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Integration of Safety Management System with other systems in Aircraft Maintenance Services Companies in Indonesia

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Abstraction---*One of the determinants of the advancement of the aviation industry is the support of aircraft maintenance companies or Aircraft Maintenance and Overhaul (MRO). The airlines are very hopeful of MRO facilities in order to extend the life of the company's assets to ensure the availability of transportation services in the future. MRO services are very complex because they involve various processes whose performance depends on aircraft buildup and maintenance reliability, regulations, spare parts availability, and availability of certified human resources (Vieira & Loures, 2016). The number of incidents of civil aviation accidents is the biggest issue for the entire world community. both national and international flights. There are four main parts of the organization that are operational actors in the aviation world: Aircraft Operator Company, Air Traffic Control Organization, Airport Operations and Aviation Operations (Aviation & Regulation, n.d.). The implementation process of applying SMS to MRO companies was built with four main pillars, namely: Safety policy, Safety Risk Management, Safety Assurance and Safety Promotion media. The safety policy covers the concentration and commitment of the company's leadership to the implementation of the Safety Management System in an MRO, especially regarding the resources that must be provided by the leadership. Safety risk management includes monitoring of all ten potential hazards with conditions below the acceptable risk threshold. Safety assurance is a safety guarantee that is demonstrated by maintaining all potential hazard data below the permitted value threshold. Safety promotion is an activity carried out continuously by the company to enhance the safety awareness of all company employees*

Keywords---*MRO, SMS, Implementation, safety, awareness.*

I. Background

The aeronautics sector including aircraft construction, supply parts or maintenance parts, repair service modification is currently one of the most dynamic industries in the world (Romero et al., 2016). This industry creates a large part for economic activity and financial benefits in various parts of the world.

One of the determinants of the advancement of industry is the presence of aircraft maintenance companies or Aircraft Maintenance and Repair (MRO). The company moved very hopeful of the MRO facility in order to extend its company's assets to approve the upcoming transportation service agreement. MRO services pass through a complex because it involves various processes whose performance depends on aircraft flight and reliable maintenance, managing, distributing

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spare parts, and the availability of approved human resources (Vieira & Loures, 2016). Meanwhile, asking for safety, quality, and security at the best cost (Romero et al., 2016).

The number of incidents of civil aviation accidents is the biggest issue for the entire flight community both nationally and internationally. There are four main parts of the organization that are operational actors in the aviation world: Aircraft Operator Company, Air Traffic Control Organization, Airport Operations and Aviation Operations (Aviation & Regulation, n.d.). One organization that plays an important role in aviation safety systems is the aircraft maintenance company Aircraft Maintenance Organization (AMO). This organization is responsible for care, maintenance and overhaul. The largest percentage of aircraft accidents is caused by human error in maintenance (Kvalheim & Dahl, 2016).

The aviation industry is one of the most unique businesses in the world (Gerede, 2015). Complex problems that affect operations management in the aviation industry are

not simple. There are people, goods, long-distance goods movement, flight processes, crew, maintenance, cargo and even food must be scheduled quickly and accurately. Fuel, spare parts, supporting equipment, training and publications must be available in the time required (Authors, 2006). All of the above needs are the burden and obligation of the company to be provided. The aircraft operator and workshop must have adequate supporting tools, tools and GSE (Ground Support Equipment) according to the type of aircraft the operator has.

Each airline must determine the type of ground support device that is suitable for its aircraft such as the Boeing 757, Airbus, Foker F100 and so on. The balance of operational costs with the number of passengers is crucial that must be carefully calculated by the operator (Talluri, 1998). This will have an impact on how to routinely handle aircraft maintenance at the operator. If the maintenance process of the operator is inadequate, it will be a huge burden for the MRO company when the aircraft is maintained in the MRO hangar and triggers many errors in the MRO company. Research in one airline in Taiwan by adopting the SHELL theory and from the results of a questionnaire opinion of senior experts in the company, from 107 risk factors there are 77 serious risk factors in the realm of aircraft repair shops (Atak & Kingma, n.d.).

