
Airworthiness Analysis in the Maintenance Department to Improve the Safety Rating in the Aircraft Industry: Indonesian Aviation Case

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Abstract

Safety rating on aircraft can be declared airworthy based on the results of maintenance documentation by performing verification, validation, system updating, and scanning in the quality management process. The findings of the analysis of the 2023 safety rating globally from countries in Asia, it is known that the Indonesian region has the lowest safety rating of various aircraft industries. This research aims to analyse the safety rating in the aircraft industry to support the business process in the operational process with the Total Quality Management (TQM) method, and measure the safety rating. Continuous improvement of TQM on business process with the result of Cluster Technical Record justification has its own hierarchy, which focuses on maintenance status and record component to improve aircraft safety rating. The results of measuring the safety rating of aircraft in 2023 registration PK-LAO with the highest safety rating of 96.6% and PK-LAZ with the lowest safety rating of 92.3%. The most dominant cause in PK-LAZ registration is known to be the six most dominant factors, namely hardcopy and system status open, overload work, late validation, analysis time, system error, scanning only one. Continuous system improvement is the implementation of TQM elements in making periodic improvements to support the achievement of quality and risk management. This recommendation can help the implementation and improvement process so that it can be used as a safety rating evaluation material in the aircraft industry.

Keywords: Safety rating, maintenance, aircraft industry, Total Quality Management (TQM).

1. Introduction

Safety rating in the aircraft industry is regulated by the Indonesian state authority regulations and in various regions in accordance with the regulations of the state authority where the aircraft is registered. An aircraft is fit for operation or airworthiness called Airworthiness in the form of a Standard Certificate of Airworthiness document which is the output of an aircraft maintenance document. The safety aspect based on the role of maintenance known from the safety rating in Indonesia is relatively poor as evidenced by the issuance of a flight ban by the authority of the United States, namely the Federal Aviation Administration (FAA), as a result of frequent aircraft accidents in 2004 to 2007 then in 2015 Indonesia by the FAA authority was able to show improvements in the safety rating of aircraft (Majid, 2018).

Globally and nationally in the safety rating of the aircraft industry must have a safety rating of 100%, it is known that the American region is represented by the United States and Canada, the European region is represented by Germany and Italy, then Asia is represented by Singapore and Malaysia with an average safety rating of 99.6% in 2023, Asia is able to adjust flights in the American and European regions which can be categorised as the safest airline in the world. The aircraft industry safety rating assessment includes fatality free, incident rating, audits, and concluded in the safety rating value. Figure 1 shows the safety rating of four Indonesian aircraft industries, namely: Sriwijaya Air, Garuda Indonesia, AirAsia Indonesia, and Batik Air.

