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Estimating Average Costs of a Failure Airplane Diagnostic and Maintenance on Ground After a Long Journey

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Abstract

This study aims to estimate the costs of maintenance of the aircraft that has a failure and needs some maintenance operations and laying on ground for some specific amount of time, the maintenance and checkup of any plane after it is landing at any airport is very important to the next fly. Such maintenance and checkups costing any aircraft amount of money. The main objective of this study is to discuss such maintenance operations and specify their cost of maintenance compared with other costs. A strategy is demonstrated here to reduce such costs.

Keywords: Aviation Services, Maintenance, Costs, Failures.

Introduction

The operation phase of any airplane includes maintenance and repair as well as management of aircraft use. Depending on its fundamental design and how it is operated, each aircraft performs or fails differently. A breakdown of one aircraft component can also affect another, resulting in many faults. Because the cost of the operational phase is unknown, it differs from the design, manufacturing, and decommissioning phases. During the operational phase, the maintenance process focuses on increasing aircraft reliability and lowering maintenance costs. While, the decommissioning phase, involves safe disposal or recycling of the aircraft. Fig. 1 illustrates different phases of aircraft life cycle and cost at each stage. According to Fig. 1, the operational phase has the highest cost [1].

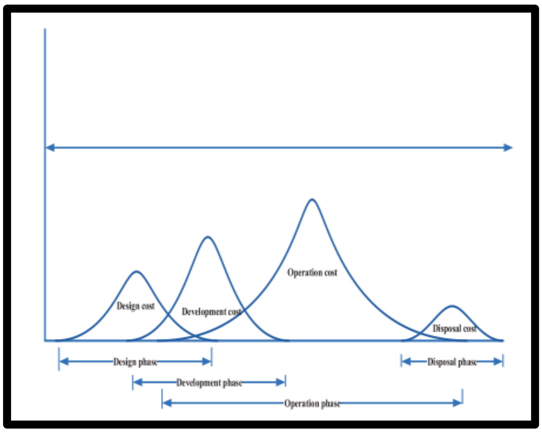

Figure 1. Different phases of aircraft life cycle and cost at each stage [1].

The following procedure depicts a generic airplane maintenance procedure used by many airlines [2]:

• An aircraft arrives in the hangar for maintenance such as A- check, C-check, or D-check.

• Documents are inspected for reported defects on flight logs and task cards. • Technicians open the panels to gain access into areas requiring maintenance

• Operational test is performed to confirm reported sub-system defects

• Servicing of aircraft and repairing of reported defects are carried out according to aircraft maintenance manuals

• All replaced parts are checked for leaks and integrity of installation

• Operational test is carried out to confirm aircraft state of air- worthiness e.g., ground run, flight controls, or thrust reversers

• Aircraft documentations are then signed, and aircraft released to service.

The following factors have been identified as the maintenance cost drivers by different researchers:

• According to [3] and [4], aircraft age is a significant contributor to the contribution of maintenance cost drivers. As an airplane and its systems age, they degrade to the point where they can no longer perform all planned activities. Aircraft aging has an impact on the engines, avionics, airframe, interior, and wings. Age-related variables are the outcome of the following:

a) Routine maintenance tasks which increase with age of the aircraft

b) Aircraft materials deteriorates with age which increases costly repairs

c) Airworthiness directives and bulletins requesting removal of components.

• False component removal can occur as a result of difficult-to-understand test processes and/or complicated technologies utilized for problem identification [5].

• Frequent check intervals and excessive maintenance chores result in high costs and decreased aircraft availability. Too lengthy intervals also reduce maintenance efficacy; thus, adequate maintenance intervals must be developed to assure maintenance effectiveness [6].

• When spare parts are few, unplanned downtime occurs. When parts are unavailable when needed, the company incurs additional expenditures [7, 8].

• The following cost considerations were discovered by [9] and [10]. (i) fleet size; (ii) aircraft usage in hours per year; (iii) landings per hour; (iv) fuselage length; (v) aircraft age; and (vi) seat number.

Methodology: Materials and Methods

The data is collected from pervious studies and then analyzed and recalculated to estimate the average costs of maintenance of the aircraft. Figure 2 shows the Air Carriers Filing Schedule P-5.1 Aircraft Operating Cost Categories.

Variable Costs	
Economic Values Cost Category	Form 41, Schedule P-5.1 Cost Item
Fuel and Oil	Aircraft Fuel and Oil
Maintenance	Maintenance - Flight Equipment
Crew	Pilots and Copilot

Fixed Costs	
Economic Values Cost Category	Form 41, Schedule P-5.1 Cost Item
Depreciation	Depreciation and Rental - Flight Equipment

Other Costs	
Economic Values Cost Category	Form 41, Schedule P-5.1 Cost Item
Other	Flying Operations - Other

Figure 2. Air Carriers Filing Schedule P-5.1 Aircraft Operating Cost Categories

The Passenger Air Carriers Filing Schedule P-5.1 Operating and Fixed Costs per Block Hours are shown in Table 1. The total length of time it takes a flight to travel from the departure gate ("off-blocks") to the destination gate ("on-blocks") is referred to as "block time" or "block hours," and airline block times vary for the same itineraries [11].