The high number of accidents caused by human error (Wiegmann, Zhang, & Von, 2009) has become a homework which has attracted a lot of attention from all parties. The government as a regulator has full authority to continue to improve supervision and improvement in terms of regulation but can not provide guarantees that the regulations made can reduce the number of aircraft accidents (S. Shappell, Carolina, Detwiler, & Boquet, 2007). While the manufacturer continues to strive to create and create aircraft designs that are familiar to operate and easy to maintain. The improvement of the skills of the flight crew continues to be improved by attending various kinds of training in an effort to improve the capabilities of the flight crew. But these efforts have not been able to reduce the number of aircraft accidents at the minimum point probability. The evolution of the causes of aircraft crashes is grouped into three phases (Standards, Practices, & Aviation, 2013). Phase one, the cause of accidents which is mostly caused by technology failures occurred in the era of 1970 to 1990 where aircraft technology was not yet perfect. The next phase of the biggest failure factor is caused by human error and violation factors. In this phase the existence of technology is getting better and minimal error, so that the failure of technology is relatively more controlled, this phase occurred in the decade 1990 to 2000, and the last is the phase where technology is more advanced and qualifications of human capabilities are more perfect but the complexity of the organization as well as the existing system makes the main triggering factors of failure that occur at this time. The current accident factor is mostly caused by collective error, referred to as organizational error.

Organizational error is relatively difficult to control and correct because it contains a complex system involving various organizational interests, business competition and efficiency efforts and the burden of regulatory complexity that must be

obeyed by business operators in the aviation world. Every effort made sometimes forces the organization to make a variety of policies that are wrong and tend to open up opportunities for risks and potential dangers, both individual and organizational dangers. The potential ultimately results in the emergence of various kinds of mistakes and violations committed by individuals as an excess of organizational interests that must be fulfilled.

Airplane accidents can occur due to many factors, including the aircraft itself, human error, maintenance processes, weather factors, or even the malfunction of airport facilities (Sicily, 2009). Organizational mistakes have a big enough share in every incident. One other contributing factor is the exhaustion of operators in aircraft maintenance workshops. The fatigue factor can affect all tasks in aircraft maintenance through impaired judgment, unfocused, memory lapses, reduced mood and motivation, and other performance effects. The reduction of accidents and flight incidents caused by fatigue is one of the issues discussed at the National Transportation Safety Board (NTSB) worldwide (Hobbs, n.d.).

Product safety assurance is one of the requirements for the development of an MRO company, product safety guarantee and minimum failure in the maintenance process. The term sms incident or accident is related to product failure which includes reduced or loss of construction capabilities / components including aircraft engines so that the impact on the incident or katastropic (Aviation & Regulation, n.d.). Incidents also do not stop there, work time delays, disruptions to work flow and top management pressure that leads to irregularities and violations. Tight business competition leads to an unfair competition situation where the dominance of large companies can freely make unilateral policies.

Three important elements that must be included in enhancing the capabilities of the MRO industry are: GSE tools, aircraft / component manuals, spare parts support, and certified personnel (Certifying staff) (Aviation & Regulation, n.d.). GSE and Manual Special Tools are the most difficult resource to provide because the procurement process must go through an agreement contracting mechanism with aircraft manufacturers or aircraft components. The occurrence of Aliance and mergers of various aviation companies throughout the world has made it even more difficult for MROs in the developing world, especially in Indonesia, given that the alliance and mergers of most vendors have an impact on spare parts support, and GSE manuals and tools that have changed ownership and changed new vendor policies.

Government policies in various countries apply basic rules for all industries in which the company operates. The deregulation of the aviation industry that began in the 1970s has led to competitive out sourching programs in aircraft maintenance so as to increase open competition and efforts to keep costs suppressed (Taylor, Miller, Park, Miller, & Park, 2010). With the concept of out sourching work, the MRO company can reduce the operational costs of procurement of GSE Tools, the main components and breakdown of aircraft component parts and aircraft manuals. But from the business aspect, this method is clearly detrimental to the MRO organization because the main business switches to other companies. From the safety aspect of work like this it does not have a significant risk.

II. Formulation of the Problem

Based on the background explanation described above, the problems that will be formulated relate to efforts to increase safety awareness through an integrated safety management system in an MRO company including the following:

1. Why do most MRO companies find it difficult to implement or implement SMSs that are based on predetermined regulations in terms of safety compliance regulations and the company's business performance goals?

