Comparison Study of the Application of Line Balancing and the Theory of Constraint

Comparison Study of the Application of Line Balancing and the Theory of Constraint

Jessica Novelia Sagitta*, Lina Gozali, Frans Jusuf Daywin Industrial Engineering Department, Faculty of Engineering Universitas Tarumanagara

*Jessicanovelias15@gmail.com@gmail.com

Abstract. Bottleneck is one of the most important problems in the work station process. The problem that will be studied in bottleneck theory is minimizing bottlenecks at work stations that experience bottleneck constraints. Line Balancing is one of the main keys to solve the problem with an optimal solution. If not carried out the balance of the track it can lead to inefficiency of work in several work stations where between work stations with other work stations have unbalanced workloads. However, it may also be time-consuming, so we need a theory of constraint method to minimize costs so that the results are more optimal for the company. The purpose of this paper is to compare research using other methods in minimizing bottlenecks, optimal efficiency at each work station, and minimizing relevant costs.

1. Introduction

The manufacturing system emphasizes improving quality, productivity and material efficiency. One of the problems that often arises is the occurrence of a queue of material to be processed, so that often creates a bottleneck. Bottleneck is the accumulation of material or product to be produced to the next stage in a certain period of time. This bottleneck will reduce the utility of other production components, such as machinery and workers, which can cause work stations to be ineffective, inefficient and not optimal [1]. The method used to handle work efficiency at each work station is Line Balancing and Theory of Constraint (TOC), where both can minimize bottlenecks and optimize work efficiency at work stations. This paper is used to contribute to the research gap by developing a review of the comparative study process with the topic of applying line balancing and Theory of Construction. The purpose of this paper is to help many researchers on the topic of line balancing and Theory of Constraint.

2. Literature Study

2.1. Line Balancing

Assembly lines are defined as a group of workers and machines that carry out a series of tasks to assemble a product. The main purpose in developing line balancing is to form and balance the workload allocated to each work station. If the track balance is not carried out, it can result in inefficient work in several work stations where between one work station with another work station has an unbalanced workload. To overcome the balance of the track method is usually used the Killbridge and Wester method (Region Approach), Moodie Young method, Helgeson Birnie method (Ranked Positional Weight System), and J-Wagon method [2].

2.2. Theory of Constraint

Theory of Constraint is an approach towards improving processes that focus on the elements that are constrained to increase output. Efforts that focus on the problem can increase or re- maximize existing initiatives, so that the system achieves significant progress, obstacles need to be identified and the whole system needs to be regulated. The application of Theory of

Constraint is more focused on the management of constrained operations as a key in improving the performance of production systems, which in turn can affect overall profitability [3].

In implementing ideas as a solution to a problem, there are five steps for the improvement process to be more focused and have a better impact on the system, including:

1. Identifying the constraint
2. Exploiting the constraint
3. Subordinating the remaining resourch
4. Elevating the constraint
5. Repeating the process

3. Comparison Study and Research Gap

3.1. Research of Minimizing the bottleneck on work stations

Jembar Kurnia, Didit Damur Rochman (2010) research title is Bottleneck Reduction with Theory of Constraint Approach in Sock Production at PT. Matahari Sentosa Jaya. This paper analyzes several constraints that occur in the production process, one of which is the product queue at a particular work station or often called Bottleneck. This condition causes the company's throughput in producing socks to be less than optimal. The purpose of this study is to balance the production line in the socks production section, another goal is to reduce the obstacles that occur in the production of socks at PT. Matahari Sentosa Jaya. While the benefits to be gained from this research provide input advice in reducing congestion in cross-socks production and providing solutions to companies to reduce build-up in cross-production. The method used is the Drum Buffer Rope method in the Theory of Constraint analysis. TOC is an approach to process improvement that focuses on elements that are limited to increasing output. The first step taken is determining the cycle time of each workstation involved in the process of producing socks at MSJ. Based on this cycle time, the mapping is done to determine the workstation that is stuck. Then TOC is applied to reduce congestion at work stations [4].

Yayan Indrawan, Ni Luh Putu Hariastuti (2013) research title is Minimization of Production Process Bottlenecks Using the Line Balancing Method. This research minimizes bottlenecks and will improve work efficiency of the production line. The line balance method is needed to plan and control a production process flow, because by using this method the company will be able to evaluate its production line and improve its production line in order to maximize work efficiency in order to increase production output and also to minimize imbalances from the production line. To implement this line balance method required data include: the flow of the production process, the time of each production process and also the amount of output produced within a certain period of time. The data is then processed using the rangked position weighting method and the region approach method to obtain an effective work station to improve work efficiency to minimize bottlenecks so that production output can increase [5].

