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Analysis of Production Planning Problem in Palembang's Jumputan Industry Using Earlier Deadline First Algorithm

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Abstract

Palembang is one of the big cities that has jumputan cloth as one of its characteristics. Palembang has many areas where craftsmen produce jumputan fabrics, one of which is in the area of Tuan Kentang. Many craftsmen in the area have not used existing technological developments s there are several problems that occur such as in the scheduling process. Scheduling issues are important because craftsmen usually produce fabrics based on the history of the previous year so when there is an order outside the available stock, there are often delays in the order being completed. In this study, researchers took the initiative to solve this problem by analyzing the scheduling process using the Earlier Deadline First (EDF) algorithm. This algorithm serves to help craftsmen determine when each manufacturing process is carried out and helps craftsmen to determine which orders to work on first based on the deadline. The results obtained after the implementation of this algorithm prove that the algorithm can minimize the occurrence of order delays and successfully prioritize which orders should be done so as to minimize the occurrence of delays in orders which creates a decrease in the level of consumer confidence in craftsmen.

Keywords: EDF Algorithm, Scheduling, Production Planning, Jumputan Fabric

1. INTRODUCTION

Palembang is one of the big and old cities in Indonesia where it has its own city characteristics ranging from food, tourism, cloth, and culture. One of the traditional fabrics in Palembang is called jumputan. Jumputan cloth is a plain white cloth that is processed by being tied to a certain part, sewn, and wrinkled into dyes to produce a certain motif [1]. There are many production centers which produce typical traditional fabrics called jumputan in Palembang, one of the largest is the Tuan Kentang area.

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Until 2022, Griya Tuan Kentang coordinated 25 craftsmen under it. All craftsmen produce and sell their product locally and their production facilities are located in closed area and using traditional tools and manual mechanism. The process of making jumputan fabric takes quite a long time. This is because the manufacturing process has not utilized well-developed technology. Tuan Kentang's craftsmen typically did not use technology in control production processes, especially the scheduling of production. Craftsmen had not schedule and control yet their production planning using computer technology, when and how many they produce the fabric in each process. They typically plan and produce jumputan fabrics based on sales history from previous years.

The problem that arises in their operational is how to plan production better in supplying and satisfying all customer demand. The special case is how to fulfill demand if there is demand outside of the availability of their stock. This can affect the level of consumer confidence and satisfaction if the ordered fabric is not completed on time. This kind of thing can harm craftsmen if they lose their consumers. IT deployments can have a direct and indirect impact [2,3]. In addition, the increase in IT innovation can also optimize the demand for consumer needs [4]. Based on the existing problems, the author gets several alternative solutions, one of which is to analyze the management of production scheduling with the adaptive scheduling method and using EDF algorithm. This can be a solution because after the analysis carried out, craftsmen can determine when a new order can be completed with the capacity of workers and tools which they have by putting orders that have a deadline closer to the previous one.

2. METHODS

2.1. Research Methods

We used qualitative research as a research method. The research stage starts from identifying research problems in research object at Tuan Kentang industrial area. A literature study was carried out where researchers focused on the application of the EDF algorithm.

2.2. Research Design

This study aims to analyze the solution of solving scheduling problems with its production scheduling management. Data were collected using interview technique with one of the craftsmen at Tuan Kentang industrial area. After we collected the required data, we analyzed and interpreted data by coding it using Pycharm as a tool and using the Python programming language. When all the data has been analyzed, the researcher reported using a descriptive approach.

