Calculation of Labor Amount with Theory of Constraints and Line Balancing Method in PT. XYZ Fish Crackers Factory

by Lina Gozali

UNTAR TICATE

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Program Book

Tarumanagara International Conference on the Applications of Technology and Engineering 2019

November 21st - 22nd, 2019

Auditorium, M building 8th fl.
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(TICATE 2019)

UNTAR

JAKARTA – INDONESIA

WELCOME MESSAGE
BY CHAIRMAN OF TICATE 2019

On behalf of the organizing committee of TICATE 2018, I would like to welcome all delegates to Jakarta, Indonesia with great pleasure. Being held from November 21 to 22, 2019 at Campus I- Jl. Letjen. S. Parman No. 1, Jakarta, the international conference is organized by Universitas Tarumanagara (UNTAR) and technically sponsored by IOP Publisher.

TICATE 2019 has attracted many academicians, scientists, engineers, postgraduates and other professionals from many countries. This conference accepted 215 papers from 5 different countries, those are Australia, Taiwan, India, Malaysia, and Indonesia. The aim of the conference is to promote exchange of ideas among engineers, researchers, and scientists active in the related areas of TICATE.

Our special thank goes to our Rector, Prof. Dr. Agustinus Purna Irawan, who has initiate this international conference, to our Plenary Speakers, Dr.-Ing. Joewono Prasetijo from Universiti Tun Hussein Onn, Malaysia, Prof. Dr. Tjokorda Gde Tirta Nindhia from Udayana University, Indonesia, Prof. Dr. Srikantappa A.S. from Cauvery Institute of Technology, India, Prof. Dr. Mohd. Zulkifli Abdullah from Universiti Sains Malaysia, Malaysia and Prof. Yasuyuki Nemoto, Ph.D. from Ashikaga.

Our special thank also goes to Tarzan Photo and Morin as our patrons. Also to all individuals and organizations such as the members of international editorial board, the conference organizers, the reviewers and the authors, for their contribution in making TICATE 2018 as a successful international conference and a memorable gathering event. I am also grateful for the support of publication service of IOP Publisher. We hope that the conference could present you wonderful memories to bring home in addition to new insights and friendship congregated during the event.

We truly value your participation and support for the conference. We hope that you will enjoy TICATE 2019 and culture and tradition in Jakarta.

Dr. Hugeng, S.T., M.T. (SMIEEE)
CHAIRMAN OF TICATE 2019

FOREWORDS
BY UNTAR RECTOR

Dear our Distinguished guests, ladies and gentlemen,

It is such a great pleasure for me to welcome all the participants to the Tarumanagara International Conference on the Applications of Technology and Engineering (TICATE) 2019. It is the first international conference which is organized by Universitas Tarumanagara in the field of technology and engineering whose proceedings will be indexed by Scopus. With the success of this first TICATE, I hope this event would be held annually.

As we all know, the goal of this conference is to provide a forum that facilitates the exchange of knowledge and experience of both practitioners and academics in the fields of the applications of technology and engineering. Under these circumstances, they can mutually share their findings. Besides, the topic itself, which is about the Implementation of Research Results and Innovation for People's Prosperity, is extremely interesting. I can agree with the conference committee that a little thing has been done to provide comprehensive understanding of the importance of technology and engineering to support people's prosperity.

I would like to take this opportunity to extend my appreciation to the following institutions. Firstly, this year's conference becomes special due to the support from our Plenary Speakers: , Dr. Ing. Joewono Prasetijo from Universiti Tun Hussein Onn Malaysia, Malaysia, Prof. Dr. Tjokorda Gde Tirta Nindhia from Udayana University, Indonesia, Prof. Dr. Srikantappa A.S. from Cauvery Institute of Technology India, India, Prof. Dr. Mohd Zulkufli Abdullah from Universiti Sains Malaysia, Malaysia, and Prof. Yasuyuki Nemoto, Ph.D. from Ashikaga University. We are thankful for your wonderful cooperation. Secondly, our gratitude goes to our sponsors: Tarzan Photo, and Morin for the utmost support and kind contribution.
I would also sincerely say thanks to the organizing committee for their commitment, hard work and dedication, making this internationally reputable conference successfully realizable.

