THE APPLICATION OF RELIABILITY METHODS FOR HELICOPTER AIRCRAFT PERIODIC MAJOR OVERHAUL INSPECTION

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ABSTRACT

Background: In aviation, reliability and maintainability are essential for ensuring system safety. Minimizing periodic inspection time and costs, reducing maintenance actions, consequently increasing fleet readiness and customer satisfaction is the need of the hour.

Purpose: To address and demonstrate the role of reliability and maintainability (R.M.) application and prediction methods in optimizing the extended aircraft periodic major overhauls. Case study considered was the Super Puma (S.P.) aircraft that belongs to European aviation industry with a second major overhaul (after 24 years since first flight) .

Design/Methodology/Approach: Field and operational data of the S.P. and reliability distributions were analyzed for the last 24 years on major aircraft systems (Airframe, Power plant, Electrical & Instrument, and Radio Systems) and the results were compared with the international aircraft system reliability standard indexes like Complex General Aviation (G.A.) Aircraft System and NASA aircraft aviation systems.

Findings: The S.P. aircraft systems reliability was lower beside higher systems rate of failure Compared to figures specified in the to international standards, Weibull and normal distributions found to fit the S.P. failure data better, Best reliability and the hazard rate function found for the following systems(power plants, electric and instrument, and radio systems)respectively.

Originality/Value: This paper examined the system's reliability for improving aircraft safety, addresses reliability prediction issues, and analyzed it at the major overhaul periodic inspections every 12 years and demonstrates that reliability is a crucial matter to consider in all phases of the life cycle of S.P. aircraft. Authors recommend that users execute root causes analysis to improve reliability and reduce the hazard rates for maximum S.P. airworthiness.

KEYWORDS: Reliability, Aircraft Engineering, Helicopter Aircraft, Systems Safety & Preventive Maintenance

Received: Apr 03, 2020; **Accepted:** Apr 23, 2020; **Published:** Jun 30, 2020; **Paper Id.:** IJMPERDJUN2020142

INTRODUCTION

The reliability is defined as the probability that the proposed system does its designed function under normal conditions during its specified life cycle" (Stephens, 2010). Barlow and Proschan (1975) studied the probabilistic features of reliability theory and find that different life distributions offer an accurate probabilistic representative of a physical property". Smith (2005) said that reliability and safety engineering integrate each others and " no equipment that has zero rates of failure and reliability engineering, beginning

in the design phase and going through manufacture and field use." Herbert (2002) stated in his thesis "designing for Reliability, Maintainability, and Sustainability (RM&S) in Military Jet Fighter Aircraft Engines" believed that in military aviation (U.S. Navy) the components of Maintenance, Repair, and Overhaul (MRO) cost a lot and could be reduced by better design with reliability, maintainability, and sustainability (RM&S). Smith (2017) stated that Low-reliability systems consequences might result in fatalities or damage and prediction of frequency considered as reliability prediction" and reliability prediction defined as "process of calculating the anticipated system RAMS (reliability, availability, maintainability, safety) from assumed component failure rates." Smith (2017) stated that predicted model accuracy depends on many factors like" relevance of the failure rate data and the chosen environmental multiplication factors, accuracy of the mathematical model, the absence of gross over-stressing in operation and tolerance of the design to component parametric drift."

Jain (2017) stated that modern aircraft had become extremely safe because of sufficient (engine, an on-board computing system, and outstanding flight crew training," but "despite all these measures, accidents do happen." Dhillon (2002) stated that maintenance systems correction actions cost 80% of the industry dollars" and can be reduced in the range between 40 and 60% through sufficient and adequate maintenance," especially reliability centered maintenance, among other related methods.