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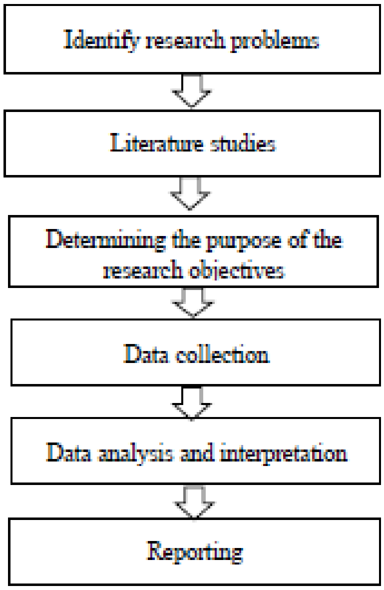

Figure 1. Research Design [8]

2.3. Production Scheduling

Production scheduling is an activity to make decisions carried out in a series of production activities with limited existing resources [5]. This activity is very important activity in production activities. The purpose of schedule is as follows:

1. Increase productivity by reducing total processing time
2. Improve time efficiency by reducing waiting work and reducing semi-finished goods.
3. Minimize late fees by reducing delays in orders being completed.

A scheduling activity can be carried out successfully if the time process is reduced, the number of late orders, and the number of idle machines.

2.4. Earlier Deadline First

Earlier Deadline First is an algorithm that will precedence Workmanship assignments that have deadlines that are more near than deadlines that are more old [6]. The algorithm in IS Dynamic is appropriate with assignment new that keep Run. Figure 1 shows that the task before the EDF starts will be done that has a shorter deadline first. Meanwhile, after the EDF is successfully carried out, it can be seen in Figure 2 where task 3 is the first priority, task 1 becomes the 2nd priority and task 2 becomes the priority to 3rd [7].

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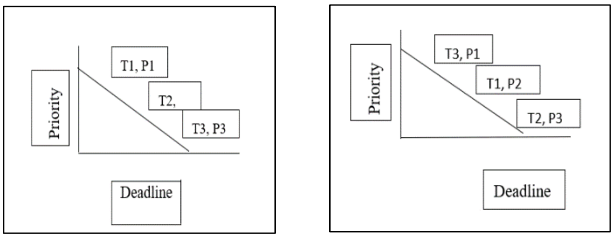

(a) (b)

Figure 1. EDF Process: (a) before, and (b) after

3. RESULTS AND DISCUSSION

3.1. Jumputan Manufacturing Process

The jumputan manufacturing process consists of 11 processes, consist of: fabric cutting, motif making, sewing, rope binding, soaking, mastery, coloring, initial washing, rope removal, final washing, and drying. Generally, craftsmen carry out all activities from 07.00am to 16.00pm. This manufacturing process can be seen in Table 1.

Table 1. Jumputan Making Process

No	Production Process	Creation time
1	Fabric Cutting	07.00 – 12.00
2	Motive Making	10.00 – 16.00
3	Tailoring	09.00 – 16.00
4	Rope binding	10.00 – 16.00
5	Soaking	13.00 – 16.00
6	Mastery	10.00 – 16.00
7	Coloring	08.00 – 16.00
8	Laundering	08.00 – 16.00
9	Rope Removal	08.00 – 16.00
10	Final wash	08.00 – 16.00
11	Drying	08.00 – 16.00

In the process of making jumputan, a number of craftsmen were employed where each worker has their own production capacity every day. We calculate the resources required especially the tools and usable equipment resources required. The number of workers and their production capacity of each worker can be seen in Table 2, as well as the production code of each manufacturing process. This production code was created to make it easier for researchers to code data so that the management of production scheduling can be carried out in accordance with existing processes.

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Table 2. Number of Workers and Production Capacity

No.	Stages of manufacture	Production Code	Number of Workers	Each person's ability per period
1	Cutting	A	2 persons	100 sheets/ day
2	Motive making	B	3 people	50 sheets/ day
3	Tailoring	C	65 people	1 sheet/period
4	Rope binding	D	65 people	1 sheet/ period
5	Soaking	E	2 persons	50 sheets/day
6	Mastery	F	2 persons	50 sheets/ period
7	Coloring	G	4 people	25 sheets/day
8	Initial washing			
9	Rope Removal			
10	Final wash			
11	Drying			

3.2. Order Assumptions

We started to code data by entering order assumptions as variables to be analyzed. The assumption of this order is taken based on the sales history at one of the craftsmen in April 2022. The assumption of the order can be seen in Table 3 below.