Finally, I would like to express my gratitude for the presence of distinguished speakers, authors, reviewers, and a number of active participants from several countries. I wish you all a wonderful and great conference. Thank you.

Prof. Dr. Ir. Agustinus Purna Irawan, Asean Eng.
RECTOR OF UNIVERSITAS TARUMANAGARA

TIME AND VENUE OF INTERNATIONAL CONFERENCE

The International Conference will be held with following details:

Venue	:	Auditorium Building "M", 8th Floor, Campus I Universitas Tarumanagara Jalan Letjen S. Parman No. 1, Grogol, Jakarta Barat, Indonesia, 11440
Date	:	21-22 November 2019
Time	:	08.00 – 17.00 WIB

:

:

:

2. SPEAKER

Plenary Session

Keynote Speaker:

1. Dr. Ing. Joewono Prasetijo

(Universiti Tun Hussein Onn Malaysia, Malaysia)

2. Prof. Dr. Tjokorda Gde Tirta Nindhia

(Udayana University, Indonesia)

Invited Speakers:

1. Prof. Dr. Srikantappa. A.S.

(Cauvry Institute of Technology India, India)

2. Prof. Dr. Mohd Zulkifli Abdullah

(Universiti Sains Malaysia, Malaysia)

3. Prof. Yasuyuki Nemoto, Ph.D

(Ashikaga University, Japan)

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4. TOPIC AREA

Scientific fields of the implementation of Tarumanagara International Conference on the Applications of Technology and Engineering 2019 (TICATE 2019) are as follows:

Track	Subtrack
Mechanical Engineering and Technology	Hydraulic and Pneumatics System; Fluids & Thermal Systems; Dynamics and Mechanical Vibrations; Mechanical Design and Manufacturing; Microsystems Integration; Cooperative Intelligent Systems; Advances for Process Industries; Power Generation – Conventional and Renewable; Computer Integrated Manufacturing; Design and Manufacturing Engineering; Industrial and Systems Engineering; Mechatronics and Automation; Operations Research; Production Planning and Control; Textile and Leather Technology
Electrical Engineering	Power Generation; Transmission and Distribution; Power Electronics, Systems and Applications; Electrical Machines and Adjustable Speed Drives; Electrical Power Systems; Circuits and Systems; Communication Systems; Analog and Digital Electronics; Electric Drives and Control; Instrumentation Engineering; Power System Engineering; Smart Grids Technologies & Applications; Computer Application Technology; Control Technology; Telecommunication Engineering; Network Engineering Communication; Signal and Image Processing; 4G/3G/LTE Mobile Networks Applications; Renewable Energy Sources, Smartgrids Technology & Application; High Voltage Engineering and Insulation Technology Controls

Track	Subtrack
Industrial Engineering	Quality Engineering & Management (QM), Supply Chain Management, operation research (OR), Decision Support System and Artificial Intelligence (DSS & AI), Production System (PS), Industrial Management (IM), Ergonomics (ER)
Civil and Environmental Technology	Bridge and Tunnel Engineering, Geotechnical Engineering, High-rise Structure and Large-span Structure, Modern Trends in Civil Eng., Structural Engineering, Surveying, Transportation Engineering, Water resource Engineering, Coastal Engineering, Computational Mechanics, Construction Technology, EngineeringManagement, Environmental Management, Environment-Friendly Construction and Development, Hydraulic Engineering, Safety Management
Food and Agriculture Technology	Agricultural Machinery, Biotechnology, Bio Fuel, Food Processing, Food Safety, Technologies in secure food packaging, Irrigation & water management, Forest and Natural Resource Management, New strategies in food packaging
Informatic Engineering and Technologies	Computer Application Technology, Software Engineering, Multimedia Technology, Mobile Computing, Artificial Intelligence, Computer Vision, Information Systems, Database Systems
Medical & Health Technology	Active Implantable Technology, Electromechanical Medical Technology, Hospital Hardware, Ophthalmic and Optical Technology, Dental Technology, Laboratory Equipment, Reusable Instruments, Technical Aids for Disabled

5. PROGRAM AT A GLANCE

Tarumanagara International Conference on the Applications of Technology and Engineering
Jakarta, 21-22 November 2019

