Analysis of Designing Job Shop Scheduling at PT. Harmoni Empat Selaras with Heuristic Classic Method, Tabu Search Algorithm Method and Active Scheduling Method to Minimize Production Makespan

by Lina Gozali

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Ninth International Conference

on Industrial Engineering and Operations Management

JW MARRIOTT HOTEL–

Bangkok, Thailand

MARCH 5–7, 2019

Organizer

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Host University

Chiang Mai University

Welcome to the Ninth IEOM Annual International Bangkok Conference

To All Conference Attendees:

On behalf of the IEOM Society International, we would like to welcome you to Bangkok, Thailand and the **Ninth Annual International** Conference on Industrial Engineering and Operations Management. This unique international conference provides a forum for academics, researchers and practitioners from many industries to exchange ideas and share recent developments in the field of industrial engineering and operations management. This diverse international event provides an opportunity to collaborate and advance the theory and practice of major trends in industrial engineering and operations management. There were more than 700 papers/abstracts submitted from 60 countries and after a thorough peer review process, approximately 450 have been accepted .The program includes many cutting edge topics of industrial engineering and operations management.

This conference will address many of the issues concerning continuous improvement for quality and service. Our keynote speakers will address some of these issues:

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We will continue to offer a special session on 13th Global Engineering Education Series. This session will feature distinguished speakers who will discuss the workforce readiness and engineering education challenges and opportunities. The Industry Solutions will showcase best industry practices and share their experiences.

The IEOM Society would like to express our deep appreciation to our sponsors, university partners, organization partners, exhibitors, authors, reviewers, keynote speakers, panelists, track chairs, advisors, the local committee and the many volunteers who have given so much of their time and talent to make this unique international conference an overwhelming successful event.

Chiang Mai University, conference host, welcomes all participants to Thailand. We are delighted to have you visit our county and participate in the IEOM Society International Conference in Bangkok. We are very pleased that industry is well represented at this event. Their involvement adds much value to our program. Chiang Mai University would like to acknowledge all of the student participants for their workshop presentations at this international event. Please take time to enjoy Bangkok and all that it has to offer with its diverse culture, rich history and exceptional cuisine.

Lastly, my sincere best wishes to you all for a successful conference and an enjoyable stay in Bangkok.

Enjoy the conference!

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ID 473 Analysis of Designing Job Shop Scheduling in PL Harmony of Four Selaras with Tabu Search Algorithm Method to Minimize Production Makespan

Lina Gozali, Lilyana Jap, Melcya Anggriani Halim, Industrial Engineering Department, Faculty of Engineering, Universitas Tarumanagara, Jakarta, Indonesia

At the 9th Annual International IEOM Conference on Industrial Engineering and Operations Management, JW Marriott Hotel, Bangkok, Thailand.

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2:30 – 4:00, TUESDAY Operations Research Room 4

Session Chair: Venkata Seshachala Sarma Yadavalli, University of Pretoria, South Africa

ID 267 Selection and Scheduling of Interdependent Projects Using a Modified Genetic Algorithm
Manish Kumar, M L Mittal, Gunjan Soni and Dheeraj Joshi, Department of Mechanical Engineering, Malaviya National Institute of Technology, Jaipur, India

ID 291 Solving Multi-Objective Assignment Problem with Decision Maker's Preferences by Using Genetic Algorithm
Md. Mahbubur Rahman, Dept. of Industrial Engineering and Management, Khulna University of Engineering & Technology, Khulna, Bangladesh
Md. Kutub Uddin, Department of Mechanical Engineering, Khulna University of Engineering & Technology, Khulna, Bangladesh

ID 380 Price-Quantity-Setting Mixed Duopoly Models: Market Opening
Fernanda A. Ferreira and Flávio Ferreira, Polytechnic Institute of Porto, School of Hospitality and Tourism, Applied Management Research Unit (UNIAG), Portugal

ID 397 The Capacitated Team Orienteering Problem
Aldy Gunawan and Hoong Chuin Lau, School of Information Systems, Singapore Management University, Singapore
Kien Ming Ng and Gordy Adiprasetyo, Department of Industrial Systems Engineering & Management, National University of Singapore, Singapore
Vincent F. Yu, Department of Industrial Management, National Taiwan University of Science and Technology, Taipei 106, Taiwan

