Line Balancing Method As An Effort To Improve Cable Production In PT. KMI Wire AndCable Production Management

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Abstract.
Write Line Inner Sheating at PT. KMI Wire and Cable has idle time due to processing time on Unbalanced work stations sometimes cause stop lines. From calculations it is known that the cycle time gap / cycle time obtained is as big as 109.2 seconds and the figure is taken based on the biggest time from 6 stations existing work. The author intends to examine the causes of its occurrence processingtime delays that occur on the Inner Sheating line and deliver give suggestions for future improvements. This research uses line balancing method and production system layouts. Among them is looking for the cycle time at the 6 largest stations as a reference in determining the next calculation, calculating the company's capacity, determining the efficiency of the machine, calculating the number of machines, adding the number of machines and additional floor area. Data is taken from field observations and records. The author uses two methods, namely the line balancing method and the system method production layout. he line balancing method and production layout system that has been carried out can be causing it to be able to meet market demand of 17,688 coils / month with the addition of machines / work stations, the required floor area is 14 m² with details, 7 m² at the Inner Sheat workstation and 7m² at the Outer Sheat station.

Keywords: *Line Balancing, Cable and Production.*

I. INTRODUCTION

The manufacturing industry in cable production and consumer demand continues to increase every year, forcing manufacturing industry companies to come up with innovative ideas in order to increase the optimal use of available resources to produce the maximum possible level of product both in terms of quantity and quality. Generally, in reality, it is often found that a production system is regulated soberly, where these industrial companies are more concerned with keeping production going and still making profits without going through careful production planning calculations, this can indirectly result in the accumulation of raw materials and intermediate products (semi-finished goods) on the production floor, this is referred to as a Bottleneck. Bottlenecks occur due to processing time and long waiting times for certain processes that occur on the production floor. Overall, increasing the capacity of a production process depends on whether there are machines that experience bottleneck . So indirectly if the number of machines experiencing bottlenecks can be minimized then production capacity can increase. The problem under study is the capacity that cannot keep up with market demand, in this case the capacity of the combined machine of the inner sheating, thus causing the request to be postponed. An increase in orders is something that needs to be anticipated, because if it is not anticipated other than uncontrolled delivery, production operational costs will increase due to many things such as high overtime, high production overhead, and others.Line balancing is a group of people or machines that carry out sequential tasks inassembling a product that is given to each resource in a balanced manner in each production line, so that high work efficiency is achieved at each work station [1].

Line balancing is an assignment of a number of jobs to interrelated work stations in one line or production line. The work station has a time that does not exceed the cycle time of the work station. The function of line balancing is to create a balanced trajectory. The main objective of track balancing is to minimize idle time on the track which is determined by slow operation [2]. The concept of production line

balance is very suitable for mass production type companies, this line balancing will be very useful. In production, for example, a slight decrease in the production cycle time will give a largesavings in production costs. A balanced production line means that there are no idle operations, it will also provide efficiency which leads to optimal production costs. Previously, there was a similar study conducted by [3] found that using the linebalancing method to increase output results and also identify waste that occurs andhow to solve it and the results of the improvement are an increase in productivity by 104% and an increase in line efficiency by 3% and 15% cycle time reduction.Meanwhile, [4] used the line balancing method to obtain an increase in balance efficiency (by 25.74%), reduced production costs by (- 2.41 birr / pcs), 35.5% increase in productivity and production rate production increased from 49 to 68 pieces per hour. this is in line with what was done by [5] which in his research emphasized that by applying the concept of line balancing there were improvements that could reduce the number of work stations to seven work stations with seven operators and line efficiency increased to 96.7%. In accordance with these problems, in this study an analysis will be carried out to increase production capacity using the line balancing method, so that in the end the company can fulfill orders from increasing customersand apply line balance to the company's assembly lines such as whether there is a cycletime gap in the assembly line. ?,

How to increase production capacity?, How is the efficiency of the line to increase production capacity at PT. KMI Wire and Cable?. This study uses the application of the line balancing method because based on previousresearch the line balancing method can be used to increase line productivity andefficiency. The application of the line balancing method in this study is used to reduce cycle time and equalize production lines which will result in increased efficiency and increased productivity through saving production time and saving resources. This studyalso uses a production system approach for the application of just in time, namely the use of takt time and a cable production system approach used for light reduction and standardization of work.