Table 3. Order Assumptions

No	Types of Motifs Ordered	Order Quantity	Deadline
1	Point 9	50 sheets	90 days
2	Pattern	100 sheets	60 days
3	Sunflowers	150 sheets	60 days

3.3. Results of Applying the EDF Algorithm

The scheduling of jumputan fabric's production was created and developed using the Earlier Deadline First (EDF) algorithm. The process of implementing scheduling can be seen in the following table.

Table 4. 1st week scheduling process

Order	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Pattern	A: 1(100)	B: 2(100)	C: 65(65)	C: 65(65)	C: 65(65)	C: 35(35) D: 65(65)	C: 35(35) D: 65(65)
Sunflowers	A: 1(100)	A: 1(50) B: 1(50)	B: 2(100)			C: 30(30)	C: 30(30)
Point 9		A: 1(50)	B: 1(50)				

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Based on data of week 1 at Table 4 above, we could describe that:

a) On 1st day, 100 cloths were cut (A) by 1 worker. They create motif for each pattern and sunflowers,
b) On the 2nd day, 50 pieces of cloth were cut (A) by 1 worker for sunflower motif and pattern, 50 pieces of cloth were made for pattern motif (B) for pattern motif by 2 workers, and 50 pieces of sunflower motif (B) were made,
c) On day three, a sewing process was carried out (C) for pattern motif by 65 workers as many as 65 pieces of cloth, and the process of making motif (B) for sunflower motif was carried out as many as 100 pieces of cloth by 2 workers and as many as 50 pieces of cloth by 1 worker for point 9 motif,
d) On day four and five, only the sewing process (C) was carried out by 65 workers for 65 pieces cloth of pattern motif.
e) On day six and seven, the typical sewing process (C) of 35 pieces pattern motif that carried out by 35 workers and 30 pieces sunflower motif by 30 workers, and the rope binding process (D) by 65 pieces pattern motif by 65 workers.

After focus on cutting and making the motive as well as tailoring and rope binding in the first week batch, in second week (Table 5) we focus allocating schedule on finishing first batch until final wash and drying. We found that The EDF algorithm was effective on handling the production schedule.

Table 5. 2nd week scheduling process

Order	Day 8	Day 9	Day 10	Day 11	Day 12	Day 13	Day 14
Pattern	C: 35(35) E: 2(65)	D: 35(35) F: 2(65)	D: 35(35) F: 2(65)	E: 1(35) G: 3(65)	F: 1(35)	F: 1(35)	G: 2(35)
Sunflowers	C: 30(30)	C: 65(65) D: 30(30)	C: 65(65) D: 30(30)	C: 65(65) E: 1(30)	C: 65(65) F: 1(30)	C: 65(65) F: 1(30)	C: 65(65) G: 2(30)
Point 9							

We could describe the result of scheduling pattern (Table 5) as follow:

a) On day eight, a suturing process of 35 pieces of pattern motifs was carried out (C) by 35 workers and 30 pieces of sunflower motifs by 30 workers, as well as soaking process of 65 pieces pattern motifs (E) by 2 workers,
b) On day nine and ten, the typical sewing process of 65 pieces of cloth was carried out (C) by 65 workers, the rope binding process of 35 pieces cloth for pattern motifs (D) by 35 workers as well as 30 pieces of cloth by 30 workers for the sunflower motif, and mastering process of 65 pieces of cloth (F) by 2 workers,
c) On day eleven a sewing process of 65 pieces sunflower motifs was carried out (C) by 65 workers, the soaking process of 35 pieces cloth for pattern motifs (E) by 1 worker as well as 30 pieces of sunflower motifs by 1 worker, and the motifs processing (coloring, initial washing, rope removal, final washing, and drying (G)) of 65 sheets fabric by 3 workers,

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d) On day twelve and thirteen, the typical sewing process (C) for 65 pieces sunflower motifs was carried out by 65 workers as well as the mastery process of (F) 35 pieces pattern motifs by 1 worker and 30 cloth sheet sunflower motif by 1 worker.
e) On day fourteen, a sewing process (C) for 65 pieces sunflower motifs was carried out by 65 workers as well as the motifs processing (coloring, initial washing, rope removal, final washing, and drying (G)) of 35 sheets pattern motif by 2 workers and 30 sheets sunflower motif by 2 workers.

