Comparison of First In First Out with Shortest Job First in a Production Schedule Development: A Case of Backpack Production Scheduling Systems

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Abstract
The scheduling process is very closely discussed with job monitoring activities. First In First Out (FIFO) and Shortest Job First (SJF) is one method that is familiar used in scheduling a process. The execution process of these two methods looks very significant seen from various existing research sources, but these results are applied in the process of scheduling the Control Procession Unit (CPU). This study aims to determine the ideal method used related to increasing production efficiency, mainly in textile production. This study can be a reference for the use of scheduling methods with cases of long processing time and is done by taking samples taken using the FIFO and SJF methods. Once the sample data has been obtained, it is carried out using the time required. This will determine the method that either FIFO or SJF compilation is applied under certain conditions. The results obtained consist of the difference between ATT with a value of 62 % and an AWT of 68,6% which shows a considerable impact on the reduction of time when applied in the bag production sector. In this study, We propose further research to increase the estimated arrival time of the process in more complex cases.

Keyword
Scheduling process, FIFO, SJF, Comparison

1. Introduction
The existence of a scheduling algorithm aims to prevent deadlocks in a process that results in hampered execution of a program. However, the initial scheduling algorithm was created only for processing lines or in broad outline, the basic purpose of scheduling is to utilize CPU usage to facilitate the process of completion and response time, waiting and completion time, priority and system throughput(Sharma and Bansal 2015). Until now, many modern computer applications have been built as real-time distributed object systems(Kalogeraki, Melliar-Smith, and Moser 2000). This makes showing the development of architecture and hardware technology so that the case of scheduling algorithms that are classified more and more complex. Scheduling is an overall process of making a product on some specific machines and sorting is defined as making a product on one machine in a certain period (Irawan, Suhandi, and Arisandhy 2009). Scheduling work is important because it impacts on resource utilization, performance parameters, and is one of the most important activities of the process manager who decides to choose which in the ready queue to be assigned (Khan and Kakhani 2015) (Yeboah, Odabi, and Hiran 2015). In the manufacturing world, the purpose of scheduling is to minimize production time and costs (Marsurol 2011). In the research published in this journal, taking a sample of different test cases, taking samples, and processing into the real-time world with the bag production test cases is tested in this study. This research provides education and appropriate method selection techniques and must be applied in a production when viewed from the case of the process. Scheduling can be defined as a set of policies that govern the processing of processing tasks (Alworafi et al. 2017).

Seeing the reality in the field, technical production constraints certainly make the company owner feel the need for checking so scheduling is needed. Static algorithms like FIFO are often used to schedule periodic tasks with difficult deadlines(Kotecha and Shah 2008). However, when the request consists of several classes of work with different characteristics, customers usually want to be given preferential treatment for one or more classes of work at the expense of another so that a sort of priority scheduling strategy is applied(Mitrani and King 1981). Priority
Scheduling techniques are recommended to reduce hours of loss because there is no material supply (Manohar and Aappaiah 2017). In this study, trials were conducted using the First In First Out and Shortest Job First methods based on previous research references with different test cases (Alworafi et al. 2017) (Elnikety et al. 2004) (Siahaan 2016). The research of this method aims to find out how ideal it is related to increasing production efficiency. Efficiency in production as a comparison of output and input associated with achieving maximum output with several inputs, meaning that if the ratio of input-output is large, the efficiency is said to be higher (Aldida and Santosa 2013).

2. Methods
In scheduling, there are several important variables to determine the time usage of a process including Turn Around Time, Burst Time, Waiting Time, Process, Average Waiting Time, and Arrival Time. The procedure of implementing work on this scheduling takes into account the time of arrival of the work. Any work that comes first will be executed first, regardless of their service time (Gupta and Rakesh 2010). Turnaround Time or better known as the dirty time of a job, either the job has not been executed or is being executed until a job has been completed.

2.1 Assumptions on the Experiment
In this study, we set up 15 test data with four classifications of bag types including goodie bag, backpack, waist bag, and advanced bag. Available data will be converted and then tested into eight scheduling conditions using one to eight machines. The results of the calculation will be in the form of details waiting time, turnaround time, order number conversion, comparison of average waiting time, average waiting time, and average turnaround time.

