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# AN INTEGRATIVE ANALYSIS OF AVIATION RISK MANAGEMENT PERFORMANCE PROFILE TO LEVERAGE DATA-DRIVEN SAFETY MANAGEMENT FOR BUSINESS COMPETITIVE ADVANTAGE

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## Abstract

The downturn in the oil and gas industry is also adversely affecting the air charter services market. Despite of most air operators following with the low-cost strategy, the industry still put a high value on the performance of Safety Management System (SMS). However, the misleading information from invalid safety data analysis may cause a poor managerial decision, discredit the SMS process and lower the company business competitive advantage. The study is aimed to find a method of safety data analysis which can provide a reliable basis for communicating the risk management results to stakeholders. An integrative approach is developed to transform large amounts of safety data collected from the SMS activities into useful information that supports effective decision making. ARMS Methodology of Event Risk Classification and Flight Safety Foundation BARS bow tie schematic diagram are combined to create the Risk Management Performance Profile model. Case study was performed using the Travira Air SMS implementation data in the period of 1 January 2019 until 20 April 2020. Quantitative risk indexes as the result can be used as a reference for understanding how the accidents occurs and monitor the effectiveness of preventive barriers or recovery measures.The model can be implemented by Safety Managers who interested in correctly identify the safety hotspots and find solution based on informed data and sufficient analysis.

***Keywords:*** Data-Driven, Risk Assessment, Safety Management System, Competitive Advantage, Aviation.

## 1. Introduction

### 1.1. Background

The downturn in the oil and gas industry had led the producers to severe cuts in expenditure over exploration, production and maintenance activities globally, thereby adversely affecting the air charter services market. However, one of the features in the Oil & Gas industry that is valued the most despite of the downturn fluctuation is the performance of Air Operator's Safety Management System (SMS). The company with a sound SMS implementation as its valuable and unique differentiation will most likely gain the competitive advantage and outperform its competitors in the market.

Ever since the government of Indonesia had deregulated the aviation industry in 2000, the aviation sector in Indonesia has been growing rapidly in terms of passengers, airlines, fleets, flights and airports. Currently, Indonesia has 62 (sixty-two) Air Operator Certificate (AOC) as a holder for commercial airlines services. It consists of 20 (twenty) AOC 121 holders for scheduled airlines services and 42 (forty-two) AOC 135 holders for unscheduled air charter services (DAAO, 2019).

### 1.2. Business Issue

Large amounts of safety data collected from SMS activities are stored in a database to be analysed and used to enable effective decision making. However, the misleading information which is coming from invalid safety data analysis method may cause poor managerial decision in communicating safety priorities and evaluating the effectiveness of risk mitigation measures. Moreover, this problem will discredit the SMS process and lower the company business competitive advantage.

### 1.3. Methodology

This study is composed with the objective to solve the problem on the effort to find a method of safety data analysis which can provide a reliable basis for communicating the risk management results to stakeholders in a consistent and comparable manner. In order to solve it, an integrative approach is developed to transform large amounts of safety data collected from the SMS activities into useful information that supports effective decision making. ARMS Methodology of Event Risk Classification is used as the Risk Assessment methodology which capable to provide Quantitative Risk Index approach to analyse the safety data. Whilst, the Flight Safety Foundation BARS Bow tie schematic diagram is used as a frame of reference for accident causation model. By combining those two methods, we can conduct the integrative risk assessment of the various safety data which can show the Risk Management Performance Profile of the company based on demonstrated performance and be continuously improved with experience.

### 1.4 Scope and Limitation

The case study was performed based on Travira Air SMS implementation data during the period of 1 January 2019 until 20 April 2020. Safety Reporting System data are used as the main source for the case study. While limited case trials on other hazard identification activities such as safety investigation, audit and surveillances were also performed to test the viability of the method proposed .3. The Report of Risk Management Performance Profile is limited to the primary Quantitative Indexes resulting from General Aviation Bowtie Schematic Model based on Flight Safety Foundation BARS framework. Advanced data analysis method can be performed further using computer generated process.