Day 1 (Thursday, 21 November 2019)

TIME	ACTIVITY
08.30 – 09.00	Registration & Coffee Morning
09.00 – 09.15	**Opening Ceremony** • Singing "National Anthem" & " Mars Tarumanagara" • Traditional Dance • Report from Chairman: Dr. Hugeng (SMIEEE)
09.15 – 09.30	**Welcome Speech:** Rector of Universitas Tarumanagara Prof. Dr. Agustinus Purna Irawan (ASEAN Engineer) **Untar Video Profile**
09.30 – 11.45	**Keynote Speaker:** 1. Dr. Ing. Joewono Prasetijo (Universiti Tun Hussein Onn Malaysia, Malaysia) 2. Prof. Dr. Tjokorda Gde Tirta Nindhia (Udayana University, Indonesia) **Invited Speakers:** 1. Prof. Dr. Srikantappa. A.S. (Cauvry Institute of Technology India, India) 2. Prof. Dr. Mohd Zulkifli Abdullah (Universiti Sains Malaysia, Malaysia) 3. Prof. Yasuyuki Nemoto, Ph.D. (Ashikaga University)
11.45 - 12.00	Souvenir Presentation & Photo Session
12.00 - 13.00	Lunch Break
13.00 – 15.00	Paper Presentation Session I
15.00 – 15.15	Coffee & Tea break
15.15 – 17.15	Paper Presentation Session II

Day 2 (Friday, 22 November 2019)

TIME	Activity
08.30 – 08.30	Registration & Coffee Morning
08.30 – 11.30	Paper Presentation Session III
11.30 – 13.00	Lunch Break
13.00 – 16.00	Paper Presentation Session IV

PARALLEL SESSION SCHEDULE
Friday, 22 November, 2019

Room : Conference Room 6
Time : 08.30 – 11.45
Track : Industrial Engineering

NO	SCHEDULE	PAPER TITLE	AUTHORS	INSTITUTION
1	08.30-08.45	Calculation of Labor Amount with Theory of Constraints and Line Balancing Method in PT. XYZ Fish Crackers Factory	Lina Gozali, Frans Jusuf Daywin and Alvin Jestinus	Universitas Tarumanagara
2	08.45-09.00	Research Gap of Facility Planning and Layouts Studies	Bintang Bagaskara	Universitas Tarumanagara
3	09.00-09.15	Comparison Study about Production Scheduling System from Some Paper Case Studies	Vania Eliyanti, Lina Gozali, Lamto Widodo and Frans Jusuf Daywin	Universitas Tarumanagara
4	09.15-09.30	Comparison Study about Inventory Control System from Some Papers in Indonesia Case Study	Shelinsca Hoswari, Lina Gozali, Iveline Anne Marie and I Wayan Sukania	Universitas Tarumanagara
5	09.30-09.45	Comparison Study of the Application of Line Balancing and the Theory of Constraint	Jessica Sagitta, Lina Gozali and Frans Daywin	Universitas Tarumanagara
6	09.45-10.00	Comparison Study about Warehouse Layout from Some Paper Case Studies	Natalia Sudiarta, Lina Gozali, Iveline Anne Marie and I Wayan Sukania	Universitas Tarumanagara
7	10.15-10.30	Designing Press Tool For Carton Finishing Process To Improve Productivity And Efficiency	Lamto Widodo, Adianto Adianto, Siti Rohana Nasution and Priadi Wijaya	Universitas Tarumanagara
8	10.30-10.45	Consumer Preference Analysis Of Snack With Conjoint Analysis Method Approach (Case Study : Telur Gabus).	Lithrone Laricha Salomon, Wilson Kosasih and Carla Doaly	Universitas Tarumanagara

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Tarumanagara International Conference on the Applications of Technology and Engineering 2019

CERTIFICATE

OF ACHIEVEMENT

this certificate is presented to

LINA GOZALI, ST., MM., Ph.D

for the contribution as ***Presenter***

Paper Title: Calculation of Labor Amount with Theory of Constraints and Line Balancing Method in PT. XYZ Fish Crackers Factory

November 21st - 22nd, 2019 | Universitas Tarumanagara, Jakarta

Chairman

TICATE

Dr. Hugeng, S.T., M.T.

