Jakarta, Indonesia

ARTICLE INFORMATION
Received: 1 February 2020  
Revised: 7 February 2020  
Issued: 11 February 2020

Corresponding author: first author  
E-mail: marisa.tanggang@gmail.com

DOI: 10.31933/DIJEMSS

Abstract: The thesis is compiled to analyze the ratio of man power, productivity and output between short and long conveyor conveyor. In addition to analyzing the conveyor which is better to be applied in PT. EDS Manufacturing Indonesia by using micro motions. The analysis used by researchers working maps, motion studies and calculation of standard time obtained from the data retrieval researchers with methods of micro motion (use a stop watch). The sample in this study is that there are in the final process assy namely setting. From the results, it can be calculated that for man power has the addition of 58% from 7 to 12, to the output increase from 23.49 unit be 51.17 units and produktivitas taktime increased 9% from 4 units to 4.41 units and 20% productivity standard time of 3.35 units to 4.2 units.

Keywords: productivity, output, micro-motion

INTRODUCTION
The results achieved by the final assy output, found the problem inability to achieve production output target set by the company. Therefore, the company is required to make improvement or change activities to increase the efficiency of the company.

Output data used is output by two conveyor-type car harness suzuki solio and suzuki ignis where this conveyor has the same characteristics and harness of the same carmaker is suzuki. Aggregate output in 2016 was 28712 harness, 2017 harness as many as 25817, and 2018 as many as 992 harness. The average achievement of output in 2016 was only 72%, in 2017 by 73% and in 2018 in January and February by 76%.

Table 1. Total output short conveyor is the target and actual 2016 until 2018 (February)
LITERATURE REVIEW

Productivity
According Hatani (2008), in general productivity can be defined as the ratio between the amount of goods and services produced (output) with the amount of resources used (input).

Work Map
According Sutalaksana et al. (2006), work map is a tool that describes the work activities in a systematic and clear. Map can be divided into two major groups based on their activities, namely the maps that are used to analyze the overall work activities and maps are used to analyze the activities of local labor. Group work activities include the whole operation process map, map process flows, process maps and flow charts of the working group. On the other hand, the local work group activities is a map of workers and machines as well as a map of the left hand and right hand.

Motion Studies
According Sitohang and Norita (2015), the study is an analysis of the movement of the body parts of workers in adjusting their work, so that movements are not effective can be reduced or even eliminated, so that would be obtained savings and reduction of working time worker fatigue.
According Astuti and Iftadi (2016), the benefits of the movement study include:
1. Improve the ability of workers, due to implementing a good method, using a good tool and stop the unnecessary activities.
2. Reduce worker fatigue.
3. Reduce labor costs, because the waste in the plant is reduced.

Calculation of time standard
According Wignjosoebroto (2006), there are various ways to measure and set the standard time. Some industries only make time estimates based on historical experience. Timing is done by measuring standard work such as stop watch time study, work sampling, delay ratio study, standard data, and predetermined motion time system.

RESEARCH METHODS

Figure 1. Research Method Framework
FINDINGS AND DISCUSSION

Data retrieval time when the process in regular and long conveyor conveyor collected and processed to be used in research. Then analyze the operator working map obtained from the determination of work processes by drawing harness operator that has been done by the department of concept and then later researchers will analyze the sequence of the process and there is no wait process between processes. Later analysis of motion studies with sorting operator operator movement if the movement is effective movements or movements ineffective as to the concept of working elements therblig. Further analysis with the standard time measurement cycle time calculation (2.1), the calculation of normal time (2.2), the standard time (2.3). And lastly fishbone diagram analysis of environmental conditions and why-why analysis of 4M (machine, material, method, method).