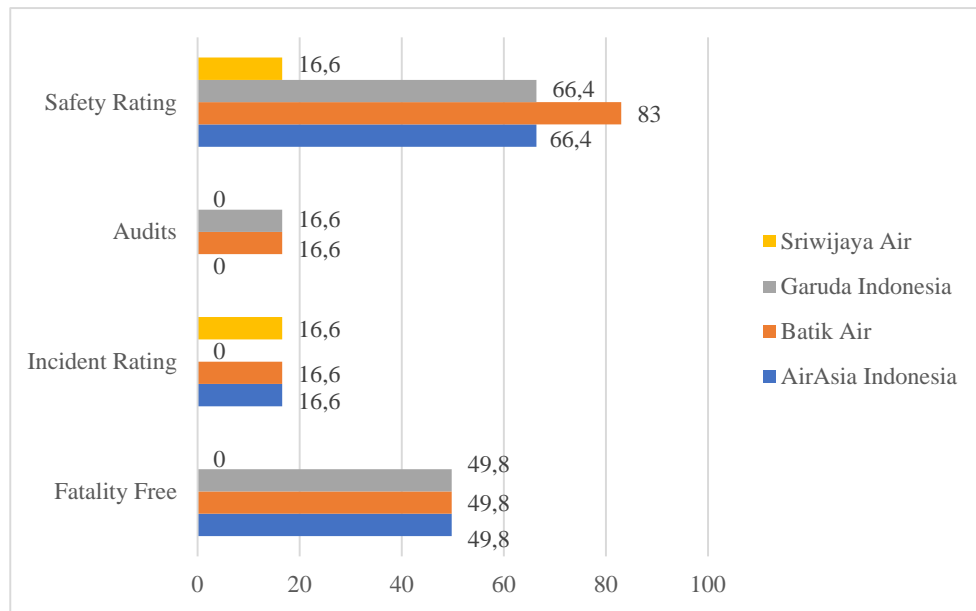


Figure 1. Safety rating of Indonesia's aircraft industry in 2023
 Source: (<https://www.airlineratings.com/airline-rating/>, n.d)

It is known that the highest safety rating value is on Batik Air, but it is still unable to reach the 100% target. The implementation of safety rating in the aircraft industry in Indonesia is still uneven in all airlines in Indonesia, to be able to follow the safety rating standards which are the value of all aircraft maintenance management reports. It is expected that the implementation of TQM in safety rating analysis in the aircraft industry can increase the safety rating value of airlines in Indonesia (<https://www.airlineratings.com/airline-ratings/>, n.d.).

The aircraft industry in Indonesia has policies and regulations that have been set by management, implementation process there are gaps, dynamics, obstacles that can risk flight safety, which is known from the results of the safety rating value. The aircraft industry has conducted TQM by referring to the regulations of the aviation authority, in improving operations on an ongoing basis there needs to be a process oriented to support the safety rating of aircraft by ensuring all organisations work together (Rochaety, 2017).

Previous research is known from the development of various industrial journals focusing on improvements to quality management, this is analyzed from national and international journals from 2020 to 2024. Researchers analyzed the role of maintenance in improving safety rating which has a departmental work system based on an integrated relationship with the TQM method. The priority factor in TQM implementation is to involve the entire organization, with success criteria in each perspective starting from top management commitment, continuous improvement, focus on customer satisfaction, and performance measurement. Research results from journal references show that maintenance variables have an influence on airline performance such as aircraft scheduling (Sofyan & Danang Maulana, 2022); (Saputra & Hasibuan, 2020). Continuous improvement is a management approach to quality improvement with the application of the check sheet method, cause effect diagram, Nominal Group Technique (NGT), 5W1H can be used to determine the cause of the most dominant problems to reduce high risk failures in improving appropriate maintenance strategies and recommendations in improving operational efficiency and quality to achieve organisational goals (Bitan et al., 2023); (Zhou et al., 2023); (Rosdiana et al., 2021); (Hamta et al., 2021).

The focus of the application of TQM methods in various industries is generally still on the improvement of quality management, no research has been found in the case of the aircraft industry that analyses and the role of maintenance in improving safety rating which has a departmental work system based on integrated relationships. This research aims to analyse the safety rating of aircraft in the aviation industry to support business processes in the operational process with a TQM approach and conduct measurements on a case study in one of the aviation industries in Indonesia.

2. Method

2.1 Research Approaches

This research uses a quantitative approach with the focus of data and data analysis on the TQM improvement process for improving safety ratings in the aircraft industry. Design in descriptive research, describing the characteristics of the nature of an event data collection then testing hypotheses is carried out by continuous improvement in various methods relevant to the aircraft industry, then the results of the analysis will be correlated with the characteristics of TQM to support safety rating.

2.2 Data Analysis Technique

The data analysis in this study combines TQM methods which are the beginning to analyse, measure and implement sustainable strategies. Then supported by methods related to continuous improvement in improving safety ratings in the aircraft industry. The process of implementing the method is expected to make continuous improvements, and improve the safety rating in the aircraft industry, can be seen in Figure 2.