LITERATURE REVIEW

Reliability is considered as a critical factor in all industries. It has significant effects in the aviation industry, where aviation maintenance organizations perform the aircraft reliability analysis frequently to confirm that different jobs and tasks of the aircraft maintenance program are effective, safe, and their periodicity intervals are adequate. The result of this will be a reduction of components life cycle costs, systems maintenance, and meeting the requirement of high customer satisfaction. Aircraft, in general, consists of many components and systems, so the reliability of systems includes (Series, Parallel or Combined Series-Parallel Configuration, High / Low-Level Redundancy, K out-of-n Redundancy up to Complex Configurations) (Ebeling, 2010). Reliability programs are considered as the best method to check if aircraft components are performing adequately" through tracking every component and then track system reliability using standardized forms (MMM, 2014). The unreliability issue is of imminent importance in a complicated military system that leads to complex, delayed, repeated, and costly maintenance. The reliability of aviation engineering departments' reliability is a fundamental issue in aviation engineering departments. The reliability can be improved by optimizing the aircraft design manufacturing processes, improving the assembly and disassembly operations during maintenance actions, and enhancing aircraft systems and components safely (Vieira et al., 2016). Aircraft is essentially a platform where multiple components and various systems integrated into the aircraft. These components are designed to function with optimal performance and with the highest reliability for safe flight. Enhancement of Aviation safety can be done by detecting the deterioration symptoms before the actual onset of actual component failure and used to improve the aircraft's component and systems with the highest reliability as much as possible. All of these measures results in attaining the best airworthiness and safety results in decreased (human, economic) losses, (accidents, incident) occurrences (NASA, 2008). Epstein (2017) studied the competitive Jet engines industry, its innovation challenges in the High-Tech components and linked it to reliability

as a costly industry over" \$50 billion per year" where " Aircraft engines require a very long time commitment to generate profits by selling parts " where all supply chain members are affected by low reliability competes or systems. Porte and Consolini (1998) examined the U.S. Navy's nuclear aircraft carriers as High-Reliability Complex Organizations (HRCO) with different alerting modes," where errors might result in "catastrophic consequences." They found that high-reliability systems and operations reveal a range of theoretical (and operational) surprises. Weckman et al. (2001) modeled the jet engines' life by fielding actual data extracted from numerous systems through using the "Weibull process, a non-homogenous Poisson process," as "very useful means in modeling repairable systems." Sheikh et al. (1996) used the "Weibull model to analyze the failure records of numerous aircraft tires, and the researcher found its appropriateness for reliability representation of tires."

(Liu and Peng, 2016) evaluate system reliability index stated that "reliability modeling ignores the repair history, and the preventive maintenance strategy has a significant influence on the reliability of the repairable system." He suggested using the " log-linear baseline intensity function " to optimize and overcome reliability and **maintenance behavior** issues. At the same time, Junliang et al. (2016), developed a new method of reliability modeling and stated that it meets the engineering practice needs of military aircraft reliability evaluation.

European Aviation Safety Agency classified the aircraft systems into four major categories and sub-divided the aircraft type training into the airframe and power-plant and avionics/electrical systems type training courses." Research paper adheres to these classifications and used in reliability analysis as follows (1) Airframe systems :(structure integrity, flight control, ground systems and rotor flight control systems), (2) Power plant systems: (Thrust generated systems), (3) Electrical & instrument: (electrical power generating systems, lighting, indicating systems and instruments), (4) Radio systems: (radio transmission/reception systems and autopilot systems). According to the Super Puma S.P. maintenance manual, (Airbus Helicopters Manual AS332 Version M1 (AHM), 2013). According to AHM (2013), the aircraft should undergo a scheduled major Overhaul inspection every 12 years' service life or complete of 7500 flight hours. Aircraft maintenance systems can be divided into three main categories (1) Airframe systems, (2) Power plant systems, (3) Electrical and Instrument (E&I) systems, and (4) Radio systems (Airbus Helicopters Manual AS332 Version M1, 2013). They should regularly undergo a periodic inspection, major inspection (overhaul) that intends to check the health of components, update or renew the aircraft systems components until the next overhaul schedule, where it ensures that it faces no more problems excellent reliability during this period or flying hours. Moreover, continuously meeting its designed functions for components or systems (Dhillon, 2002, Lyman, 1933, Smith, 1934) required researchers to perform the Reliability-Centered Maintenance (RCM) as " an efficient procedure in determining what has to be accomplished to guarantee that each component and systems " able to."

RESEARCH METHODOLOGY, ANALYSIS, RESULTS & DISCUSSIONS

Field and operational data of the S.P. was presented and reliability distributions were analyzed for the last 24 years on major aircraft systems (Airframe, Power plant, Electrical & instrument, and Radio systems). The results were compared with the international Aircraft System reliability standard data like Complex General Aviation (G.A.)

Aircraft System and NASA aircraft aviation systems.

