Case study Exploration

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# Case study Exploration

# Question 1

According to the Boeing 737 MAX, the reliability requirements for Maneuvering characteristics were defined and prioritized to address the aerodynamic issues. It also focuses on ensuring aircraft safer operation. The requirement focuses on addressing the aircraft tendency in understanding the condition including AOA situation. The maneuvering characteristics augmentation system is particularly designed to automatically perform function and to prevent from aerodynamic stalls. All the requirements were established by combining with regulatory standards, industry practices and meet overall design specifications.

Even though it focuses on address the aerodynamic issues and priority he safety measures, there were some of the discrepancies that it might undergoes with (Cusumano, 2020).

***Over dependent on single sensor***

The MCA system is over reliance on the single AOA sensor at the time of activation. Due to that there are more possibilities of single point of failure. The sensor failure might affect the entire device activation. To minimize the sensor failure, the critical system should adopt with standard reliability engineering principles.

***Insufficient evaluation on failure modes***

According to the given case, the model does not make comprehensive addressing on the failure caused because of AOA sensors. Due to it, there are more inaccuracies in data has made that results in improper MCAS activation. It is essential to address the failure and conduct risk assessment for implementing appropriate safe guards (Jennifer Kuczynski et al., 2021).

***Lack of training to team members***

The system requirement does not focuses on the pilot training towards managing MCAS failure. By making more assumption on the training, there are several model involved in managing entire system. The lack of training to all the human resources affected the system reliability, and its overall performance

***Inadequate communication of system***

For the MCAS, the communication system is one of the essential requirement bt that is not addressed effectively. The reliability requirement were not made effectively and alos there are only few training materials are taken place. It will led to lack of awareness among pilots to activate the augmentation system.

# Question 2

The MCAS design does not incorporated with effective fault tolerance mechanism. It causes severe catastrophic failure and two fatal accidents. The fault tolerance plays an effective role in implementing entire design on highly severe safety critical systems. Some of the key shortcoming in the current design of MCAS were lack of redundancy, insufficient sensor validation, limited system awareness, inadequate pilot override capability, and fails to address systematic issues. The effectiveness of preventing from the catastrophic failures occurs on MCA system (Letko, & Rostáš, 2021).

***Lack of redundancy***

The MCAS relies on single angle of attacks sensor. It is observed that the system design does not consists of multiple sensor or any other independent sensor to manage their overall data. The absence of data redundancy affect their overall data from single sensor and causes hazardous maneuvers.

***Insufficient sensor validation.***

The fault tolerance is not effective to validate the sensors taken place in sensor. The adoption of AOA sensor in design could not manage the data accurately. The management of single sensor affect the overall decision making process and causes severe catastrophic failures.

***Limited system awareness.***

The MCAS system involve in collecting inaccurate sensor information that might affect overall faults. The fault tolerance mechanism should continuously monitor the system capabilities and detect anomalies effectively. As the self-awareness is lacking in system, it might causes severe reliability issues (Grose & Mansfield, 2023).

***Inadequate pilot override capability.***

The current design does not collect the pilot input, there is an effective feature will be minimized. If the pilot is not provided effective information about the MCAS behavior, there are more possibility of recognizing the faults lies on system. It causes severe contribution to make more reliability model and prevent from additional catastrophic failures.

***Fails to address systematic issues***

The current design does not able to address the issues related to the system. It does not incorporate with risk assessment on managing overall failures and manage their data. The fault tolerance should be taken place to understand the system operational but the current design is lacking in fault tolerance (Grose & Mansfield, 2023).

# Question 3

**Process of failure analysis**

A comprehensive investigation for failure analysis for the MCAS involve various entities such as Boeing, regulatory agencies and independent experts. The process of failure analysis includes incident data collection, physical evidence examination, software analysis, system interaction analysis and human factor analysis.

In the stage of incident data collection for MCAS system failure analysis, the information related to Lion Air and Ethiopian airline accidents has been collected. The information were about flight data, cockpit voice recording and aircraft system data. After the data were collected, involve in examination of physical evidence from the site directly to identify the malfunction or mechanical failure has been taken place. Next to that involve in analysis of entire software codes that has designed the MCA system (Saveir, 2019). The investigation should focuses on identification of potential bugs, design flaws, vulnerabilities and etc. The integration of system were well examined on manging its overall integration and their dependencies. At this stage, there were severe code base errors are easily identified. Then involve in examination of human factors about how the pilots were informed to handle MCAS related scenario.

**Critical analysis**

The failure analysis on the MCAS system have identified several criticisms including lack of transparency, limited independence, complex system interaction and immediate causes. The Boeing initially identified that the MCAS system causes delays in understanding aircraft accidents (Tuczek, 2022). The involvement of Boeing in investigation causes unbiased results on managing the analysis.

# Question 4

In the potential failure scenarios, the reliability testing has been conducted for the MCAS systems were limited scenario coverage, inadequate integration testing, insufficient pilot involvement, certification process shortcomings and failure to simulate real world conductions.