Analysis of the operator Conveyor Regular map

| NO | WORK | MAP SYMBOL OF WORK |
|----|------|---------------------|
| 1  | Home position |  |
| 2  | Take kanban from surishage, save in sao clamp kanban being processed. |  |
| 3  | Open the rubber on a roll circuit |  |
| 4  | Take connector 7289-3740-30, the setting for part matting Edge 43 |  |
| 5  | Take circuit 480 (0.0 B), setting the matting to the end part 95 |  |
| 6  | Take connector 7283-4779-30, setting matting to the tip part 42 |  |
| 7  | Open the rubber rolls |  |
| 8  | Take matting connector 7283-0391-30 setting to end part 57 |  |
| 9  | Take matting connector 7123-2312-30 setting to end part 60 |  |
| 10 | Take circuit 469 (Sb 0.3), 462 (Y 0.3) setting to matting part ends 49 |  |
| 11 | Take the 7283-7699 setting to matting connector end part 73 |  |
| 12 | Take circuit 461 (Lg 0.3) setting to matting part 77 ends. |  |
| 13 | Take matting connector 7383-1571-30 setting to end part 76 |  |
| 14 | Take circuit 531 (V 0.35), 530 (Y 0.75), 529 (Y 0.75) Setting matting to the tip part 29 |  |
| 15 | Take circuit 175 (Y 0.35) setting matting to the tip part 72 |  |
Table 3

Analysis motion studies operator setting regular CV

| RIGHT HAND | LEFT HAND |
|------------|-----------|
| WORK | NAME THERBLIG | SYMBOL THERBLIG | WORK | NAME THERBLIG | SYMBOL THERBLIG |
| Home position | Reach | RE | Home position | Reach | RE |
| Take kanban from surishage, save in sao clamp kanban being processed. | Reach | RE | Take kanban from surishage, save in sao clamp kanban being processed. | hold | G |
| Open the rubber on a roll circuit | release | RL | Open the rubber on a roll circuit | release | RL |
| Take connector 7289-3740-30, the setting for part matting Edge 43 | Choose | S | Take connector 7289-3740-30, the setting for part matting Edge 43 | assembl e | A |
| Take circuit 480 (0.0 B), setting the matting | Choose | S | Take circuit 480 (0.0 B), setting the matting | assembl e | A |

Analysis motion studies operator *conveyor regular*
| Action | Connector/Part Number | Action | Connector/Part Number |
|--------|----------------------|--------|----------------------|
| Take matting connector 7283-4779-30 | to end part 95 | Take matting connector 7283-4779-30 | to end part 95 |
| setting matting to the tip part 42 | Choose S | Take matting connector 7283-4779-30 | setting matting to the tip part 42 assembl e A |
| Open the rubber rolls | release RL | Open the rubber rolls | release RL |
| Take matting connector 7283-0391-30 | to end part 57 | Take matting connector 7283-0391-30 | to end part 57 assembl e A |
| setting to end part 60 | Choose S | Take matting connector 7123-2312-30 | setting to end part 60 assembl e A |
| Take circuit 469 (Sb 0.3) | to end part 49 | Take circuit 469 (Sb 0.3), 462 (Y 0.3) | setting to matting part ends 49 assembl e A |
| Take the 7283-7699 setting to matting connector end part 73 | Choose S | Take the 7283-7699 setting to matting connector end part 73 assembl e A |
| Take circuit 461 (Lg 0.3) | setting to matting part 77 ends. | Take circuit 461 (Lg 0.3) | setting to matting part 77 ends. assembl e H |
| Take matting connector 7383-1571-30 | to end part 76 | Take matting connector 7383-1571-30 | to end part 76 assembl e A |
| setting to matting part 29 | Choose S | Take circuit 531 (V 0.35), 530 (Y 0.75), 529 (Y 0.75) Setting matting to the tip part 29 | assembl e A |
| Take circuit 175 (Y 0.35) | setting matting to the tip part 72 | Take circuit 175 (Y 0.35) | setting matting to the tip part 72 assembl e A |
| Take circuit 478 (W 1:25) | setting matting to the tip part 95 | Take circuit 478 (W 1:25) | setting matting to the tip part 95 assembl e A |
| Take matting connector 7283-1225-40 | setting to end part 82 | Take matting connector 7283-1225-40 | setting to end part 82 assembl e A |
| Take circuit 223 (V 0.5) | setting to matting | Take circuit 223 (V 0.5) | setting to matting assembl e A |
Take matting connector 7283-4672-90 setting to end part 49
Take circuit 469 (Sb 0.3), 462 (Y 0.3) Insert the connector to the end of the 49
Take the 7287-7165 setting to matting connector end part 77
Take circuit 459 (0.3 Lg) Insert the end of the connector to the circuit 77 through VO-B
Take circuit 544 (Br 0.35) setting matting to the tip part 29