ID 827 Green Marketing Mix Role Toward Sustainability Performance of Petrochemical Industry in Indonesia
Yuary Farradia and Abdul Talib Bin Bon, Faculty of Technology and Management, Universiti Tun Hussein Onn, Batupahat, Johor, Malaysia

ID 544 Performance Evaluation of Sustainable Innovation Practices in Food Supply Chain Using Best-Worst Method
Jyoti Darbari, Rashi Sharma and P.C. Jha, Department of Operational Research, University of Delhi, India
Venkata Seshachala Sarma Yadavalli, University of Pretoria, South Africa

2:30 – 4:00, TUESDAY Lean Six Sigma Room 5

Session Chair: Simon Peter Nadeem, University of Derby, Derby, U.K.

ID 029 The Application of Lean Manufacturing to Reduce Setup Time of a Printing Process
Kasarin Chivatxaranukul, Aeronautic Engineering, Vincent Mary School of Engineering, Assumption University, Thailand

ID 113 Decrease Scrap of Railroader Axle on Carajás Railroad
Francisco das Chagas Barbosa Nascimento, Reliableness of Wagon Maintenance Management, Carajás Railroad to VALE S.A., Av. dos Portugueses, S/N Anjo da Guarda, CEP 65085 580 São Luís, MA – Brasil
Gerisval Pessoa, North Carrier Capacity and Operational Process of Management, Executive Management of Maintenance Engineering EFC VALE S.A., Av. dos Portugueses, S/N Itaqui, CEP 65085 580 São Luís, MA – Brasil

ID 202 Operational Excellence: Concept Review and Meaning Restructuration
Jacobo Tijerina Aguilera & Nancy Lucero Tapia Ruiz, Universidad de Monterrey, San Pedro Garza García, Nuevo León, México

ID 249 Implementation of Overall Equipment Effectiveness (OEE) in Garment Manufacturing Industry
Abeeq ur Rehman, Muhammad Babar Ramzan, Abher Rasheed and Muhammad Salman Naeem, Department of Garment Manufacturing, National Textile University, Faisalabad, Pakistan

ID 376 Identifying Drivers of Lean Six Sigma Implementation in the Process Industries: A Case Study
Ferdous Sarwar, Farzana Islam, Md Sadman Sakib and Sampa Halder, Dept. of Ind. & Prod. Eng., Bangladesh University of Engineering & Technology, Dhaka, Bangladesh

ID 748 Quality Improvement in Refrigerator Division for 1-Door Refrigerator with Implementation of Six Sigma and Data Mining Method
Rina Fitriana, Johnson Saragih and Adizah Khairina Sarasetyo, Quality Control Laboratory, Industrial Engineering Dept., Trisakti University, Indonesia

2:30 – 4:00, TUESDAY Operations Management Room 6

Session Chair: Lina Gozali, Tarumanagara University, Jakarta, Indonesia

ID 473 Analysis of Designing Job Shop Scheduling In Pt. Harmony of Four Selaras with Tabu Search Algorithm Method to Minimize Production Makespan
Lina Gozali, Lilyana Jap, Meisya Anggriani Halim, Industrial Engineering Department, Faculty of Engineering, Universitas Tarumanagara, Jakarta, Indonesia

ID 526 A Principal Criteria Searching Approach Based Leanness Assessment Method Considering Industrial Diversity
Geng Cui, Fei Xie and Cunrong Li, Department of Industrial Engineering, School of Mechanical and Electronics Engineering, Wuhan University of Technology, China

ID 602 Factors Influencing the Success and Failure of Small and Medium-Sized Enterprises in Tembisa Township, South Africa
E I Edoun, Professor C Mbohwa and Thobile Yvonne Bhila, Faculty of Engineering and the Built Environment, Department of Quality and Operations Management, University of Johannesburg, Auckland Park, South Africa

ID 339 Knowledge Management by Farmers in the Win-Win Relationship Project in Land Reform Areas, Northern Thailand
Wallratat Intarucompom, Department of Agricultural Economy and Development, Faculty of Agriculture, Chiang Mai University, Thailand