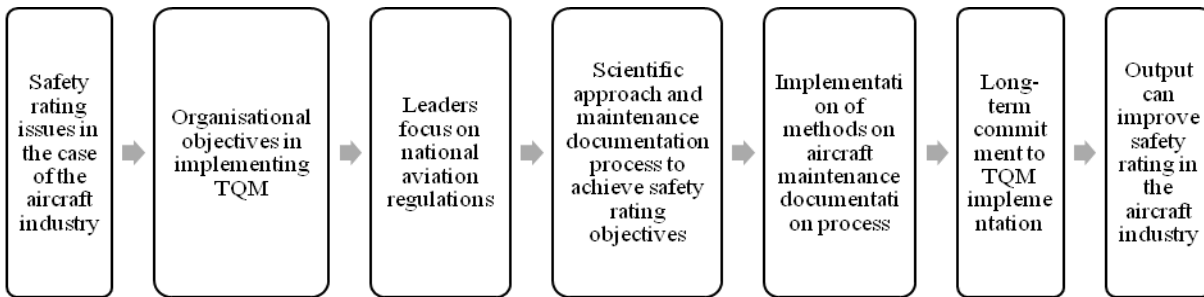


Figure 2. Analysis Technique Implementation Process

3. Results and Discussion

3.1 Business Process

This research was conducted on the Technical Record Cluster, which is a cluster that focuses on the safety rating cycle on aircraft. Technical Record on safety rating is part of the process to achieve safety on every aircraft in operation, can be seen in Figure 3.

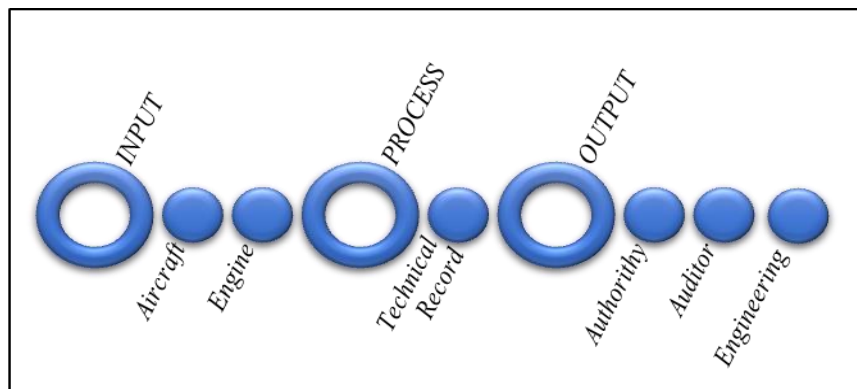


Figure 3. Flow of Records

3.2 Statistics and Data Analysis

Analysis of aircraft maintenance documents was conducted at Batik Air on five registrations PK-LAL, PK-LAM, PK-LAO, PK-LAQ, PK-LAZ. The average safety rating in 2023 was 94.8%, as shown in Table 1. The check sheet for the work order analysis process is presented in Table 2.

Table 1. Achievement of safety rating in 2023

No	Batik Air Registration	Work Order	Work Order Achievement	Safety Rating (%)
1	PK-LAL	471	441	93,6
2	PK-LAM	386	372	96,4
3	PK-LAO	414	400	96,6
4	PK-LAQ	437	415	95,0
5	PK-LAZ	428	395	92,3
Average safety rating in 2023				94,8

Table 2. Check sheet safety rating in 2023

No	Batik Air Registration	Work Order	Work Order Achievement	Safety Rating (%)	%
1	PK-LAO	414	400	96,6	20,4%
2	PK-LAM	386	372	96,4	20,3%
3	PK-LAQ	437	415	95,0	20,0%
4	PK-LAL	471	441	93,6	19,8%
5	PK-LAZ	428	395	92,3	19,5%
Total amount				473,9	

Justification of the business process in 2023 there are two divisions that are in one hierarchy and the safety rating does not reach 100%, this is based on the safety rating report process set by management within 5 working days. From the results of verification, validation, scanning work orders in the business process, the highest safety rating achievement is 96.6% on PK-LAO aircraft and the lowest is 92.3% on PK-LAZ aircraft. The results of the justification and decision of top management aimed at changing the hierarchy, namely by changing the business process in divisions and departments to achieve safety rating which is the goal of the organization, can be seen in Figure 4.