After 14th day, some of our cloth sheets have passed final washing step and drying. It means that one production cycle had been passed. To achieve our optimal production schedule, we than plan the rest step to finish all our raw material at this batch. We could find the third week planning result in the following tables (Table 6 – Table 10).

Table 6. 3rd & 4th week scheduling process

Order	Day 15	Day 16	Day 17	Day 18	Day 19	Day 20	Day 21
Pattern							
Sunflowers	C: 65(65)	C: 55(55) D: 65(65)	C: 55(55) D: 65(65)	C: 55(55) D: 65(65)	C: 55(55) E: 2(65)	C: 55(55) F: 2(65)	C: 55(55) F: 2(65)
Point 9		C: 10(10)	C: 10(10)	C: 10(10)	C: 10(10)	C: 10(10)	C: 10(10)
Order	**Day 22**	**Day 23**	**Day 24**	**Day 25**	**Day 26**	**Day 27**	**Day 28**
Pattern							
Sunflowers	C: 55(55) G: 3(65)	D: 55(55)	D: 55(55)	D: 55(55)	E: 2(55)	F: 2(55)	F: 2(55)
Point 9	C: 10(10)	C: 50(50)	C: 50(50)	C: 50(50)	C: 50(50)	C: 50(50)	C: 50(50)

Based on Table 6 above, it can be seen that:

a) On day fifteen, 65 workers will be scheduled to handle sewing process of 65 pieces sunflower motif cloth,
b) On day sixteen, seventeen and eighteen, typical sewing process of 55 pieces of sunflowers motif was carried out (C) by 55 workers and 10 pieces of point 9 motif by 10 workers, as well as sewing process of 65 pieces pattern motif (E) by 65 workers,
c) On day nineteen, a suturing process (C) of 55 pieces sunflower motif was carried out by 55 workers, and 10 pieces of point 9 motif cloth by 10 workers for as well as the soaking process (E) of 65 pieces sunflower motif by 2 workers,
d) On day twenty dan twenty-first, typical sewing process (C) of 55 pieces sunflower motif was carried out by 55 workers and 10 pieces of point 9 motif by 10 workers, as well as a mastery process (F) of 65 pieces sunflower motif by 2 workers,

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e) On day twenty-two, a suturing process (C) of 55 pieces sunflower motif was carried out by 55 workers and 10 pieces point 9 motifs by 10 workers, and the motifs processing (coloring, initial washing, rope removal, final washing, and drying (G)) of 65 sheets fabric by 3 workers,
f) On day twenty-three, twenty-four, and twenty-five, typical sewing process (C) of 50 pieces point 9 motif was carried out by 50 workers, and the rope binding process (D) of 55 pieces sunflower motif by 55 workers,
g) On day twenty-six, a sewing process (C) of 50 pieces point 9 motif was carried out by 50 workers, and the soaking process (E) of 55 pieces sunflowers motif by 2 workers,
h) On day twenty-seven and twenty-eight, typical sewing process (C) of 50 pieces point 9 motif was carried out by 50 workers, and the mastery process (F) of 55 pieces sunflower motif by 2 workers.

Table 7. 5th & 6th week scheduling process

Order	**Day 29**	**Day 30**	**Day 31**	**Day 32**	**Day 33**	**Day 34**	**Day 35**
Pattern							
Sunflowers	G: 3(55)						
Point 9	C: 50(50)	C: 50(50)	C: 41(41) D: 9(9)	C: 40(40) D: 10(10)	C: 40(40) D: 10(10)	C: 40(40) D: 10(10)	C: 40(40) D: 10(10)
Order	**Day 36**	**Day 37**	**Day 38**	**Day 39**	**Day 40**	**Day 41**	**Day 42**
Pattern							
Sunflowers							
Point 9	C: 40(40) D: 10(10)	C: 40(40) D: 10(10)	C: 40(40) D: 10(10)	D: 40(40) E: 1(10)	D: 40(40) F: 1(10)	D: 40(40) F: 1(10)	D: 40(40) G 1(10)