| Action | Select | Select | Action | Select |
|--------|--------|--------|--------|--------|
| Choose | S      | Take matting connector 7283-4672-90 setting to end part 49 | assemble | A      |
| Choose | S      | Take circuit 469 (Sb 0.3), 462 (Y 0.3) Insert the connector to the end of the 49 | hold     | H      |
| Choose | S      | Take the 7287-7165 setting to matting connector end part 77 | hold     | H      |
| Choose | S      | Take circuit 459 (0.3 Lg) Insert the end of the connector to the circuit 77 through VO-B | hold     | H      |
| Choose | S      | Take circuit 544 (Br 0.35) setting matting to the tip part 29 | hold     | H      |
| Check  | I      | Make sure that at the time of connector insert circuit to perform 4T (press and press tensile pull) | Check    | S      |
| Check  | I      | Make sure all the circuit into the fork and no one setting | Check    | I      |
| Reach  | RE     | Back to the home position | Reach    | RE     |

Analysis of the standard time measurement \textit{conveyor Regular}

A. Value flats

\[ \chi = \frac{\sum xi}{k} = \frac{117+118+121+119}{4} = 118.75 = 119 \]

B. Standard deviation

\[ \sigma = \sqrt{\frac{\Sigma (Xj - \chi)^2}{N-1}} = \sqrt{\frac{9}{3}} = 1.73 \]

C. The standard deviation of the distribution of the average value subgrub

\[ \sigma \chi = \frac{\sigma}{\sqrt{n}} = \frac{1.73}{\sqrt{4}} = 0.86 \]

D. Limits control of the upper and lower control limits

Available Online: \url{https://dinastipub.org/DIJEMSS}
EKA = X + 3 σx = 119 + 3 x 0.86 = 121.58

EKA = X - 3 σx = 119 -3 x 0.86 = 116.42

E. Test adequacy of the data

\[ N' = \left( \frac{40}{\sqrt{\frac{\sum x_j^2 - (\sum x_j)^2}{\sum x_j}}} \right)^2 = \left( \frac{40 \sqrt{4 x 56415 - (475)^2}}{475} \right)^2 = 0.24 = 1 \]

F. Factor Adjustment class with Westinghouse engineering

**Table 4**
Value Adjustment regular cv Westinghouse engineering

| Skills            | Average       | 0:00 |
|-------------------|---------------|------|
| Effort            | Good effort   | 0:02 |
| Events Work       | Average       | 0:00 |
| Consistency       | Good          | 0:01 |
| **AMOUNT**        | **0:03**      |      |
| Energy released   | very light    | 6%   |
| attitude to work  | Standing on both feet | 1%   |
| labor movement    | Normal        | 0%   |
| eyestrain         | The views continuously with fixed focus | 4%   |
| State temperature of the workplace | Normal | 2%   |
| state of the atmosphere | Enough | 2%   |
| Environmental conditions | Cycle of repetitive work | 1%   |
| Personal needs    | Woman         | 5%   |
| Allowances are not spared | May be assisted by other operators | 4%   |
| **AMOUNT**        | **25%**       |      |

Source: Authors (2019)

Normal time (Wn) Wn = Ws x P = 119 x (1+ 0.03) = 122.57 seconds

Standard time (Wb) = Wn x P = 122.57 x (1+ 0.25) = 153.21 seconds

G. Comparison of current productivity and standard time

**Table 5**
Comparison Tacktime and Standard Time

| Productivity       | Tacktime | standard time |
|--------------------|----------|---------------|
| Units / hour       | 128      | 153.21        |
| Unit / person      | 7        | 7             |

From the calculation of the author, the time required by workers on short conveyor to carry out a process of 153.21 seconds from 128 seconds or an increase of 19% over the targeted company due niai adjustment (P) in the calculation of standard time are taken into account and the amount of man power the same (7)
Analysis of standard time measurement Long conveyor

