A STUDY ON GRASPING THE FLOW OF INFORMATION IN INDIRECT OPERATIONS

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Abstract
Nowadays, manufacturing companies have been competing for new product development under the unstoppable demands of the global market. Most of the manufacturing companies active today have shortened their product development period as well. This is especially true in the department of research and development, where patents are required for the development of new products and technologies. This study focus on the indirect operations defined by the manufacturing companies’ flow of information, here understood as the immaterial part of the operations and their product development cycle. As such, we have applied process analysis as its method study considering its main characteristic, which is determined by its simple rule that separates products from humans.

Keywords:
Indirect operations, method study, process analysis, flow process chart.

1 INTRODUCTION
Nowadays, manufacturing companies have been competing for new product development under the unstoppable demands of the global market. Most of the manufacturing companies active today have shortened their product development period as well. This is especially true in the department of research and development, where patents are required for the development of new products and technologies.

Considering that, to win in the global market, most companies have quickly decided to draw information from various business situations present in the global market environment. Because of that, this production information needs to be shared among different departments in the same company. Consequently, the volume of necessary information about production and development that needs sharing is increasing to each businessman/woman involved in production tasks. Therefore, it became vital for these business people to grasp, compile and organize information continuously. Additionally, manufacturing companies’ operations must synchronize relationship between direct operations in the factory and indirect operations in the office dealing with the flow of information that this entails. In the analysis made, special attention was given to new product information awareness in the production site and, also in how this information is viewed by the office operations.

This study focus on the indirect operations defined by the manufacturing companies’ flow of information, here understood as the immaterial part of the operations and their product development cycle. As such, we have applied process analysis as its method study considering its main characteristic, which is determined by its simple rule that separates products from humans.

Finally, the difference between these two views of flow-process-chart-human type of process is understood as the immaterial part of the operations and their product development cycle. As such, we have applied process analysis as its method study considering its main characteristic, which is determined by its simple rule that separates products from humans.

Measurement used as a unit of time which is applied at the production site. Work measurement is the standard set for production time in which standard operations are based on. This study focus on the process analysis of method study.

Process analysis is of two different types. Depending on its target a different type is used. If the target analyzed is human, flow-process-chart-human type of process is applied. If the target analyzed is a product, flow-process-chart-material is used. Process analysis is then transformed from production activity to process-analysis-symbol [3]. Table 1 below is showing the symbol of process analysis which is viewed through the flow-process-chart-material.

Figure 2 represents flow-process-chart-material on certain production site. The most common value symbol is “process (□)”. Except for “process (■)” there are no other creation of value. Accordingly, their symbols are the target of the “KAIZEN” process. In Japanese, KAIZEN means “continuous improvement” [4]. Japanese manufacturing companies and production sites have continuously implemented KAIZEN-based processes, which aim high operation efficiency, high quality standards and it also aims to minimize waste of resources and time.

![Figure 1. Three views of method study.](image)

2 WHAT IS PROCESS ANALYSIS?
Work study which analyzes the production site operations is composed by method study and work measurement [1] [2]. Method study has three views which are process, operation and motion (see figure 1 below). Method study is a direct approach at the production site. Method study is the standard operation set for manufacturers for the making of products. Another factor to consider is the work

3 FLOW-PROCESS-CHART-INFORMATION
This study focus on the office work indirect operations. The characteristic of office work is information processing. Accordingly, the target of process analysis is to deal with production of information.

What is the difference between flow-process-chart-material and flow-process-chart-information? Figure 3 shows the result of process analysis. We would like to consider the meaning of the processing symbol (the mark
showed after storage mark as present in figure 3). In the case the target of the process analysis is material, it should be processed after storage. For example, in the production site the material is transformed from its previous form to the processed form in which this material is based on its standard production time. If the target of the process analysis is information, this information is processed by a personal computer (desktop PC). For example, the document (data) that has been saved in the computer in a previous moment (yesterday, for example) so that it will be available for editing process at any time in the same “PC” today. In case the target is information, the office worker cannot edit it as soon as it is available. That happens because the office worker must remember and locate the file where this document is saved within this personal computer. Editing time in regards of this document is longer than the standard editing time. Accordingly, the processing time after storage is the difference between flow-process-chart-material and flow-process-chart-information.

Table 1. Symbols of process analysis [5].

