

Optimizing Production Time in Book Printing using PERT/CPM

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Abstract: Advanced planning will generate best production process in accordance to its production implementation schedules. Any delay in production process affect to other following activities such as the packing process, shipping and so on. This can lead to consumer dissatisfaction. Time in producing is important in accordance with the agreement to consumer. Printing production process includes pre-press, press and post-press (finishing). Beside production process time, the instruction and the order of the production process are significant. The aim of this research is to produce an optimal production time with a case study of a production of a printed book entitled Brilliant. This book was printed in Jakarta printing areas for about 20,000 units. The methods used in this study include: Project Evaluation and Review Technique (PERT) and Critical Path Method (CPM) methods. The methods used are Project Evaluation method and Review Technique (PERT) and Critical Path Method (CPM). This research reveals that a total production process time of the book is 2700 minutes or 41.5 hours. After applying the PERT / CPM method, the sequence of production processes that result by the critical path is the B (pre-press web activity) – D (press web activity) – E (post press activity) path.

1 INTRODUCTION

Advance planning is essential in any production system. Any deferral or postpone might affect to the production schedule. According to Fadli (2010), a project activity is limited by time and allocation of resources to complete the specific tasks. This applies especially in printing process where customers' order or Make to Order (MTO) become the main part of the production process. Each customer order has an agreement including product specifications and product completion time.

The printing production process includes pre-press, press and post-press (finishing). Each activity can be both parallel and not parallel process, depends on the machine. Seeing the importance of time and sequence of the production process is necessary to conduct research to solve the problems that have been described above. There are many methods that can be applied to measure the production process time based on ordering process. The character of this case study is the MTO product, considering the time, the sequence of the production process and the suitable method. Project Evaluation and Review Technique (PERT) and Critical Path Method (CPM) methods are

examined and proven. Determination of the optimal production time required good scheduling method, and this can be applied using the PERT / CPM approach (Mas'ud, 2017). This method is often and suitable to be used in scheduling projects in the civil field for example housing construction (Raharja, 2014), shop houses (Caesaron, 2015) and construction of sewage treatment (Mas'ud, 2017).

This CPM method is applied to obtain the critical path that occurs in the order of the production process. From the sequence of processes, evaluation of the actual production process time are carried out using PERT to obtain the optimal time. Based on the optimal time and planning the cost calculation can be done to see the comparison. The object taken in this research is a printed book entitled Brilliant which were produced for 20,000 units. This case study was conducted at a printing company in Jakarta. Based on the description above, the main purpose of this research is to obtain an Optimization Production Time in Book Printing using PERT / CPM approaches.

2 PRODUCTION SYSTEM

A book entitled “Brilliant” is an object of this research. The material used for this book is art paper for the book’s cover and LWC paper for the book’s content pages.

The production process of a printed product involves 3 stages i.e. pre-press, press and post-press (finishing). Each stage has sub-stages for each production process activity. The pre-press process includes the preparation of the Final Art Work (FA) to plate. The press process is converting blank paper to printed paper. Then, the last process is finishing (post-press) which includes folded and stacked the books. All processes are observed and the time of each process is calculated using a stop watch. This research primary data was taken directly from book printing company. Secondary data is used as a reference to the sequence of processes in production activities.

The sampling method has been done randomly where each activity took five measurements data. The data taken during the process, starting from the process of pre-press, press to post press of making a book with the circulation above. All processes (pre-press, press, post-press) provide one measure of time to facilitate observation. A road whiteboard and calculator also needed to calculate the real time in each process.

2.1 Printing Production Process

Printing or commonly called graphic is a technique of conveying messages, ideas, information, thoughts, feelings through duplication by printing and presenting to the public (Kipphan, 2001). Prepress is the steps needed to prepare a printed product such as writing and editing, graphic design, proofing, and plate making. Prepress procedure includes the manufacture of plates printed references, image or form which ready for mounting on a printing press. The adjustment of image and text or the creation of file need to be in high quality. The source of prepress is soft file because the output of prepress is a plate to print reference. Press process is production of printing product. Techniques used in the press process are flat printing, high printing, deep printing, digital printing and filter printing.