## 2. Conceptual Framework

### 2.1. Safety Management System

The Indonesian Aviation Act No 1/2009 accommodates and promulgates the concept of aviation safety management system (SMS) aligned with the International Civil Aviation Organization (ICAO) safety programme. Air Operator Certificate (AOC) shall establish a safety management system appropriate to the size and complexity of the operation, for the proactive management of safety that integrates the management of operations and technical systems with financial and human resource management, that reflects quality assurance principles. In addition, the International Association of Oil & Gas Producers also developed a Report No. 590 Aircraft Management Guidelines (AMG) which provides recommended common guidance for the safe, effective and efficient management of all aviation operations to be adopted by all of their members(IOGP AMG, 2017).

ICAO defines the SMS Framework includes four components representing the minimum requirements for SMS Implementation. *The Safety policies and objectives* create the frame of reference for the SMS. *The safety risk management* component has the objective to identify hazards, assess the related risks and develop appropriate mitigations in the context of the delivery of the organization's products or services. *Safety assurance* is accomplished through ongoing processes that monitor compliance with international standards and national regulations. Furthermore, the safety assurance process provides confidence that the SMS is operating as designed and is effective. *Safety promotion* provides the necessary awareness and training.

**2.2. Data-Driven Safety Management**

The concept of safety management is evolving toward predictive risk management. ICAO in Doc. 9859 Safety Management Manual (SMM) define "effective safety management is Data-Driven" (ICAO, 2013). While the traditional approach was limited to retrospective actions, the new approach is prospective, which is concerned with leveraging safety data and information to develop actionable insights. Such insights are used by an organization's leadership to make data-driven decisions including those related to the most effective and efficient allocation of resources (Jung, H., 2018).

The transition towards a predictive and systemic approach for aviation safety management can be supported by data-driven decision making. Once the decision-making process is based on the right data and information, it is referred to as data-driven decision making. Data-driven decision making involves making decisions that are backed up by the data and quantifiable evidence, rather than making decisions that are intuitive or based on observation alone (Merens,M., 2018).

**2.3. ARMS Methodology of Event Risk Classification (ERC)**

About ARMS Working Group

Aviation Risk Management Solutions (ARMS) is a non-political, non-profit working group, with a mission to produce a good Risk Assessment methodology for the industry.The working group consisted mainly of safety practitioners from airlines(ARMS, 2010).

Event Risk Classification (ERC)

The ERC within the ARMS methodology is based on the concept of "event-based risk", which is an assessment of the risk associated with that one event and not the risk associated with all similar events. The ERC value is based on two questions as shown in Figure 1 below:

| **Question 2** Effectiveness of Barriers (Probability) | | | | | |
|---|---|---|---|---|---|
| Effective | Limited | Minimal | Not Effective | | |
| **50** | **102** | **502** | **2500** | Catastrophic Accident | **Question 1** Credible Accident Outcome (Severity) |
| **10** | **21** | **101** | **500** | Major Accident | |
| **2** | **4** | **20** | **100** | Minor Injuries or Damage | |
| **1** | | | | No Accident Outcome | |

Figure 1: ARMS Methodology of Event Risk Classification (ERC) Risk Matrix

The two questions as shown in Figure 1 above are detailed in the following complete sentences:

Question 1 : If this event had escalated into an accident, what would have been the most credible accident outcome?

Question 2 : What was the effectiveness of the remaining barriers between this event and the most credible accident outcome?

The ERC has two outputs. The first output of the ERC is a number, called the ERC risk index. This index gives a quantitative relative risk value and is very useful in compiling statistics. The ERC Index is based on Real Accident Data studies from ARMS working groups. The second output is a risk tolerability matrix as shown in Table 1 below:

Table 1: Tolerability Matrix of ERC Index

| NO. | RISK LEVEL | INDEX RANGE | RECOMMENDATION |
|---|---|---|---|
| 1. | HIGH (Red) | 103 - 2500 | Unacceptable Risk Condition. Investigate immediately and take action |
| 2. | MEDIUM (Yellow) | 20 - 102 | Medium Risk Condition. Perform Proactive Investigation or carry out further Safety Issue Risk Assessment to mitigate the Risk |
| 3. | LOW (Green) | 1 - 19 | Low Risk Condition. Used for continuous improvements (flows into the database for trend monitoring purposes) |

The Tolerability Matrix as shown in Table 1 above consist of three risk level. It can be used as a reference to develop recommendation on what should be done about the Barrier based on Risk Acceptability/Tolerability.

The ERC cumulative risk values analysis based on quantitative risk index is one of the substantial approach used in this study compared to the alternative indexes from a standard Qualitative Risk Assessment Matrix. Because “Although qualitative evaluation methods are simple and easy for application, it is not recommended or high-risk system especially when the risk factors show complex relationships with each other” (Kang, J., 2016).