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Activity</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Symbol" /></td>
<td>Processing</td>
<td>The symbol indicates the process to give change in shapes and properties for raw material, working material, or product.</td>
</tr>
<tr>
<td><img src="image" alt="Symbol" /></td>
<td>Transportation</td>
<td>The symbol indicates the process to give change in position of raw material, working material, or product.</td>
</tr>
<tr>
<td><img src="image" alt="Symbol" /></td>
<td>Storage</td>
<td>The symbol indicates the process storing the raw material, working material, or product according to plan.</td>
</tr>
<tr>
<td><img src="image" alt="Symbol" /></td>
<td>Delay</td>
<td>The symbol indicates the state in congestion of raw material, working material, or product in reverse of plan.</td>
</tr>
<tr>
<td><img src="image" alt="Symbol" /></td>
<td>Quantity Inspection</td>
<td>The symbol indicates the process to obtain the difference of the results in comparison with the reference by measuring the quantity of raw material, working material, or product.</td>
</tr>
<tr>
<td><img src="image" alt="Symbol" /></td>
<td>Quality Inspection</td>
<td>The symbol indicates the process to judge the compliance of the lot or goods quality of the piece by testing the quality characteristics of raw material, working material, or product and by comparing the results with the reference.</td>
</tr>
</tbody>
</table>

Figure 2. Flow-process-chart-material [6].

Figure 3. The processing symbol after storage.

4 EXPERIMENT

This study consists of making the experiment of simulating the analysis of the information dealt in the office work. The details are indicated in the model below as follows:

4.1 Simulation model

Figure 4 shows the overview of the model. The object of the model is the office, which is composed of several operators. The characteristics (task specifications) of the jobs arrive at a random order that might expand according to production needs defined by exponential distribution. In case two operators are doing the same job, the job is done in turns (operator1 → operator 2). Routing of the job represents flow type in this model (see table 2). The job processing of each operator is done according to what has been planned in office before the real processing. In this model, processing time is set by Erlang distribution of phase four (see table 2).
Figure 5 shows details of the model explained. Now suppose that job A has arrived at the office. The operator 1 processes job A, and send it to operator 2. Then job B has arrived at office while job A is still being processed by operator 1. Next, job B has started after the completion of job A. Accordingly, job B should wait until operator 1 is unoccupied. This situation means “storage” as seen in process analysis in case of dealing with information. Operator 1 has started job B after completion of job A. If job B is put on “wait” for a certain time, processing time of job B becomes longer than the planned processing time for it. In this model, extra time ratio means that job B will be a multiple of that planned processing time. This happens in case the waiting time for the job processing is over during the planned processing time. The same situation applies to operator 2 as well.

4.2 Criteria
The criteria of this model is mean lead time. Lead time is time measured from the order’s arrival until the completion of the job. Therefore, mean lead time is expressed as equation (1).

\[ L = \frac{\sum l_i}{n} \]

Where:
- \( L \): mean lead time
- \( l_i \): lead time of job i
- \( n \): number of samples

4.3 Factors used in this model
Table 2 shows the factors of the model. The ratio of the work to be loaded by the operations in the office are measured according to the processing capacity of the office, this is called arrival load ratio in this model. Extra time ratio 1.00 means that planned time do not add any extra time to these operations. Accordingly, this situation corresponds to the process analysis in case of dealing with material.

The mean lead time is sought after by simulation which sets each factor of the model. This one experiment is processing 5000 jobs. The same parameter of factor in this model is done by 50 experiments.

5 EXPERIMENTAL RESULTS
Figure 6 shows the relationship between number of operators and mean lead time. In this case the graphic
shows arrival load ratio corresponding to 0.8 while extra time ratio is 1.20. The X axis is the number of operators, and the Y axis is mean lead time.

As showed by this figure, mean lead time increases linearly according to the number of operators. This is true regardless of any value showed by arrival load ratio and extra time ratio.

Figure.7 shows the relationship between arrival load ratio and mean lead time. In this case the number of operators is 5, extra time ratio is 1.2 as showed in the graphic. The X axis is arrival load ratio, and the Y axis is mean lead time.

As the arrival load ratio approaches to 1.0, the mean lead time increases exponentially. This is true regardless of the number of operators and extra time ratio.

Figure.8 shows the relationship between extra time ratio and mean lead time. In this case arrival load ratio is 0.80, and number of operators is 5 as showed in the graphic. The X axis is extra time ratio, and the Y axis is mean lead time.

As showed in this figure, mean lead time increases exponentially according to the extra time ratio. This is also true regardless of arrival load ratio and number of operators. Furthermore, the mean lead time which is the difference between dealing material and dealing information is made clear.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrival time</td>
<td>Exponential distribution</td>
</tr>
<tr>
<td>Processing time</td>
<td>Erlang distribution of phase four</td>
</tr>
<tr>
<td>Routing of jobs</td>
<td>Flow type</td>
</tr>
<tr>
<td>Number of operators</td>
<td>1~5</td>
</tr>
<tr>
<td>Arrival load ratio</td>
<td>0.700~0.800</td>
</tr>
<tr>
<td>Extra time ratio</td>
<td>1.00~1.20</td>
</tr>
</tbody>
</table>

Table 2. Factors of the model.
6 CONCLUSION
This study focused on flow of information in indirect operations. In the first place, the difference between process analysis in case of dealing with material and process analysis in case of dealing with information is made clear. Secondly, the factors that affect each information dealt in the process is made clear by the simulation that was done. However, future research should be conducted with the objective of clarifying the equation that determines mean lead time in case of dealing with information that is already set by the production process.

7 REFERENCES