The printing technique used in this study is offset printing. The input of the press process is the blank paper and the output is the printout. The final process in printing is finishing / post press. In this process, printed products were added some features

and functions based on customer order specifications. These steps are including cutting, folding, joining, binding, lamination, etc. Source of post press is the printed paper and the output is in the form of a finished product (for example: a book). General description of the printing industry production process is as follows:

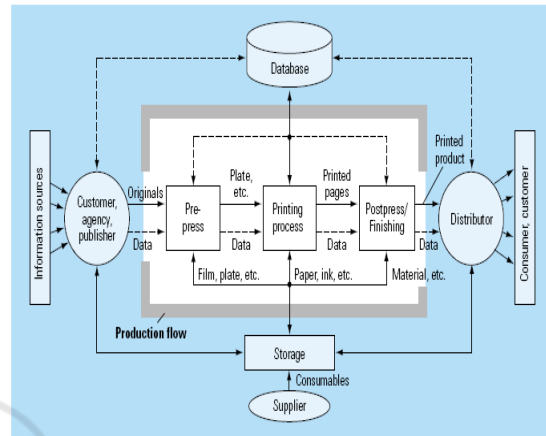


Figure 1. Production Printing flow
(Source: Kipphan, 2001)

2.2 Concepts of PERT / CPM Methods

Network analysis is a conventional way to find the optimal way to link a number of activities directly or indirectly which meet the supply and demand requirements at different project activities and scheduling locations. Over the years, two approaches that have proven useful in project planning, scheduling and control are PERT and CPM (Agyei, 2015).

2.2.1 CPM

According Levin and Kirkpatrick (1972), the Critical Path Method (CPM) is a method for planning and monitoring projects. This system is most widely used among all other systems. CPM method is widely used by industry or construction projects. This method can be applied if the duration of the work is known and not fluctuate too much. CPM as a project management model that prioritizes costs as the object being analysed. CPM is a network analysis which seeks to optimize the total project cost through reducing the total project completion time. Using the CPM method can save time in completing various stages of a project.

2.2.2 PERT

Project Evaluation and Review Technique is a management science model for planning and controlling a project. According to Levin and Krikpatrick (1972), the PERT method is a method to reduce production delays, disruptions and conflicts, coordinate and synchronize as part of an overall work and accelerate the completion of projects. The application of PERT method can be known where CPM the amount of time required, the level of confidence desired in determining the time of each activity. There are surveillance activities especially in the critical path that can be more concentrated (Prog, 2014).

The PERT method accommodates the existence of uncertain elements, then analyzes the possibilities of the extent to which the project deviates or meets (Caesaron, 2017). PERT and CPM can be used as references in setting up the schedule, so as to facilitate the course of the project to determine delays in each process, so as to overcome these problems (Sari, 2018).

According to Grace (2016), the steps in making PERT are:

1. Identification of activities and events
2. Establish the order of activities
3. Make a network diagram
4. Estimated time for each activity
5. Specifies the critical path
6. Update the diagram according to project progress.

The planning step for PERT approach is intended to find out the probability value of project activities, especially on the critical path, either is completed on time according to the expected schedule or not (Chuong, 2007).

2.3 Optimizing Production Activity

The product specifications are as follows: The size of the book will be 17.6 x 2 5 cm; Cover is Art Paper 210 GSM ; Content page is HVS 70 gsm, Color processes using 4 /0 color to cover and 1 /1 color to book; Number of pages are 115 pages; Finishing is with glue.

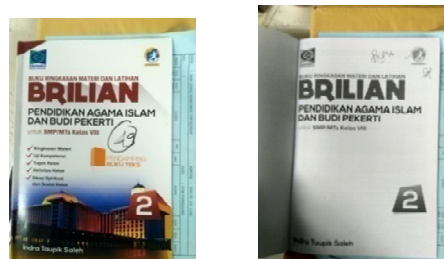


Figure 2. Book product
(Source: CV Arya Duta, 2018)

2.3.1 Production Activity

Pre-press activity is using a soft file of book design in and output is printed plate. The activities are file checking/ color reproduction, paper deposition, proofing, printing plate, and buckling and plate holes. The pre-press activity is divided into two parts, cover plates for sheet machines and fill plates for web machine. The production of this book needs seven plates which are ready to be printed. This consists of six content plates (using a web offset machine) and one cover plate (using an offset sheet machine).

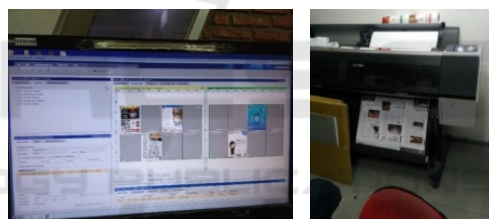


Figure 3. Pre-press activity
(Source: CV. Arya Duta, 2018)

Second stage is press activity, content of the book printed with web offset machine and cover printed with sheet offset machine. In the press stage, activity include: preparation of paper, ink and equipment and supporting materials, machine settings, plate mounting, print try, mass printing, cleaning of machines and work areas. The process of sheet printing uses the Hiedelberg machine and web printing uses the Komori machine.

The final stage in book making is post-press (finishing). The activity includes cutting, folding, collation and binding. Binding method is perfect binding.



