January 10th, 2017

Dear Ellysa Nursanti, Suaidy Avief, Fourry Handoko,

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Title: Overhaul Maintenance Scheduling Optimization of Indonesian Air Force HAWK MK-209 Aircraft using CPM PERT

We have completed our assessment process. On behalf of the editor in chief of the International Journal of Advanced Industrial Engineering (IJAIE), we are pleased to inform you that your paper has been PASSED initial screening and is now awaiting reviewer invitation.

Thank you for your contribution and please do not hesitate to contact us for further inquiries.

With best regards,

T. Herawan

T. Herawan
Managing Editor
The International Journal of Advanced Industrial Engineering (IJAIE)
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Overhaul Maintenance Scheduling Optimization of Indonesian Air Force Hawk MK-209 Aircraft Using CPM/PERT

Ellysa Nursanti, Suaidy Avief, Fourry Handoko

Abstract: The importance of air defense in a country becomes a reference basis of this research. With the overhaul implementation of the Indonesian Air Force (TNI AU) Hawk MK-209 aircraft in accordance with technical order/maintenance manual for 101 848 minutes or 1697.46 hours or 283 days or 14 months flight hours, making air defense readiness decreased indirectly and being an impedence situation for the Indonesian people against threats, interference, obstacles either from inside or outside the country. This research method implements the Critical Path (Critical Path Method/CPM) and (Program Evaluation and Review Technique/PERT) analysis on the implementation of Indonesian Air Force (TNI AU) Hawk MK-209 aircraft. Objectives to be achieved in the implementation of CPM and PERT are getting the estimated duration of the overhaul efficient, as well as the identification of critical path and the value of the opportunities in the finish. After implementation, testing and analysis of these two methods showed implementation time savings of (1) Hawk MK-209 aircraft from 101.848 minutes or 1697.46 hours or 283 days or 14 months into 2894.50 seconds or 483.08 hours or 81 days or 4 months with savings conversion about 60%.

Keywords: CPM/PERT, Hawk MK-209, Optimization, Overhaul, Maintenance

1 Introduction

Current conditions in the Hawk Mk-209 aircraft overhaul total time in accordance with the technical order/maintenance manual is 101.848 minutes or 1697.46 hours or 283 days or 14 months, assuming normal time is 1 day (6 hours), 1 week (5 weekdays), 1 month (4 weeks) and 1 year (12 months) so it will affect the principal task of the Indonesian Air Force (TNI AU) which to reduce the readiness of aircraft in Indonesian Air Force (TNI AU) Squadron, a routine patrol to safeguard the sovereignty of the Republic of Indonesia reduced because of the low readiness of the aircraft led to the potential threat, challenges, obstacles and interference from both inside and outside the country, pilot skill Hawk Mk-209 poorly trained so Hawk Mk-209 pilot skill is poorly trained so led potentially led to the occurrence of incident and accident, the decreasing military cooperation with
neighbouring countries in order to create the conditions of national security, regional and international levels to improve the relationship between the State, lack of border security, decreasing of strategic vital national objects security, less maximum to help the government in order to secure the shipping and aviation against piracy, piracy and smuggling, considering the overhaul period of 14 months were deemed too long then need an alternative solutions proposed to shorten the maintenance time. The purpose of this study was to minimize maintenance time scheduling overhaul for the Hawk Mk-209 aircraft using CPM/PERT methods. The benefits of this research is to get more comprehensive alternative policy that are expected to minimize the duration of aircraft maintenance in the coming years, generated the maintenance study effectively and efficiently in order to improve the defense readiness of the Republic of Indonesia. Premaratne Samaranayake and Senevi Kiridena in 2012 with the title of Aircraft maintenance planning and scheduling: an integrated framework of the School of Management, University of Western Sydney, Perth, Australia, School of Mechanical, Materials and Mechatronic Engineering, University of Wollongong, Wollongong, Australia, using CPM / PERT for the C-130 Hercules propeller assembly (propeller is one part of the plane C-130 Hercules). Omar M. Elmabrouk in 2011 under the title A Linear Programming Technique for the Optimization of the Activities in Maintenance Projects, Department of Industrial and Manufacturing Systems Engineering Garyounis University, Benghazi-Libya using CPM method for replacing an existing boiler with an energy efficient boiler. Muhammad Rizki Ridho and Syahrizal titled Evaluation of Scheduling Time And Cost Project Method PERT and CPM of the Department of Civil Engineering University of North Sumatra, using PERT and CPM for the construction of the Central Bureau of Statistics Medan located on the street Gaperta Medan, and how the project can be accelerated by the addition of working hours if there is a delay.

2 Research Methods

The following step in the method of research CPM / PERT as shown in Figure 2.1 below
Problem Identification and objective analysis of the operation:
Overhaul of Hawk MK-209 aircraft every 14 months

Model Formulation
1. Objective function
   Maintenance scheduling minimization of Hawk MK-209 Air force aircraft using CPM/PERT
2. Constraint function
   Poor component utility, bad weather, alternately utilization of tools

Application:
POM (CPM/PERT)

Activity and milestone identification

Determine maintenance phase

Construct the network diagram model

Determine time-needed for each activity

Determine critical path and steps

monitoring, evaluation and correction of PERT Diagram during maintenance

whether the maintenance interval is optimal?