### 2.4. Flight Safety Foundation BARS (Basic Aviation Risk Standard) Bowtie Schematic Diagram

The BARS Program is an International Aviation Safety Program made up of a suite of risk-based aviation industry Standards with supporting Implementation Guidelines. All Standards are developed and presented in the Bow-Tie model for easy understanding and include a set of controls and defences for the identified risks.The BARS Bow tie schematic diagram offer a complete frame of reference for understanding how the accidents occurs. List of barriers are available to prevent the accidents and accompanied with recovery barriers to mitigate further escalation of consequences.

BARS schematic bowtie diagram enables us to integrate the SMS activities. With this integration, we may concentrate design effort on the correct safety hot spots, which will occur in operation. Moreover, it helps to understand which events and occurrences during operation truly represent precursors to or indicators of more severe incidents” (Acfield, A., 2012).

## 3. Integrative Analysis for Risk Management Performance Profile

### 3.1. Risk Analysis of Incoming Safety Data

### Risk Analysis

The relevant safety data which are relevant and suitable to be included in the integrative analysis are safety data which contain information of an actual safety event occurred or found from operations whether it is coming from internal or external sources that can be analysed on a risk-based approach. It includes Safety Reporting, Investigation Findings, Audit Findings, Safety Meeting issues, Flight Data Analysis Events, Management of Change and other hazard identification data collected from operations.

Each suitable incoming safety data above will be analysed by using ARMS Methodology of ERC for Risk Analysis. The failed barrier identified from the risk analysis is categorized by adopting the list of barriers from BARS Bow Tie Risk Model Schematic diagram. As the result, each of barriers analysed based on the incoming safety data will have a Risk Scoring Value that will be used in the computation for the development of Risk Management Performance Profile Quantitative Indexes.

Integrative Analysis

A simple moving average analysis is used to represent the qualitative performance index of a Risk Barrier in the system. It is based on the notion the the OGP Aviation standards demand that the effectiveness of barriers assessment should be based on demonstrated performance and be continuously improved with experience (IOGP AMG, 2017). A simple moving average which is used in time series data will capture longer-term trends or cycles. The behaviour of the safety data collected will beas defined in Heinrich's Triangle (Heinrich, H.W., 1931), where the collection of data in a time series basis, will give a significant range of quantitative risk values, ranging from the least risk events, which will occupy most of the population, up until the higher risk events, which are rarely occurred.

### Risk Barrier Performance Index (*RB Index*)

Based on the simple moving average concept, if the cumulative Risk Assessment Value for n safety data from different BeSafe modules is $RA_1 + RA_2 + \cdots + RA_n$ ,the Risk Barrier Performance Index (*RB Index*) for each Risk Barrier in the selected period of time can be computed using the following formula:

$$RB\ Index = \frac{RA_1 + RA_2 + \cdots + RA_n}{n}$$

*RB Index* : Risk Barrier Performance Index

*RA* : ERC Matrix Risk Index Score for each Safety Data

*n* : Number of Safety Data Available in the selected period of time for computation

### Risk Threat Performance Index (*RT Index*)

In order to define a barrier system effectiveness, we have to understand the dynamics of barrier in a bowtie schematic system. A common assumption in bow-tie models is that barriers are independent of each other and that threats follow a linear path up to the consequences. "In practice, barriers are highly interactive and complementary and may not exhibit causal or sequential relationships. Thus, barriers and threats may combine in complex ways to give rise to unimaginable events and consequences" (Anand, N., 2015).

With that consideration, it is understood that each barrier within a system of barriers for a specific threat as modelled in BARS bowtie schematic diagram is unique and equally important to prevent an incident / accident occurred. The BARS Bow Tie schematic diagram identify two types of risk controls which are Specific Control and Common Control. Therefore, each barrier in the specific control and common control will be used in the computation for Risk Threat Performance Index (*RT Index*).