Table 6
Map of the operator setting Long conveyor

| NO | WORK                                                                 | MAP SYMBOL OF WORK |
|----|-----------------------------------------------------------------------|--------------------|
| 1  | Home Position                                                         |                    |
| 2  | Take circuit no.091 (B 0.5) insert circuit connector to no.7283-8050-30 to fork U / 58, through the VO-B D10X11 L = 370 download 7158-5246-60 of wasurenbou spacer and plug the connector 7283- 8050-30 Key spacer (Make 4T press press tensile pull) |                    |
| 3  | Take circuit no.261 (B 0.35) circuit to the connector insert no.7283-1225-40 to fork U / 65, through the VO-B L = 300 Key D8X9 spacer (Make 4T press press tensile pull) |                    |
| 4  | Take circuit 257 (B 0.3) insert circuit connector to no.7283-1527 to fork U / 84, through the VO-B L = 360 Key D8X9 spacer (Make 4T press press tensile pull) |                    |
| 5  | Take circuit 122 (B 0.75), 130 (B 0.75), 252 (B 0.75), 128 (Sb 0.75) circuit to the connector insert no.7283-1289-10 to fork U / 70, through the VO-B D14X15 L = 105 Key spacers (Make 4T press press tensile pull) |                    |
| 6  | Take circuit 248 (B 0.35) circuit to the connector insert no.7283-0392-40 to fork U / 67, through the VO-B D08X09 L = 70 Key spacers (Make 4T press press tensile pull) |                    |
| 7  | Take circuit 374 (B 0.75), insert the connector to the circuit no.7123-3233-30 to fork U / 66, through the VO-B L = 110 Key D16X17 spacer (Make 4T press press tensile pull) |                    |
| 8  | Take circuit no.042 (B 0.35) circuit to the connector insert no.7183-7725-40 to fork U / 97, through the VO-B L = 125 Key D6X7 spacer (Make 4T press press tensile pull) |                    |
| 9  | Take circuit 438 (B 0.35) circuit to the connector insert no.7183-7725-40 to fork U / 97, through the VO-B L = 125 Key D6X7 spacer (Make 4T press press tensile pull) |                    |
| 10 | Take circuit no.436 (B 0.35) circuit to the connector insert no.7183-7725-40 to fork U / 97, through the VO-B L = 125 Key D6X7 spacer (Make 4T press press tensile pull) |                    |
| 11 | Take circuit 441 (B 0.35) circuit to the connector insert no.7183-7725-40 to fork U / 97, through the VO-B L = 125 Key D6X7 spacer (Make 4T press press tensile pull) |                    |
| 12 | Check and make sure there is no damage to the connector circuit U / 70 with visible and in touch. |                    |
| 13 | * Back to the home position * |                    |