* The utilization of the AOA sensor causes more inaccuracy on test results. The testing is focusing on adopting nominal condition and causes severe catastrophic failures.
* The reliability testing has been failed because of integrating it with aircraft systems. The failure is caused because of not testing the system effectively and not identified their interdependencies. So that the system causes lack of understanding and failures in operational mode.
* At the testing stage, there are only lesser number of pilots are involved. So there is only limited opportunity has been collected for testing aircrafts and MCAS. Due to providing longer oversight causes severe awareness risks and affected entire operations. There are more possibilities that the pilots were not contributed to identify potential risks involved in the system (Tuczek, 2022)
* The certification process results in much flaws for the overall system and affected their operations. The Boeing involvement in certification affected the testing procedure objectives.
* The reliability testing is not conducted on simulated environment with real time condition. So that the MCA system operation is not observed in weather condition, sensor malfunction and operational complexities. It causes that the system functionality is not observed completely or testing in diverse environment.

# Question 5

**Unique challenges**

There are several challenges has been involved in ensuring reliability of the safety critical system such as MCAS.

* As Boeing MCAS is one of the safety critical system, it can able to operate in high complex environment for interactions. The complexity in understanding and predicting the failure of the system is stull challenges.
* The system needs a human interaction for activation. To activate the system operation, there are several factors included such as pilot training and awareness are required to detect anomalies but it is quite challenging (Smith, 2021)
* The aviation industry have attained higher benefits that might cause severe challenges in meeting standards. In addition to that the existing system of MCAS could not be compatible with existing infrastructure.
* There might be more complexity of aviation system due to regulatory framework and evolving complexities.

**Impacts on Boeing 737 Max Safety**

The reliability issues identified in the Maneuvering characteristics Augmentation System faces severe consequences for safety of Boeing 737 Max aircraft. The unaddressed issues causes two falat accidents such as Lion Air Flight 610 and Ethiopian Airlines Flight 302 that losses more than 100 people lives. The subsequent accidents loss confidence to travel among passengers, airless and severely affected Boeing reputation. It also faces severe financial losses because of fleet accident, compensation cost of addressing issues and etc.

# Question 6

The proactive monitoring and maintenance plays a crucial role in ensuring reliability of safety critical systems such as MCAS. The proactive monitoring adopted in business operation continuous surveillance on overall system performance to detect the issues at the early stage. Even the proactive monitoring supports in peroming analytics and adopt more machine learning approaches to proceed with forecasting (Hause, 2014). These technologies can easily detect the system faiilures and mitigate those risks effectively. The proactive monitoring and maintenance support the remote diagnostics and provide engineers to assess the health of entire system virtually. They can able to provide the solution of the identified reliability issues. Through the monitoring, the system updates and patching activities are addressed easily that will enhance overall system reliability date. By observing the system performance, we can able to prevent from additional issues.

# Question 7

In the case of safety reliability system, the organizational factors are playing an vital role in influences reliability engineering practices. The Boeing corporate culture focuses on cost cutting measure and allocated tight schedule to make decision according to safety consideration. In this case the inadequate communication and transparency with Boeing affects MCAS functionality and acts as an effective model for mitigating reliability issues (Denning, 2013). Boeing relationship with regulatory authorities such as FAA helps in overseeing manufacturing process and to involve in regulatory oversight. The final factor is decision making process that is an effective factor directly relevant to the design changes. All these factors are included in reducing the cost and schedule made for testing Boeing MCAS system. In overall, it is essential to address all these factors to improve the safety measures on aviation technologies.

# References

Cusumano, M. A. (2020). Boeing's 737 MAX. Communications of the ACM, 64(1), 22-25. <https://doi.org/10.1145/3436231>

Denning, S. (2013). Boeing's offshoring woes: Seven lessons every CEO must learn. Strategy & Leadership, 41(3), 29-35. <https://doi.org/10.1108/10878571311323190>

Grose, V., & Mansfield, N. (2023). Relationships in supply chains. Fashion Supply Chain Management, 59-79. <https://doi.org/10.4324/9781003145783-3>

Hause, M. C. (2014). SOS for sos: A new paradigm for system of systems modeling. 2019 IEEE Aerospace Conference. <https://doi.org/10.1109/aero.2014.6836335>

Jennifer Kuczynski, Chaojie Wang, Marie Glass, & Fred Hoffman. (2021). Boeing 737 Max: A case study of failure in a supply chain using system of systems framework. Issues In Information Systems. <https://doi.org/10.48009/1_iis_2021_51-62>

Letko, M., & Rostáš, J. (2021). Analysis and consequences of Boeing 737MAX accidents. Práce a štúdie - Vydanie 10. <https://doi.org/10.26552/pas.z.2021.2.24>

Saveir. (2019). The meaning and role of management information system in the telecom companies in Sindh province. Computer Engineering and Intelligent Systems. <https://doi.org/10.7176/ceis/10-3-02>

Smith, J. B. (2021). Boeing 737MAX through DC6 fleet grounding decisions revisited with event interval probability analysis. 2021 Annual Reliability and Maintainability Symposium (RAMS). <https://doi.org/10.1109/rams48097.2021.9605749>

Tuczek, F. (2022). Enhancing supply chain resilience through incorporating business continuity management systems. Supply Chain Resilience, 77-86. <https://doi.org/10.1007/978-3-030-95401-7_7>