Where the total number of specific controls is varied for each particular threat, the common controls which are required to be effective against all threats encountered is consists of fourteen (14) barriers. Therefore, by using the simple moving average concept, the Risk Threat Performance Index (RT Index) for each threat in the selected period of time can be computed using the following formula:

$$RT\ Index = \frac{(CCRB\ Index_1 + \cdots + CCRB\ Index_{14}) + (SCRB\ Index_1 + \cdots + SCRB\ Index_n)}{14 + n}$$

or

$$RT\ Index = \frac{(CCRB\ Index \times 14) + (SCRB\ Index \times n)}{14 + n}$$

*RT Index* : Risk Threat Performance Index

*CCRB Index* : Common Control Risk Barrier Index for the selected period of time

*SCRB Index* : Specific Control Risk Barrier Index for the selected period of time

*n* : Number of Specific Risk Control for each particular threat

For computation purposes, the minimum index for each risk barrier is 1 (one). Since the internal audit program covered the review of all Risk Barriers available, RB Index 1 (one) also means that the current performance of the particular risk barrier is effective.

## 4. Case Study Results: Risk Management Performance Profile

### 4.1. Model Development

Series of Focus Group Discussion were conducted with the Travira Air QSS Department Personnel and IT Department Software Developer. In this Case Study, Travira Air QSS Department develop and utilize 3 (three) models of Bow-Tie Schematic system to demonstrate causal relationships in different types of high-risk scenarios as shown in Table 2 below:

Table 2: Bow-Tie Schematic System Models Used

| No. | Bow-Tie Model | Description | BeSafe Taxonomy |
|---|---|---|---|
| 1. | General Aviation<br>*Refer to BARS Model* | Covers threats and controls applicable to all aircraft operations and addresses the role specific requirements applicable to certain aviation activities<br>No. of Threats: 11<br>No. of Common Controls: 14<br>No. of Recovery Measures: 15<br>No. of Barriers: 79 | 1 xx xx |
| 2. | Offshore Helicopter Operations<br>*Refer to BARS Model* | Emphasize the relationship between major threats to offshore helicopter safety performance requirements, their associated controls and applicable recovery/mitigation measures<br>No. of Threats: 8<br>No. of Common Controls: 8<br>No. of Recovery Measures: 8<br>No. of Barriers: 39 | 2 xx xx |
| 3. | Occupational Health, Safety and Environment (OHSE) Risk | Covers the major threats in the Occupational Health, Safety and Environment (OHSE) Risk issues<br>No. of Threats: 24<br>No. of Recovery Measures: 3<br>No. of Barriers: 24 | 3 xx xx |

This case study will present the Risk Management Performance Profile by using the General Aviation Bow Tie model as described on Table 2 above.

### 4.2. Data Collection and Processing

Travira Air utilize BeSafe, an internally developed web application, to store safety data from its SMS activities. There is a total of 324 Safety Data collected and processed using the Risk Management Performance Profile Model from BeSafe data in the period of 1 January 2019 until 20 April 2020. The breakdown of Safety Data based on data source from BeSafe Modules can be seen on Table 3 below:

Table 3: BeSafe Modules Data Source Breakdown

| DATA SOURCE | 2019 | | | | 2019 Total | 2020 | | 2020 Total | Grand Total |
|---|---|---|---|---|---|---|---|---|---|
| | Qtr1 | Qtr2 | Qtr3 | Qtr4 | | Qtr1 | Qtr2 | | |
| **External Audit** | 6 | | 11 | | 17 | 4 | | 4 | 21 |
| **Internal Audit** | | | | 6 | 6 | 43 | | 43 | 49 |
| **Investigation** | | | | | | 7 | | 7 | 7 |
| **Other CAR** | 3 | 11 | 10 | | 24 | | | | 24 |
| **Safety Report** | 22 | 28 | 34 | 60 | 144 | 75 | 4 | 79 | 223 |
| **Grand Total** | **31** | **39** | **55** | **66** | **191** | **129** | **4** | **133** | **324** |

Table 3 above shown that Safety Report Module is the primary source in this case study with the total of 223 Safety Data collected and processed. The combined total of External Audit, Internal Audit, Investigation and Other CAR BeSafe Modules is 101 Safety Data.Out of from 324 safety data in total, the data categorized in the General Aviation Bowtie Model is 191 and a total of 47 Risk Barriers analysed in this bowtie model.

### 4.3. RB Index Calculation

Refer to the Risk Barrier Performance Index (RB Index) formula we can calculate the RB Index for each Risk Barriers Analysed in the case study. Table 4 below shows the calculation of the RB Index on Date 20 April 2020 for Risk Barrier System in the Threat No. 10800 Collision on Ground using the 24 months period moving average.

