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Analysis of time acceleration using Critical Path Method (CPM) to increase motorcycle maintenance in authorized service station

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Abstract. Numerous studies have shown that maintenance requires proper scheduling by using preventive and corrective maintenance scheduling to maintain the state of the machine. The fact is the number of Honda motorcycle products has increased. This has resulted in a long motorcycle queue. Motorcycle queues cannot be prevented only by scheduling preventive and corrective maintenance, so scheduling of maintenance activities is necessity to speed up motorcycle maintenance time. This study uses the Critical Path Method (CPM) activity scheduling method with the help of the POM-QM program to increase the acceleration of maintenance time. Scheduling is made by calculating the logic of dependency and time of each maintenance activity. Activity scheduling is carried out on 7 types of maintenance, namely carburetor light service, carburetor and CVT light service, injection light service, injection and CVT light service, oil change, spare part replacement, oil and spare part replacement and final inspection of each type of maintenance. After that, the analysis of the scheduling results is done by comparing the results before and after the proposed improvement. Based on the results of research conducted it can be seen that the maintenance time at the authorized service station can be accelerated by using the CPM scheduling method. The efficiency of acceleration of maintenance time is 16.666% to 57.889%. The preparation of maintenance activities and processing of heavy service data is required if there is heavy service maintenance in the authorized service station.

1.Introduction

Maintenance activities are undertaken to maintain the condition of the equipment and its components to be ready for operation [1]. Millions of motorbike populations need routine maintenance to function properly, this results in queues at workshops, eventually requiring maintenance scheduling to speed up maintenance time. Some research on scheduling planning using several methods, namely bar chart method, network method (CPM, PERT, PDM), LOB and Time Chainage Diagram. Where Bar Charts are easy to make and understand, but cannot recognize the critical path, determine the interrelationships between these activities and are not effective on large projects [2]. The network method such CPM, PDM, and PERT, it has the reliability to show specifically the logic of dependency relationships between activities and determine the critical trajectory of project activities so that the priority activities in the event of delays can be identified, but cannot directly detect activities that experience disturbances in scheduling projects [3][4]. LOB is simple and easy to understand because as a line that shows the productivity of a job. However, LOB cannot show specifically the relationship between the logic of dependency and activities. LOB has the advantage of being able to directly detect activities that experience disturbances in project scheduling by looking at the presence of intersecting bar charts [5]. Another name for Time Chainage Diagram is Space-Time Diagram. Time Chainage Diagrams are another variation of the LOB. This method is also known as Time Distance Chart which is a simple extension of the Bar Chart method which is widely known by users of the planning system [6]. The scheduling needs to determine the relationship of each activity, identify relationships that should take precedence over other activities, help the use of labor and other resources in an optimal way on a project. In the CPM diagram, it can be showing specifically for dependency logic relationship used on all work items is Finish to Start (FS). Likewise, the maintenance completion time can be estimate by mathematics calculation. Also, the CPM method can also be seen a critical trajectory in a project schedule so that if there is a delay in project work, the priority of the work to be evaluated becomes easier to do. Work items traversed by the critical track monitored, the other hand overall maintenance delays cause of experience delays as well [7].

Long queues at official service stations can be described as a good level of customer loyalty [8]. However, this can also be a serious problem because they can lose up to 10 customers a week. Therefore, the Critical Path Method (CPM) is a suitable method to solve critical trajectory of maintenance activities in the authorized service station. This study uses CPM method to propose priority work on maintenance activities and increasing time acceleration for motorcycle maintenance.

2. Method

The scheduling method used in this study is CPM using a POM computer program. Sample taken is the type of motorcycle maintenance such as carburetor-type light service, carburetor and CVT light service, injection-light service, injection-light service and CVT, oil change, replacement of spare parts, oil and spare parts replacement and inspection of each type of maintenance. Sample total is taken based on the type of maintenance served during the duration of data collection. The research design stage showed in Figure 1

