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# Implementation of Nawaz, Enscore, and Ham (NEH) for Minimize Makespan in Job Shop Scheduling

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**ABSTRACT**

***Objective:*** *PT. OPQ is a company that specializes in providing construction materials such as ready-mix concrete, precast concrete, concrete bricks and crushed stone. With 4 different compositions and high demand, it is not uncommon for problems to occur, namely late delivery. This research aims to increase work efficiency by minimizing makespan to reduce idle time which will impact delays in product delivery to customers.* ***Method:*** *The results of production scheduling using the NEH method produce smaller makespan results and faster production process completion times compared to the scheduling method used by the company.* ***Results:*** *The NEH method produces a makespan of 2.29 with the job sequence P3-P4-P2-P1. The method used by the company obtained a makespan of 3.01 with a partial work sequence of P2-P3-P4-P1.* ***Novelty:*** *This can prove that the calculation results using the NEH method can minimize makespan and this method can be used by companies as a reference for scheduling the production process to overcome the problems being faced by the company.*

## INTRODUCTION

Production Scheduling in the Manufacturing Sector aims to provide the best results for customers [1]. One of the best ways to deliver excellent customer service is by ensuring products are delivered on time and made available according to their schedules. Achieving optimal and timely production is essential, and the most important solution is to create an efficient supply chain to achieve the best results in production operations; all production processes must be carefully planned in advance [2]. Scheduling is the process of formulating a plan that allocates resources to several tasks over a specific period. It is an important step because it helps optimize company goals and strategies [3]. Production scheduling is defined as the process of allocating materials or machines to complete a series of tasks within a given timeframe. Production is crucial for businesses using a make-to-order system, where new products are manufactured in response to customer demand [4].

Scheduling refers to the allocation of limited resources to complete a set of specific tasks. Problems may arise during operations when multiple employees require the same workstation. Failures in production processes are critical issues in the manufacturing industry. Poor scheduling in manufacturing can negatively affect various aspects, including work or process efficiency. The use of scheduling is therefore vital for product planning and development. The objective of scheduling is to maximize the use of available resources in planning production and managing resources effectively. With proper scheduling, tasks can be organized and sequenced while optimizing the time and resources needed for each process [5]. Optimization is the process of making a task as efficient as possible to achieve the desired results. Optimization can only occur when work is performed efficiently and effectively [6]. The main goals of scheduling are [7] to increase equipment or resource utilization by reducing idle time, minimizing the number of jobs in the queue, and eliminating delays.

PT. OPQ is a company that specifically provides construction materials such as ready-mix concrete, precast concrete, concrete bricks, and crushed stone. With four different product compositions and high demand, problems often arise — one of which is delivery delays caused by several factors such as varying customer requests, the absence of effective scheduling within the company, and alternating machine use among concrete variations. A decline in customer trust is often caused by delays in the delivery process. At PT. OPQ, delivery delays of 5–8 hours per loading process occur daily. Continuous delays over a six-month period can result in the termination of partnerships with related vendors and a decrease in demand due to declining customer trust. This situation can have severe impacts on the company, such as partnership termination and decreased orders. Therefore, when issues occur in the production and delivery processes, the company must improve its management system [8].

The manufacturing system used by the company is designed to meet customer demand based on purchase orders. Businesses generally emphasize the importance of completion time (makespan) to meet customer needs. Currently, the company uses the First Come First Serve (FCFS) system. This system has several weaknesses, one of which is that when multiple orders arrive simultaneously, it becomes difficult to determine which order should be processed first. Such problems are likely to affect the completion time (makespan). A longer makespan increases the risk of orders being completed past their due dates [9]. The main measure of successful scheduling is the reduction of production completion time (makespan) [10].

Several previous studies have addressed this issue. A study conducted by Martin [11] discussed scheduling using the CDS, NEH, and Palmer methods. The research found that the NEH method produced a shorter total completion time compared to the CDS and Palmer methods. Another study conducted by Nino [1] examined scheduling optimization using the Nawaz Enscore Ham (NEH) method and found a makespan reduction of 3.16 hours. Similarly, Siti [5] investigated minimizing makespan using the NEH method and found a production time reduction of 13,519.65 seconds compared to the company's existing method. These results demonstrate that the NEH method can significantly reduce production time compared to traditional company methods.