ID 655 Newsvendor Models and Biases under Ambiguity
Peeyush Mehta, Indian Institute of Management Calcutta, Operations Management Group, Kolkata, India
R K Amit, Indian Institute of Technology Madras, Dept. of Management Studies, Chennai, India

2:30 – 4:00, TUESDAY Case Studies Room 7

Session Chair: Kiros Gebreanegawi Kebedow, Hawassa University, Hawassa, Ethiopia

ID 378 A Case Study of 5S Implementation in Inspection Process
Karthik Subburaman, Dept. of Mechanical Engineering, Vellech Rangarajan Dr Sagunthala R&D Institute of Science and Technology, Avadi, Chennai, Tamil Nadu, India

ID 437 Continuous Improvement to Create Value: Warehouse Management in a Telecommunications Company
José Vasconcelos Ferreira and Ana Luísa Ramos, GOVCOPP/Dept. of Economics, Management, Industrial Engineering and Tourism, University of Aveiro, Portugal
Adriana Ferreira Esteves, Department of Economics, Management, Industrial Engineering and Tourism, University of Aveiro, Aveiro, Portugal

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Bangkok, Thailand, March 5-7, 2019

Analysis of Designing Job Shop Scheduling at PT. Harmoni Empat Selaras with Heuristic Classic Method, Tabu Search Algorithm Method and Active Scheduling Method to Minimize Production Makespan

Lina Gozali, Meisya Anggriani Halim, Lilyana Jap,
Industrial Engineering Department, Faculty of Engineering
Universitas Tarumanagara
Jakarta, 11440, Indonesia
ligoz@ymail.com, limmeisyaa@gmail.com, lilyanajap@yahoo.com

Abstract

PT. Harmoni Empat Selaras is a manufacturing company engaged in making racking systems and office needs. The company applies the make to order system in production process with job shop production flow, that is, production begins when there is an order coming in and processing the order production flow has a different process flow for each item. Erratic production scheduling in companies can increase the value of production makespan, and to reduce productivity and efficiency in similar industries. The company manufacture the gondola rack products, with the result of 2760 seconds makespan production time. By paying attention to the existing provisions, in minimizing makespan time this research use taboo search algorithm method and active scheduling methods, by making the initial solution with the classical heuristic method. The scheduling proposal with the active scheduling algorithm produces makespan is 2194 seconds and the proposal with tabu search algorithm produces an makespan value is 2011 seconds. So it can be said that scheduling with tabu search algorithm method is more optimal than active scheduling algorithmSo from the results of the new scheduling found that the decreasing of the gondola rack efficiency production makespan time by 27,1%.

Keywords
Scheduling, Job Shop, Makespan Production, Tabu Search Algorithm, Active Scheduling.

1. Introduction

Currently the manufacturing industry is rapidly grow, seen from the number of new companies that started their own businesses in the industrial sector. The increasing number of manufacturing industry companies will certainly make a tight and competition, so the company must have its own strategy in order to be trusted by every customer. Timely fulfillment of orders is a major factor in winning competition, and effective scheduling is the right method, besides being able to increase productivity and facility utilization (Ashwani & Pankaj, 2010).

PT. Harmoni Empat Selaras is a manufacturing industry engaged in making racking systems and office equipment. Production scheduling in this company is uncertain and having a job shop production type. With the job shop process flow and the use of erratic production scheduling at PT. Harmoni Empat Selaras can cause a high production makespan time values. Also this can effect the waste in the production line, such as a wasteful amount of labor that has not been allocated well, thus making it difficult for companies to compete with similar industries.

This research propose to find a best production scheduling using the tabu search algorithm and active scheduling. Scheduling with this method aims to compare proposals from both methods and minimize makespan time so the company can compete with other similar industries.

2. Literature Review

Production scheduling is defined as an allocation of time to carry out each job in order to complete the whole project in achieving an optimal results by considering the limitations resources (Husen, A. 2009). Better production scheduling will result in coordination better so it increases productivity and minimizes operational costs (Guilherme et al., 2003).

2.1 Scheduling Objectives

The existence of scheduling optimization efforts is needed. The production scheduling objectives include (Nahmias, S. 1997):

a. Findthe production time.
b. Minimize set-up time, work in process time, and idle time.
c. Generate high machine or worker usability.
d. Determine work quickly.
e. Minimize the production costs and the number of workers.