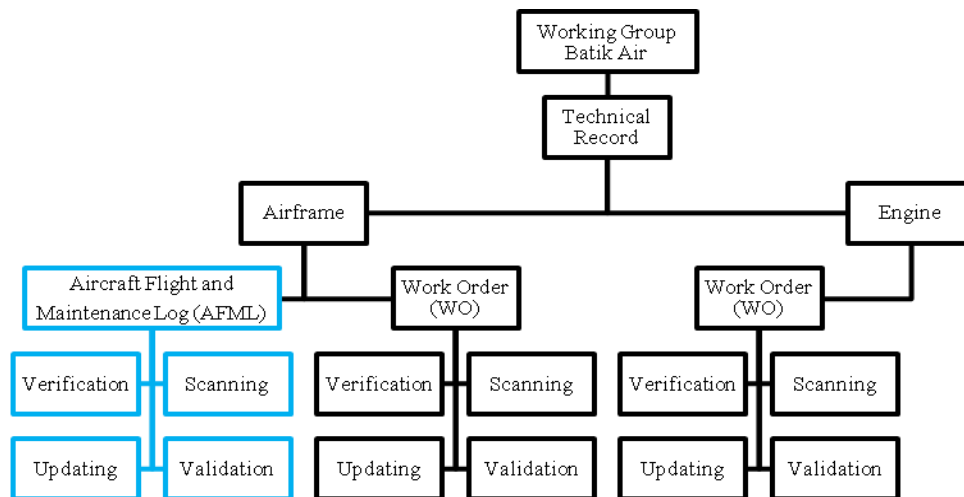


Figure 4. Business process hierarchy

PK-LAZ registration aircraft which has the lowest safety rating of 92.3% compared to other registrations, then analysed with cause effect diagram involving five supervisors in the company. Figure 5 cause effect diagram is the result of identifying the cause of a low safety rating problem from the verification, scanning, validation, system updating, and manpower processes.

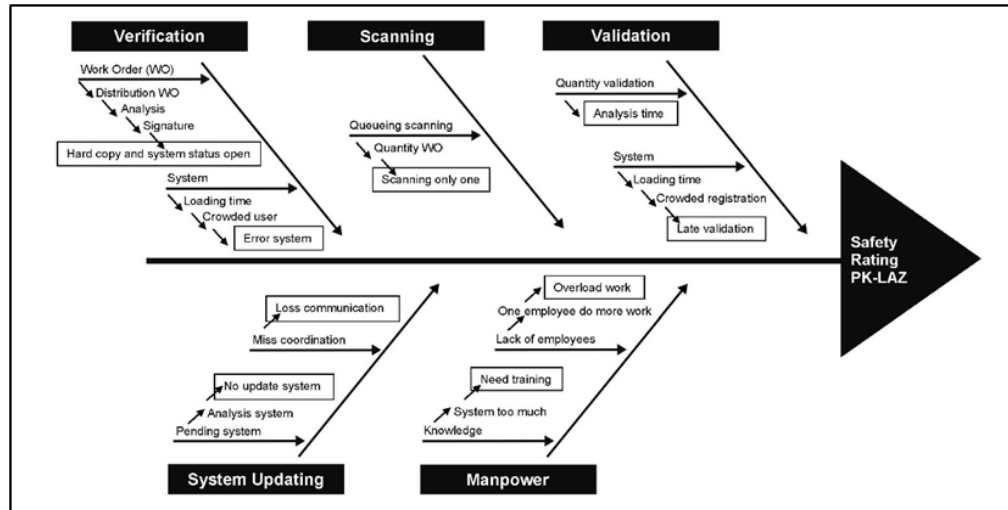


Figure 5. Cause effect diagram of the causes of low safety rating in airline companies

Cause and effect diagram known 9 dominant causal factors, then determine the most dominant causal factor with the NGT method and provide a value to determine the priority of the problem. Nominal Group Technique (NGT) is a structured method used to achieve consensus within a group, and risk assessment. NGT can be used in the stages of risk identification, analysis, and evaluation, the technique then conducts the risk identification process in a discussion. After the risk register and risk formulation are agreed upon, the next step is to determine which risks are prioritised and determine the risks that have the highest risk exposure (Alijoyo et al., 2021).