Table 4: RB Index Risk Barrier System: Threat No. 10800 Collision on Ground

| **Date: 20 April 2020** | | **THREAT NO. 10800 COLLISION ON GROUND** | | |
|---|---|---|---|---|
| **Period: 1 Jan 2019 – 20 Apr 2020** | | | | |
| **Bowtie Model: General Aviation** | | | | |
| **No.** | **Risk Barrier** | **Data Count** | **Risk Assessment** | **RB Index** |
| 1. | 10801 Passenger Terminal Area | 0 | 0 | 1 |
| 2. | 10802 Designated Freight Area | 0 | 0 | 1 |
| 3. | 10803 Passenger Control | 1 | 20 | 20 |
| 4. | 10804 Ground Procedures | 2 | 60 | 30 |
| 5. | 10805 Pilot at Controls | 1 | 30 | 30 |
| 6. | 10806 Parking Apron | 0 | 0 | 1 |
| 7. | 10807 Perimeter Fence | 1 | 10 | 10 |
| 8. | 10808 Airfield Control | 3 | 240 | 80 |

Table 4 above shows that Threat No. 10800 Collision on Groundconsist of 8 (eight) barriers that form the barrier system to prevent the threat to become an accident. There are 5 (five) barriers analysed in this barrier system from the incoming safety data in the period. Refer to Risk Tolerability Matrix there are 4 (four) barriers in the Threat No. 10800 that show Medium Risk Condition. This condition means that QSS Department should perform further Proactive Investigation or carry out further Safety Issue Risk Assessment to those barriers in order to mitigate the Risk.

### 4.4. RT Index Calculation

By using the Risk Threat Performance Index (RT Index) formula, the RB Index and CCRB Index results, we can calculate the RT Index for Threat No. 10800 Collision on Ground for Date 20 April 2020 as shown in Table 5 below.

Table 5: RT Index for Risk Barrier System: Threat No. 10800 Collision on Ground

| **Date: 20 April 2020** | | **THREAT NO. 10800 COLLISION ON GROUND** | | |
|---|---|---|---|---|
| **Period: 1 Jan 2019 – 20 Apr 2020** | | | | |
| **Bowtie Model: General Aviation** | | | | |
| **CCRB Index = 14,524** | | ***RT Index = 17,106*** | | |
| **No.** | **Risk Barrier** | **Data Count** | **Risk Assessment** | **RB Index** |
| 1. | 10801 Passenger Terminal Area | 0 | 0 | 1 |
| 2. | 10802 Designated Freight Area | 0 | 0 | 1 |
| 3. | 10803 Passenger Control | 1 | 20 | 20 |
| 4. | 10804 Ground Procedures | 2 | 60 | 30 |
| 5. | 10805 Pilot at Controls | 1 | 30 | 30 |
| 6. | 10806 Parking Apron | 0 | 0 | 1 |
| 7. | 10807 Perimeter Fence | 1 | 10 | 10 |
| 8. | 10808 Airfield Control | 3 | 240 | 80 |

Table 5 above shows that the RT Index of Threat No. 10800 Collision on Ground is 17,106 which is on Low Risk Condition level based on Risk Tolerability Matrix. Similar computation method can be performed on the remaining Threats in the General Aviation Bowtie Schematic Model. Table 6 below shows the calculation of RT Index Date 20 April 2020 for all the Threats in the General Aviation Bowtie Schematic Model refer to Flight Safety Foundation BARS.

Table 6: RT Index for All Threats in the General Aviation Bowtie Schematic Model

| Date | | : 20 April 2020 | RT Index GENERAL AVIATION | | |
|---|---|---|---|---|---|
| Period | | : 1 January 2020 – 20 April 2020 | | | |
| CCRB Index | | : 14,524 | | | |
| Bowtie Model | | : General Aviation | | | |
| No. | BeSafe Taxonomy | Threat | Total Barriers | SCRB Index | RT Index |
| 1. | 10200 | Runaway Excursions | 7 | 17,857 | 15,635 |
| 2. | 10300 | Fuel Exhaustion | 6 | 7,333 | 12,367 |
| 3. | 10400 | Fuel Contamination | 5 | 2,800 | 11,439 |
| 4. | 10500 | Controlled Flight into Terrain (CFIT) | 10 | 37,900 | 24,264 |
| 5. | 10600 | Loss of Control - In Flight (LOC - I) | 5 | 30,200 | 18,649 |
| 6. | 10700 | Incorrect Loading | 7 | 2,286 | 10,444 |
| 7. | 10800 | Collisions on Ground | 8 | 21,625 | 17,106 |
| 8. | 10900 | Collisions in Air | 5 | 29,067 | 18,351 |
| 9. | 11000 | Structural or Mechanical Failures | 9 | 27,426 | 19,572 |
| 10. | 11100 | Weather | 6 | 17,369 | 15,377 |
| 11. | 11200 | Medical Evacuation | 11 | 2,636 | 9,293 |