5. Analysis motion studies Long conveyor operator
| RIGHT HAND | WORK | NAME | SYMBOL | LEFT HAND | WORK | NAME | SYMBOL |
|------------|------|------|--------|-----------|------|------|--------|
|             |      | THER | BLIG   |           |      | THERB| BLIG   |
|             |      | BLIG | THER   |           |      | BLIG | THERB  |
| Home Position | Reach | RE | Home Position | Reach | RE |
| Take circuit no.091 (B 0.5) insert circuit connector to no.7283-8050-30 to fork U / 58, through the VO-B D10X11 L = 370 download 7158-5246-60 of wasurenoup spacer and plug the connector 7283-8050-30 Key spacer (Make 4T press press tensile pull) | Choose assemble | S | A | Take circuit no.091 (B 0.5) insert circuit connector to no.7283-8050-30 to fork U / 58, through the VO-B D10X11 L = 370 download 7158-5246-60 of wasurenoup spacer and plug the connector 7283-8050-30 Key spacer (Make 4T press press tensile pull) | hold | H |
| Take circuit no.261 (B 0.35) circuit to the connector insert no.7283-1225-40 to fork U / 65, through the VO-B L = 300 Key D8X9 spacer (Make 4T press press tensile pull) | Choose assemble | S | A | Take circuit no.261 (B 0.35) circuit to the connector insert no.7283-1225-40 to fork U / 65, through the VO-B L = 300 Key D8X9 spacer (Make 4T press press tensile pull) | hold | H |
| Take circuit 257 (B 0.3) insert circuit connector to no.7283-1527 to fork U / 84, through the VO-B L = 360 Key D8X9 spacer (Make 4T press press tensile pull) | Choose assemble | S | A | Take circuit 257 (B 0.3) insert circuit connector to no.7283-1527 to fork U / 84, through the VO-B L = 360 Key D8X9 spacer (Make 4T press press tensile pull) | hold | H |
| Take circuit 122 (B 0.75), 130 (B 0.75), 252 (B 0.75), 128 (Sb 0.75) circuit to the connector insert no.7283-1289-10 to fork U / 70, through the VO-B D14X15 L = 105 Key spacers (Make 4T press press tensile pull) | Choose assemble | S | A | Take circuit 122 (B 0.75), 130 (B 0.75), 252 (B 0.75), 128 (Sb 0.75) circuit to the connector insert no.7283-1289-10 to fork U / 70, through the VO-B D14X15 L = 105 Key spacers (Make 4T press press tensile pull) | hold | H |
| Take circuit 248 (B 0.35) circuit to the connector insert no.7283-0392-40 to fork U / 67, through the VO-B D08X09 L = 70 Key spacers (Make 4T press press tensile pull) | Choose assemble S A | Take circuit 248 (B 0.35) circuit to the connector insert no.7283-0392-40 to fork U / 67, through the VO-B D08X09 L = 70 Key spacers (Make 4T press press tensile pull) | hold H |
|---|---|---|---|
| Take circuit 374 (B 0.75), insert the connector to the circuit no.7123-3233-30 to fork U / 66, through the VO-B L = 110 Key D16X17 spacer (Make 4T press press tensile pull) | Choose assemble S A | Take circuit 374 (B 0.75), insert the connector to the circuit no.7123-3233-30 to fork U / 66, through the VO-B L = 110 Key D16X17 spacer (Make 4T press press tensile pull) | hold H |
| Take circuit no.042 (B 0.35) circuit to the connector insert no.7183-7725-40 to fork U / 97, through the VO-B L = 125 Key D6X7 spacer (Make 4T press press tensile pull) | Choose assemble S A | Take circuit no.042 (B 0.35) circuit to the connector insert no.7183-7725-40 to fork U / 97, through the VO-B L = 125 Key D6X7 spacer (Make 4T press press tensile pull) | hold H |
| Take circuit 438 (B 0.35) circuit to the connector insert no.7183-7725-40 to fork U / 97, through the VO-B L = 125 Key D6X7 spacer (Make 4T press press tensile pull) | Choose assemble S A | Take circuit 438 (B 0.35) circuit to the connector insert no.7183-7725-40 to fork U / 97, through the VO-B L = 125 Key D6X7 spacer (Make 4T press press tensile pull) | hold H |
| Take circuit no.436 (B 0.35) circuit to the connector insert no.7183-7725-40 to fork U / 97, through the VO-B L = 125 Key D6X7 spacer (Make 4T press press tensile pull) | Choose assemble S A | Take circuit no.436 (B 0.35) circuit to the connector insert no.7183-7725-40 to fork U / 97, through the VO-B L = 125 Key D6X7 spacer (Make 4T press press tensile pull) | hold H |
| Take circuit 441 (B 0.35) circuit to the connector insert no.7183-7725-40 to fork U / 97, through the VO-B L = 125 Key D6X7 spacer (Make 4T press press tensile pull) | Choose assemble S A | Take circuit 441 (B 0.35) circuit to the connector insert no.7183-7725-40 to fork U / 97, through the VO-B L = 125 Key D6X7 spacer (Make 4T press press tensile pull) | hold H |
Check and make sure there is no damage to the connector circuit U / 70 with visible and in touch.

| Press press tensile pull) | Check I | Check and make sure there is no damage to the connector circuit U / 70 with visible and in touch. | Check I |
|---------------------------|---------|-------------------------------------------------------------------------------------------------|---------|
* Back to the home position *

Reach RE

* Back to the home position *

Reach RE

Analysis standard time measurement Long Conveyor

A. the average value

\[ \chi = \frac{\sum xi}{k} = \frac{55+59+56+58}{4} = 57 \text{ detik} \]

B. Standard deviation

\[ \sigma = \sqrt{\frac{\sum (xj - \chi)^2}{n - 1}} = \sqrt{\frac{10}{3}} = 1.82 \]