Figure 4. Post Press Activity
(Source: CV Arya Duta, 2018)

2.3.2 Work Breakdown Structure (WBS)

Before using PERT/CPM method, first, the sequence of the production process of this book can be done by creating a Work Breakdown Structure (WBS) with the following scheme:

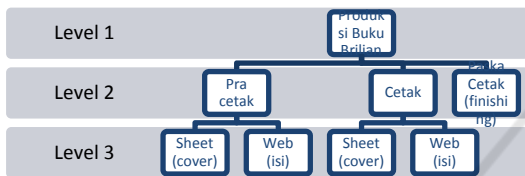


Figure 5. WBS level

The production of the book can be done WBS development to emphasize the activity of the actual activities that occur, so it can be accordance to the project schedule.

Table 1. Activity using WBS
Activity Time (Hours)

Activity	Start	5	10	15	20	25
PrePress Sheet (Cover)	Start					
Pre press Web (Isi)	Start					
Press Sheet (Cover)	Start					
Press Web (Isi)	Start					
Post press (finishing)	Start					

To create network diagrams, this study uses the AOA diagram approach. Activity using PERT shows like below:

Table 2. Activity using PERT

No	Activity	Activity description	Begin Activity	Time (menit)	Time (hours)
1	A	Pre-press Sheet (Cover)	-	35	0.6
2	B	Pre-press Web (Isi)	-	394	6.6
3	C	Press sheet	A	187	3.1
4	D	Press Web	B	757	12.6
5	E	Post press	C, D	1335	22.3

Using PERT have 5 activity: Pre-press sheet (A), pre-press web (B), press sheet (C), press web (D) and post press or finishing (E).

3 RESULTS AND DISCUSSION

Overall, the process of graphics production includes three stages: pre-press, press and post press. However, before the actual production process time, it is necessary to know the actual process flow. First after observing in a book printing, process there are several activities that can be done simultaneously, but there are also activities that to be done sequentially. The activity in printing production of this book needed is 45.2 hour or 2708 minutes.

The printing process of the content pages and cover page of the book used two different machines. The content page use web offset machine and the cover page use sheet offset machine. Therefore, both press activities can be done in parallel. However, post-print activities must wait until the completion of these two press activities, the network diagram is formed as shown below:

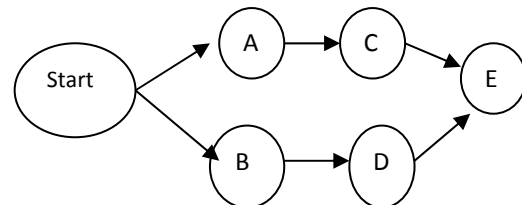


Figure 6. Path using PERT method

A PERT chart allows managers to evaluate the time and resources necessary to manage project. It needs information about Earliest Start Time (ES), Earliest Finish Time(EF), Latest Start Time(LS) and Latest Finish Time (LF) as set like this:

Table 3. Optimizing time using PERT method

No	Event	Time (hours)	Schedule				Slack (LS-ES)
			Early		Late		
			ES	EF	LS	LF	
1	A	0.6	0.0	0.6	15.5	16.1	15.5
2	B	6.6	0.0	6.6	0.0	6.6	0.0
3	C	3.1	0.6	3.7	16.1	19.2	15.5
4	D	12.6	6.6	19.2	6.6	19.2	0.0
5	E	22.3	19.2	41.5	19.2	41.5	0.0

There are three activities which contain of slack activity (with nominal slack is zero). The three activities are B, D and E. Those activities cannot be delayed in production system.

The PERT analysis can be performed further using CPM. By doing so, it can find out which activities are going through the critical path. Based on the PERT table, this shows that the activity is a critical activity so it can be concluded that the critical path in the book production activities is on the B-D-E.

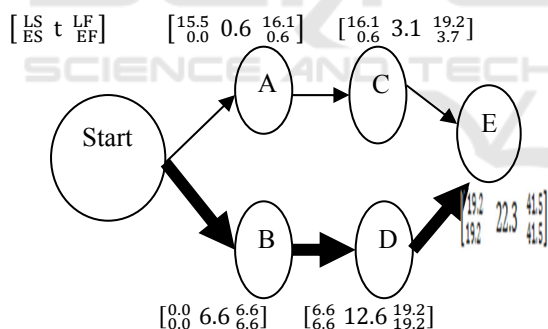


Figure 7. Optimizing Using PERT/CPM

4 CONCLUSIONS

This research reveals that the actual total production time needed is 45.2 hour or 2708 minutes, meanwhile after applying PERT/CPM method need 2700 minutes or 41.5 hours. Applying the PERT method shows there are five activities sequences i.e. sheet prepress (A), web prepress (B), sheet press (C), web press (D) and finishing (E). slack time showed in B, D and E activity. Meanwhile, applying

CPM method obtained the sequence of production processes path is the B (pre press web activity) – D (press web activity – E (post press activity) path.

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