As shown by Table 6 above, by using the Tolerability Matrix, we can analyse that the Threat No. 10500 Controlled Flight into Terrain (CFIT) and Threat No. 11000 Structural or Mechanical Failures are in the Medium Risk Condition indicated by the yellow colour.

The RT Index for each Threats in the Bowtie system can be used as the Predictive index for analysing and anticipating the potential threats that can appear in the system By looking at this Risk Management Performance Profile data, the Safety Manager can accept recommendation to perform Proactive Investigation or carry out further Safety Issue Risk Assessment to mitigate the Risk related to the threat.

In other methods of data presentation, by using a bar chart, the RT Index was used to classify the ranking system of Top Risk Threats in the operationsBy looking at the chart, Safety Manager and stakeholder interested in the SMS implementation can easily identify the Top Risk Threat in the General Aviation operations and ranking them based on RT Index scoring. Threat No. 10500 Controlled Flight into Terrain (CFIT) is the top threat based on Risk Management Performance Profile on 20 April 2020.

### 4.5. Simple Moving Average Analysis

The moving average of the ERC Matrix Risk Index Score of the overall Incoming Safety Data can form another useful source for data-driven risk management. The trends can give a Quantitative Representation of Safety Alert trends in the Company.Risk Management Performance Index with a simple moving average method will be an important analytical tool used by Safety Analyst to identify current Risk trends and the potential for a change in an established trend.

In this Risk Management Performance Profile model, if the simple moving average index pointing down it means that the Risk Performance Profile is improving. In contrary, if it is pointing up, this means that the Risk Management Performance is decreasing thus will increase the alertness level of the safety management system implementation of the company.

The threshold between short-term and long-term trends depend in the application. As similar to its popular application in financial market, analytical use of moving average is to compare a pair of simple moving averages with each covering different time frames. If a shorter-term simple moving average RA 1 (RA Index 1 month) is above a longer-term average RA 24 (RA Index 24 months), an uptrend of Risk Alert is expected.

## 5. Benefits to Stakeholders

ICAO define stakeholders of the SMS to involve all internal and external aviation system having a potential impact on the organization's safety performance situation (ICAO, 2013). Risk related decisions are made by all the related stakeholders in the Safety Management System (SMS). The extent to which stakeholders have an interest in the decision will depend on the nature of the risk and the stakeholder perception of that risk. This, in turn, drives the degree of stakeholder influence and therefore the decision context and the way in which the decision will be made (OIL & GAS UK, 2014).

The Table 7 below shows an implementation of data-driven safety management with a clear profile of risk management performance, may support the business competitive advantage and provide benefit to stakeholders with the following possibilities:

Table 7: Stakeholders Benefits from Data-Driven Safety Management

| No. | Stakeholder | Interest | Possible Benefits |
|---|---|---|---|
| 1. | *Type: Internal*<br>Operational Staff, Line Managers and Supervisors, Safety Manager, Senior Management, Shareholders | Safe and healthy work place, Being properly advised regarding the potential risk in area of operation, Protection of investment | Ensures that hazard identification and safety risk management are carried out<br>Build up safety awareness among staffs through real time information feedback<br>Bring confidence to operational staffs that the organization can provide a measured safe working environment<br>Data-driven reviews on the effectiveness of previous safety recommendations or action taken<br>Continuously improve corporate image which give assurance to shareholder on the protection of their investment to the company |
| 2. | *Type: External*<br>Customers (Corporate & Passengers), Regulators, Service Providers (Airport Operator, Ground Handling, etc.), Aviation Professional and Industry Associations | Personal safety while using the services, compliance with all relevant safety legislation and standards, Improvement of safety level of the aviation industry | Bring confidence and addressing concern for the monitoring and measurement of SMS performance of the contractors<br>Bring confidence to passengers on the safety level of the services<br>Output from the AOC Holder Risk Management Result can become input and attention to service providers to improve their safety management system process (Such as; FOD issues, Catering, Passenger Services, etc) |