Based on Table 7 above, we schedule as follows:
a) On the 29th day, a sewing process (C) of 50 pieces point 9 motif was carried out by 50 workers, and the motifs processing (coloring, initial washing, rope removal, final washing, and drying (G)) for 55 pieces sunflower motif by 3 workers,
b) On day thirty, only a sewing process (C) of 50 pieces point 9 motifs are scheduled and will be handled by 50 workers,
c) On day thirty-one, a sewing process (C) of 41 pieces point 9 motifs are scheduled carried out by 41 workers, and a rope binding process (D) of 9 pieces of point 9 motif by 9 workers,
d) From day thirty-two until thirty-eight, typical sewing process (C) of 40 pieces point 9 motifs are scheduled carried out by 40 workers, and a rope binding process (D) of 10 pieces of point 9 motif by 10 workers,
e) On day thirty-nine, a sewing process (C) of 40 pieces point 9 motifs are scheduled carried out by 40 workers, and soaking process (E) of 10 pieces of point 9 motif by 1 worker,

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f) On day forty and forty-one, typical sewing process (C) of 40 pieces point 9 motifs are scheduled carried out by 40 workers, and mastery process (F) of 10-point 9 motif by 1 worker,
g) On day forty-two, a sewing process (C) of 40 pieces point 9 motifs are scheduled carried out by 40 workers, and a motifs processing (coloring, initial washing, rope removal, final washing, and drying (G)) of 10 sheets fabric by 3 workers.

Finally, we finish our scheduling batch case after pass 7 (seven) weeks. Our last processing result could be seen in Table 8. It means that all of one production cycle had been passed. This result will be a figure when we try to achieve our optimal production scheduling using Earlier Deadline First Algorithm.

Table 8. 7th-week scheduling process

Order	Day 43	Day 44	Day 45	Day 46	Day 47	Day 48	Day 49	Day 50
Pattern								
Sunflowers								
Point 9	D: 40(40)	D: 40(40)	D: 40(40)	D: 40(40)	E: 1(40)	F: 1(40)	F: 1(40)	G: 2(40)

We could describe the result of scheduling pattern for week seven (Table 8) as follow:

- From day forty-three until forty-six, typical sewing process of 40 pieces pattern motif are scheduled carried out by 40 workers,
- On day forty-seven and forty-eight, a typical sewing process of 40 pieces pattern motif are scheduled carried out by 1 worker, and
- Finally, on day fifty, a sewing process of 40 pieces pattern motif are scheduled carried out by 2 workers.

After we run EDF algorithm in our sample data we found that our production scheduling that were calculated were more optimal compared to historical data of craftsman's production time. We found that all orders are completed earlier than the deadlines usually predicted by craftsmen. The comparison of craftsman's time schedule normally they used to compare to production scheduling resulted using EDF algorithm could be seen in Table 9.

Table 9. Comparison results

No	Types of Motifs	Order Quantity	Prediction of Craftsman	EDF Algorithm Calculation
1	Point 9	50 sheets	90 days	50 days
2	Pattern	100 sheets	60 days	14 days
3	Sunflowers	150 sheets	60 days	29 days

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4. CONCLUSION

Based on our analysis, the EDF algorithm was effective in handling production scheduling of traditional jumputan fabric. The craftsman in Tuan Kentang area currently used traditional manual production mechanism. They just planned the process by routine activity without analysis and support by any tool. We found that the application of EDF algorithm increase the efficiency of craftsman's duration of production handling in its each process. We found that the completion time is faster than the deadline time normally predicted by craftsmen. We argue that our finding could be implemented as an alternative solution to maintain their customer satisfaction by preventing them from out-of-stock situation especially the final product as well as the raw material. The application of the EDF algorithm in production scheduling management could also help craftsmen in deciding which orders should be prioritized to be done based on the closest deadline. For the next researchers, our research could be improved by considering several aspects such as the variable cost exist, or the selection of supplier's factor.

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