2. What are the inhibiting factors that make MRO companies difficult to develop in Indonesia, if the Safety management system is implemented strictly?

3. Any business impacts or risks faced by MRO companies in the event of an incident or accident related to the product caused by the non-optimal implementation of the SMS

4. How to make the concept of optimizing the application of SMS that is integrated with the existing quality management system, so that safety policies are made in line with the objectives and business performance of the company

III. Research Objectives

Based on the formulation of the problems outlined in the previous section regarding efforts to improve safety awareness through an integrated safety management system in an MRO company, they are as follows:

1. Explain in detail the factors that cause the difficulty of implementing SMS maximally in MRO companies so that the occurrence of leak of safety factors that cause obstacles to the company's business performance goals.

2. Know in detail the main factors that hinder the company's business performance if SMS is applied consistently to MRO companies in Indonedia.

3. To examine in detail the factors triggering the incident or accident caused by organizational errors and the impact of any business risks caused by the non-optimal implementation of the SMS

4. Develop a concept of optimizing the implementation of safety management which is integrated with the quality management system used by MRO companies.

IV. Literature Review

4.1 MRO organizations

Maintenance Repair and Overhaul (MRO) is an official organization formed by the government that is appointed and has the authority to carry out maintenance, repairs and aircraft overhauls (Aviation & Regulation, n.d.). The task of this organization is to fulfill the regulations of aviation regulation to maintain the airworthiness after the aircraft flies out of the manufacturer. The authority of MRO in carrying out its activities is divided into three capabilities namely (Aviation & Regulation, n.d.):

1. Functional Test, i.e., the authority of MRO is only limited to certain aircraft function test activities or components.

2. Maintenance, the authority granted to perform maintenance of certain types of aircraft by referring to the Aircraft Manitenance Manual issued by the manufacturer.

3. Repairing the structure, i.e. an aircraft repair action with the provisions of repairs carried out referring to the structure of the repair manual.

The more planes that operate, the higher the need for aircraft maintenance facilities, the establishment of MRO companies has the following objectives (Lee, Ma, Thimm, & Verstraeten, 2008):

a) To ensure or restore the safety and reliability of the aircraft and its supporting devices

b) To obtain product information and process information needed to obtain optimal care related to safety and reliability that have not been met.

c) To obtain the information needed to repair components and design Tools for components that must be completely repaired or replaced during the repair process

d) To achieve the goal of minimizing costs, including maintenance costs and residual failure costs.

V. MRO Classification Based on Function

Based on regulations that apply both nationally and internationally MRO activities are divided into several operational activities (Ayeni, Baines, Lightfoot, & Ball, 2011). MRO activities in Indonesia are regulated in Civil Aviation Safety Regulation number 145 (Aviation & Regulation, n.d.) issued by the Ministry of Transportation of the Republic of Indonesia dividing it into five operating capabilities, namely:

a. Line maintenance activities, are types of light maintenance activities that are carried out outside the hangar with a relatively short period of time, by nature only doing a functional check. Line maintenance is referred to as on-aircraft Maintenance where the work does not need to be carried out in a hangar (Lee et al., 2008). Examples of this type of treatment such as: transit for 48 hours to do an "A" or "B" check include checking the oil, braking system, batteries, aircraft tires and other light work.

b. Base maintenance / Heavy maintenance, is a type of heavy maintenance where the aircraft must enter the hangar with a relatively long period of time. Often called a maintenance schedule with the categories "" C "and" D "Check. This type of aircraft maintenance category is carried out if the aircraft has entered 600, 1200, 5000, and 25000 Flight Hour intervals (FAA, 2016).

c. Component maintenance, Is a type of maintenance repair and overhaul for aircraft components. There are thousands of aircraft components that must enter a maintenance workshop based on a calendar or flight hours, such as: Propeller, Main Transmission, Landing Gear, and avionic devices and aircraft instruments (FAR, 2015).

d. Engine maintenance, is a type of maintenance, repair, or overhaul that is specific to aircraft engines.