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Calculation of Labor Amount with Theory of Constraints and Line Balancing Method in PT. XYZ Fish Crackers Factory

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Calculation of Labor Amount with Theory of Constraints and Line Balancing Method in PT. XYZ Fish Crackers Factory

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Abstract. *The right amount of labor on work station is important to avoid uneven workload, that might reduce efficiency on production line, and cause bottleneck. Therefore, this research focus at searching the optimal amount of labor using line balancing and bottleneck that occurs on XYZ Fish Crackers Factory. Theory of constraints method is used to identify bottleneck, and line balancing method that will be used is Kilbridge-Wester, Moodie Young, Helgeson-Birnie, and J-Wagon. Fish cracker drying is the process that encounter bottleneck. The beginning line efficiency is 50.09%, with Kilbridge-Wester, Helgeson Birnie, and J- Wagon method, the line efficiency is 89.22%, and with Moodie Young method, the line efficieny is 89.45%. Therefore, Moodie Young method is the best method to apply, because it has the best result, with 89.45% line efficiency, 10.55% balance delay, 13.96% smoothness index, 20.3 minutes of idle time, 5 work station, and amount of labor needed is 10 person.*

1. Introduction

Calculation of the right amount of labor at work station need to be done to avoid the imbalance of operating time at the work station. Labor imbalance in the production line may decrease efficiency of work stations. The impact due to imbalance in the time distribution of work stations, may cause bottlenecks, and high idle time at work stations.

Therefore, to produce balanced production line, increase the efficiency of work station, and avoid bottleneck process, theory of constraints and line balancing method can be used to analyze the problems.

XYZ Fish Crackers Factory is a small industry engaged in fish crackers manufacturing, usually known as white crackers. Problems that occur in XYZ Fish Crackers Factory such as bottleneck at work station, uneven workloads, and cracker production time is quite time consuming because there is drying process. Therefore, calculation of the right amount of labor and equal distribution of workloads need to be done to increase efficiency in the production line to meet the increasing consumer demand.

This research emerges from the problem of bottleneck that occurs, and uneven workload. This study aims to identify bottleneck work elements in the production process, balancing workloads at production line. Theory of constraints and line balancing methods is used to handle these problems, so the workload is evenly distributed, minimize the bottleneck process, and found the right amount of labor needed in the production process.

2. Literature Review

2.1 Stopwatch Time Study

Stopwatch time method measure the standard time to finish working process in every station for each product.

2.2 Line Balancing

Line balancing according to Gasperz [1], balancing assignment of task elements from an assembly line to work stations to minimize the number of work stations and minimize total idle time at all

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stations for a certain level of output. In balancing this task, product units must be specified for each task and sequential relationship must be considered.

The purpose of line balancing to obtain smooth production flow in order to obtain high utilization of facilities, labor, and equipment through balancing work time between work stations. Each task element in a product activity is grouped in such way to several work stations so a good working time balance is obtained. There are terms in line balancing:

a. Precedence Diagram: graphical description sequence of operating work, and dependence on other work operations that aim to facilitate the control and planning of activities related to it.
b. Assemble Product: Product that passes through sequence of work stations where each work station provides certain process until the final product is finished.
c. Work Element: Part of the entire assembly process. Operation Time (Ti): Standard time to complete an operation.
d. Work Station (WS): Place on the production line where the production process is carried out.
e. Cycle Time (CT): Time needed to make one unit of product.
f. Station Time (ST): Total time from work element carried out on the same work station. Idle Time (I): Difference between cycle time (CT) and station time (ST).
g. Balance Delay (BD): Often called balancing loss, a measure of line inefficiency that results from actual idle time due to imperfect allocations between work station.
h. Line Efficiency (LE): Ratio of total time at the work station divided by cycle time multiplied by number of work stations.
i. Smoothness Index (SI): An index that shows the relative smoothness of balancing certain assembly line.