2.2 Classic Heuristic Method

Job shop scheduling can be completed using the classic heuristic method. Classical heuristic methods that are often used in scheduling are (Baker, K. R., & Trietsch, D. 2009):

a. *First Come First Serve* (FCFS)
   According to this rule, the scheduling sequence is carried out based on the arrival time of a job or customer order. So, the job that came first, will be done first and so on for the next job (Baker, K. R., & Trietsch, D. 2009).
b. *Earliest Due Date* (EDD)
   According to this rule, the scheduling sequence is based on the due date of each job. This rule ignores the arrival time and the total processing time of each job. That is, jobs that have the earliest due date among other jobs are selected as jobs that have the highest priority for processing on a machine. This rule tends to be used to minimize the maximum lateness of jobs in the queue (Baker, K. R., & Trietsch, D. 2009).
c. *Longest Processing Time* (LPT)
   By using this rule, the process with the longest operating time will be scheduled first. This rule is also very simple, that is by sorting 14 jobs from the largest to the smallest processing time ($t1 \geq t2 \geq \ldots \geq tn$). After that, the scheduling is done according to the order (Baker, K. R., & Trietsch, D. 2009).
d. *Shortest Processing Time First* (SPT)
   According to this rule, jobs are sorted based on the length of time each process is processed. So, the jobs with a shortest processing time will be processed first and then continued by other –jobs, until the last job has the longest processing time. This rule is useful for balancing workloads among parallel machines arrangement parallel (Baker, K. R., & Trietsch, D. 2009).

2.3 Tabu Search Algorithm

Tabu Search is an algorithm that is a better level than some other algorithms, such as Simulated Annealing, to do search efficiently and prevent trapping solutions in local optimum (Heragu, 2006). The basic concept of Tabu Search is effectiveness the process of finding solutions by finding the best solution at each stage of tracking (Laguna at al. 1991). This method uses a tabu list to store a set of solutions that have just been evaluated. During the optimization process, in each iteration, the solution that will be evaluated will be matched first with the contents of the tabu list to see if the solution is already in the tabu list. If it already exists, then the solution will not be evaluated again. This situation keeps repeating until no solution is found that is not contained in the tabu list. In the tabu search method, a new solution is chosen if the solution which is a member of the neighboring solution set is the solution with the best objective function compared to other solutions in the neighboring solution set (Suyanto, A. O. 2010).

2.4 Completion of the Tabu Search Algorithm

The tabu search algorithm in completing the solution must pass each particular stage which has been set up in stages in the settlement is (Glover 1998):

1. Generating initial solutions
   First of all what is done is to generate the initial solution by searching for a solution manually.
2. Determining aspiration criteria
3. Make a move
   The move selected during the search process takes is neighborhood search. Searching with this technique every possible attribute of each structure can be moved. Permutation of n-change neighborhoods takes n elements from the solution matrix (which relate to items that are being produced on a machine at a time), and for each item change being produced with another item. Changes used by the two neighborhoods by swapping matrix elements or combination elements by exchanging other elements in the matrix.
   An example of a neighborhood can be seen in Figure 1 and the solution in Figure 2 and Figure 3:

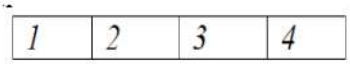

Figure 1 Initial Structure Illustration of Neighborhood

Example 1

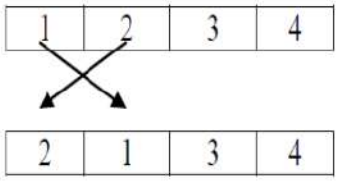

Figure 2 Illustration of Final Structure 1 Neighborhood

Example 2

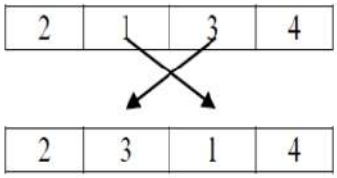

Figure 3 Illustration of the Final Structure of 2 Neighborhood

4. To avoid repeated steps taken, a tabu test is conducted. Tabu test utilizes the existing tabu list. The tabu list contains the attributes of the solutions that have been visited before. The true purpose of the tabu list is not to prevent the recurrence of the steps taken, but rather not to back down. To prevent repetition, a list of the solutions that have been reached is stored in a table. However, repetitive situations are rare, because some neighborhoods have been combined, which will expand search space, making the possibility of repeating the solutions that have been visited become almost impossible. The solution in this table is tabu. The only exception is to blockage situation. If this situation occurs, then all paths will be tabu. To avoid this, the earliest path is used in the tabu list.
5. Alternative move that passes the test tab still has to pass the aspiration test, whether it can pass the aspiration threshold or not, if not then continue the next iteration.
6. If the alternative move has a better aspiration criteria than the aspiration threshold, it is executed against the alternative move and updates the memory that is not relevant.
7. If the stop rule has fulfilled the termination requirement, then the search stops.

2.5 Active Scheduling Algorithm

The active scheduling method is a scheduling method with a set of schedules that does not allow to shift the global left. The steps according to the active scheduling method are as follows (Baker, K. R. 1974):

1. Step 1: t = 0, Pst = 0 (i.e. a partial schedule containing t scheduled operations). Set St (i.e. a set of operations that are ready to be scheduled) is the same as all operations without precursor.
2. Step 2: Determine r * = min (Rj) where rj is when the first operation j can be completed (Rj = Cj + Tij). Determine m*, which is the machine where r * can be realized.
3. Step 3: For each operation in Pst that requires the m * machine and has Cj <r * for a certain priority rule. Add the highest priority operation to the PSt so that a partial schedule is formed for the next stage.
4. Step 4: Create a new Pt + 1 partial schedule and fix the data set by removing the j dar St operation then making St + 1 by adding the direct followers of the k operation that have been removed and then adding one to t.
5. Step 5: Return to step 2 until all work is scheduled.

Information;
PSt is a partial schedule consisting of scheduled operations
St is a set of operations that can be scheduled at stage t, after PSt is obtained
Cj is the fastest operating time j ∈ St can be started
Rj is the fastest operating time j ∈ St can be completed

3 RESEARCH METHOD

The following is a research method carried out during the thesis report.

3.1 Field Study and Literature Study

Field studies are carried out the company to find out the solution of the problems, and literature study is done to increase knowledge by reading papers or books that can help in determining the theme.

3.2 Identification of Problems and Formulating Problems

Identify the problems that are found in the company and also formulate the company problems.

3.3 Data Collection

Conduct factory reviews to get the data needed. The data needed is in the form of company general data, and production time data.

3.4 Data Test

Testing the data that has been obtained from the company, whether the data is feasible and adequate to fulfill the next processed of research completion.

3.5 Generating Initial Solutions with the Best Heuristic Classic Method

The first step is to find out the initial solution with the classical heuristic method. The optimal makespan time value will be used as the initial solution for the tabu search algorithm.

3.6 Data Processing with Tabu Search Algorithm and Active Scheduling Algorithm

The most optimal results from the classical heuristic method will be used as the initial solution in the tabu search algorithm method to have the optimal makespan time value.

3.7 Analysis of Initial Method Calculation Results with Proposed Methods

The results of the job sequence with the most optimal makespan value in the heuristic method will be used as the initial solution in the tabu search algorithm method and also the active scheduling algorithm, to have the optimal makespan time value for the final result.

3.8 Conclusions and Recommendations

Summarize the data that has been analyzed and provide advice for company. The flowchart of the research process can be seen in Figure 4.