Data collected was considered as a complete failure data set when operating systems fail and did not operate, which has a severe impact resulting in grounding the aircraft, and it will be able to fly only after fixing the related system. Systems failure data included (1) Operational data reflecting the standard operational mechanism of the aircraft systems categories like Pilots reports (Systems failures documented at aircraft documents after their flights), (2) Field Data like Maintenance logbooks and reports (Systems failures reported by maintenance personnel during any maintenance work or inspection) and (3) Unscheduled removals: (Any system's component that removed due to component failure itself).

Reasons for failures included a combination of thermal, mechanical or electrical loading, fatigue problems. We carried out the failure data analysis and analyzed the systems reliability indexes and reliability of the S.P. Helicopter and is calculated as follows (1) defining the helicopter systems main categories, (2) collecting the helicopter failure data (3) classifying the data to the aircraft systems categories, (4) statistically analyzing the data to identify the proper distribution that fit the failure data, (5) Performing the goodness of fit to validate the identified distribution fit, (6) finding the results by developing the mathematical models that describe the reliability function and the hazard rate function and finally (8) compare the results with NASA General Aviation Aircraft Reliability Study, (Ebeling, 2010) and with accurate estimate of Complex General Aviation (CGA) Aircraft Systems reliability indexes from the study performed by Pettit et al. (2001).

Failure Times

The failure time represents the aircraft total elapsed flight hours since the last second overhaul inspection, as shown in Table 1 below:

Table 1: Airframe Systems Failure Times

25.8	124.7	262.5	543	599.5	632.8	644	680.5
26.2	121.7	389.9	545.7	600.5	640.2	645.2	690.2
26.2	156.3	431.4	595.4	600.5	641.9	664.7	690.2
26.6	252	466.2	596.5	622.9	641.9	664.7	690.2
124.7	257.9	467.7	599.5	630.8	641.9	670.1	694.3
697.3							

Table 2: Power Plant Systems Failure Times

38.4	74.5	380.5	403.4	484.4	579.9	581.2	657.8
74.5	76	387.2	432.7	484.4	579.9	581.2	670.1
74.5	76.7	395.2	433.7	484.4	579.9	581.2	670.1
74.5	119.4	400.4	466.2	542.5	579.9	584.5	673.7
74.5	163.9	401.2	476.6	579.9	579.9	584.5	685.1
74.5	223.3	401.9	477	579.9	579.9	584.5	687.5
74.5	331.7	401.9	477.6	579.9	581.2	655.7	690.2

Table 3: Electric & Instrument Systems Failure Times

26.2	146.3	230.9	336.5	466.2	472	542.6	596.5
82.2	152	234.4	397.7	467.7	476.6	573.8	641.9
86.3	161.9	252	438.3	468.3	479	577.4	641.9

97.3	173.2	254.4	454.1	468.3	484.4	582.1	641.9
119.4	230.9	282.3	462.6	469.2	497.3	586.9	691.7
123.7	230.9	290	462.6	472	502.7	588.5	694.3
694.3							

Table 4: Radio Systems Failure Times

13.7	153.5	267.4	373.9	439.5	528.6	577.4	599.5
13.7	155.3	288.6	376	454.1	528.6	583.1	599.5
31.3	161.9	320	397.7	466.2	542.5	584.5	618.6
50.7	198	331.7	411.7	467.7	542.5	588.5	622.9
74.5	201	332.4	411.7	482.0	543.7	588.5	624.8
83.3	204.5	336.5	411.7	485.8	543.7	591.3	632.8
83.3	206.5	340.1	425.8	485.8	545.7	593.1	642.9
86.3	206.5	354.1	431.4	487.2	545.7	594.1	644
118.7	227.6	362.9	432.7	487.2	559	595.4	646.1
130.6	262.5	367.4	433.7	521.6	561.4	595.4	655.7
152	264.9	368.3	439.5	526.8	568.9	596.5	655.7
664.7	664.7	666.8	668.1				

Table 1 below shows the descriptive statistics for super puma helicopter determined by using reliability computer software provided by Ebeling (2010).