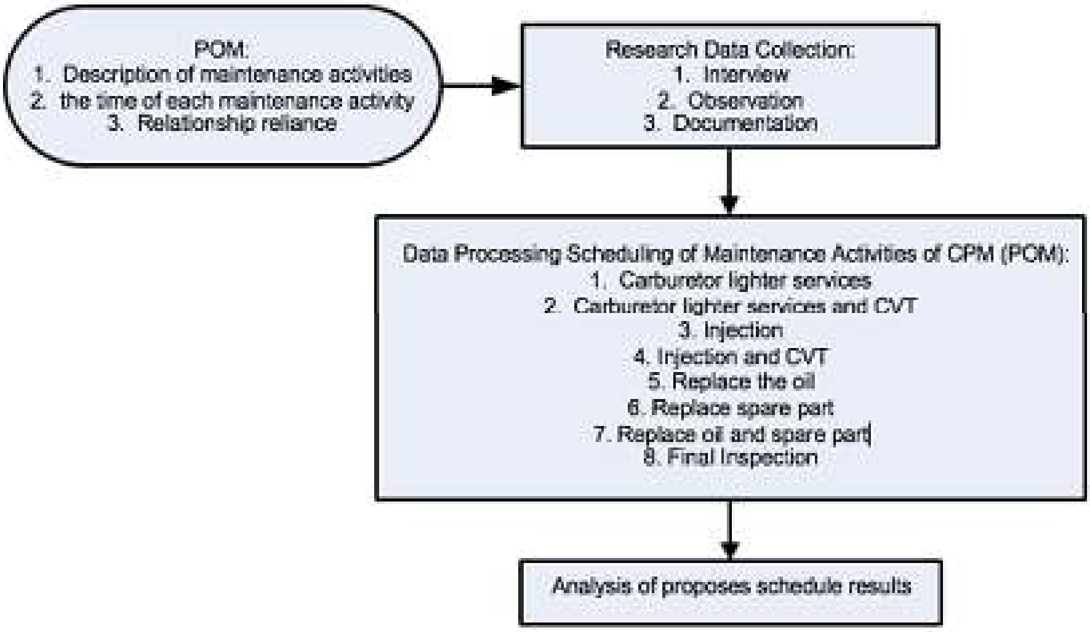

Figure 1. Research design stage

CPM has six basic steps [9], namely:

1. Identify the project and prepare a fractional work structure.
2. Building relationships between activities, deciding which activities should go first and which ones follow.
3. Describe the network that connects the whole activity.
4. Establish an estimated time for each activity
5. Calculate the longest time path through a network called the critical path.
6. Using networks to help with project planning, scheduling, and control.

Data processing using the POM program can be formulated into 4 steps, namely [10]:

1. In the Project management module select a single time estimate with network immediate predecessor.
2. Enter the number of numbers based on the number of work activities.
3. Input by existing data, ranging from tasks (activities) to activities that precede (Predecessor).
4. Then solve.

3. The results

Reliable logic of each activity item that is protected for scheduling maintenance activities, one of the results of scheduling using the CPM method can be seen in Table 1. Early Start is the earliest start time of an activity while Early Finish is the earliest time to finish the activity. Late Start shows the slowest start time of the activity can be started without delaying maintenance. time. Late Finish shows the end time of the activity can be ended at the latest without an extended period of maintenance. The Slack is the difference in time, if slack is zero then the activity is called critical activity.

Table 1. The logic of carburetor type motorcycle light service maintenance dependency

Activity Code	Activity	Activity Time (Second)	Pre-deccessor	Early Start	Early Finish	Late Start	Late Finish	Slack
1	Light Check	30		0	30	1650	1680	1650
2	Horn Check	30		0	30	1650	1680	1650
3	Cover Body Removal	420		0	420	0	420	0
4	Engine Oil Inspection	60		0	60	1620	1680	1620
5	Oil Filter Check	60	3	420	480	960	1020	540
6	Inspection and Adjustment	60	3	420	480	960	1020	540
7	Carburetor Cleaning and Adjustment	600	3	420	1020	420	1020	0
8	Cleaning and Replacement of Fuel Filters	60	3	420	480	960	1020	540
9	Cleaning and Replacement of Air Filters	60	3	420	480	960	1020	540
10	Valve Check and Adjustment	300	3	420	720	720	1020	300
11	Clutch Check and Adjustment	120	3	420	540	900	1020	480
12	Chain Adjustment	120			120	1560	1680	1560
13	Brake Check and Adjustment	60			60	1620	1680	1620
14	Brake Light Switch Adjustment	60			60	1620	1680	1620
15	Battery Checkup Examination	120	3	420	540	1560	1680	1140
16	Addition of Tire Wind Pressure	120			120	1560	1680	1560
17	Shock Beaker examination	60			60	1620	1680	1620
18	Steering Handlebar Checks and Adjustments	60	3	420	480	1620	1680	1200
19	Wheel Bearing Inspection	60			60	1620	1680	1620
20	Mounting Cover	600	4,5,6,7,8, 9,10,11	1020	1620	1020	1620	0
21	Nuts and Bolts Inspection and Tightening	60	20	1620	1680	1620	1680	0
	Total Before Proposed Improvement = 3120				Total After Proposed Improvements (CPM) = 1680			

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Based on the results of scheduling the overall type of maintenance using the CPM method, it is known that the speed of time before and after the proposed improvement can be seen in Table 2.