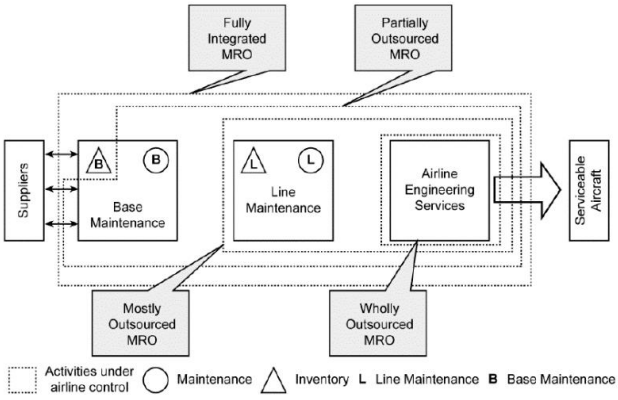

Figure 1. MRO Capabilities (Source: P. Ayeni, 2011)

Completeness of MRO Capability Requirements

MRO activities are limited by capabilities provided by the regulator. Capability requirements are given if the MRO organization has fulfilled the mandatory requirements that must be met, these mandatory requirements are (Aviation & Regulation, n.d.):

a. The availability of special skilled personnel for certain types of aircraft or certain components (certifying staff). Their expertise must be accompanied by a certificate issued by the airworthiness service.

b. Special equipment (Ground Support Equipment) for certain types of aircraft.

c. There is a maintenance manual or component maintenance manual that is used as a reference in performing aircraft maintenance and repair.

d. There is material support and spare parts from suppliers that have been bound by an agreement with the MRO organization.

e. Have a Quality System that refers to applicable regulations.

If all of the terms and conditions have been fulfilled, the MRO organization has the right to propose an increase in the capability to carry out certain aircraft maintenance and repairs to the regulator.

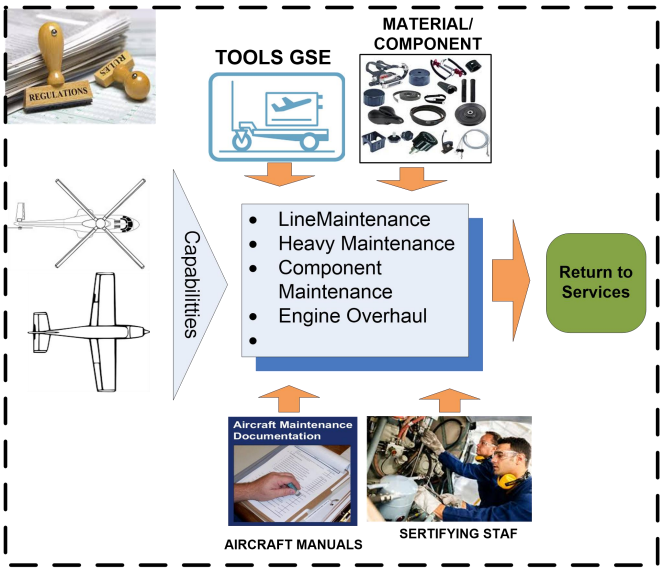

Figure 2. MRO Component(Source: Processed by authors from various sources)

Relationships between functions in MRO organizations

MRO companies have a mutually binding organizational function relationship and vary depending on the type of capabilities that MRO has, one of which is a supplier. Suppliers are the main key to the success of the delivery target factor because aircraft parts are supported by all aircraft component manufacturers (Vieira & Loures, 2016).

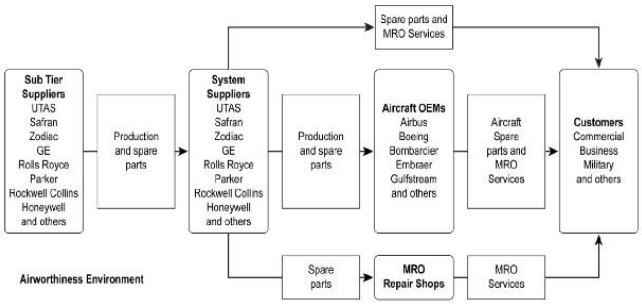

Figure 3 MRO Organizational Functions(Sources: (Vieira & Loures, 2016)