2.3 *Line Balancing Method*

2.3.1. Kilbridge-Wester Method

This method is trying to impose operations that have a large initial responsibility first. Steps in Kilbridge-Wester method are [2]:

a. Determine precedence diagram according to actual situation.
Divide work element into regions from left to right.
b. In each region, sort work element starting from largest operating time to smallest
c. operating time.
d. Charge work element from the left most area first, and between regions, charge work element with the largest operating time first.
e. After the work station charged, determine whether the time utilization is acceptable. If not, check all work process that meet relationship related with the operations that have been charged. Decide whether exchange of work element will increase the utilization of work station time.

2.3.2. Moodie Young Method

Moodie Young method has two stage of analysis [3]:

a. The first phase is the grouping of work stations. The work element is placed on a work station with rule if there are two work element that can be choose, the work element that has a larger time is placed first. Precedence diagram is made with matrix P (Prior Work Elements), and matrix F (Following Work Elements) for all work element.
b. The second phase identify largest work station time and smallest work station time. Then specify GOAL. GOAL = $(ST_{max} - ST_{min}) / 2$. Identify work element at work station with maximum time that has smaller time than GOAL. The maximum work element is moved to the minimum work station time. Then move other work element

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and repeat until there are no more work element to move.

2.3.3. Helgeson-Birnie Method

This method is usually better known as position weight method. Steps in Helgeson-Birnie method are [4]:

a. Determine precedence diagram according to actual situation.
b. Determine position weight for each work element related to operating time from longest working time from the start of operation to the rest of the operation.
c. Rank each work element based on position weight. Work element that has the highest weight is placed in the first rank.
d. Group work elements to work stations provided that they do not exceed the specified cycle time.

2.3.4. J-Wagon Method

This method prioritize highest number of work elements, that work element will be prioritized to the work station. The steps in the J-Wagon method are [4]:

a. Determine the weight for each element of work.
b. Sort the weights from the largest to the smallest.
c. Assign work elements to work station, with condition total work station time should not exceed the cycle time and prior work element have been done.
d. If work station time exceed the cycle time, last operation in the work station must be assigned to the next work station.
e. Repeat steps c and d until all work element have been grouped into the work station.

2.4 Theory of Constraints

Theory of Constraints was introduced by E.M. Goldratt, a management philosophy based on continuous improvement principles through focus on constraint system. In the view of Theory of Constraint, the organization's main goal to obtain profits can be achieved by increasing output while reducing operating and inventory costs [5].

2.5 Theory of Constraints Stages

Continuous improvement by using Theory of Constraints has five stages, as follows [6]:

a. Identify the Constraint
b. This stage trying to identify the weakest part or relationship from the system that limits or decreases system performance.
c. Exploit the Constraint
d. This stage is trying to identify various possible ways to manage and eliminate constraints.
e. Subordinate Everything Else to the Constraint
f. After handling constraints effectively, it is very important to equalize the rate of each non-constraint element with rate of the element that was previously a constraint so constraint utilization is efficient.
g. Elevate the System's Constraint
h. This stage is needed to increase the constraint capacity to turn it into a non-constraint.
i. If a Constraint is Broken, Repeat the Cycle
j. If the constraints chosen for system development have been solved, it is necessary to re-identify other constraints.

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2.6 Bottleneck

Bottleneck is source that has the same or smaller capacity than needed. Bottleneck is process that limits throughput. In Theory of Constraint method, bottlenecks can be minimized from the system where the constraint is located. Bottleneck is closely related to capacity-constraint resource (CCR), process capacity in production that is close to the standard. The CCR and bottleneck identification table can be seen in Table 1.

Table 1. CCR-Bottleneck Identification [7]

Category	*Bottleneck*	*Non-Bottleneck*
CCR	Inhibits actual flow, both in number and time. Must be considered in product flow planning.	Inhibits the flow of actual time, but not quantity. Must be considered in product flow planning.
Non-CCR	May inhibit actual flow, both in number and time. Does not require consideration in product flow planning.	Does not inhibit actual flow, both in number and time. Does not require consideration in product flow planning.