Table 2. Comparison results of scheduling activities before and after proposed improvements

No	Type of Maintenance	Before Proposed Improvement	After Proposed CPM Repair	Time Saving	Equivalent Efficiency
1	Carburetor	3120 second (52 minute)	1680 second (28 minute)	1440 second (24 minute)	46,153 %
2	Carburetor and CVT	3900 second (65 minute)	1680 second (28 minute)	2220 second (37 minute)	43,076 %
3	Injection	3120 second (52 minute)	1680 second (28 minute)	1440 second (24 minute)	46,153 %
4	Injection and CVT	3900 second (65 minute)	1680 second (28 minute)	2220 second (37 minute)	57,894 %
5	Oil	720 second (12 minute)	600 second (28 minute)	120 second (2 minute)	16,666 %
6	Spare part	2760 second (46 minute)	2700 second (45 minute)	60 second (1 minute)	2,173 %
7	Oil and Spare part	660 second (11 minute)	510 second (8,5 minute)	150 second (2,5 minute)	22,727 %
8	Final Inspection	270 second (4,5 minute)	120 second (2 minute)	150 second (2,5 minute)	55,555 %

The graph of the comparison of the scheduling of activities before and after the proposed improvement can be seen in Figure 2. The graph of the results of the comparison of the scheduling of the activities before and after the proposed improvement shows that there is an acceleration of maintenance time after the proposed improvement of the activity schedule using the critical path method.

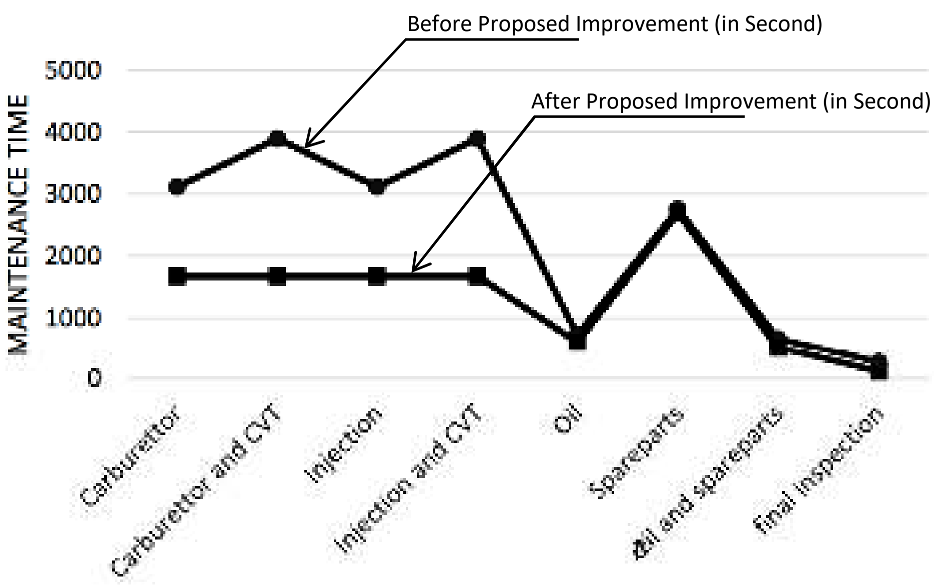

Figure 2. Comparison results of scheduling activities before and after proposed improvements

4. Conclusion

Maintenance of a light carburetor motorcycle service accelerates for 1440 seconds, with an efficiency of 46.153%. Maintenance of the carburetor and CVT lightweight service motorcycle accelerates for 2220 seconds, with an efficiency of 43.076%. Maintenance of light injection service motorbikes accelerates for 1440 seconds, with an efficiency of 46.153%. Maintenance of light injection and CVT service motorbikes accelerates for 2220 seconds, with an efficiency of 57.894%. Motorcycle oil changes obtain acceleration for 120 seconds with an efficiency of 16.666%. Motorcycle spare parts replacement gained acceleration for 60 seconds with an efficiency of 2.173%. Oil and motorcycle spare parts changes have accelerated for 150 seconds, with an efficiency of 16.666%.

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