II. METHODS

This research methodology is an overview of the stages that are passed in solving a problem encountered in a study, which is made based on the background and objectives to be achieved by using theories that support solving the problem under study. The types of data sources contained in this study are primary data and secondary data both qualitative and quantitative. Primary data was obtained through observation and interviews with the company, especially the Backpost & Rib working group in the packaging division and distribution division. The primary data obtained includes cycle time and operator skill map. Secondary data is data that belongs to the company itself as well as literature data, research results, articles and journals. The data needed is a brief history, company organizational structure, effective working hours, working day schedules, journals, articles, and research results with the theme of line balancing. The steps of data collection carried out by researchers to obtain the data needed to complete this research were carried out by means of observation, interviews, and literaturestudies. Processing data to carry out planning for balancing the production line is by using the Ranked Positional Weight method[7-8]. The analysis steps carried out include data testing including data uniformity tests and data adequacy tests, standard time calculations by adding the adjustment factor and allowance factor given to prevent irregularities in work, production process analysis to measure the level of efficiency of the production process at the initial state of the production line, analysis track balance using the Ranked Positional Weight method, comparison of the initial state results withthe calculation results of the line balancing method with tack time. Based on the resultsof the data processing carried out, then we can further analyze the results of the data processing[9, 10].This analysis will lead to research objectives and will answer questions in the formulation of the problem. Data analysis in this study is to evaluate the balance of the packaging line.The place of research is PT KMI Wire and Cable.

Research data were obtained from research subjects who were key informants. Key informants (key informants) can be interpreted as those who know and have various basic information needed in research or informants who know in depth about the problem being studied [6]. The number of research samples is 50 workers at PT KMI Wire and Cable where data is processed using IBM SPSS Statistics 20 and processing

using univariate analysis of therespondent's characteristic variables, namely education level, age and years of service. While the bivariate test used is the spearman rank to determine the relationship between legal regulations and sample behavior. The population in this study were all workers at PT KMI Wire and Cable, totaling 40 people. The sample is part of the entire object examined which is considered to represent the entire population. In this study,the sample was all workers on duty at PT KMI Wire and Cable. Determining the number of samples using total sampling technique This sampling method is to take all members of the population as a sample because the population is limited. Multivariate analysis was carried out to explain or describe the characteristics of the observed and measured variables based on the value of the data distribution, namely the minimum and maximum value[11][12]. The proposed model is made based on line balancing calculations where the proposed model is based on maximum cycle time, demand takt time and production takt time. Furthermore, the proposed model is compared with the initial (existing) model so that it is found that the proposed model is better than the existing model and can be seen from various parameters such as the number of work stations[13], track idle time, track efficiency, track balanced delay, smoothness index and system output[14].

III. RESULT AND DISCUSSION

Results of Secondary Data Collection

The company was founded on January 19, 1972 as PT Kabelmetal Indonesia by Kabel-und Metalwerke Guetehoffnungshuette AG, a German company which became known as Kabelmetal Electro Gmbh. Its first commercial product was launched in1974 under the well-known KABELMETAL brand. The company was listed on the Indonesia Stock Exchange in 1992. Since mid-2007, by maintaining the brand name " Kabelmetal Indonesia" for the domestic market, the Company introduced the brand name "KMI Wire and Cable" to the overseas market. Then, effective from 1 September 2008, the new overseas brand became the company name PT KMI Wire and Cable Tbk. The Company is one of the suppliers of electrical cables that meet the requirements for PT Perusahaan Listrik Negara (Persero), a state-owned electricity company. The company is also a major supplier of cables to the private and industrial sectors, namely oil and gas, mining, various industries and many others, either directly or through a national chain of distributors and retailers.

The company was awarded ISO 9002 for its cord production in 1995 and for the newly established Aluminum and Copper Casting in 1996. It was followed by ISO 14001 in 1997 for environmental management systems and ISO 9001 for design control of cable production in 1998. The company has adopted and ratified the latest update of the ISO 9001 Quality Management System version 2015 which defines the requirements for continuous improvement and risk management in its implementation. In early 2007, the Company acquired OHSAS 18001 and simultaneously SMK3 (Indonesian version) for occupational health and safety systems, which were then refined with ISO 45001: 2018 in September 2020. All Management Systems implemented in this company are assessed regularly every year. Strategic cooperation with various international manufacturers has been developed to expand the product range and optimize the utilization of the company's machines.