2.2 Turnaround Time
In the case of turnaround time there are many possibilities, but what should be underlined is the rough time of a job, whether the work has interruptions at the beginning or end by any condition, the calculation is still carried out. In the calculation of turnaround time using the formula

\[ TAT_n = (\sum_{i=1}^{n} BT) + WTN \]  

To calculate the average turnaround time, we use formula (2)

\[ ATAT = \frac{\sum_{i=1}^{n} TAT}{n} \]  

2.3 Burst Time
Burst Time is the net time of a job that is being executed in a process, as seen in figure 1.

![Figure 1. Burst Time](image)

Separate burst time or work time of the process is very influential in the processes before and afterward. The Gantt chart circled above is an example of the net time of a job, as seen in figure 2.

![Figure 2. Separate burst time](image)
2.4 Waiting Time and Average Waiting Time

According to Rajput and Gupta, the waiting time in the queue and ready to use is the waiting time (Rajput and Gupta 2012). Waiting Time is a time outside the execution of a job. In the case of scheduling, waiting time can be in the form of free time on the job and time between the one process with another process outside the specified time of execution of the work. Examples of waiting times can be seen in Figures 3 and 4.

Waiting Time

\[ WT_n = (\sum_{i=1}^{n-1} BT_i) - AT_n \] (3)

![Figure 3. Waiting Time](image)

![Figure 4. Waiting Time between process](image)

Average Waiting Time is the average waiting time of work sequences in a process. Average waiting time is a record of time that allows users to analyze the process of the results of a job whether ideal or experiencing starvation. Starvation can be interpreted as too much free time on a job that results in work delays. To calculate the average waiting time can be calculated using the formula (4) (Alworafi et al. 2017).

Average Waiting Time

\[ AWT = \frac{\sum_{i=1}^{n} WT_i}{n} \] (4)

2.5 Criteria of Optimization Scheduling

Targeting scheduling based on these optimization criteria are:

a. Ensure that each process gets service from a fair machine production (sewing machine).
b. Keeping the processor busy so that the efficiency reaches the maximum. The meaning of being busy is that the processor is not idle, including the time spent executing user programs and operating systems.
c. Minimize response time.
d. Minimize turnaround time.
e. Avoid indefinite blocking or starvation: A process should not wait for an unbounded time before or while process service.
f. Maximizes the number of jobs processed at a time interval. The greater the throughput, the more work the system does (Parinduri and Hutagalung 2019).

To create optimal scheduling, this research requires sewing machine readiness with prime condition, and the process is assumed to work for 24 hours so there is no idle time.

2.6 The FIFO Scheduling

FIFO is the simplest known discipline for scheduling flow in a network, it transmits packets in the order of their arrival (Sahni, Goyal, and Vin 1999). At the time the job arrives, the job will immediately be executed (Lee, Leu, and Chang 2011). While a process arrives at the same time, then their service is carried out through the sequence of work in the queue. Processes in the back queue must wait until all processes in front of them are finished. Every process that is in the ready status is entered into a queue (queue data structure) according to the time of arrival (Parinduri and Hutagalung 2019). FIFO is known to be inefficient for many workloads because many jobs waiting for execution can produce idle time (Hamscher et al. 2000). FIFO is often equated with First Come First Serve (FCFS). In our study, we...
did this process by collecting the classification of bag order data and sorting. FIFO are sorted according to the date of
the most recent job order. In research studies that have been done by Anderson and Leontyev concluded that FIFO is a
sensible scheduling option to consider for applications requiring a good average case delay and a somewhat higher
maximum delay can be tolerated(Leontyev and Anderson 2007).

\[ \text{FIFO} = (AT_1, \ldots, AT_n) \]  

(5)

2.7 Priority Schedule Based on SJF  
Priority Scheduling is a scheduling algorithm that prioritizes processes that have the highest priority. Each process
has its priorities. The new incoming process has a higher priority than the current process, so the current process is
stopped and the process will be transferred to the new incoming process. Scheduling based on preemptive priority
specifies a run-time environment where tasks, with priority attributes, are sent in priority order. Priorities are
static(Burns 1993).