Safety Management System

Safety Management System is a set of concepts and stages of decision making intended for holders of all operational operations to handle and manage safety so as to create a safe atmosphere with minimum risk (Model, 2012). The International Civil Aiation Organization (ICAO) defines SMS as an organized approach to managing safety, including the need for organizational structure, accountability, policies and procedures (Standards et al., 2013). Whereas the Federal Aviation Administration (FAA) defines SMS as a formal approach to organizations to manage safety risks and ensure the effectiveness of safety risk control (S. A. Shappell, City, Wiegmann, & Report, 2000). SMS is a management tool that uses proactive tools, in addition to being reactive and relying on safety performance with a focus on the process (Gerede, 2015). Effective SMS is a tool in the identification of hazards and risk mitigation before work operational threats occur (Gill & Shergill, 2004). SMS consists of four main components (Standards et al., 2013) namely Safety Policy and Objectives, Safety Risk Management, Safety Assurance, and Safety Promotion

Business Processes of MRO Aircraft Companies

An MRO has two forms of business operations that are carried out, namely: maintenance services, aircraft repair and overhaul and maintenance services, repair and overhaul of aircraft components (Chang & Kora, 2014). For aircraft MRO services, licenses are obtained from aircraft manufacturers such as Boeing, Eurocopter, Bell helicopter textron or Dasault, while MRO component licenses are obtained from aircraft component vendors such as: Honeywell, Collin, Bendix King, Roll Roice or other component vendors (Taylor et al., 2010). If the license has been obtained, the next step is to apply for an operational permit to the authority, where an MRO company is established. For Indonesia, permission will be granted by the Directorate General of Civil Aviation (DGCA), which is an authorization agency under the Director General of Civil Aviation of the Department of Transportation, which has the duty as a supervisory agency for all aerospace activities related to aircraft manufacturing, airliners, and MRO activities. Permit for MRO authorization can also be obtained directly from international authority agencies such as the FAA (Federal Aviation Administration), JAA (Joint Aviation Authorities) or EASA (European Aviation Safety Agency). After the permit is received, a document called capability list (CAPLIST) will be sent, which contains a list of aircraft or aircraft components that can be repaired or overhauled. Passing whether or not a capability refers to three main aspects, the first is the existence of a manual with an official license from the vendor, the second has adequate equipment or test band, and the third has licensed human resources. CAPLIST is the main tool for marketing to get customers from various airliners or aircraft owner agencies. Capability lists are submitted by MRO companies through the Quality Inspection function (Jabarullah et al., 2020).

VI. Ideal Conditions for Implementing SMS in MRO Companies in Indonesia

The aircraft Maintenance and Overhaul (MRO) company is a profit-oriented organization. Building and developing an MRO company in a developing country like Indonesia has a high level of complexity and a very large source of capital. The safety aspect is the main concentration in the aviation business, especially in aircraft maintenance. Regulation is the main benchmark for MRO business rules in each of its operations. Safety management in the aviation industry has been formulated by the ICAO (International Civil Aviaiton Organization) in the ANNEX 19 named Safety Management System in which several countries, including Indonesia, have ratified it as CASR-19. Safety Management System is a rule base to ensure the creation of safety in every form of work task in the Civil aviation realm. In the CASR-19 (Civil Aviation Safety Regulation-19) regulation the consideration of civil aviation safety areas is more focused on the following companies:

1. Aircraft Operation Certified Company, which is a company that has the feasibility to operate an aircraft fleet
2. AMO (Airceaft Maintenance Organization) is an MRO company that has aircraft maintenance and modification functions
3. Airctrafic Services (ATC) is a government agency that has the function to regulate air traffic.
4. Aerodrome is the location of the airport where the aircraft arrive and take off in the area.

All four areas have the responsibility of implementing SMS consistently and continuously in one cycle. The implementation of the SMS Policy will run well if each core business aviation has the maximum role in carrying out the safety assurance set by CASR regulation 19