Table 1. Passenger Air Carriers Filing Schedule P-5.1 Operating and Fixed Costs per Block Hours

Aircraft Category	Cost per Block Hour								Block Hours
	Fuel and Oil	Maintenance	Crew	Variable Costs	Depreciation and Rentals	Fixed Costs	Other Variable and/or Fixed Costs	Total	
Narrow-body more than 160 seats	$6,470	$2,105	$301	$8,876	$2,086	$2,086	$3,252	$14,215	2,313
Narrow-body 160 seats and below	$1,621	$873	$565	$3,059	$777	$777	$1,012	$4,849	39,553
RJ more than 60 seats	$4,649	$2,804	$2,191	$9,644	$2,932	$2,932	$2,182	$14,758	1,240
All Aircraft	**$1,969**	**$995**	**$597**	**$3,561**	**$910**	**$910**	**$1,166**	**$5,636**	**43,106**

(Sources: 2018 Form 41 financial data and T-100 traffic data)

Results and Discussion

A typical airplane lease will cost between $60,000 and $500,000 USD, depending on the age and model of the aircraft. For the sake of simplicity, the average monthly cost for an Airbus A320 model is $200000. This would equate to $6451 each day. This is only the cost of leasing the plane; it does not include fuel or operational costs. If the aircraft is grounded, it will be charged $6451 per day if it is not flying. A maintenance check will take 120-150 hours, or up to five days, to diagnose the problem, order replacement parts, and install them when they come. If the operation is headquartered in the United States, the cost per hour will be roughly $50.39 (based on average earnings reported by the US Bureau of Labor Statistics). The maintenance costs $51,300 USD (150 hours x 50.39) [12].

-costs of spare parts

Another report based on the average Aircraft on Ground (AOG) incidences in the Middle East showed that the average part cost was $8,785.36 US per event.

Combining all of these numbers:

- Aircraft lease - 3 days - $19,354
- Maintenance wage - 3 days - $51,300
- Spare parts - $8,785.36
- Total cost - $79,440.29

Figure 3 shows the average cost of maintenance of a failure airplane (For 3 days) compared with other costs and total cost.

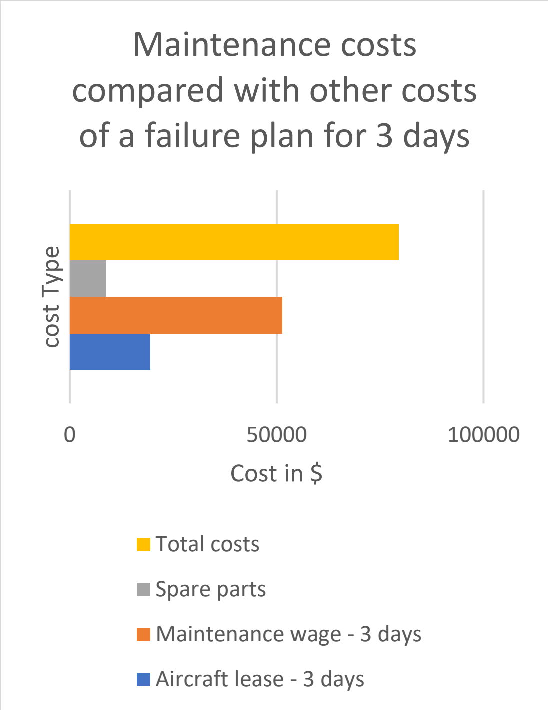

Figure 3. The average cost of maintenance of a failure airplane (For 3 days) compared with other costs and total cost.

That is assuming that the aircraft costs that much, that it takes three days, and that the spare components arrive on time. While an airline may be able to control these expenses by stockpiling tools, assembling a strong team of engineers, and stockpiling spare parts, they will not have the benefit of a specialized AOG team on standby, ready to deliver as quickly as feasible. Of course, AOG incidents will have a greater impact in rural regions and emerging countries, where delivery can be a problem due to the lengthier delivery times. Also, keep in mind that these figures do not account for the amount of business lost while the aircraft is in AOG [12].

Now, how to reduce maintenance costs? It can be reduced using the following strategy: Scheduled maintenance program development.

