RELIABILITY ANALYSIS FOR AIRCRAFT SYSTEMS: A CASE STUDY

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Master of Science in Financial Mathematics

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This dissertation is submitted in partial fulfillment of the requirements for the degree Master of Science in Financial Mathematics

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DECLARATION

I declare that this is my own work and this thesis/dissertation does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other University or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text. I retain the right to use this content in whole or part in future works (such as articles or books).

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The above candidate has carried out research for the Master's thesis/dissertation under my supervision. I confirm that the declaration made above by the student is true and correct.

Name of Supervisor: Dr. Priyanga Talagala

Signature of the Supervisor: Date:

DEDICATION

I, Rathnayaka Mudiyanselage Chalitha Asanga, hereby declare that this thesis titled, “Reliability Analysis for Aircraft Systems: A case study” represents my own work and is original to the extent stipulated by University of Moratuwa regulations. I affirm that the research conducted during this study respects the rights and dignity of any participants, adhering to the ethical guidelines established by University of Moratuwa.

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ACKNOWLEDGEMENT

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ABSTRACT

Ensuring the reliability of aircraft systems is paramount in aviation for safety, efficiency, and economic viability. This thesis investigates statistical methodologies used for reliability analysis, focusing on the application of advanced statistical models to enhance the assessment of aircraft system reliability. A novel, model-based approach integrating real-time data analytics was developed to predict potential system failures, thereby refining maintenance schedules and improving aircraft uptime. The study employs a comprehensive review of existing reliability models, critiques their limitations, and proposes an innovative approach that uses Extreme Value Theory (EVT) and other statistical tools to address these challenges. Data collected from a fleet of commercial aircraft over a four-year period provided a robust dataset for analysis, enabling the identification of failure patterns and the prediction of future maintenance needs with greater accuracy. A detailed reliability analysis was conducted on critical systems such as air condition, communication, flight control, fuel, landing gear, and light under various operational conditions. The research revealed that traditional models, which often rely on unrealistic assumptions and manual adjustments, fall short of accurately reflecting the complex realities of modern aviation operations. In response, the proposed model incorporates dynamic data inputs and environmental variables, offering a more nuanced understanding of system behaviors. The results indicate that the approach significantly enhances the prediction of failure probabilities and maintenance demands, facilitating proactive maintenance strategies that align with real-world conditions. This leads to reduced downtime and maintenance costs, while improving safety and reliability. This thesis contributes to the advancement of reliability engineering in aviation by providing a scientifically rigorous, data-driven methodology for the assessment and management of aircraft system reliability. By integrating contemporary statistical methods with real-time data analytics, it sets a new standard for predictive maintenance in the aviation industry, promising enhanced operational efficiency and a reduction in unscheduled aircraft maintenance.

Key Words: Aircraft System Reliability, Predictive Maintenance, Extreme Value Theory

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LIST OF ABBREVIATIONS

Abbreviation	Description
ATA	Air Transport Association
AOG	Aircraft-On-Ground
BMM	Block Maxima Model
CMMS	Computerized Maintenance Management Systems
EVT	Extreme Value Theory
FMECA	Failure Mode, Effects, and Criticality Analysis
FMEA	Failure Modes and Effects Analysis
FTA	Fault Tree Analysis
GEV	Generalized Extreme Value
IoT	Internet of Things
MRO	Maintenance, Repair, and Overhaul
POT	Peak Over Threshold
PDF	Probability Density Function
Pirep	Pilot Report
RSS	Rotor Support Systems
RCM	Reliability Centred Maintenance
MEA	More-Electric Aircraft
SD	Standard Deviations