Mustika Sari (2018) research title is Designing the Production Line Balance to Minimize Bottlenecks. In the production process bottlenecks occur. The aim is to get an improved balance of the production line so that it can increase production output. Appropriate problem solving methods are Rangked Weight Position, Constraint Theory, and Simulation Annealing Algorithm. RPW is used to calculate the performance of actual production lines. The results obtained indicate that there is a path imbalance, so the analysis of the causes of the problem occurs using the TOC method. Obtain results from the cause of the problem at the work station

and reduce the time of work elements, so that the leveling index value is obtained as tracking the balance parameter. The smoothing index value is then used as an initial solution for the Simulation Annealing Algorithm [6].

Jason Nathanael Chandra, Lina Gozali, Lilyana (2018) research title is Calculation of Safety Stock and Bottleneck Minimization with Theory of Constraint Approach in the Production of Sandy Metal Tile at PT. XYZ. This research focuses on safety stock planning and bottleneck that occurs on sand coated metal roof production at PT. XYZ. Occuring risk cots from non- optimal safety stock quantity and failures to achieve production target as occurring bottleneck on production are the main problems. By using Theory of Constraint to minimize the occurring bottleneck on production line, the chosen best alternative is by recruiting 2 additional workers and 10 drying racks for production to maximize the company's profit [7].

3.2. Research of Improvement of Productivity

Pawar Kuldeep, Pant Reena, Pandit Shamuvel (2016) research title is Improvement of Productivity by Theory of Constraint and Line Balancing. This paper reveals the application of Theory of Constraints to improve the productivity of component under consideration. Company was facing problem for delivering the targeted component after increase in demand from their customer. The past data of housing component manufacturing process, resources required, work in process inventory and raw material inventory was collected. When analyzed the past data, constraints were observed on two machines in the production line which were needed to be focused. Eliminating the bottlenecks on these resources was the solution to cope up with the increased demand and also to minimize the raw material inventory as well as work in process inventory. The concepts described in Theory of Constraints were applied to overcome the bottlenecks on the constraint resources. The results obtained were at satisfactory level. The actual performance against the targeted level was measured and observed that productivity improved with considerable reduction in work in process as well as raw material inventories [8].

Mahmud Parvez, Faria Binta Amin, Fahmida Akter (2017) research title is Line Balancing Techniques to Improve Productivity Using Work Sharing Method. Line balancing is an effective tool to improve the throughput of assembly line while reducing bottleneck, cycle time. Line balancing is the problem of assigning operation to work station along an assembly line, in such a way that assignment is optimal in some sense. This project mainly focuses on improving overall efficiency of single model assembly line by reducing the bottleneck activities, cycle time and distribution of work load at each work station by line balancing, using line balancing techniques mainly work sharing method. The methodology adopted includes calculation of cycle time of process, identifying bottleneck activities, calculating total work load on station and distribution of work load using code block (c++) software on each workstation also redesigning the layout by line balancing, in order to improve the efficiency of line and increase overall productivity [9].

Rony Prabowo (2016) research title is Application of the concept of line balancing to achieve optimal work efficiency at each work station at PT. HM. Sampoerna Tbk. In the

production process of PT. HM. Sampoerna Tbk. faced with the problems of balancing the lack of efficiency at the work station, so it is planned to determine the optimal production line so that the load on each work station will be more evenly and reduce idle time. The method used is the method of measurement of working time with stop watch and the method of weighting positions (Method Ranked Positional Weight). The data analyzed is the time required by the operator to complete the production of cigarettes and the number of output rate to the average product produced to establish the ideal cycle time. Then both the above data were analyzed using the method of weight position, and came up production time and efficiency optimal trajectory and optimal work station anyway [10].

Anita Mustika Sari, Dodo Ardiles (2017) research title is Theory of Constraint Implementation to Increase Productivity Process Painting Battery Cover at PT. HIT Kudus. PT. Hartono Istana Teknologi is a company engaged in the production of electronic equipment to smartphones with the trademark Polytron. Based on the Market Research Team conducted by the marketing department of PT. HIT, the future demand for smartphone products will rise up to 3 times that of current production. The process of painting is one of the most important processes in making smartphones. Painting section at PT. HIT bottlenecks often occur in operations. Based on Theory of Constraints, to overcome the problem of frequent backorder, namely by implementing a new machine and adding 2 operators [11].