As illustrated in figures 4 and 5, the scheduled maintenance program for the Boing 717 airliner dramatically decreases maintenance labor-hour needs, cutting total maintenance costs. Labor hours are saved as a result of enhanced scheduled maintenance programs, new design initiatives, and the replacement of line-replaceable units (LRUs) [13].

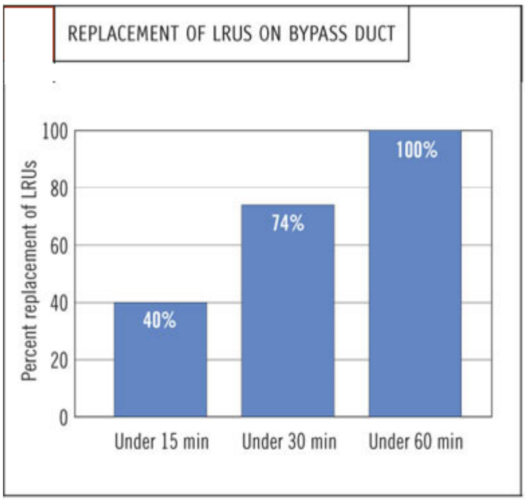

Figure 4. The scheduled maintenance program for the Boing 717 airplane/ on bypass Duct [13].

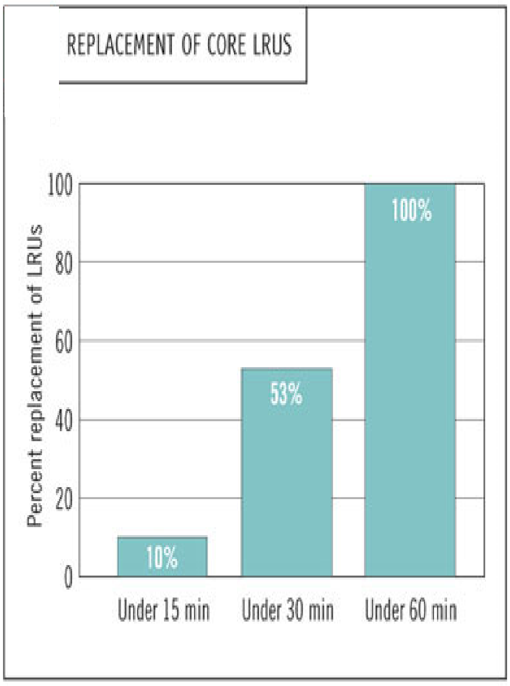

Figure 5. Replacement of Core LRUS [13].

The 717 planned maintenance programs were created through a procedure established by the Maintenance Steering Group (MSG), a committee comprised of members from airframe manufacturers, airlines, and the United States Federal Aviation Administration. Maintenance programs are generated utilizing a top-down, systems-level approach in the MSG Level 3, Revision 2 (MSG-3 Rev. 2) method, rather than the bottom-up, component-level approach utilized in the development of MSG-2 maintenance plans. Only actions deemed relevant and effective are included in the maintenance programs, reducing scheduled maintenance activities by extending maintenance intervals and eliminating some chores required by previous maintenance programs. (This method was also employed in the development of the 777 and 737-600/700/800/900 maintenance programs.) Furthermore, the MSG-3 Rev. 2 process incorporates aging airplane maintenance programs, such as the Corrosion Prevention and Control program, removing some work duplication (e.g., entry and access activities) [13].

The time needed to conduct scheduled maintenance tasks also was reduced on the 717 compared with its predecessors through several design features:

A single point of entry for maintenance inspections.

Timesaving CFDS inspection procedures (e.g., checking the proper rigging of all 14 landing gear, 4 slats, and 8 door proximity sensors is accomplished from the flight deck in moments, rather than inspecting each at the location).

Single-switch activation and reset of all cabins reading and call lights during service inspections.

Figure 6 depicts the time-saving enhancements made in the 717 scheduled maintenance routines. Converting an MD-80 maintenance program to MSG-3 methods results in a 35% reduction in cumulative MD-80 scheduled maintenance labor-hours over a 10-year period. Furthermore, due to advancements in aircraft design, the 717 requires 45% fewer total work hours than an MD-80 on an MSG-3 maintenance schedule [13].