In preemptive scheduling, it means that any work done on the processor can be interrupted by new jobs provided
that there is a job with higher priority status, so that old work will be temporarily rested until the new work is completed
or this job occupies high priority at a time based on certain rules enforced in scheduling(Kerlooza and Budiyantroro
2018).

\[ \text{SJF} = (\text{BT}_{\text{min}}, \ldots, \text{BT}_{\text{max}}) \]  

(6)

Because the average waiting time is less than other scheduling algorithms, the SJF is included in the optimal
scheduling algorithm(Akhtar, Hamid, and Humayun 2015). In our study, we carried out this process by looking at the
number of bag orders received. the fewer orders, the greater the chance of getting a queue at the beginning of time.

Research conducted by regarding the use of the first shortest job method can be concluded that reducing waiting
time and reducing the effect of bottlenecks on bandwidth by 31.38% in case studies of cloud computing-based
scheduling (Ru and Keung 2013).

3. Result and Discussion  
The results of a study of 10 process data samples conducted by Khan and Kakhani showed differences in the
waiting time and processing time difference of 15.7 seconds between the SJF and FIFO scheduling(Khan and Kakhani
2015). The research is applied to the process of scheduling a computer processor and only uses 10 sample data with
burst time variables in each process and each priority has been determined. In this test, it was stated that the work
process had the same arrival time (AT = 0) with a total of 15 jobs. For FIFO, data has been sorted by the time the bag
order was received. Whereas the time management for SJF is done based on the large number of orders sorted by large
and the least number of orders. Below can be seen the data input classification we used in this study in Table 1.

<table>
<thead>
<tr>
<th>No.</th>
<th>Type of Bag</th>
<th>Processing Time/ unit</th>
<th>Processing Time / Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Waist Bag</td>
<td>10 Minute</td>
<td>6 unit/hour</td>
</tr>
<tr>
<td>2.</td>
<td>Rucksack</td>
<td>12 Minute</td>
<td>5 unit/hour</td>
</tr>
<tr>
<td>3.</td>
<td>Goodie Bag</td>
<td>5 Minute</td>
<td>12 unit/hour</td>
</tr>
<tr>
<td>4.</td>
<td>Advanced Rucksack</td>
<td>30 Minute</td>
<td>2 unit/hour</td>
</tr>
</tbody>
</table>

The data in table 1 is a bag work unit based on the type of bag using a standard sewing machine. Note the number
of units worked and the working time only applies to one sewing machine. The data in table 2 is the number of bags
ordered, the large number of bags made is likened to a process. The data is converted into units of time-based on table
1. The results of the data obtained from the conversion into units of time will be used as burst time data. Conversion
time is adjusted to the number of bags compared to sewing machines assuming one or eight sewing machines are
available. Below can be seen the data scheduling in bag production we used on this study in Table 2.
Table 2. Scheduling Data

<table>
<thead>
<tr>
<th>No.</th>
<th>Burst Time (Amount of Order)</th>
<th>Type Of Bag</th>
<th>Date of Entry</th>
<th>Order in FIFO</th>
<th>Order in SJF</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1000 Unit Waist Bag</td>
<td>13 January 2020</td>
<td>1</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>200 Unit Waist Bag</td>
<td>4 March 2020</td>
<td>9</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>300 Unit Waist Bag</td>
<td>26 March 2020</td>
<td>11</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>250 Unit Rucksack</td>
<td>21 January 2020</td>
<td>2</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>3000 Unit Rucksack</td>
<td>3 March 2020</td>
<td>8</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>10000 Unit Goodie Bag</td>
<td>1 February 2020</td>
<td>3</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>500 Unit Goodie Bag</td>
<td>13 February 2020</td>
<td>6</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>2000 Unit Advanced Rucksack</td>
<td>6 February 2020</td>
<td>4</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>200 Unit Goodie Bag</td>
<td>23 February 2020</td>
<td>7</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>1000 Unit Advanced Rucksack</td>
<td>11 February 2020</td>
<td>5</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>1000 Unit Goodie Bag</td>
<td>5 April 2020</td>
<td>13</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>1700 Unit Goodie Bag</td>
<td>15 April 2020</td>
<td>14</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>1200 Unit Goodie Bag</td>
<td>1 May 2020</td>
<td>15</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>250 Unit Waist Bag</td>
<td>14 March 2020</td>
<td>10</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>200 Unit Rucksack</td>
<td>2 April 2020</td>
<td>12</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

The data contained in table 2 is then converted. The conversion is done based on the number of order orders into the specified time unit and sees the number of sewing machines used as conversion reference. Table of conversion results can be seen in table 3 below.