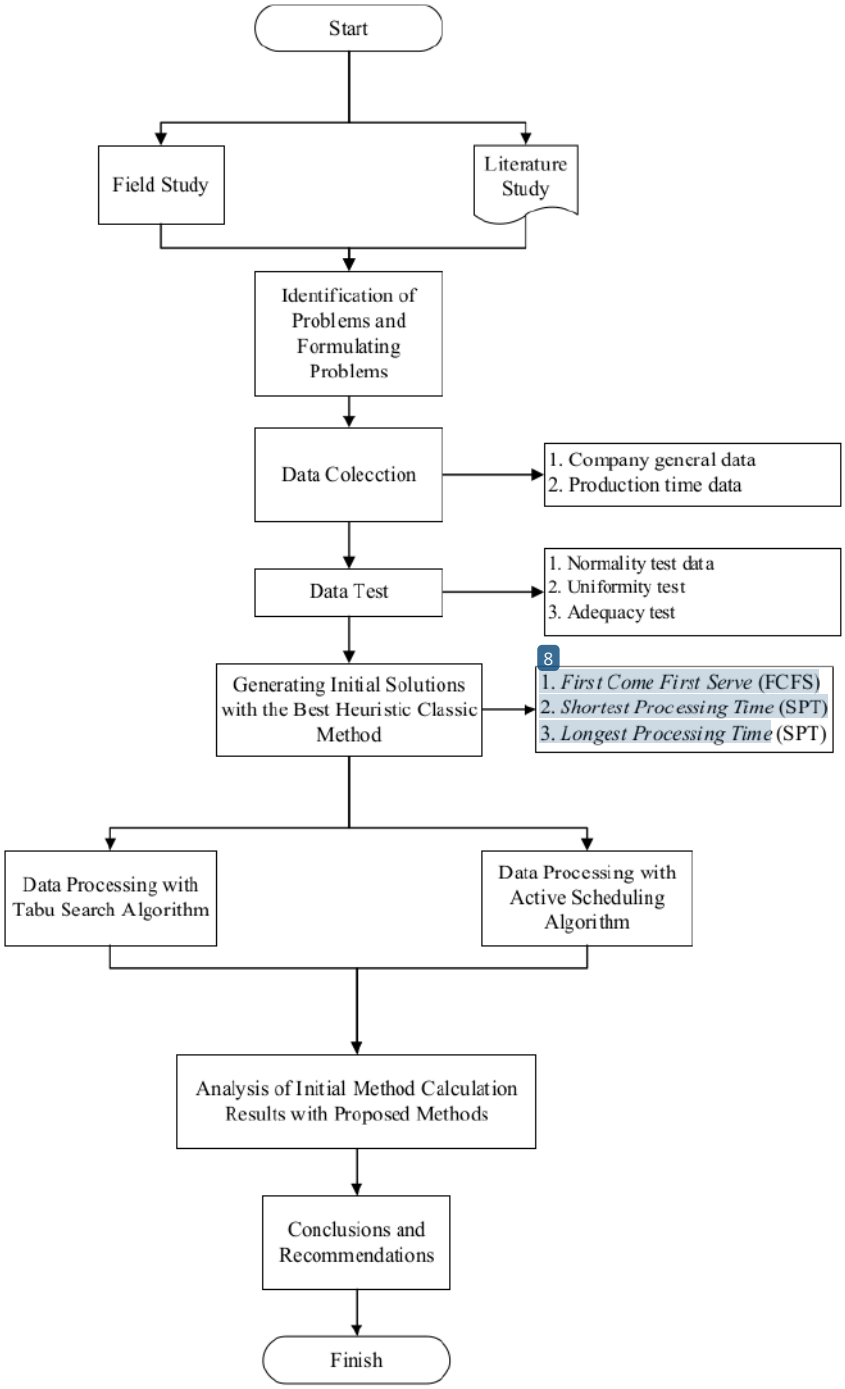

Figure 4 Research Method Flowchart

4 RESULTS AND DISCUSSION

The job shop scheduling requires some data, namely the number of machines used and the production time data for each component. the results of company data observations, are data on the number of machines in table 1 and production time data in table 2.

Table 1 Number of Machine Data

No	Name of Machine	Total	Work
1	Cutting Machine	1	Cutting
2	Laser Machine	1	Cutting
3	Power Press Machine	1	Pounding
4	Press Breake Machine	1	Bending
5	Bench Drill Machine	1	Drilling / Milling
6	Welding Machine	2	Weld
7	Spot Welding Machine	1	Weld spot
8	Punch Machine	1	Embos

Table 2 Standard Production Time Data (Second)

Job	Operation	Machine	Time (Second)	Name
1 (Base)	1	B (Laser Machine)	1146	11B
	2	D (Press Brake Machine)	76	12D
	3	G (Welding Machine)	648	13G
2 (Pole)	1	B (Laser Machine)	141	21B
	2	D (Press Brake Machine)	650	22D
	3	F (Welding Machine)	160	23F
3 (Shelving)	1	A (Cutting Machine)	499	31A
	2	C (Power Press Machine)	180	32C
	3	D (Press Brake Machine)	452	33D
	4	H (Punching Machine)	133	34H
	5	I (Spot Weldig Machine)	238	35I
4 (Support Shelf)	1	A (Cutting Machine)	242	41A
	2	D (Press Brake Machine)	126	42D
	3	E (Bench Drill Machine)	107	43E
5 (Bracket)	1	B (Laser Machine)	114	51B