## Conclusion

The previous discussion shows that, the integrative analysis of Risk Management Performance Profile can leverage the implementation of data-driven safety management system which may support the business competitive advantage and provide benefit to stakeholders. Table 8 below summarizes the advantages of the proposed Risk Management Performance Profile method compared others.

| No. | Advantages | Proposed Method |
|---|---|---|
| 1. | Data Sources | Able to accommodate and integrate different Safety Management System (SMS) activities |
| 2. | Output Data | Able to provide Quantitative Risk Index as an output of the process |
| 3. | Continuity | Enables live and continuous Risk Management monitoring process |
| 4. | Risk Management Model | Ability to be used to analyse and demonstrate causal relationships in high risk scenarios<br>Offer a frame of reference for understanding how hazardous events occur and for refining the barriers, control and recovery measures to prevent recurrence<br>Suitable to be used as a framework for Predictive Risk Management<br>Capable to support the data-driven Risk Management related decision making |
| 5. | Credibility | Using the BARS framework as the recognized international best practices |
| 6. | Efficiency | The development process become more efficient and may respond quickly to further innovation |
| 7. | Index Rationale | The ERC Index is based on Real Accident Data studies from ARMS working groups |
| 8. | Integrative Analysis | Integrative representation of overall company Risk Management Performance will enable to identify the correct safety hot spots |
| 9. | Realtime | Able to captures system performance as it happens in real-time normal operations |
| 10. | Data Analytics | Open for various methods for further data analysis method and correlation studies |

Further research in terms of application of the model is open wide. Since this model is counted on the lagging part of the Risk Management, the possibilities of Leading Indicator measurement method for Risk Management Activities can be utilized as a comparison with the Lagging Indicators. Further research in terms of application of the model such as the development of data analysis method, other indicators, and correlation analysis between safety data attributes can be explored further to gain the most benefit from this model.

## References


i. Acfield, A., Weaver, R., 2012. Integrating Safety Management through the Bowtie Concept A move away from the Safety Case focus, *Proceedings of the Australian System Safety Conference (ASSC 2012), Conferences in Research and Practice in Information Technology (CRPIT),* Vol. 145

ii. Anand, N., 2015. Breaking the myth: the effectiveness of bowties in risk and safety management, *BIMCO Bulletin*, Volume 110: 34-35.

iii. ARMS Working Group, 2010. *The ARMS Methodology for Operational Risk Assessment in Aviation Organisations*, pp. 1-67.

iv. Directorate of Airworthiness and Aircraft Operations (DAAO), 2019.*Civil Aircraft Register 2019*. Ministry of Transportation, Directorate General of Civil Aviation (DGCA) Indonesia.

v. Flight Safety Foundation, 2018.*Basic Aviation Risk Standard Contracted Aircraft Operations*, Version 7, pp. 1-64.

vi. ICAO, 2013.*Doc 9859 AN/474 Safety Management Manual (SMM)*, Third Edition.

vii. IOGP, 2017.*Report 590: Aircraft Management Guidelines, 590-B Safety Management System, Quality and Emergency Response*,The International Association of Oil & Gas Producers,pp. 4-27.

viii. Jung, H., et al., 2018. Data-Driven Decision-Making Processes, Data Services and Applications for Global Aviation Safety, *ITU Journal: ICT Discoveries*, Special Issue No. 2

ix. Kang, J., Zhang, J., Gao, J., 2016. Analysis of the Safety Barrier Function: Accidents Caused by the Failure of Safety Barriers and Quantitative Evaluation of Their Performance, *Journal of Loss Prevention in the Process Industries (2016)*, doi: 10.1016/j.jlp.2016.06.010.

x. Merens M., Hui, A. W. & Dunia A., 2018. Aviation Training Intelligence, Supporting Strategic Partnership, *ICAO Training Report*, vol. 8, no. 1, pp. 4 – 6

xi. OIL & GAS UK, 2014.*Guidance on the Risk Related Decision Making*, The UK Oil and Gas Industry Association Limited trading as Oil & Gas UK, ISBN: 1 903 004 32 2

xii. Travira Air, 2018.*Safety Management System Manual (SMSM)*, Revision 04, Quality, Safety and Security Department, DOC No.: QS-01-000