Evaluating Working Time and Work Capacity of Aircraft Cabin Line Maintenance Services

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Abstract. Along with the development of modernization and technology, high mobility has been transformed into the basic needs of each individual. To achieve high mobility, various kinds of transportation are highly needed, ranging from land, sea to air transportation. Aircraft as one of the main transportation, requires high maintenance costs to anticipate and minimize the risk of air accidents. Generally, aircraft maintenance can be divided into line maintenance that handles light (minor) maintenance and base maintenance that consist of heavy maintenance. One of the focuses on line maintenance beside of navigation and communication systems is Cabin maintenance. Cabin Maintenance Services usually perform the transit check, 24 hours check, daily check, weekly check, up to A Check. One of the focus of cabin maintenance is cabin standard check. Cabin standard check that consist of several checks from passenger aircraft entrance door, service door, cockpit interior, galley, lavatory, passenger seats is currently allocated 150 minutes. However, it was found that with an allocation of 150 minutes by 1 man power, it was not possible to complete the cabin standard check for A330 series aircraft. Therefore, measurements of standard times and standardization for several types of aircraft is needed. Data collection is done by using a stopwatch time study to get the actual cycle time, then interview with mechanics on duty to get things that require an allowance, and consider the capacity of man hours and man powers available in the Maintenance Control Center (MCC). After measurement and recalculation, it was proposed to add another man power to the A330 series and proposed cabin standard check processing time for B737 series aircraft by 130 minutes, CRJ1000 by 95 minutes, and B777 and A330 using 2 manpowers each of 220 and 160 minutes to finish the Cabin Standard Check during cabin maintenance in various series of aircraft.

1. Introduction

Along with the development of modernization and globalization, high mobility has become a necessity for all people. To achieve this, development of adequate facilities and transportation is needed. In 2016, Indonesia had 27 international airports; While airports that only serve domestic flights are 264 airports. The number of passengers flying in Indonesia on international flight lines was 14,801 thousand, domestic passengers were 83,350 thousand, and transportation of cargo served by airports for international flights was 534,594 tons and domestic flights were 205,419 tons [1].

The air transport business is large in its operations, integrated, automated and complex. Air carriers are constantly striving to achieve high standards of safety and simultaneously to attain an increased level of availability performance at minimal cost [2]. The maintenance processes share a significant amount of operating costs to an industrial organization. For instance, the cost of maintenance activities ranges from 15 to 70% of the total production costs, constituting the second largest part of the operational budget after energy costs [3].

When planning how maintenance activities take place, important aspects to be considered are the company location, the activity profile, and the characteristics for the available means of production. The systematic approach considers the following maintenance activities’ organising forms which,
according to the allocated resources and the objectives, are directed to ensure the optimum availability of the technical systems [4]. Hence, it is vital to incorporate the lean management principles into maintenance activities through applying its principles and practices/tools which focus on minimizing waste in aircraft maintenance [5]. Beside that, airline accident/incident is inacceptable and is sufficient to highlight everyone from the manufacturer to the user [6].

2. **Research Methodology**
2.1. **Type of Research**
This type of research is a quantitative research where is a systematic and empirical investigation of observable phenomena via statistical, mathematical, or computational techniques.

2.2. **Research Object**
The object of this research is the company’s aircraft cabin maintenance cabin standard check performance time.

2.3. **Problem Solving Methodology**
The methodology used to solve the problem consist of:
1. Measure the cycle time of cabin standard check by stopwatch time motion study
2. Conduct an interview with the mechanics on duty
3. Check the average man hours and man powers availability in Aircraft Maintenance Control Center.
4. Define the allowance for each series of aircraft
5. Calculate the proposed standard time for each series aircraft cabin standard check.

3. **Literature Review**
3.1. **Aircraft Maintenance**
Basically, maintenance program can be divided into two major groups, namely preventive and corrective maintenance. Preventive maintenance is a treatment that prevents component failure before it is damaged. While corrective care is treatment after damage has occurred to return to the initial condition.

Aircraft manufacturers, such as Airbus, Boeing, etc. provide MPD (Maintenance Planning Documents) which is an aircraft maintenance guide in accordance with the type and series of aircraft operated. MPD consist of certain types of maintenance and those are still general, included some non-mandatory maintenance options.