Scheduling for companies begins with makespan time calculation with classical heuristic methods and continued with tabu search algorithm method. Calculation with classical heuristic method uses 3 methods, namely FCFS (First Come First Serve) method, SPT (Shortest Processing Time First), and LPT (Longest Processing Time First).

From the three classic heuristic methods, the makespan value for the FCFS (First Come First Serve) method is 2760 seconds, with the SPT method (Shortest Processing Time First), the makespan value is 2194 seconds, and the LPT (Longest Processing Time First) method gets the value makespan is 2557 seconds. So that the smallest makespan value is 2194 seconds to be used as the initial solution in scheduling using the tabu search algorithm.

The calculation with an active scheduling algorithm produces a makespan value of 2194 seconds with a sequence of jobs in the machine as shown in table 3 below:

Tabel 3 Sequence of Job Active Scheduling

St[a]	Cj[b]	Tij[c]	Rj[d]	t*	m*	PSt[e]
51B	0	114	114	114	B	51B
41A	0	242	242	242	A	41A
21B	114	141	255	255	B	21B
42D	242	126	368	368	D	42D
43E	368	107	475	475	E	43E
31A	242	499	741	737	A	31A
32C	737	180	917	917	C	32C
22D	368	650	1018	1018	D	22D
23F	1018	160	1178	1178	F	23F
11B	255	1146	1401	1401	B	11B
33D	1018	452	1470	1470	D	33D
12D	1470	76	1546	1546	D	12D
34H	1470	133	1603	1603	H	34H
35I	1603	238	1841	1841	I	34I
13G	1546	648	2194	2194	G	13G

[a] set of operations that can be scheduled at stage t, after PSt is obtained
[b] the fastest operating time j ∈ St can be started
[c] the time when the job is done on the machine
[d] the fastest operating time j ∈ St can be completed
[e] partial schedule consisting of scheduled operations

The calculation with tabu search algorithm will be done with the number of iterations of 5 and the number of tabu lists as much as 5, this is done so that the most optimal makespan value of each iteration is not lost, and reduces the same calculation for the data already in the tabu list.

In the calculation with tabu search algorithm, there is a tabu list which can be seen in Table 3.

Table 3 Tabu List

Job Order	2-4-5-3-1	2-5-4-3-1	2-3-4-5-1	2-3-1-5-4	2-3-1-4-5
Makespan	2125	2125	2125	2011	2011
	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5

So the most optimal solution is obtained during the 4th and 5th iterations, with an makespan value of 2011 seconds and the order of each job as:
Iteration 4
Base - Shelving - Tiang - Bracket - Support Shelf
Iteration 5
Base - Shelving - Pole - Shelf Support - Bracket

The results of manual calculations have the same result value with the results using the application program. To run the program application, it is necessary to input the number of jobs, the number of machines, the number of iterations, and the maximum number of operations. After that input process time is needed in each operation and machine, so that a sequence of production processes is formed. Then after entering the input, you will get the results in the application program like Figure 5.


First order : 5,4,2,3,1
Makespan: 2194

Tabu List

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Orders	2-4-5-3-1	2-5-4-3-1	2-3-4-5-1	2-3-1-5-4	2-3-1-4-5
Makespan	2125	2125	2125	2011	2011

	Tabu Search	Active Scheduling
Order	2-3-1-4-5	5-4-2-3-1
Makespan	2011	2194
Gant Chart	Gant Chart	Gant Chart

Figure 5 Result From Program

Based on the results of research, the efficiency improvement obtained after rescheduling with the tabu search algorithm method is 27.1% with the following calculations:

$$\text{Efficiency} = \left|\frac{(2011-2760)}{2760}\right| x\ 100\%$$

Efficiency = 27,1 %

The efficiency improvement obtained after rescheduling with the active scheduling algorithm method is 20.5% with the following calculations:

$$\text{Efficiency} = \left|\frac{(2194-2760)}{2760}\right| x\ 100\%$$

Efficiency = 20,5%

So that the tabu search algorithm method produces greater efficiency values than the active scheduling method.