Determining the most dominant causal factor with the formula is known from the sequence of problems, the calculation of the formula is as follows:

$$\text{Problem Sequence} = \frac{1}{2} \cdot N + 1$$

N = Number of dominant factors

The problem order of the most dominant causal factors with NGT is:

$$\text{Problem Sequence} = \frac{1}{2} \cdot 9 + 1 = 4,5 + 1 = 5,5 \approx 6$$

The results of the sequence of safety rating problems with the NGT method obtained 6 most dominant causal factors, namely: (1) hardcopy and system status open, (2) overload work, (3) late validation, (4) analysis time, (5) system error, (6) scanning only one.

Table 3. Prioritisation of safety rating issues using the NGT method

No	Dominant Causal Factor	TEAM Problem solver					Total Value	Problem Sequence
		SPV	SPV	SPV	SPV	SPV		
		1	2	3	4	5		
1	Hardcopy and system status open	8	9	9	9	7	42	1
2	Error system	3	4	4	5	4	20	5
3	Scanning only one	2	1	5	4	5	17	6
4	Analysis time	6	5	7	6	6	30	4
5	Late validation	9	8	6	7	8	38	3
6	No update system	1	2	3	3	2	11	8
7	Loss communication	4	3	1	2	1	11	9
8	Need training	5	6	2	1	3	17	7
9	Overload work	7	7	8	8	9	39	2

The six most dominant contributing factors to the problem of low safety rating in the case of the aircraft industry were analysed more deeply using the 5W1H method (what, who, when, where, why, how). 5W1H is a comprehensive analysis to support improvement recommendations based on the results of total quality management analysis, check sheet, cause effect diagram, and nominal group technique. The results of the 5W1H analysis of safety rating problems can be seen in Table 4.

Table 4. 5W1H

No	What	Why	How	Who	When	Where
	What are the problems that occur?	Why did the problem occur?	How are improvements proposed?	Who is in charge?	When is the implementation target?	Where is the location?
1	Hardcopy and system status open	Specialisation of work order handling has not been implemented	Addition of a new department	Bobby	1 August 2023	Department Maintenance Status
2	Overload work	One employee does 5 types of work	Addition of Human Resources (HR)	Eko	1 October 2024	Department Maintenance Status
3	Late validation	Irregular work programme	Monthly work programme	Hakim	1 January 2024	Department Maintenance Status
4	Analysis time	Standardisation of validation time is not yet structured	Monthly work programme	Hakim	1 January 2024	Department Maintenance Status
5	Error	No regular programme	Regular	Dadang	1 October 2024	Department

	system updates	system development				Maintenance Status
6	Scanning only one	Inventory procurement procedures are not easy	Addition of a scanning machine	Dadang	1 October 2024	Department Maintenance Status

A summary of improvement recommendations for each of the most dominant contributing factors to the low safety rating of the airline can be seen in Table 5.

Table 5. Proposed improvements for the most dominant causal factors

Priority	Causal Factors	Proposed Improvements
1	Hardcopy and system status open	Addition of a new department
2	Overload work	Addition of Human Resources (HR)
3	Late validation	Monthly work programme
4	Analysis time	Monthly work programme
5	Error system	Regular system development
6	Scanning only one	Addition of a scanning machine

Improvement of business process hierarchy towards safety rating is done based on analysis and justification results that have been implemented by management to achieve safety rating. The improvement process is carried out in the Technical Record Cluster in the maintenance status department, by specialising in the verification, validation, and scanning work order processes. Cluster Technical Record is part of the process that has the output of aircraft safety rating at Batik Air.