Table 5: Airframe Systems Sample Descriptive Statistics

Total Number of Failures	41
Mean Time to Failure(MTTF)	481.078
90% confidence interval lower bound	420.0
90% confidence interval upper bound	542.156
Median failure time	599.5
The standard deviation of failure times	232.207
Minimum failure times	25.8
Maximum failure times	697.3
Range of failure time	671.5

Table 6: Power Plant Systems Sample Descriptive Statistics

Total Number of Failures	56
Mean Time to Failure(MTTF)	431.602
90% confidence interval lower bound	385.001
90% confidence interval upper bound	478.203
Median failure time	481
The standard deviation of failure times	208.395
Minimum failure times	38.4
Maximum failure times	690.2
Range of failure time	651.8

Table 7: Electric & Instrument Systems Sample Descriptive Statistics

Total Number of Failures	49
Mean Time to Failure(MTTF)	398.033
90% confidence interval lower bound	352.286

90% confidence interval upper bound	443.78
Median failure time	466.2
The standard deviation of failure times	190.885
Minimum failure times	26.2
Maximum failure times	694.3
Range of failure time	668.1

Table 8: Radio Systems Sample Descriptive Statistics

Total Number of Failures	92
Mean Time to Failure(MTTF)	420.699
90% confidence interval lower bound	388.058
90% confidence interval upper bound	453.339
Median failure time	460.15
The standard deviation of failure times	183.357
Minimum failure times	13.7
Maximum failure times	668.1
Range of failure time	654.4

The index of fit values from (Exponential, Weibull, Normal, Lognormal) distributions of the least-squares plot of failure data estimated for the aircraft systems categories by using the reliability computer software program Ebeling, (2010). Table 9 below shows that the highest index of fit values is for the Weibull and normal distributions. Both represent the data best-fit distribution and can be used to fit aircraft systems categories failures data. Furthermore, to get more analysis accuracy and define the best distribution that fit the failure data, we did the Mann's goodness of fit test for Weibull distribution and the Kolmogorov-Smirnov goodness of fit test normal distribution, as shown in tables 10 through 17.

Table 9: Aircraft Systems Categories Index of Fit Values				
Distribution System Catagory	Exponential	Weibull	Normal	Lognormal
Airframe systems	0.67689	0.89914	0.89768	0.81417
Power Plant Systems	0.73112	0.91513	0.93085	0.85676
E & I Systems	0.79309	0.97326	0.97176	0.91527
Radio Systems	0.73645	0.94897	0.96477	0.86012

Table 10: Mann's Goodness-of-fit Test for Weibull Distributions for Airframe Systems

Null Hypothesis H0: Distribution is Weibull	
MLE for μ	255.503
MLE for σ	470.029
Value of K1	20
Value of K2	20
The numerator of test statistics	40.033
The denominator of test statistics	395.063
Mann's test statistics-M	0.101
Degree of freedom- numerator	40
Degree of freedom- denominator	40
Since $M = 0.101 < F_{crit, 0.1, 40, 40} = 1.51$, Accept H0	

Table 11: K-S Goodness-of-fit Test for Normal Distribution for Airframe Systems

Null Hypothesis H0: Distribution is Normal	
MLE for μ	481.078
MLE for σ	229.358
Number of failures	41
D1 Max	0.2763
D2 Max	0.1729
K-Stest statistics D41	0.2763
The critical value for K-S test at $\alpha = 0.1$	0.1257
Since $D41 = 0.2763 > D_{crit,0.1} = 0.1257$, Reject H0	

Table 12: Mann's Goodness-of-fit Test for Weibull Distribution for Power Plant Systems

Null Hypothesis H0: Distribution is Weibull	
MLE for μ	425.96
MLE for σ	214.155
Value of K1	28
Value of K2	27
The numerator of test statistics	172.907
The denominator of test statistics	578.549
Mann's test statistics-M	0.299
Degree of freedom- numerator	54
Degree of freedom- denominator	56
Since $M = 0.299 < F_{crit,0.1,54,56} = 1.45$, Accept H0	

Table 13: K-S Goodness-of-fit Test for Normal Distribution for Power Plant Systems

Null Hypothesis H0: Distribution is Normal	
MLE for μ	431.602
MLE for σ	206.526
Number of failures	56
D1 Max	0.1922
D2 Max	0.1357
K-S test statistics D56	0.1922
The critical value for K-S test at $\alpha = 0.1$	0.1076
Since $D56 = 0.1922 > D_{crit,0.1} = 0.1076$, Reject H0	

Table 14: Mann's Goodness-of-fit Test for Weibull Distribution for E&I Systems

Null Hypothesis H0: Distribution is Weibull	
MLE for μ	396.1
MLE for σ	190.092
Value of K1	24
Value of K2	24
The numerator of test statistics	140.307
The denominator of test statistics	409.961
Mann's test statistics-M	0.342
Degree of freedom- numerator	48
Degree of freedom- denominator	48
Since $M = 0.342 < F_{crit,0.1,48,48} = 1.42$, Accept H0	