C. The standard deviation of the distribution of the average value subgrub

\[ \sigma x = \frac{\sigma}{\sqrt{n}} = \frac{1.82}{\sqrt{4}} = 0.91 \]

D. limits control of the upper and lower control limits

\[ BKA = \chi + 3 \sigma x = 57 + 3 \times 0.91 = 59.73 \]

\[ BKA = \chi - 3 \sigma x = 57 - 3 \times 0.91 = 54.27 \]

E. Test adequacy of the data

\[ N' = \left( \frac{40 \sqrt{\sum xj^2 - (\sum xj)^2}}{\sum xj} \right)^2 = \left( \frac{40 \sqrt{13006 - (228)^2}}{228} \right)^2 = 1.23 = 1 \]

Class F. Adjustment Factor with Westinghouse engineering

| Table 8 |
|---------|

### Value Adjustment with Westinghouse engineering Long conveyor

| Skills       | Average       | 0:00 |
|--------------|---------------|------|
| Effort       | Good effort   | 0:02 |
| Events Work  | Average       | 0:00 |
| Consistency  | Average       | 0:00 |

**AMOUNT** 0:02

| Energy released       | very light | 6% |
| attitude to work      | Standing on both feet | 1% |
| labor movement        | Normal     | 0% |
| eyestrain             | The views continuously with the focus turns | 2% |
| State temperature of the | Normal     | 2% |
workplace
state of the atmosphere  | Enough  | 2%
Environmental conditions | Cycle of repetitive work | 1%
Personal needs | Woman | 5%
Allowances are not spared | May be assisted by other operators | 2%

AMOUNT 21%

Normal time $(W_n) = \text{Ws} \times P = 57 \times (1 + 0.02) = 58.14 \text{ sec}$

Standard time $(W_b) = W_n \times P = 58.14 \times (1 + 0.21) = 70.34 \text{ sec}$

G. Comparison of current productivity and standard time

Table 9

| Comparison Tacktime and Standard Time |
|--------------------------------------|
| Productivity | Tacktime | standard time |
| Units / hour  | 68       | 70.34         |
| Unit / person | 12       | 12            |

From the calculation of the author, the time required by the worker on Long conveyor in performing a process of 70.34 seconds from 68 seconds or an increase of 3% over the targeted company due to the adjustment (P) in the calculation of standard time are taken into account and the amount of man power the same (7)

7. Comparison of Productivity and Output

A. Conveyor Regular

Productivity is not time $= \frac{\text{output}}{\text{input}} = \frac{28}{7} = 4$ unit/jam

$\text{output} = \frac{\text{jumlah waktu yang tersedia}}{\text{waktu baku}} = \frac{3600}{153.21} = 23.49 \text{ unit}$

Productivity standard time $= \frac{\text{output}}{\text{input}} = \frac{23.49}{7} = 3.35 \text{ unit/jam}$

B. Long conveyor

Productivity is not time $= \frac{\text{output}}{\text{input}} = \frac{53}{12} = 4.41 \text{ unit/jam}$

$\text{output} = \frac{\text{jumlah waktu yang tersedia}}{\text{waktu baku}} = \frac{3600}{70.34} = 51.17 \text{ unit}$

Productivity standard time $= \frac{\text{output}}{\text{input}} = \frac{51.17}{12} = 4.2 \text{ unit/jam}$

Calculation resulting from the increase in productivity of between short conveyor into a long conveyor is taktime 9%, 54% and productivity output standard time 20%

CONCLUSION AND SUGESTION

Conclusions

1. The comparative study man power, productivity, and output in the short and long conveyor conveyor is for man power has the addition of 58% from 7 to 12 for the output has increased from 23.49 unit be 51.17 units and to poduktivitas taktime increased 9% from 4 units to 4:41 units and 20% productivity standard time of 3:35 units to 4.2 units
2. According to the author's calculations using the micro-motions, long-conveyor better to be applied in PT.EDS Manufacturing Indonesia by considering the amount of man power, output, and productivity

Suggestions
1. Workers perform effective movement appropriate to use both hands to ease the process
2. The Company considers the standard time obtained in this study, because the calculation results higher than when using standard takt time as the completion of the product.
3. It should be further research on the time standard in all production processes in the process of setting by incorporating elements of the workload on each production process

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