Table 1
Research Gap

Description	Jembar K.	Yayan I.	Mustika Sari	Jason N.C.	Pawar K.	Mahmud P.	Rony Prabowo	Anita Mustika S.
Method	TOC (Drum Buffer Rope)	Line Balancing (RPW and Region Approach)	Line Balancing (RPW and ASA), Theory of Constraint	5 step TOC	Line Balancing and TOC	Software C++	Line Balancing (RPW)	5 step TOC
Improvement	X	X	X	X	X	X	X	X
Industry	Textile (sock)	Polyester thread	Crumb Rubber	Sandy Metal Tail	Housing products	Garment	cigarette	Battery Cover
Instutution/Publisher	Widyatama Bandung University	Adhi Tama Institute of Technology Surabaya	University of Northern Sumatra	Tarumanagara University	International Journal of Research in Advanced Engineering and Technology	Khulna University of Engineering & Technology, Bangladesh	Adhi Tama Institute of Technology Surabaya	Diponegoro University

4. Research and Discussion

Based on studies and research among all papers, we can conclude that to minimize bottlenecks in work stations, we can use several methods. We can use the Line Balancing and Theory of Constraint methods. Line Balancing that can be used include: The Killbridge and Wester method (Region Approach), Moodie Young method, Helgeson Birnie method (Ranking Positional Weight System), and J-Wagon method, and then look for comparisons of the four methods and determine the smallest value of the balance delay and smothing index and the greatest efficiency value. whereas for Theory of Constraint apply TOC steps. Where is Line Balancing to balance the workload at each work station and TOC to minimize costs.

References

[1] Beer, Jacob E. 2015. *Analyisis and Management of Bottleneck in Supply Networks,* Faculty of Science and Technology, Department of Mechanical and Structural Engineering and Material Science, Centre for Industrial Asset Management, University of Stavanger.

[2] Ginting, Rosnani. "Sistem produksi." *Yogyakarta: Graha Ilmu* (2007).

[3] Goldratt, Eliyahu M., and Jeff Cox. "The Goal: a process of on-going improvement." (1984).

[4] Kurnia, Jembar; Rochman, Didit Damur (2010). *Pengurangan Bottleneck dengan Pendekatan Theory Of Constraint Pada Bagian Produksi Kaos Kaki di PT. Matahari Sentosa Jaya.* Seminar Nasional Design and *Application of Technology* 2010, Faculty of Engeneering Widya Mandala Catholic University Surabaya.

[5] Indrawan, Y., Ni Luh Putu H. 2013. Minimalisasi *Bottleneck* Proses Produksi Dengan Menggunakan Metode *Line Balancing.* Jurusan Teknik Industri, Institut Teknologi Adhi Tama Surabaya.

[6] Sari, Mustika (2018). *Perancangan Keseimbangan Lintasan Produksi Untuk Meminimumkan Bottleneck.* Departmen Teknik Industri, Universitas Sumatra Utara.

[7] Gozali, L., Jason C.N., Lilyana. 2018. *Perhitungan Safety Stock Dan Minimasi Bottleneck Dengan Pendekatan Theory Of Constraint Pada Produksi Genteng Metal Berpasir Di PT. XYZ.* Jurnal Ilmiah Teknik Industri, Fakultas Teknik Universitas Tarumanagara.

[8] Kuldeep, Pawar, Pant R., Pandit S. 2016. *Improvement of Productivity by Theory of Constraints and Line Balancing*, International Journal of Research in Advanced Engineering and Technology, ISSN: 2455-0876; Impact Factor: RJIF 5.44, Vol. 2, Issue 6, Page No. 01-04.

[9] Parvez, M., Faria B.A., and Fahmida A. 2017. *Line Balancing Techniques to Improve Productivity Using Work Sharing Methods,* IOSR Journal of Research & Method in Education (IOSR-JRME), e-ISSN: 2320-7388, p-ISSN: 2320-737X Vol. 7, Issue 3 Ver, IV, PP 07-14.

[10] Prabowo, Rony. 2016. *Penerapan Konsep Line Balancing Untuk Mencapai Efisiensi Kerja Yang Optimal Pada Setiap Stasiun Kerja Pada PT. HM. SAMPOERNA Tbk.*, Jurnal IPTEK Vol. 20(2) pages 9-20. Jurusan Teknik Industri, Institut Teknologi Adhi Tama Surabaya.

[11] Sari, A.M., Dodo A. 2017. “Anita Mustikasari, Dodo Ardiles (2017). *Implementasi Theory Of Constraint Untuk Meningkatkan Produktivitas Proses Painting Battery Cover Pada PT. HIT Kudus*. Seminar dan Konferensi Nasional IDEC 2017, ISSN: 2579-6429. Teknik Industri Fakultas Teknik Universitas Diponegoro.