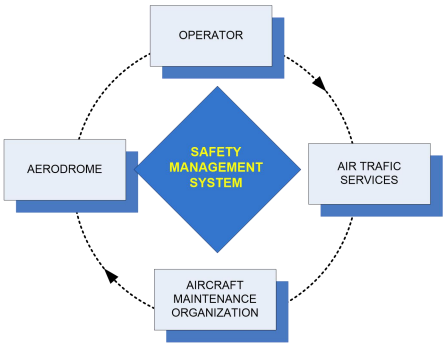

Figure 4. The area of civil aviation safety

In the realm of the Aircraft Maintenance Organization (AMO) SMS is applied in an effort to backup all elements of activities which include planning and scheduling aircraft maintenance, controlling and implementing spare parts purchasing, operating activities which include: inspection, disassembly, and reassembling activities. Equally important in maintenance operations are the planning and allocation of HR, GSE Tools, and transportation (Samaranayake, 2006). This complex problem must be able to collaborate between one activity and another without being separated from the need for policy implementation on all fronts. The maintenance activity process is a lifecycle process to return the airworthiness level condition of an aircraft to the standard level state when the aircraft was first delivered from the manufacturer. The process of returning the airworthiness condition in the form of maintenance is generally divided into 3 maintenance levels, namely: Line Maintenance, Midle maintenance, Heavy Maintenance and Engine Overhaul. Line Maintenance Process or often known as A-Check is a routine check or maintenance process carried out by the aircraft operator. While Midle Maintenance or maintenance is often referred to as B-Check and C-Check. Both of these types of treatments must be carried out in regulatory hangar MRO that has the capability for this type of treatment. This type of maintenance is carried out on the condition of the plane has pocketed 1000 hours of flying upwards. As for Heavy Maintenance or often referred to as D-Check is a total Overhaul process carried out including overhauling aircraft engines. D-Check level maintenance process is usually carried out for aircraft that have pocketed more than 2500 flight hours. The process of aircraft maintenance cannot be separated from the work partnerships that are absolutely necessary. The biggest support is from the aircraft manufacturer or often referred to as OEM. The most needed support from OEMs is in the form of technical support, Training, Material Spare, Technical Documents and field services.

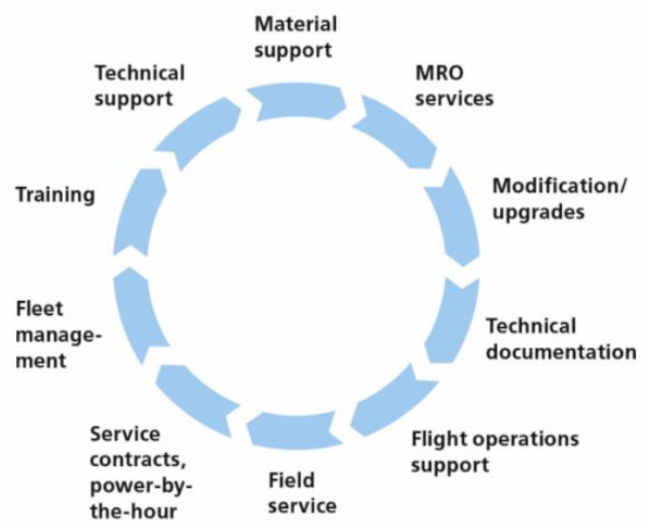

Figure 5. Airplane operation life cycle

VII. Review of SMS Implementation in MRO companies

The implementation process of applying SMS to MRO companies was built with four main pillars, namely: Safety policy, Safety Risk Management, Safety Assurance and Safety Promotion media. The safety policy covers the concentration and commitment of the company's leadership to the implementation of the Safety Management System in an MRO, especially regarding the resources that must be provided by the leadership. Safety risk management includes monitoring of all ten potential hazards with conditions below the acceptable risk threshold. Safety assurance is a safety guarantee that is demonstrated by maintaining all potential hazard data below the permitted value threshold. Safety promotion is an activity carried out continuously by the company to enhance the safety awareness of all company employees.

Figure 6. SMS Pillar (author's interpretation from various sources)

These four pillars must be fully implemented to support the vision and mission of the MRO company so that zero fatality and minimum risk can be achieved according to the minimum standards of regulation.

VIII. Development of SMS and integration with other systems

In the MRO company there is a quality management system (QMS) as a reference in the implementation of operational activities. This guideline adheres to the reference CARS 145 ammandement 6 for National regulations and EASA 145 and FAA 145 for international regulations. Basically the references used to build a quality system are generally relatively the same. In the three regulations the regulation basically contains:

a. AMO145 operating policy

b. Planning

c. Operational Provisions include the conditions for the establishment of an AMO

d. And Supervision (internal / External Audit)

In the rules of management a system must be integrated between one process with another process. Likewise, SMS must be able to be integrated with the QMS AMO 145 system. System integration is a system development process that is absolutely necessary in the business processes of today's modern companies.