Based on previous studies, one approach that can be used to address the problems in this research is the Nawaz Enscore Ham (NEH) method. The NEH method has been proven effective in improving productivity by reducing the total time required to complete customer orders. The Nawaz Enscore Ham (NEH) algorithm is a heuristic that prioritizes tasks requiring longer overall processing times over those requiring shorter times [12]. The method was developed in 1983 by Muhammad Nawaz, Emory Enscore Jr., and Inyong Ham. In a general flowshop, where all jobs must pass through all machines in the same order, heuristic algorithms suggest that jobs with higher total processing times should be given higher priority than those with lower total processing times [13]. This concept means that in a flowshop scheduling system, all tasks must go through the same sequence of machines, and tasks with longer processing times should receive greater priority.

The principle of the NEH method is to find the optimal solution by swapping job positions to generate multiple possible job sequences, ultimately producing the best outcome [14]. The NEH approach is considered superior to other heuristic methods because it more accurately determines possible job sequences to be scheduled [15]. Production scheduling using the NEH method is carried out to minimize makespan through several stages.

This study aims to increase work efficiency by minimizing makespan (total production time) to reduce idle time, which will help prevent product delivery delays to customers. The method used in this study can serve as a reference for companies seeking to improve production process efficiency by minimizing makespan.

## RESEARCH METHOD

The calculation process using the NEH method is carried out through the following stages [16]:

1. Sum the production processing time for each job

   $T = \sum_{i}^{m} t_i$ [5]

   Explanation:

   T = total time for all jobs

   t = processing time for each job

   i = job being processed
2. Sort the total job times from the largest to the smallest.
3. Set the iteration X = 2 for the job with the largest total processing time.
4. Calculate the makespan value for X = 2.
5. Create a partial sequence candidate for X = 2 and calculate its makespan.
6. For the next partial sequence, set X = X + 1.
7. Select the job ranked third based on total production time.
8. Calculate the makespan for X = X + 1.
9. Repeat the process until all jobs are completed.
10. Recap the makespan calculations for all jobs that have been processed.
11. Choose the job sequence with the smallest makespan.
12. Finish.

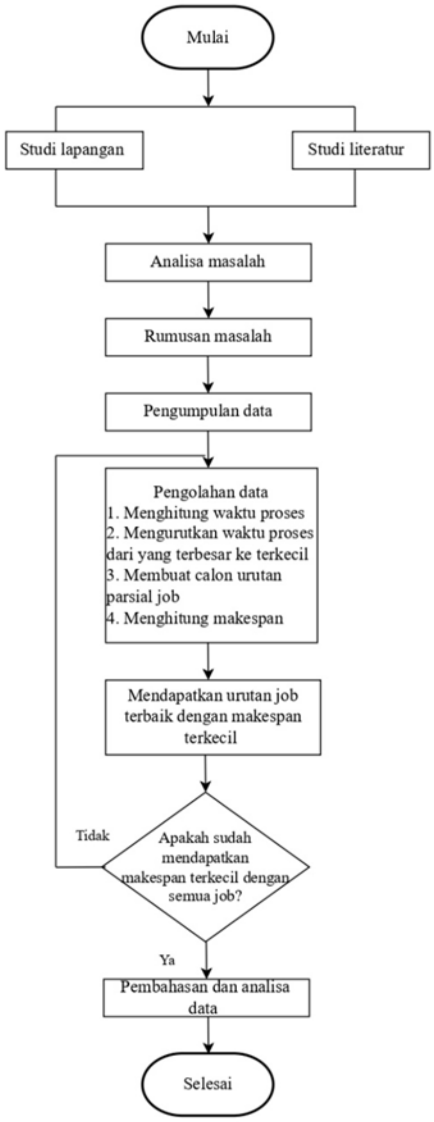


**Figure 1.** Research Flowchart.

This study focuses primarily on production scheduling for ready-mix concrete. The data collection methods used in this research include direct observation of the company environment and interviews with experts in the relevant field. The data used in this study consist of production process data, production processing time data, and machine data. Production processing time data were collected using a stopwatch during direct observation of the loading process.