Results of Primary Data Collection

Manufacturing conditions that experienced uncertainty in terms of production quantity and quality resulted in the production process at PT KMI Wire and Cable having to be continuously maintained and improved in order to meet consumer demand. Therefore, companies must plan concrete steps to anticipate this. Selection of products that have high prospects through standard time calculations and rearrangement of the company's production process will provide improvements to increase the efficiency and productivity of the company in meeting every consumer demand. In its operations, this company determines that in one week there are six working days with seven hours of work and one and a half hours of mandatory overtime every Monday to Friday and five hours of work and one and a half hours of overtime on every Saturday. Consists of two shifts for the Upper and three shifts for the finishing section. The process for dividing Upper's work time is shown in the following table:

Table 1. Allocation of PT KMI working hours

Description	Monday-Friday		Saturday	
	Shift 1	Shift 2	Shift 1	Shift 2
In	06.00	14.00	06.00	13.00
Break	10.00-10.30	18.00-18.30	10.00-10.30	16.00-16.30
Out	14.00	22.00	13.00	19.00

Source: Personal Documents PT. KMI Wire and Cable

The focus of this research is on the Soft 8 shoe article (440533-554) which is a copper cable production group, which is done by line 206. This product is one of the most frequently worked on products and often experiences delays in the ongoing production process in hall 3 So this product has a high value for the company. Therefore, the authors chose the Soft 8 product article as a research limitation and focus. The production process for line 206 is described based on the process flow and adjusts to the available area. In the assembly process Upper article Soft 8 (440533-554)has 44 work elements to assemble the product which is divided into 36 stations, 8 workstations of which are duplicates because the station time is greater than the predetermined cycle time. Bill Of Materials (BOM) is a list of all materials, parts and components that explain the quantity of each of these components needed to produce one pair of product units. The following is a list of BOM for Soft 8 product : Bill of Material for Upper Article Soft 8 440533-554

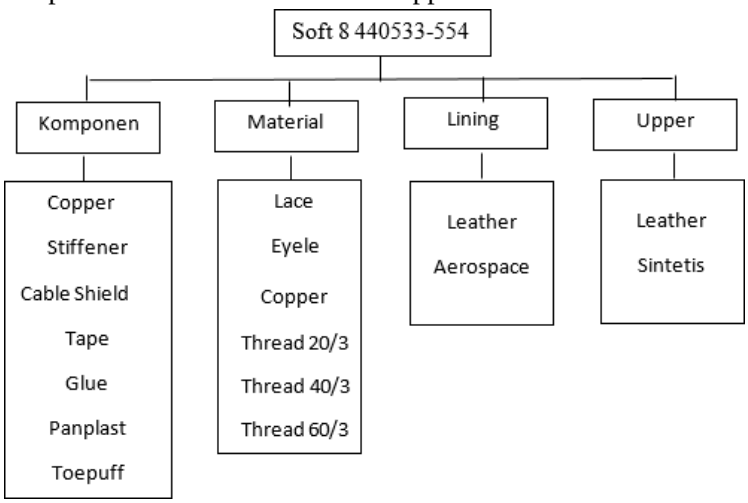

Fig 1. Bill of Materials for Upper Article Soft Products 8 440533-554

The work elements used to process one pair of upper currently are 44 work elements divided into 36 stations, 8 of which are duplication work stations. The work elements in the station are manual work using tools and machines. The Flow Process Chart for the Upper Soft 8 process will be shown below. adjustment factor and operator allowance factor. The following is the presentation .