Table 15: K-S Goodness-of-fit Test for Normal Distribution for E&I Systems

Null Hypothesis H0: Distribution is Normal	
MLE for μ	398.033
MLE for σ	188.927
Number of failures	49
D1 Max	0.1881
D2 Max	0.103
K-S test statistics D49	0.1881
The critical value for K-S test at $\alpha=0.1$	0.115
Since $D_{49} = 0.1881 > D_{crit,0.1}=0.115$, Reject H0	

Table 16: Mann's Goodness-of-fit Test for Weibull Distribution for Radio Systems

Null Hypothesis H0: Distribution is Weibull	
MLE for μ	414.715
MLE for σ	192.93
Value of K1	46
Value of K2	45
The numerator of test statistics	484.256
The denominator of test statistics	1447.739
Mann's test statistics-M	0.334
Degree of freedom- numerator	90
Degree of freedom- denominator	92
Since $M = 0.334 < F_{crit,0.1,90,92} = 1.33$, Accept H0	

Table 17: K-S Goodness-of-fit Test for Normal Distribution for Radio Systems

Null Hypothesis H0: Distribution is Normal	
MLE for μ	420.699
MLE for σ	187.331
Number of failures	92
D1 Max	0.1288
D2 Max	0.0933
K-S test statistics D92	0.1288
The critical value for K-S test at $\alpha=0.1$	0.0839
Since $D_{92} = 0.1288 > D_{crit,0.1}=0.0839$, Reject H0	

According to the above tables, aircraft system categories Goodness of fit distributions test show that the failure data for all systems followed the Weibull distribution. The aircraft systems probability distributions and parameters estimates are shown in the following table:

Table 18: The Aircraft Systems Probability Distribution and Parameters

System Category	Distribution	Parameters	
		Beta	Theta
Airframe systems	Weibull	1.915	529.82
Power Plant Systems	Weibull	2.089	480.91
Electric & instrument Systems	Weibull	2.199	447.26
Radio systems	Weibull	2.277	468.17

Equations 1& 2 below show the hazard rate functions for a two-parameter Weibull distribution with a shape parameter β , and a characteristic life is Θ estimated provided by (Ebeling, 2010) used to calculate the reliability and the hazard rate functions

$$R(t) = e^{-\left(\frac{t}{\Theta}\right)^\beta} e^{-\left(\frac{t}{\Theta}\right)^\beta} \quad (1)$$

$$\lambda(t) = \frac{\beta}{\Theta} \left(\frac{t}{\Theta}\right)^{\beta-1} \frac{\beta}{\Theta} \left(\frac{t}{\Theta}\right)^{\beta-1} \quad (2)$$

The reliability of the aircraft systems at time t given that the aircraft has operated for time T can be estimated conditionally as the following equations:

$$R(t | T) = \frac{R(T+t) R(T+t)}{R(T) R(T)} \quad (3)$$

Where in this study, the time T was the aircraft operating time after the accomplishment of aircraft another overhaul at $T = 3800$ flight hours. Therefore, the aircraft system categories reliability and hazard rate functions can be estimated, as shown in the following table:

Table 19: Super Puma Aircraft System Categories Reliability and Hazard Rate Functions

Aircraft System	Conditional Reliability Function $R(t T)$	Hazard Rate Function $\lambda(t)$
Airframe Systems	$R(t 3800) = \frac{e^{-\left(\frac{t+3800}{529.82}\right)^{1.915}}}{R(3800)} \frac{e^{-\left(\frac{t+3800}{529.82}\right)^{1.915}}}{R(3800)}$	$\lambda(t) = 0.00361 \left(\frac{t}{529.82}\right)^{0.915} 0.00361 \left(\frac{t}{529.82}\right)^{0.915}$
Power Plant Systems	$R(t 3800) = \frac{e^{-\left(\frac{t}{480.91}\right)^{2.089}}}{R(3800)} \frac{e^{-\left(\frac{t}{480.91}\right)^{2.089}}}{R(3800)}$	$\lambda(t) = 0.00434 \left(\frac{t}{480.91}\right)^{1.089} 0.00434 \left(\frac{t}{480.91}\right)^{1.089}$
Electric & Instrument Systems	$R(t 3800) = \frac{e^{-\left(\frac{t}{447.26}\right)^{2.2}}}{R(3800)} \frac{e^{-\left(\frac{t}{447.26}\right)^{2.2}}}{R(3800)}$	$\lambda(t) = 0.00492 \left(\frac{t}{447.26}\right)^{1.2} 0.00492 \left(\frac{t}{447.26}\right)^{1.2}$
Radio Systems	$R(t 3800) = \frac{e^{-\left(\frac{t}{468.17}\right)^{2.277}}}{R(3800)} \frac{e^{-\left(\frac{t}{468.17}\right)^{2.277}}}{R(3800)}$	$\lambda(t) = 0.00486 \left(\frac{t}{468.17}\right)^{1.277} 0.00486 \left(\frac{t}{468.17}\right)^{1.277}$