## RESULTS AND DISCUSSION

### A. Nawaz, Enscore, and Ham (NEH)

The results and discussion using the Nawaz, Enscore, and Ham (NEH) method, based on the steps outlined in the method, are presented in the following description:

1. Calculating Total Production Processing Time

The following data shows the processing times for ready-mix concrete jobs at PT. OPQ. The total production processing time for each job was calculated to identify which job has the longest total time, which will be used for ranking in the next stage. The results of the production time calculations can be seen in Table 1 below:

**Table 1.** Production Processing Time.

| Machine \ Job | P1 | P2 | P3 | P4 |
|---|---|---|---|---|
| M1 | 0,25 | 0,28 | 0,28 | 0,26 |
| M2 | 0,22 | 0,20 | 0,23 | 0,28 |
| M3 | 1,00 | 0,80 | 0,62 | 1,00 |
| M4 | 0,17 | 0,16 | 0,11 | 0,19 |
| M5 | 0,10 | 0,19 | 0,14 | 0,20 |
| M6 | 0,20 | 0,18 | 0,14 | 0,15 |
| M7 | 0,13 | 0,17 | 0,19 | 0,18 |
| M8 | 0,12 | 0,14 | 0,16 | 0,15 |
| Total | 2,19 | 2,13 | 1,88 | 2,41 |

Explanation:
M = Machine
P = Job

2. Ranking Total Job Time

After calculating the total production time, the next step is to rank the results of total production time from the largest to the smallest. This is based on the NEH method principle, which states that tasks requiring longer total processing times should be given higher priority than tasks requiring shorter total processing times. Therefore, the total production times are ranked accordingly. The ranking of total job times can be seen in Table 2 below:

**Table 2.** Ranking of Total Job Time.

| Code | Order | Total Time |
|---|---|---|
| P4 | 1 | 2,41 |
| P1 | 2 | 2,19 |
| P2 | 3 | 2,13 |
| P3 | 4 | 1,88 |

In Table 2, the total production times for each job are ranked as follows: P4 is ranked first with a total production time of 2.41, P1 is second with 2.19, P2 is third with 2.13, and P3 is fourth with 1.88

3. Constructing Iteration 1, X = 2

The next step is to create iteration X = 2 from i, which involves making an iteration of the two jobs with the largest total production times. In this study, iteration X = 2 from i includes P4 and P1, and two alternative partial sequences are created. The makespan for iteration X = 2 is calculated by summing the production time and setup time. The results of the makespan calculation for iteration X = 2 can be seen in Table 3 below:

**Table 3.** Makespan Iteration X = 2, Alternative 1.

| Machine | Time | P4 | P1 |
|---|---|---|---|
| M1 | Start | 0 | 0,26 |
| | Ended | 0,26 | 0,51 |
| M2 | Start | 0,26 | 0,54 |
| | Ended | 0,54 | 0,76 |
| M3 | Start | 0,54 | 1,54 |
| | Ended | 1,54 | 2,54 |
| M4 | Start | 1,54 | 1,73 |
| | Ended | 1,73 | 1,90 |
| M5 | Start | 1,73 | 1,93 |
| | Ended | 1,93 | 2,03 |
| M6 | Start | 1,93 | 2,08 |
| | Ended | 2,08 | 2,28 |
| M7 | Start | 2,08 | 2,26 |
| | Ended | 2,26 | 2,40 |
| M8 | Start | 2,26 | 2,41 |
| | Ended | 2,41 | 2,53 |

In Table 3, from the makespan calculation for iteration X = 2, alternative partial sequence 1, a makespan of 2.53 was obtained for the job sequence P4-P1. In the makespan calculation for iteration X = 2, alternative 2, the same calculation method was applied but with a different job sequence, P1-P4, resulting in a makespan of 2.34. The makespan calculation for the job sequence P1-P4 can be seen in Table 4 below:

**Table 4.** Makespan iteration X = 2, alternative 2.

| Machine | Time | P1 | P4 |
|---|---|---|---|
| M1 | Start | 0 | 0,25 |
| | Ended | 0,25 | 0,51 |
| M2 | Start | 0,25 | 0,47 |
| | Ended | 0,47 | 0,75 |
| M3 | Start | 0,47 | 1,47 |
| | Ended | 1,47 | 2,47 |
| M4 | Start | 1,47 | 1,64 |
| | Ended | 1,64 | 1,83 |
| M5 | Start | 1,64 | 1,74 |
| | Ended | 1,74 | 1,93 |
| M6 | Start | 1,74 | 1,93 |
| | Ended | 1,93 | 2,08 |
| M7 | Start | 1,93 | 2,06 |
| | Ended | 2,06 | 2,24 |
| M8 | Start | 2,06 | 2,19 |
| | Ended | 2,19 | 2,34 |