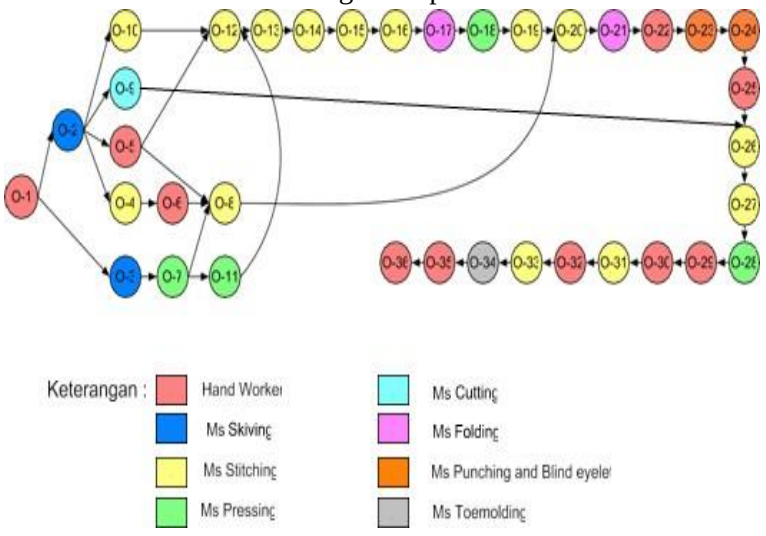

Fig 2. Flow Process Chart for Upper Soft Products 8

Results of Line Balancing Proccess

From the initial work station data that has been known above, the next step is to make a work process sequence or precedence diagram so that the production trajectory can be balanced. The following is a table of process sequences for Upper soft 8 440533-554.

Table 2. Allocation of PT.KMI working hours

Work Station	Precedence	Standard Time (s)
1	0	49,75
2	1	99,35
3	0	55,91
4	2	49,42
5	4	10,57
6	0	19,93
7	0	10,93
8	5,6	57,23
9	3,8	56,16
10	9	54,74
11	0	53,23
12	7	54,58
13	0	58,03
14	12,13	57,23
15	14	56,14
16	15	58,39
17	16	21,58
18	17	20,15
19	18	39,89
20	19	40,27
21	20	56,57
22	21	56,38
23	22	53,46
24	10,23	60,12
25	24	57,98
26	25	56.76
27	26	55,41
28	27	53,95
29	28	42,23
30	11,29	18,32
31	30	57,56
32	31	90,35
33	32	56,73
34	33	51,97
35	34	56,57
36	35	54,48
37	36	123,47
38	37	8,53
39	38	48,26
40	39	52,86
41	40	48,36
42	41	11,67
43	42	56,73
44	43	49,35

From the results of loading operations and line balancing that have been carried out, it can be seen that the assembly line initial conditions have changed with the assembly line after balancing, namely there are 36 work stations, 8 of which are parallel stations with a total of 45 cells and the number of work elements 44 in the initial conditions to 34 work stations, 4 of which are parallel stations with a total of 40 cells and 44 work elements after being balanced. And both of them have combined operations in their work stations. This is because:

1. Merging of work elements Loading + Separate + Upper Coloring with Hammering + Mal Flash Side (MFS) on upper into one work station.

2. Combination of Skiving Upper work elements with MFS on upper: vamp and backpiece (bp), which were previously separated into one work station

3. Combination of work elements Seam side in/out to collar in/out 40/40 + Tape with Tapping on tongue bot loop 8mm into one work station. Previously elements of the Tapping on tongue bot loop 8mm and MFS on upper: vamp and backpiece (bp) were a workstation. Because the two elements experience a merger, one work station can be eliminated

4. Combination of working elements Flatlock side io vamp and tongue lining with Glue and tape seam tongue into one work station. Glue and tape seam tongue elements are elements of the previous work station

5. Merging the work elements of Seam tongue on tongue lining with Hammering on seam tongue to tongue lining top + Hammering on seam tng top into one work station. Previously, the Hammering on seam tongue to tongue lining top + Hammering on seam tng top elements were a single station with Glue and tape seam tongue elements and St heelgrip on side io lining 60/60. So as to reduce the number of cells in the work station

6. Combining the working elements Glue edge eyelet to sp lining + Att edge eyelet to sp lining with the Open lining + glue + att bp strap on sp elements which are the elements at the next station. So as to reduce the number of cells in the work station

7. Merging of St. Box on side io to vamp 40/40 with Spray latex on vamp + fit vamp lining which is the working element on the station afterwards. So that the work station afterwards can be eliminated.

IV. CONCLUSION

a. Based on the calculation can the average processing time is known Cycle Time per work station, that is :

1) Drawing with time average process 13.34 seconds
2) Extruder with timing process average 73.18 seconds
3) Cabling with time average process 75.54 seconds
4) Inner Sheating with average processing time 109.2 seconds
5) Outer Sheating with average processing time 100.18 seconds
6) Colling with time average process 60.04 seconds

b. From the data above it can be seen There is a cycle time gap in the assembly line, namely at the station Inner Sheating work and stations work that has processing time the highest average is 109.2 seconds between workstations other.

c. To meet production targets from 13,255 coils/month to 17,688 coils/month company must increase the amount machine/workstation, i.e. station Inner Sheating and Outer work Sheating. Additional floor area needed ie 14 m2 with details, 7 m² at work station Inner Sheat and 7 m² at the station uter sheath work.

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