3. Research Methodology

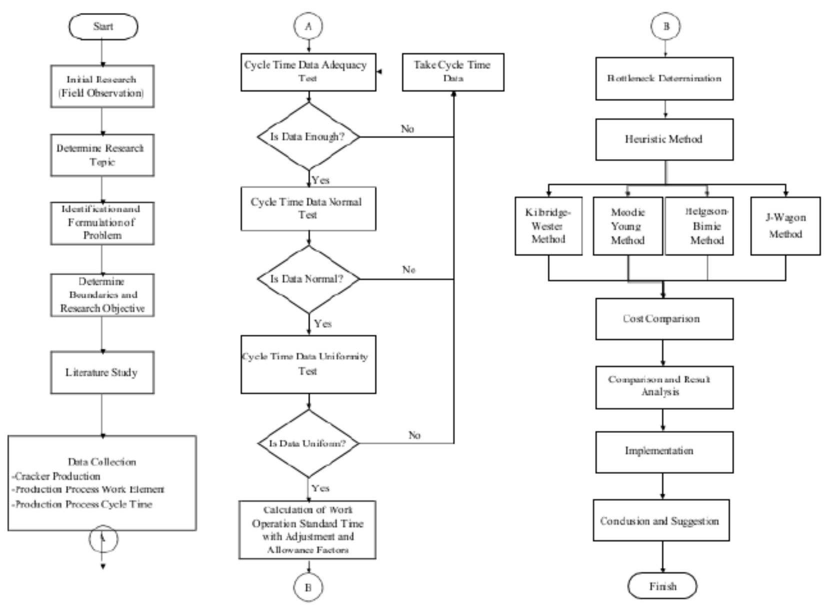

Figure 1. Research Methodology

Research methodology is stage that must be determined before carrying out research so that the research takes place in a directed and systematic manner. The stages in the research methodology in the form of a flow diagram can be seen in Figure 1.

4. Result and Discussion

The initial stage is to collect cycle time data to calculate standard time. Processed cycle time will be added with adjustment factor and allowance factor.

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4.1. Calculation of Standard Time

Implementation of Theory of Constraint in minimizing bottlenecks in the production process requires processing time data for each element of the production stage. Calculation of standard time through can be seen in Table 2.

Table 2. Standard Time of Fish Crackers Production Process

Process	Ws (min)	Adjusment Factor	Wn (min)	Allowance Factor	Wb (min)
Making Dough	7.2	0.07	7.7	0.098	8.5
Mixing Dough	25.2	0.03	26.0	0.135	29.5
Milling Dough	8.6	0.04	8.9	0.07	9.6
Making Crackers	23.8	0.1	26.2	0.11	29.1
Steaming Crackers	16.8	0.02	17.1	0.1	18.8
Drying Crackers	32.8	0.04	34.1	0.12	38.2
Oven	24.8	0.03	25.5	0.11	28.4
Frying	3.2	0.03	3.3	0.09	3.6
Packaging	5.7	0.02	5.8	0.113	6.5

4.2. Bottleneck Identification

Bottleneck identification is obtained from calculating production targets with available production capacity. If the capacity is insufficient, the operation that is bottleneck can interrupt overall production. The bottleneck calculation can be seen in Table 3.

Tabel 3. Bottleneck Calculation

Process	Standard Time (min)	Capacity Needed (min) 16 cycle	Capacity (min/day)	Workload Percentage (%)
Making Dough	8.5	135.3	480	28
Mixing Dough	29.5	471.4	480	98
Milling Dough	9.6	153.1	480	31.90
Making Crackers	29.1	465.0	480	96.87
Steaming Crackers	18.8	301.6	480	63
Drying Crackers	38.2	611.3	540	113.20
Oven	28.4	453.7	480	94.51
Frying	3.6	57.5	480	11.98
Packaging	6.5	103.5	480	22

4.1 Minimized Bottleneck

Based on the results of the identification of bottlenecks, the classification of process elements including resource and bottleneck capacity constraints can be seen in Table 4. Process elements including bottlenecks will be minimized by choosing the best alternative.

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Table 4. Bottleneck-CCR Classification

	Bottleneck	***Non-Bottleneck***
Capacity Constraint Resource (CCR)	Drying Crackers	Milling Dough, Making Crackers, Oven
Non-Capacity Constraint Resource		Making Dough, Steaming Crackers, Frying, Packaging

4.2 Precedence Diagram

The flow of fish cracker production process can be seen in Figure 2.