The reliability $R(t)$ and the hazard rate $\lambda(t)$ function graphs for the aircraft systems categories can be displayed in figures 1 through 4 as follows:

Figure 1(a): Airframe Systems Reliability

Figure 1(b): Airframe Systems Hazard Rate

Function $R(t)$ **Figure 2(a): Power Plant Systems Reliability****Function $\lambda(t)$** **Figure 2(b): Power Plant Systems Hazard Rate****Function $R(t)$** **Figure 3(a): Electric & Instrument Systems
Reliability Function $R(t)$** **Function $\lambda(t)$** **Figure 3(b): Electric & Instrument Systems
Hazard Rate Function $\lambda(t)$** **Figure 4(a): Electric & Instrument Systems
Reliability Function $R(t)$** **Figure 4(b): Electric & Instrument Systems
Hazard Rate Function $\lambda(t)$**

The S.P. Super Puma helicopter operated for time $T=3800$ flight hours at the second overhaul inspection, reliability is estimated based on the 6-hour flight to compare the obtained results with NASA study results is shown in table 20 below:

Table 20: The Super Puma Aircraft Systems Categories Reliability and the Hazard Rate Estimation at the first 6-Hour Flight after the Accomplishment of the Second Overhaul

Aircraft System	Reliability Estimate $R(6 3800)$	Hazard Rate Estimate $\lambda(6+3800)=\lambda(3806)$ Failure\ hours	The Systems Reliability According To NASA Study on 2001(NASA, 2014)
Airframe Systems	0.8766	0.02193	$0.99940 * 0.98476 * 0.99598$ $=0.9802$
Power Plant Systems	0.7808	0.04129	0.99986
E&I Systems	0.6806	0.06424	$0.99997 * 0.976$ $=0.9759$
Radio Systems	0.6546	0.07059	$0.99997 * 0.976$ $=0.9759$

CONCLUSIONS

Research study shows a general conception of S.P systems reliability and to what extent these aging systems can be reliable and trusted during flight and whether it can be continued safely even after 24 years' flight hours' operation or not.

The S.P. helicopter systems reliability analysis found to be low, and the failure rate is increased compared to international standards. Reliability indexes were highest in the airframe systems and lowest for the radio system. Research study shows that the theoretical distributions for all S.P. helicopter systems categories were two-parameter Weibull distribution, which means that the hazard rate functions are time-dependent and not constant over time. The reason for the increasing failure rates IFR of all system categories in the Super Puma aircraft are explained due to two main reasons:(1) aircraft different components and system technologies aging and obsolescence especially the electrical and radio systems and components, (2) inferior aircraft scheduled and preventive maintenance applied due to low skilled and trained technicians and engineers in some complex systems such as electrical and radio systems in particular. Furthermore, that is why the reliability of the electric and radio systems is lower than the airframe and engine systems' reliability.

RCM recommends using Preventive Maintenance (PM) to improve reliability, especially in systems where failures "account for more than 20 to 25% of the total maintenance workload." Smith's (2005) failure prediction can be improved by using System modeling, failure mode analysis, and fault tree analysis methods software." Also, maintenance engineers and technician training is a crucial factor, Dalkilic (2017) stated that Aircraft maintenance considered as one of the primary causes of aircraft accidents" and proper training of Aircraft Maintenance Technicians (AMTs) would evade failures, diminish maintenance-related incidents and accidents, improve safety, maintainability, availability, and reliability in aviation and execute root causes analysis and to take prompt actions required to improve reliability and reduce the hazard rates, thus ensure airworthiness and flights safety later on. For future studies, we recommend executing a model introduced by Liu and Peng (2016) to find any possible deficiencies between the probability distributions.

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