4. Constructing Iteration 2, X = 3

The next step is to increase the number of iterations to X = X + 1 from i, meaning after performing iteration X = 2, the next iteration becomes X = 3. In this iteration, three job sequences will form the candidate partial sequences, with makespan calculations differing for each alternative. In the previous iteration, the candidate partial sequences were taken from the first and second largest total production times. For iteration X = 3, the third largest total production time is added. Thus, in the first alternative, the candidate partial sequence is P4-P1-P2. The makespan calculation for iteration X = 3 can be seen in Table 5 below:

**Table 5.** Makespan iteration X = 3, alternative 1.

| Machine | Time | P4 | P1 | P2 |
|---|---|---|---|---|
| M1 | Start | 0 | 0,25 | 0,49 |
| | Ended | 0,25 | 0,49 | 0,78 |
| M2 | Start | 0,25 | 0,48 | 0,70 |
| | Ended | 0,48 | 0,70 | 0,91 |
| M3 | Start | 0,48 | 1,48 | 2,48 |
| | Ended | 1,48 | 2,48 | 3,28 |
| M4 | Start | 1,48 | 1,65 | 1,82 |
| | Ended | 1,65 | 1,82 | 1,97 |
| M5 | Start | 1,65 | 1,76 | 1,86 |
| | Ended | 1,76 | 1,86 | 2,05 |
| M6 | Start | 1,76 | 1,93 | 2,13 |
| | Ended | 1,93 | 2,13 | 2,31 |
| M7 | Start | 1,93 | 2,09 | 2,22 |
| | Ended | 2,09 | 2,22 | 2,39 |
| M8 | Start | 2,09 | 2,25 | 2,37 |
| | Ended | 2,25 | 2,37 | 2,52 |

In Table 6, from the makespan calculation for iteration X = 3, alternative partial sequence 1, a makespan of 2.52 was obtained for the job sequence P4-P1-P2. In the makespan calculation for iteration X = 3, alternative 2, the same calculation method was applied but with a different job sequence, P1-P2-P4, resulting in a makespan of 2.48. The makespan calculation for the job sequence P1-P2-P4 can be seen in Table 6 below:

**Table 6.** Makespan iteration X = 3, alternative 2.

| Machine | Time | P1 | P2 | P4 |
|---|---|---|---|---|
| M1 | Start | 0 | 0,24 | 0,52 |
| | Ended | 0,24 | 0,52 | 0,78 |
| M2 | Start | 0,24 | 0,46 | 0,66 |
| | Ended | 0,46 | 0,66 | 0,94 |
| M3 | Start | 0,46 | 1,46 | 2,26 |
| | Ended | 1,46 | 2,26 | 3,26 |

| | | | | |
|---|---|---|---|---|
| M4 | Start | 1,46 | 1,62 | 1,77 |
| | Ended | 1,62 | 1,77 | 1,97 |
| M5 | Start | 1,62 | 1,71 | 1,90 |
| | Ended | 1,71 | 1,90 | 2,10 |
| M6 | Start | 1,71 | 1,87 | 2,05 |
| | Ended | 1,87 | 2,05 | 2,20 |
| M7 | Start | 1,87 | 2,03 | 2,20 |
| | Ended | 2,03 | 2,20 | 2,38 |
| M8 | Start | 2,03 | 2,19 | 2,33 |
| | Ended | 2,19 | 2,33 | 2,48 |

In the next candidate partial sequence for iteration X = 3, the makespan calculation for candidate partial sequence 3 with the job sequence P2-P4-P1 resulted in a makespan of 2.40. The makespan calculation can be seen in Table 7 below:

**Table 7.** Makespan iteration X = 3, alternative 3.

| Machine | Time | P2 | P4 | P1 |
|---|---|---|---|---|
| M1 | Start | 0 | 0,28 | 0,54 |
| | Ended | 0,28 | 0,54 | 0,79 |
| M2 | Start | 0,28 | 0,49 | 0,76 |
| | Ended | 0,49 | 0,76 | 0,98 |
| M3 | Start | 0,49 | 1,29 | 2,29 |
| | Ended | 1,29 | 2,29 | 3,29 |
| M4 | Start | 1,29 | 1,44 | 1,64 |
| | Ended | 1,44 | 1,64 | 1,80 |
| M5 | Start | 1,44 | 1,63 | 1,83 |
| | Ended | 1,63 | 1,83 | 1,93 |
| M6 | Start | 1,63 | 1,82 | 1,97 |
| | Ended | 1,82 | 1,97 | 2,16 |
| M7 | Start | 1,82 | 1,98 | 2,16 |
| | Ended | 1,98 | 2,16 | 2,30 |
| M8 | Mulai | 1,98 | 2,13 | 2,27 |
| | Ended | 2,13 | 2,27 | 2,40 |

Next, iterations are carried out until all jobs are completed, creating candidate partial job sequences in the same manner as the previous steps. This process is repeated until all jobs are scheduled and the total number of jobs is fulfilled.