There are two kinds of maintenance in the aircraft namely line maintenance and base maintenance. Line maintenance generally refers to minor, unscheduled or scheduled maintenance carried out on aircraft that occurs at or near the gate or terminal (apron), aircraft parking area, or hangar. While the base maintenance refers to all heavy maintenance above A-Check that must be done in hangar area, that may consist of FOD (foreign object damage), bird strike, lightning strike, that caused major problem in an aircraft.

3.2. **Narrow Body Aircraft**
Narrow body aircraft are kind of airplanes with a width of 10-13 feet, with one aisle, usually consist of 3-3, 2-3, 2-2 or sometimes 2-1 even 1-1 seat configuration for private or commercial jets with a capacity of less than 250 people. Airplane configuration is known as the LOPA (Layout of Passenger Accommodation). Narrow body aircraft basically do not have trans-Atlantic or trans-continental flight permits and only used for short to medium distance flights (regional flight).

The A320 Series is a short to medium commercial passenger aircraft manufactured by Airbus. The A320 is the first passenger aircraft with a digital fly-by-wire control system, in which the pilot controls the flight through the use of electronic signals rather than mechanically with the handle and hydraulic system. Beside that, there is also ATR72, a twin-turboprop short-haul regional passenger aircraft built by the French-Italian aircraft company, ATR. The aircraft has a capacity of up to 78 passengers in an economic class configuration and operated by two flight crews. The most popular one of narrow body aircraft is B737 (Boeing 737 Series), a type of narrow-body commercial aircraft with
twin jet engines manufactured by the Boeing Factory that consist of Original Series, Classic Series, Next Generation, and MAX Series.

**Figure 1. Aircraft Model and LOPA (Layout of Passanger Accomodation) of B737**

3.3. **Wide Body Aircraft**

An aircraft with a width of more than 20 feet, has two aisles or commonly known as twin-aisles with seven seats or eight seats configured parallel is called Wide Body Aircraft. The diameter of this plane usually reaches 5 meters or 6 meters. In the economic class, interior cabin can accommodate passenger seats with 3-4-3 configuration or 4-4-2 with a total capacity of 200 up to 850 passengers. Most of the wide body aircraft has trans-atlantic and trans-continental flight permits. Wide body aircraft is usually used for medium to long distances flights.

The Airbus A330 Series is a series of large-capacity, wide-body, and medium-to-long range commercial jet airplanes. This aircraft was developed from the Airbus A300, Airbus’s first wide-body aircraft which was very successful on the market. The Boeing 777 is a wide-body and twin-engine civilian passenger aircraft manufactured by Boeing Commercial Airplanes. B777 can transport between 314 until 451 passengers with a range from 5,235 to 9,380 nautical miles (9,695 to 17,372 km). The Boeing 777, which was designed for a 747 replacement, became the largest twinjet (double engines) aircraft in the world.

**Figure 2. Aircraft Model and LOPA (Layout of Passanger Accomodation) of B777**

3.4. **Cabin Standard Check**

Before Departure Check (sometimes referred to as Pre-Departure Check), is done after the airplane carries out RON (Remain Over Night), routinely carried out every day at the Daily Check, or after finished an A-Check or C-Check. Cabin standard check as a part of Before Departure check, expectedly performed after finishing the daily interior cleaning. Job description of Cabin Standard Check can be seen in Tabel 1 below.
Table 1. Cabin Standard Check Job Description

| Cabin Post | Job Description |
|------------|-----------------|
| CML        | Check Cabin Maintenance Log Book (CML) for open items |
| Floor      | Carpet in entire cabin area for obvious damage and condition Floor covering in entry area for obvious damage and contamination |
| Galley     | Galley for general condition, obvious damage and contamination Check oven fitting, make sure the attaching screws are complete and installed properly Floor covering in the galley for obvious damage and contamination |
| Coatroom   | Coatroom for obvious damage |
| Seats      | Seats and seat covers for obvious damage and contamination Seat backs for vertical position, ash trays and seat belts for presence and condition F/C seat covers for correct fit Attendant seats for function and condition |
| Interior   | Side wall and ceiling panels, bins, partitions & curtains for obvious damage and contamination Ceiling panel for proper installation Dado Panel for general condition |
| Lavatories | Lavatories for obvious damage and contamination Operate lavatory flushing system and watch for proper flushing |
| Final Work | Corrective Actions, Input the CML and enter to HIL for not rectified findings |

4. Research and Discussion
Data collection done by using stopwatch time study. The result of a time study is a cycle time for performing a repetitious job once. Time study is a statistical technique that is accurate for jobs that are highly repetitive.