Figure 2. Production Process Flow

Remarks in Figure 2:

1. Making Dough (2 Labors)
2. Mixing Dough (2 Labors)
3. Milling Dough (1 Labors)
4. Making Crackers (2 Labors)
5. Steaming
6. Crackers (1 Labor)
7. Drying Crackers (2 Labors)
8. Oven (1 Labor)
9. Frying (2 Labors)
10. Packaging (1 Labor)

Comparison of line efficiency, balance delay, smoothness index, idle time, and the number of work stations needed using line balancing methods can be seen in Table 5.

Table 5. Comparison of Analysis Results with Line Balancing Methods

	Initial Line	***Kilbridge Wester***	***Moodie Young***	***Helgeson-Birnie***	***J-Wagon***
Line Balancing	50.09%	89.22%	**89.45%**	89.22%	89.22%
Balance Delay	49.91%	10.78%	**10.55%**	10.78%	10.78%
Smoothness Index	67.33%	19.81%	**13.96%**	19.81%	19.81%
Idle Time (minutes)	171.6	21.3	**20.3**	21.3	21.3
Work Stations	9	5	**5**	5	5

Description of work station results based on the results of analysis with the Moodie Young method can be seen in Figure 3.

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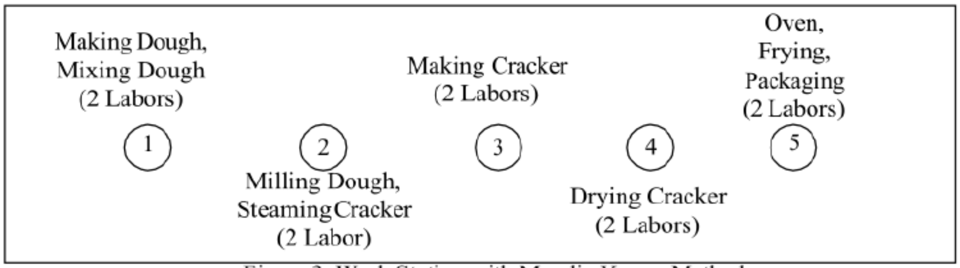

Figure 3. Work Station with Moodie Young Method

4.3 Cost Comparison
By using a comparison of line balance methods, the result is reduction in number of labors needed in the production process[9] . The amount of labors needed reduced from 14 labors to 10 labors. The result of reduction in operational costs can be seen in Table 6.

Table 6. Reduction of Operational Cost

Cost Type	**Amount of Labor**	**Salary/Month (Rp)**
Labor	4	2.100.000
Total Cost		8.400.000

The cost reduction that can be done by reducing the number of labors from 14 labors to 10 labors is Rp. 8.400.000 per month.

4.4 Initial Line and Implementation Comparison
After implementation has been done, processing time for each work station that is suggested will be calculated, and comparison between initial line condition and after implementation can be done. Comparison between initial line condition and after implementation can be seen in Table 7.

Table 7. Initial Line and Implementation Comparison

Process	**Idle Time (min)**		
	Initial Line	**Simulation**	**Implementation**
Making Dough	29.7	0.9	6.1
Mixing Dough	8.7		
Milling Dough	28.6	9.1	13.4
Steaming Crackers	19.4		
Making Crackers	9.1	6.2	6.5
Drying Crackers	0.0	3.4	4
Oven	9.8	0	3.2
Frying	34.6		
Packaging	31.7		

5. Conclusion
Based on result of analysis using theory of constraint method, the bottleneck occurs on process of drying crackers. This process is bottleneck because the workload is 113.20%, exceeding the available capacity, and inhibiting the flow of production. With the line balancing method, the best improvement result is using the Moodie Young method, with line efficiency of 89.45%, from the initial efficiency of 50.09%.

Moodie Young method have the minimum balance delay, smoothness index, and idle time

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with value of 10.55%, 13.96%, and 20.3 minutes. Number of work station recommended by Moodie Young method is 5 work station. Amount of labor needed is reduced from 14 workers to 10 workers, with reduction cost of Rp. 8.400.000 per month.

Advice given to XYZ Fish Crackers Factory, for excess labor, should be moved to help work stations that have heavier jobs, ensuring that employees work consistently so that idle time and production process cycle times are reduced so that line efficiency is optimal.

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