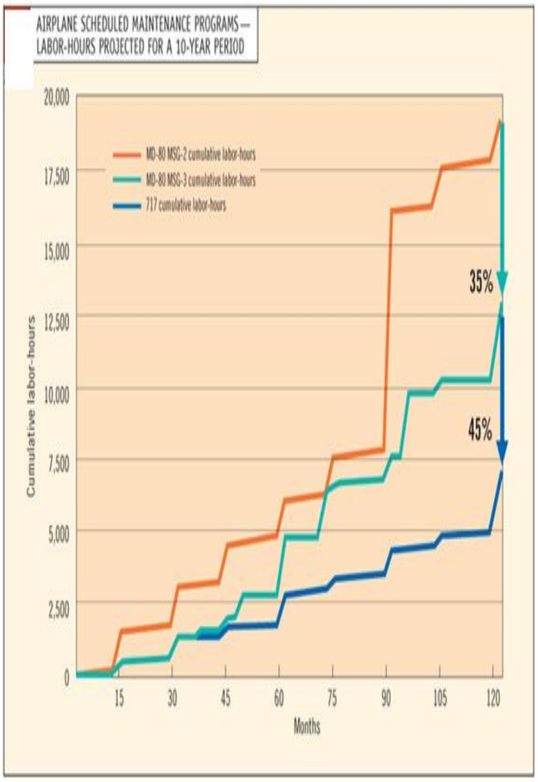

Figure 6. The time-saving improvements in the 717 scheduled maintenance programs

The 717-power plant's scheduled maintenance is similarly efficient. The BR715 engine is equipped with an on-condition maintenance program rather than a scheduled engine overhaul program, allowing for longer periods between shop visits. Monitoring of exhaust gas temperature, engine vibration, and spectrometric oil analysis program parameters are all part of engine condition analysis. Internal engine borescope examinations can be completed rapidly thanks to multiple access points [13].

Maintenance costs

Early statistics show that operators of both 717s and DC-9s have much lower maintenance expenses on their 717s-Figure 7. Because first-year maintenance expenditures are excluded from any maintenance cost study, maintenance data supplied to the US Department of Transportation are only now becoming statistically meaningful. (The inclusion of first-year data skews reported costs because of the varied effect of airplane newness on maintenance activity) [13].

Furthermore, one 717 operator, who also operates DC-9s, finds that in-service experience is exceeding Boeing forecasts:

- The operator's 717 in-service checks necessitate fewer labor-hours than its DC-9 fleet. The cumulative sum of labor-hours for 717 in-service checks during the 550 flight-hour period is 200 less than that of the DC-9.
- The operator's 717s had an 80% lower out-of-service time than its DC-9s. Extensive maintenance inspections performed on a regular basis (e.g., C-checks) take 3 days on average for the 717 against 21 days for the DC-9.
- The intervals between 717 C-checks are more than 8% longer for the operator than for its DC-9s.
- The operator's 717s have C-check expenses that are only 10% of those of its DC-9s.
- Regulatory authorities increased the operator's check intervals based on the operator's 717 in-service experience. The A-check period rose from 450 to 500 flight hours, and the C-check interval increased from 3,600 to 4,500 flight hours (15 to 18 months).
- Foreign object debris does significantly less harm to the operator's BR715 power plant than the PW JT8D on its DC-9s.

Another 717 operator discovered that the 717 allows them to decrease maintenance expenses in a variety of ways. For example, the operator uses lower engine power settings on takeoff (i.e., derate) to significantly lengthen engine life, minimizing engine maintenance expenses.

Furthermore, digital technology enables the operator to understand how each system and component inside a system works. As a result, the operator predicts problems and replaces units before functionality or performance deteriorates. This proactive maintenance capability improves dependability while reducing the expense of line maintenance staffing and inventory requirements caused by unexpected part failures [13].

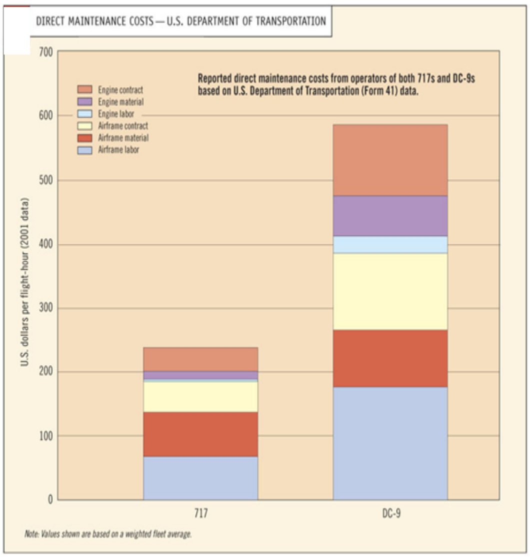

Figure 7. Data indicate that operators with both 717s and DC-9s are experiencing significantly lower maintenance costs on their 717s

Conclusions

This study showed the contribution of maintenance costs from all the costs of airplane industry, maintenance costs represent a good % of all costs, it reaches to about 10-15% of the total cost. Reducing such costs surely reducing the cost of tickets of the customers, reducing late in airplanes traffic and increase its performance. As mentioned above Boeing airlines follow an invented strategy to reduce time of plane grounding and maintenance time which reduces the costs with good percentages and increases customers confidence.

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