4.1. Actual Time Data Collection
Data collected by recording the each steps of cabin standard check such as written in Table 2 below.

Table 2. Cabin Standard Check Cycle Time and Man Power

| Aircraft Type | Date Performed | Total Man Power (MP) | Actual Time (mins) |
|---------------|----------------|----------------------|--------------------|
| B737-800      | 25-Jul-18      | 1                    | 86                 |
| CRJ-1000      | 26-Jul-18      | 1                    | 62                 |
| B777-300 (Conf. 1) | 26-Jul-18 | 2                    | 149                |
| B777-300 (Conf. 2) | 27-Jul-18 | 2                    | 140                |
| A330-300 (Conf. 1) | 25-Jul-18 | 1                    | 194                |
| A330-200 (Conf. 1) | 27-Jul-18 | 1                    | 194                |
| A330-300 (Conf. 2) | 27-Jul-18 | 1                    | 229                |
| A330-300 (Conf. 3) | 27-Jul-18 | 1                    | 206                |
| A330-300 (Conf. 4) | 27-Jul-18 | 1                    | 213                |
| A330-200 (Conf. 2) | 27-Jul-18 | 1                    | 190                |

Notes:
1. No serious damage which necessary to repair during cabin standard check.
2. No opened HIL (Hold item list) written in CML (Cabin maintenance log).
3. No aircraft part need to be remove/install/send to shop/taken from warehouse.
4. Conf. refers to seat configurations due to the number of Economic, Business, and First Class passenger seats.

4.2. Expected Time Data Collection
To find out the time expected in cabin standard check tasks, an interview with the planner and operator at the maintenance control center (MCC) is conducted regarding the time expected in cabin standard check tasks. By observing the aircraft maintenance schedule from MCC, it was found that cabin standard check work was expected to be 150 minutes averaged generally for each type of aircraft.

4.3. Defining The Allowance
Allowance is needed to calculate the standard time for each type of aircraft. Because each type of aircraft has different configuration of number of passenger seats, number of galleys, and also different lavatory configuration, it is necessary to standardize cabin standard check time for each type of aircraft. So in considering the allowance needed, an interview is conducted with mechanics on duty related to the allowance required during the cabin maintenance.

From the results of the interview it was found that generally non-value added things done by mechanics can be:
1. Allowance for finishing Hold Item List,
2. Allowance if there is any (urgent) finding need to repair as soon as possible,
3. Allowance for material and tools preparation,
4. Allowance for personal needs, and
5. And other unspecified needs.

After an interview with mechanics, discussions with the planner and engineer are related to the availability of time and manpower on average for periods per week to determine possible allowances. Based on information obtained from mechanics that the unschedule tasks and maintenance generally no more than 50% of the total maintenance time, and considering the availability of average time in weekly planning, the Maintenance Control Center (MCC) decides that the allowance given to each type of aircraft is not more than 50% of cabin standard check cycle time.

4.4. Comparison Between Standard and Actual Time
Before calculating the standard time, it is necessary to present the comparison between the actual time and standard time of each type aircraft’s cabin standard check performance. Slack can be calculated by subtract the expected time and the actual time. The slack of each type of aircraft cabin standard check can be seen in Table 3 below.

| Aircraft Type | Actual Time (mins) | Expected Time (mins) | Slack (mins) |
|---------------|-------------------|----------------------|--------------|
| B737-800      | 86                | 150                  | 64           |
| CRJ-1000      | 62                | 150                  | 88           |
| B777-300 (Conf. 1) | 149              | 150                  | 1            |
| B777-300 (Conf. 2) | 140              | 150                  | 10           |
| A330-300 (Conf. 1) | 194              | 150                  | -44          |
| A330-200 (Conf. 1) | 194              | 150                  | -44          |
| A330-300 (Conf. 2) | 229              | 150                  | -79          |
| A330-300 (Conf. 3) | 206              | 150                  | -56          |
| A330-300 (Conf. 4) | 213              | 150                  | -63          |
| A330-200 (Conf. 2) | 190              | 150                  | -40          |

From the Table 3 above it can be seen that there is a deficiency of cabin standard check processing time especially for A330 aircraft series. This is because the A330 has many economy class seat configurations that require general visual inspection (GVI) and detailed visual inspection (DVI) on each passenger seat also the safety vest inspection at the bottom of the passenger seats. The other
reason that cabin standard check of A330 series aircraft takes a lot of time is the manpower allocated to this series of aircraft was only 1 manpower. For more detailed information, see the comparison chart in Figure 3 below.