5 CONCLUSION

Initial scheduling conducted by PT. Harmoni Empat Selaras still not optimal, shown by the makespan value which is still higher than the makespan value obtained using the tabu search algorithm method or active scheduling.

From the results of the study it can be said that tabu search is a more optimal scheduling method compared to active scheduling methods and company methods because the tabu search method makes the makespan value of 2011 seconds while the active scheduling method obtained makespan value of 2194 seconds and scheduling from the company amounted to 2760 seconds.

So that the new scheduling with the tabu search method is more efficient 27,1% than the old company scheduling and scheduling with an active scheduling method is more efficient 20,5% compared to the old scheduling used by the company.

6 REFERENCES

Baker, K. R. (1974). *Introduction to sequencing and scheduling*. John Wiley & Sons.

Baker, K. R., & Trietsch, D. 2009. Principles of Scheduling and Sequencing.

Dhingra, A., & Chandna, P. (2010). Hybrid Genetic Algorithm for Multicriteria Scheduling with Sequence Dependent Set up Time. *International Journal of Engineering, Volume 3; Issue 5*, 510-520.

Glover, F. and Manuel Laguna (1998), "Tabu Search", *Article*.

Heragu, S. S. (2006), *"Facilities Design"*, Second Edition, iUniverse Inc., USA.

Husen, A. 2009. Manajemen Proyek Perencanaan, Penjadwalan dan Pengendalian Proyek. *Andi, Yogyakarta*.

Laguna, M., Barnes, J. W., & Glover, F. W. (1991). Tabu search methods for a single machine scheduling problem. *Journal of Intelligent Manufacturing*, *2*(2).

Nahmias, S. 1997. *Production and operations management. Irwin, Chicago*, 2-4.

Suyanto, A. O. (2010). Deterministik atau Probabilitik. *Yogyakarta: Graha Ilmu*.

Vieira, G. E., Herrmann, J. W., & Lin, E. (2003). Rescheduling Manufacturing Systems: A Framework of Strategies, Policies, and Methods. *Journal of Scheduling*, 39-62.

Biography / Biographies

Lina Gozali is a lecturer of Industrial Engineering Department at Universitas Tarumangara since 2006 and be a free-lance lecturer at Universitas Trisakti since 1993. She got Bachelor degree at Trisakti University, Jakarta - Indonesia, then she graduated Master Degree at STIE IBII, Jakarta – Indonesia, and graduated her Ph.D at Universiti Teknologi Malaysia, Kuala Lumpur – Malaysia in year 2018. She taught Production System and Supply Chain Management Subjects and her Ph.D research about Indonesian Business Incubator. She actively writing for almost 40 publication since 2008 in Industrial Engineering research sector such as: Production Scheduling, Plant Lay Out, Maintenance, Line Balancing, Supply Chain Management, Production and Inventory Control. She has been worked at PT. Astra Otoparts , Tbk as International Business Development Department for 4 years, Citibank, N.A as customer service for 1 year , PT. Pandrol as assistant marketing manager for 1 year. PT. Texmaco as merchandiser for 3 years.

Meisya Anggriani Halim is a bachelor degreee student at Industrial Engineering Department at Universitas Tarumanagara since 2015. She got her interested to research about production scheduling in Heuristic Classic and Meta Heuristic Classic. She finished high school at Strada St. Thomas Aquino majoring in natural sciences. She got practical experience at PT Fajarindo Faliman Zipper in the quality control division, for one month. While there she learned about quality control and production processes.

Lilyana Jap is a freelance lecturer of Industrial Engineering Department at Universitas Tarumanagara since 2017, graduated from University of Indonesia, majoring on Environmental Science (industrial scope). She interested with in-depth reasearch of modelling system with systems thinking methodes and system dynamics approachments. Her previous reasearch was using Powersim Studio 10, with utmos analytical about modeling in system dynamics.

Analysis of Designing Job Shop Scheduling at PT. Harmoni Empat Selaras with Heuristic Classic Method, Tabu Search Algorithm Method and Active Scheduling Method to Minimize Production Makespan

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