Table 3. Data Conversion

<table>
<thead>
<tr>
<th>No.</th>
<th>Amoun t of Order</th>
<th>Type Of Bag</th>
<th>Burst Time (Conversion result data by the number of sewing machines) / Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1000 Unit Waist Bag</td>
<td>166.7</td>
<td>83.3</td>
</tr>
<tr>
<td>2.</td>
<td>200 Unit Waist Bag</td>
<td>33.3</td>
<td>16.7</td>
</tr>
<tr>
<td>3.</td>
<td>300 Unit Waist Bag</td>
<td>50</td>
<td>25</td>
</tr>
<tr>
<td>4.</td>
<td>250 Unit Rucksack</td>
<td>41.7</td>
<td>20.8</td>
</tr>
<tr>
<td>5.</td>
<td>3000 Unit Rucksack</td>
<td>50</td>
<td>25</td>
</tr>
<tr>
<td>6.</td>
<td>10000 Unit Goodie Bag</td>
<td>600</td>
<td>300</td>
</tr>
</tbody>
</table>

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The data is processed into time which refers to the basic formula of each scheduling method. So that, we get a record of time in the form of waiting time process, burst time, turnaround time, and the data needed to be compared, namely the average waiting time and the average turnaround time. The results of calculations from the input variables table 1, table 2 and data conversion in table 3 can be seen in Figure 5 below.

Figure 5. Result of AWT and ATT
The comparison of the average waiting time in Figure 5 shows a significant time difference in the process of using one and two machines using SJF and FIFO scheduling. Same as the results of the average waiting time of the test, the average turnaround time can be seen in the figure that shows a difference that is in the range of 60%. Result of the data obtained based on the calculation of the formula that has been expressed in subpoints methods. Comparison results and differences can be seen in Table 3 below.

Table 4. The Difference Between FIFO and SJF

<table>
<thead>
<tr>
<th>Process/Type</th>
<th>The Different Between AWT and ATT</th>
<th>AWT (%)</th>
<th>ATT (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Machine</td>
<td>1588.2067 Hour</td>
<td>68.6 %</td>
<td>62 %</td>
</tr>
<tr>
<td>2 Machine</td>
<td>794.1267 Hour</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Machine</td>
<td>529.44 Hour</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Machine</td>
<td>397.06 Hour</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Machine</td>
<td>317.66 Hour</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Machine</td>
<td>264.6933 Hour</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 Machine</td>
<td>226.76 Hour</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 Machine</td>
<td>198.5233 Hour</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. Conclusion

From the comparative research method between FIFO and SJF, it is found that the ideal time is compared to the number of machines. In this study, SJF scheduling is superior then FIFO with an AWT difference of 68.6% and an ATT difference of 62%. The results of this time difference have a significant impact on time cuts when applied in the industrial sector, especially in the realm of garment production which requires a significant amount of time and a large level of stock orders. It is recommended to take ¾ the machine with the fastest time record and the highest number of machines. SJF scheduling is considered good enough to be applied to conditions where there is a buildup of processes close together or even at the same time, but FIFO scheduling is the right choice if the arrival period of the process is long enough. Optimization of production depends on machine readiness and the number of processes performed. To get a more accurate time record, it is recommended to convert the time in the form of minutes and also increase the estimated arrival time of the process in more complex cases.

Reference


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Biography

Iqbal Abdul Jabbar is a final year undergraduate student in the department of informatics, Universitas Jenderal Achmad Yani, Indonesia. His major interests are systems modeling, optimization, and mobile app development.

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