![Figure 3. Aircraft Model and LOPA (Layout of Passenger Accommodation) of B777](image)

From the Figure 3 above, it is known that in general, the CRJ, B777 and B737 series aircraft can be completed in 150 minutes. While for the A330 series, 150 minutes is not enough for cabin standard check tasks.

4.5. Standard Time Calculation

By adding 50% allowance for each cycle time, gained the standard time for each type of aircraft as presented in the Table 4 below.

| Aircraft Type | Actual Time (mins) | Standard Time (mins) | Rounded Standard Time (mins) | Manpower | Average Standard Time (mins) | Rounded Time |
|---------------|--------------------|----------------------|-----------------------------|----------|----------------------------|-------------|
| B737-800      | 86                 | 129                  | 129                         | 1        | 129                        |             |
| CRJ-1000      | 62                 | 93                   | 93                          | 1        | 93                         |             |
| B777-300 (Conf. 1) | 149            | 223,5                | 224                         | 2        | 217                        |             |
| B777-300 (Conf. 2) | 140            | 210                  | 210                         | 2        |                            |             |
| A330-300 (Conf. 1) | 194            | 291                  | 291                         | 1        |                            |             |
| A330-200 (Conf. 1) | 194            | 291                  | 291                         | 1        |                            |             |
| A330-300 (Conf. 2) | 229            | 343,5                | 344                         | 1        |                            |             |
| A330-300 (Conf. 3) | 206            | 309                  | 309                         | 1        |                            |             |
| A330-300 (Conf. 4) | 213            | 319,5                | 320                         | 1        |                            |             |
| A330-200 (Conf. 2) | 190            | 285                  | 285                         | 1        |                            |             |
4.6. Proposed Solution
After counting the standard time of each series of aircraft, then a suggested solution is proposed to the company regarding the cabin standard check standard with the following proposal details:

It is highly recommended to add another man power (at least 2 man powers) to accomplish the Cabin Standard Check for A330 series Aircraft. Average number of seats at A330 series is about 250 seats. If the Cabin Standard Check done by 2 man powers, the average number of seats workload (seat category tasks and passenger life vest check) of each mechanic is around 125 seats. Average time to finish an A330 airbus was around 200 minutes (50 minutes above the previous standardized time) for each aircraft. It is not logically acceptable for only 1 manpower to finish the Cabin Standard Check task. It is recommended that it should be determined the Cabin Standard Check standard time based on the aircraft type, as follows.

| Aircraft Type | Proposed Man Power | Rounded Standard Time (mins) | Proposed Performance Time (mins) |
|---------------|--------------------|------------------------------|----------------------------------|
| B737          | 1                  | 129                          | 130                              |
| CRJ-1000      | 1                  | 93                           | 95                               |
| B777          | 2                  | 217                          | 220                              |
| A330          | 2                  | 153                          | 160                              |

5. Conclusion
Cabin Maintenance Services are generally divided to inspect, maintain, and repair the entire interior cabin of the aircraft (from the cockpit to the aftward galley in the rear position). For the exterior, Cabin Maintenance Services carries out maintenance in the form of aircraft washing and cleaning consist of wet washing and dry cleaning. Cabin Standard Check is one of the major tasks that need to be finished by Cabin Maintenance Services in every Before Departure (Pre-Departure) Check. From the results obtained from that at this time the company has not allocated cabin standard check work time based on the type of aircraft being worked on, but only allocated 150 minutes for each type of aircraft with the allocation of man power as much as 2 people for B777 and 1 person for A330, B737 and CRJ-1000. After observation, it was found that the average cabin standard check for A330 aircraft was not able to be completed in 150 minutes using 1 man power. Therefore, research and standard time standardization for each type of aircraft are carried out.

From interview with mechanics on duty, it was found that there were several activities that caused the need for allowance provided for cabin standard check tasks such as damaged parts/components findings, Hold item list (HIL), or other necessities. Considering the average availability of man power and man hours from the planner engineer, the maintenance control center (MCC) responds that the allowance given is not more than 50% of the working time for the entire standard cabin check tasks. Then, after recalculation, it was proposed to add another man power to the A330 series and proposed cabin standard check processing time for B737 series aircraft by 130 minutes, CRJ1000 by 95 minutes, and B777 and A330 using 2 manpower each of 220 and 160 minutes.

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