5. Makespan Recapitulation

The next step is to recapitulate all makespan calculations for all total jobs that have been computed. The recapitulation of makespan calculations for the available total jobs can be seen in Table 8 below:

**Table 8.** Makespan Calculation Results.

| Iteration Number | Job Sequence | Makespan |
|---|---|---|
| 1 | P4-P1 | 2,53 |
| | P1-P4 | 2,34 |
| 2 | P4-P1-P2 | 2,52 |
| | P1-P2-P4 | 2,48 |
| | P2-P4-P1 | 2,40 |
| 3 | P2-P3-P1-P4 | 2,43 |
| | P1-P2-P3-P4 | 2,64 |
| | P3-P4-P2-P1 | 2,29 |
| | P4-P1-P3-P2 | 2,71 |

From the calculations above, the smallest makespan can be identified. The job sequence with the smallest makespan indicates minimal idle time, which allows production processes to be maximized effectively. Using the NEH method, the smallest makespan obtained is 2.29, with the partial job sequence P3-P4-P2-P1, meaning job 3 is performed first, followed by job 4, then job 2, and ending with job 1. In addition to the calculation tables, the output includes a Gantt chart. The Gantt chart of the optimized NEH method sequence can be seen in Figure 2.

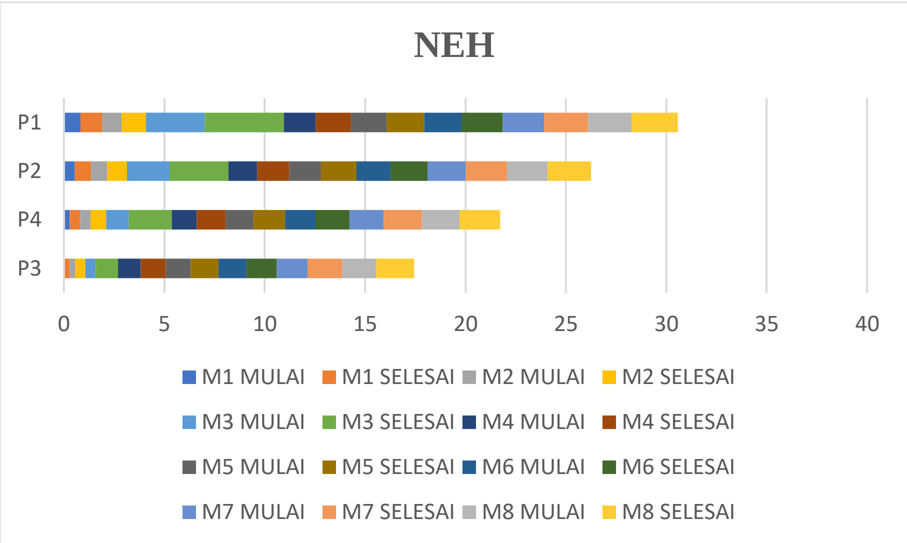


**Figure 2.** NEH Gantt Chart.

## B. First Come First Serve (FCFS)

The company schedules production using the First Come First Serve (FCFS) method, where orders that arrive first are processed first. Using this method, the total makespan obtained is 3.01 hours with the job sequence P2-P3-P4-P1. The makespan calculation using the First Come First Serve (FCFS) method can be seen in Table 9 below:

**Table 9.** FCFS Makespan.

| Machine | Time | P2 | P3 | P4 | P1 |
|---|---|---|---|---|---|
| M1 | Start | 0 | 0,28 | 0,56 | 0,82 |
| | Ended | 0,28 | 0,56 | 0,82 | 1,07 |
| M2 | Start | 0,28 | 0,56 | 0,82 | 1,07 |
| | Ended | 0,51 | 0,79 | 1,10 | 1,29 |
| M3 | Start | 0,51 | 0,79 | 1,10 | 1,29 |
| | Ended | 1,31 | 1,41 | 2,10 | 2,29 |
| M4 | Start | 1,31 | 1,41 | 2,10 | 2,29 |
| | Ended | 1,47 | 1,52 | 2,29 | 2,46 |
| M5 | Start | 1,47 | 1,52 | 2,29 | 2,46 |
| | Ended | 1,66 | 1,67 | 2,49 | 2,56 |
| M6 | Start | 1,66 | 1,67 | 2,49 | 2,56 |
| | Ended | 1,84 | 1,81 | 2,64 | 2,75 |
| M7 | Start | 1,84 | 1,81 | 2,64 | 2,75 |
| | Ended | 2,01 | 2,00 | 2,82 | 2,89 |
| M8 | Mulai | 2,01 | 2,00 | 2,82 | 2,89 |
| | Ended | 2,15 | 2,16 | 2,97 | 3,01 |

Based on the method used by the company and after calculating the makespan, the result obtained is a makespan of 3.01 hours with the job sequence P2-P3-P4-P1, which means job 2 is performed first, followed by job 3, then job 4, and ending with job 1. In addition to the calculation table, the output includes a Gantt chart. The Gantt chart of the optimized FCFS method sequence can be seen in Figure 3.

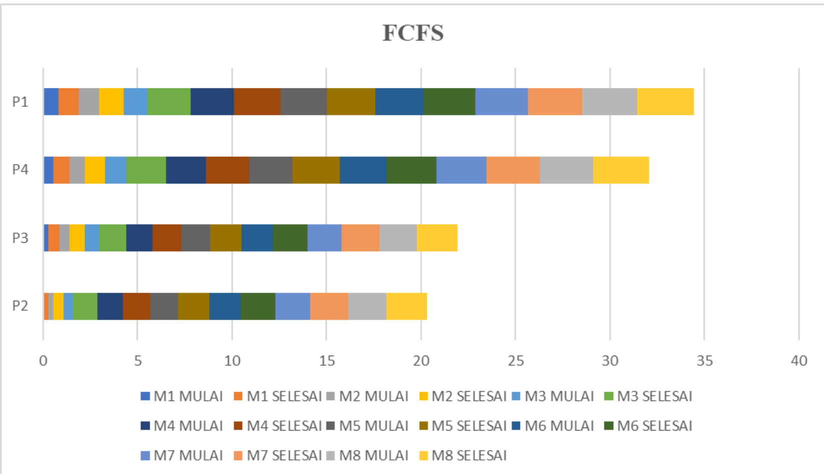


**Figure 3.** FCFS Gantt Chart.

### C. Calculation Results of NEH and FCFS Methods

After performing the calculations using the NEH method applied in this study and the FCFS method used by the company, the results are shown in Table 10 below:

**Table 10.** Makespan Results of NEH and FCFS Methods.

| No | Method | Makespan |
|---|---|---|
| 1 | Company | 3,01 |
| 2 | NEH | 2,29 |

## CONCLUSION

**Fundamental Finding :** From this study, it can be concluded that production scheduling using the Nawaz, Enscore, and Ham (NEH) method results in a smaller makespan and faster production process completion time compared to the scheduling method currently used by the company. The NEH method achieved a makespan of 2.29 after 3 iterations, with a partial job sequence of P3-P4-P2-P1, while the company's method resulted in a makespan of 3.01 with a partial job sequence of P2-P3-P4-P1. **Implication :** This demonstrates that the NEH method can minimize makespan and can be used by the company as a reference for production scheduling to address existing operational issues. **Limitation :** This study is limited in that it only examines the NEH method and compares it with the company's current scheduling method, without testing other scheduling approaches or varying production scenarios. **Future Research :** A recommendation for future research is to try several other scheduling methods, allowing for a comparison of the results obtained from each method.

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## REFERENCES

[1] N. Kurniawan and S. Suseno, "Optimasi Sistem Penjadwalan Produksi Dengan Metode Nawaz Enscore Ham (NEH) Pada PT Sinar Semesta," J. Inov. dan Kreat., vol. 3, no. 1, pp. 24–33, 2023, doi: 10.30656/jika.v3i1.6001.

[2] N. Zuya and M. O. Gurusinga, "Usulan Penjadwalan Job Menggunakan Metode Campbell, Dudek and Smith (CDS) serta Metode Nawaz, Enscore and Ham (NEH) Guna Meminimalkan Makespan Proses Produksi Pistol Mainan di PT. ABC," Talent. Publ., vol. 6, no. 1, 2023, doi: 10.32734/ee.v6i1.1904.