Results & Discussion:
Hawk MK-209 get an overhaul every 4 months

Figure 2.1 Model Testing Diagram
Activity Barriers (slack activity) and the critical path (critical path)

Slack time, is the free time of every activity to be delayed without causing a delay in the overall project.

\[ \text{Slack} = LS - ES \text{ or } \text{Slack} = LF - EF \]  \hspace{1cm} (1)

Critical path analysis to help determine the project schedule. To determine the critical path we count the two starting time and end times for each activity.

a. (Earliest start - ES), which is the time preceding an activity can begin, assuming all predecessors have been completed.
b. (Earliest finish - EF), which is the time preceding an activity can be completed.
c. (Latest start - LS), which is the last time an activity can start so do not delay the timing of completion of the entire project.
d. (Latest finish - LF), the last time an activity can be completed so as not to delay the completion of the entire project.

Calculations by Using PERT

In PERT, we use probability distributions based on three estimates of the time for each activity, that is:

a. (Optimistic time) [a] time is optimistic that the time required by an activity if everything went according to plan. Or also can be called a minimum time of an activity, where everything will go well, a very small possibility of activities completed prior to this time.
b. (Pessimistic time) [b] time pessimistic time needed an activity assuming existing conditions was not expected. Or also can be called is the maximum time needed for an activity, this situation occurs when bad luck happens.
c. (Most likely time) [m] most likely time, is the time needed to complete the activities of the most realistic. Or also can be called the normal time to complete an activity. To calculate the dispersion (dispersion) or activity completion time variance (variance of activity completion time), can use the formula:

\[ \text{Variance} = [(b - a)/6]^2 \]  \hspace{1cm} (2)

The variations in the different activities on the critical path can affect the timing of completion of the overall project and enable delays. PERT uses critical path activity variances to help determine the overall project variance by summing the variances of critical activities:
Overhaul Maintenance Scheduling Optimization of Indonesian Air Force Hawk MK-209 Aircraft Using CPM/PERT

\[ s_2 = \text{Project variances} = (\text{variance activity of critical path}) \] (3)

\[ \text{project deviation standard (s)} = \sqrt{\text{project variances}} \] (4)

\[ \text{normal deviation value (Z)} = \frac{[\text{time limit (n)} - \text{expected completion time}]}{s} \] (5)

3 Results and Discussions

For data processing optimization of overhaul scheduling maintenance of Indonesian Air Force (TNI AU) Hawk MK-209 aircraft, then all Indonesian Air Force (TNI AU) Hawk MK-209 aircraft overhaul data phases consisting of phases Pre Dock - In Dock - Post Dock added to the program POM i.e CPM / PERT viewable in the table below:
Ellysa Nursanti, Suaidy Avief, Fourry Handoko

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<th>Activity</th>
<th>Start</th>
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<th>Late Start</th>
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Table 2.4 In Dock Examination-I
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Table 2.12 Post Dock

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From the table above, it can be seen that the value of the final finish (Latest Finish - LF) gained 4.61 months so that the normal completion time of the implementation of the overhaul Hawk-209 was 4.61 months can be seen in the table.
C. Post Dock 214.50

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### 4 Conclusion

From the discussions that have been conducted regarding overhaul maintenance scheduling optimization of Indonesian Air Force (TNI AU) Hawk MK-209 aircraft, it can be concluded as follows:

a. Of process / outcome CPM / PERT obtained implementation time saving (1) Indonesian Air Force (TNI AU) Hawk MK-209 from 101,848 minutes or 1697.46 hours or 283 days or 14 months into 2894.50 seconds or 483.08 hours or 81 days or 4 months with savings conversion about 60%.

b. In the implementation, maintenance should fulfill all components or replacement parts to fit the number, specifications and labor according to the number and capabilities qualification.

### Recommendation

With the overhaul maintenance scheduling optimization of Indonesian Air Force (TNI AU) Hawk MK-209 aircraft along anticipating developments in technology and the Indonesian Air Force (TNI AU) aircraft, it is necessary to present some suggestions as follows:

a. Indonesian Air Force (TNI AU), in this regard Depohar 30 can provide support and opportunities to personnel Sathar 32 to participate in formal-education and informal education that are in the country or abroad, in order to increase knowledge, development of knowledge and skills that later can be applied in the implementation of official daily tasks.

b. Expected that the evaluation and assessment by the Indonesian Air Force (TNI AU) in particular Depohar 30 against the circumstances Sathar 32 nowadays. Evaluation includes aspects of the provision of material support, infrastructure and other supporting facilities, so the concept as a unit of weight level executive (Standard Depot Level...
Overhaul Maintenance Scheduling Optimization of Indonesian Air Force Hawk MK-209 Aircraft Using CPM/PERT

... Maintenance) can be realized and can be the basis for the development of aircraft business maintenance systems for the Air Force in the future.

c. Promoting cooperation involving Mabesau, Koharmatau, Litbangau and Depohar with strategic industries such as PT. Aerospace, PT. PAL, PT. Pindad, educational and research institutions such as ITN, ITB, ITS, UI, UGM, LIPI, LAPAN and the potential for other national aerospace, in order to participate in the support and development of defense and security interests of the country.

5 Reference

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