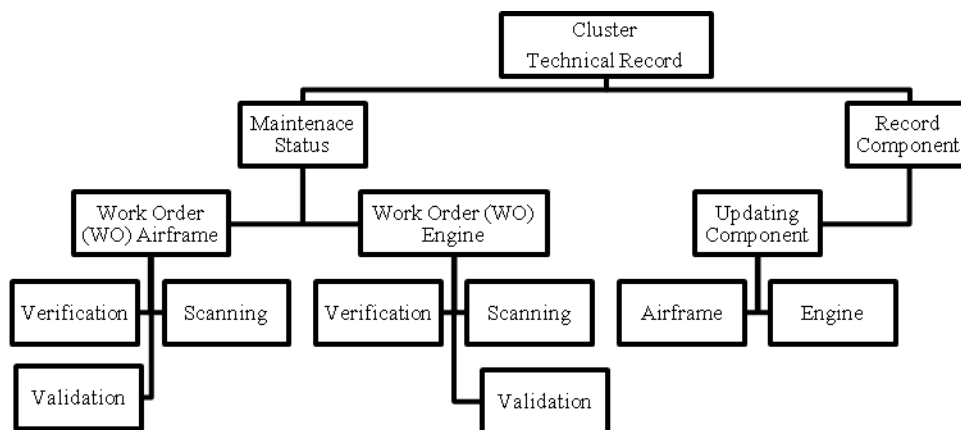


Figure 6. Improvement of business process hierarchy

Improvement of business process hierarchy towards safety rating is done based on analysis and justification results that have been implemented by management to achieve safety rating. The improvement process is carried out in the Technical Record Cluster in the maintenance status

department, by specialising in the verification, validation, and scanning work order processes. Cluster Technical Record is part of the process that has the output of aircraft safety rating at Batik Air airline, as can be seen in Figure 6.

3.3 Relationship with previous research

The relationship with previous research in the manufacturing industry and the aircraft industry in the implementation of this research, explains that the TQM method has a role in involving the organisation to achieve success in each organisational perspective. Continuous improvement has the role of analysing and measuring to improve quality improvement, in the aspect of safety rating in the aircraft industry. The analysis process uses various methods, namely check sheets, and cause effect diagrams to measure safety rating as well as supporting methods nominal group technique, and 5W1H to find out the causes of the most dominant or priority problems and provide improvement solutions known to the research results have a mutually supportive relationship to improve safety rating in the aircraft industry in Indonesia.

3.4 Research Limitations

The limitation of this study is that researchers know the results of analyses on the aircraft industry globally and nationally from airline ratings that provide a summary of the analysis, to determine the level of safety rating on various aircraft airlines in the world. To improve the safety rating, researchers conducted research on the process of managing aircraft maintenance documents, by analysing, verifying, and managing aircraft maintenance documents. To find out the limitations of the study, researchers only analysed the maintenance status department in the Technical Record Cluster, which is known to have one aircraft with the lowest safety rating percentage value, which the researchers then made improvements to this study.

4. Conclusion and Suggestions

4.1 Conclusion

Based on the results of the analysis that has been carried out, the following conclusions are drawn:

1. Analysis of aircraft safety rating is carried out in the Maintenance Department in the Technical Record Cluster using the TQM method, by managing aircraft maintenance record documents. Obtained aircraft safety rating value is in the range of 92.3% - 96.6% with an average in 2023 of 94.8%, this value has not reached the target of 100%. To improve the safety rating of aircraft from TQM in the business process, improvements are proposed so that the Technical Record Cluster has its own hierarchy, which focuses on maintenance status and component records.
2. The results of safety rating measurements on five aircraft registrations resulted in the lowest safety rating value of 92.3% on PK-LAZ registration. The results of analysis with cause effect diagram and NGT method identified six most dominant causal factors of low safety rating in aviation companies, namely hardcopy and system status open, overload work, late validation, analysis time, system error, scanning only one. Improvement recommendations

are made using the 5W1H method.

Management makes safety rating improvements on hierarchical changes to achieve effective and efficient organisational goals in managing people, time, and resources. Business process is a stage to achieve development and competition in the aircraft industry that refers to national and global aviation regulations.

4.2 Suggestions

Based on the results of the analysis carried out, suggestions that can be made in further research are the implementation and improvement process with other methods to be used as a measuring tool in strengthening the research statement, so that it can be used as an evaluation material to continue to improve safety ratings in the aircraft industry in Indonesia.

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