[3] U. Noor, A. Panggabean, and S. Sembiring, "Implementasi Penjadwalan Produksi dengan Menggunakan Algoritma Nawaz, Enscore, and Ham (NEH) dan Shortest Processing Time (SPT)," vol. 6, no. 1, 2023, doi: 10.32734/ee.v6i1.1911.

[4] E. Putri, "Usulan Perbaikan Penjadwalan Produksi Flow Shop dengan Menggunakan Metode Nawaz Enscore Ham," Sci. J. Ind. Eng., vol. 1, no. 1, pp. 10–12, 2020.

[5] S. Maretia Benu, “Minimisasi Makespan Pada Perakitan Daun Pintu Menggunakan Algoritma Nawaz, Enscore, Ham (Neh) Dan Dannenbring,” J. Otomasi, vol. 1, no. 2, pp. 53–60, 2021, [Online]. Available: http://ojs.polmed.ac.id/index.php/JOM

[6] N. R. N. R. P. S. S. Praysi, “Optimalisasi Kinerja Bidang Sosial Budaya Dan Pemerintah Dalam perencanaan Pembangunan (Studi Di Kantor Badan Perencanaan Pembangunan, Penelitian Dan Pengembangan Daerah Kabupaten Minahasa),” vol. 2, no. 1, pp. 1–23, 2022.

[7] H. Kusuma, Manajemen Produksi. Yogyakarta: CV.ANDI OFFSET, 2009.

[8] T. S. Fila Dristiana, “Pengendalian persediaan bahan baku obat dengan menggunakan metode eoq probabilistik berdasarkan peramalan,” Spektrum Ind., vol. 13, no. 2, pp. 115–228, 2015.

[9] R. D. Apnena, “Optimasi penjadwalan flow shop perusahaan garment dengan metode Campell Dudek Smith, algoritma Nawaz Enscore Ham, dan algoritma Pour dengan kriteria minimisasi makespan,” J. Informatics Electron. Eng., vol. 1, no. 1, pp. 32–35, 2021.

[10] S. F. Syabani and W. Setiafindari, “Optimasi Penjadwalan Produksi Menggunakan Metode Nawaz Enscore Ham Pada PT XYZ,” Jumantara J. Manaj. dan Teknol. Rekayasa, vol. 1, no. 1, p. 18, 2022, doi: 10.28989/jumantara.v1i1.1288.

[11] V. F. Martin, “Perbandingan Algoritma Campbell Dudek Smith (CDS), Nawaz Enscore Ham (NEH) dan Palmer pada Penjadwalan Flowshop,” Skripsi, 2015, [Online]. Available: http://repository.unej.ac.id/handle/123456789/61883

[12] M. Campbell et al., “Optimasi Penjadwalan Produksi Menggunakan,” pp. 1–6, 2023.

[13] dan A. R. H. Diomen Syahputra Manik, “Minimalisasi Makespan Pada Perusahaan Tamiya Menggunakan TALENTA Conference Series Minimalisasi Makespan Pada Perusahaan Tamiya Menggunakan,” vol. 6, no. 1, 2023, doi: 10.32734/ee.v6i1.1903.

[14] R. Kharisma P., E. Ferbrianti, and L. Herlina, “Penjadwalan Produksi Flow Shop Menggunakan Metode Campbell Dudek Smith (CDS) dan Nawaz Enscore Ham (NEH),” J. Tek. Ind. Univ. Sultan Ageng Tirtayasa, vol. 5, no. 3, p. 1432, 2017.

[15] Y. Muharni, K. Kulsum, and D. A. Utami, “Usulan Penjadwalan Produksi Pipa Erw Menggunakan Metode Nawaz Enscore Ham Dan Genetic Algorithm,” FLYWHEEL J. Tek. Mesin Untirta, vol. 1, no. 1, p. 29, 2019, doi: 10.36055/fwl.v1i1.6385.

[16] A. Hamad, U. Teknologi, Y. Suseno, and U. T. Yogyakarta, “Optimasi Penjadwalan Produksi Menggunakan Metode Algoritma Nawaz Enscore Ham dan Metode Harmony Search Algorithm Untuk Meminimasi Makespan,” J. Penelit. Rumpun Ilmu Tek., vol. 2, no. 3, pp. 218–226, 2023, [Online]. Available: https://doi.org/10.55606/juprit.v2i3.2210

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