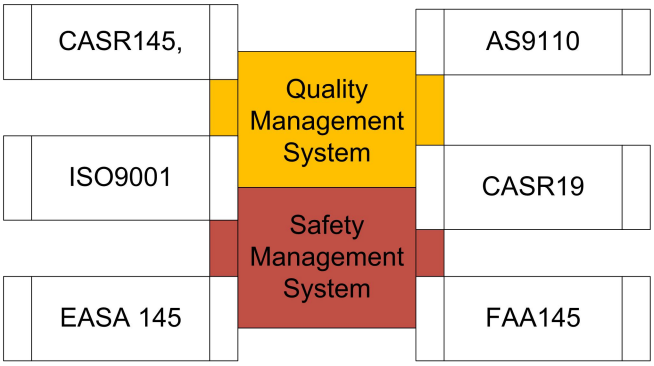

Figure 7. AMO Policy

QMS and SMS are built based on six references adopted from various applicable standards and regulations. The application of regulations is based on customer preconditions that require the implementation of various existing regulations. The integration of QMS and SMS systems is focused on one point, risk management, which in both systems ratifies the rules of various regulatory provisions for implementing risk management. If described the integration of QMS and SMS systems in the risk management spec is as follows:

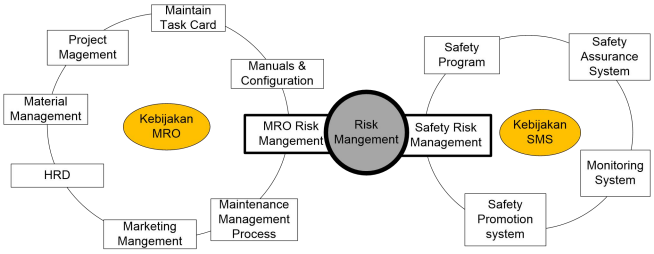

Figure 8. QMS and SMS System Integration

Based on ANNEX 19 provisions of the International Civil Aviation Organization that every ICAO member country is required to implement SMS in every aerospace industry. This binding agreement is ratified through the laws of each

country, which in Indonesia is ratified into Law No. 1 of 2009 concerning flight safety. Furthermore, it is stated in CASR19 technical reference issued by the Director General of Civil Aviation. The four SMS pillars contained in the regulation are integrated components that must be implemented for all members of the aviation industry community, including aircraft maintenance companies (AMO). In the SMS the emphasis is on how to manage risk management and safety asurance going well.

Figure 9. SMS component

IX. Ideal Business Process for AMO

To establish an aircraft maintenance service company, there are three main requirements that must be met [CASR145], namely:

1. Availability of GSE Tools along with facilities including hangars, workshops and laboratories
2. Certified personnel who have the ability and expertise in the maintenance process for certain products (both aircraft and aircraft components)
3. Airplane / aircraft components that are always updated

If the three main requirements are met, the AMO company can legally have the capability to perform maintenance and overhaul of certain products. In carrying out its activities AMO activities are controlled by two functions, namely the Quality function and the Safety Function. Ideally, both functions must be free from the influence of MRO business interests. Viewed from the function, there are two different aspects of importance between the maintenance function and the sales function, where the priority is the customer service aspect in on time delivery and low cost maintenance. While the Safety and quality functions have different views, where the aviation safety aspect is the first measure of success in a maintenance process.

NO	FUNCTIONS IN MRO	SUCCESS PARAMETERS	ORIENTATION
1	Top Management	Target acquisition contracts continue to increase	Business Oriented

2	Maintenance / Work shop	On Time Delivery	Business Oriented
3	Sales Marketing	Customer Statisfaction	Business Orieented
4	Quality Assurance	Base on Quality System Work	Regulation Oriented
5	Safety Function	Safety performance & assurance controlled	Aviation Safety oirented

To avoid the pressure of interest, ideally the quality and safety functions are always separated from the realm of maintenance activities. The Safety function in the organization is ideally outside the maintenance and sales marketing activities. This is intended to be able to objectively control maintenance activities and sales activities in the case of un aproval tasks or control work activities that are not in accordance with procedures so that they can easily be corrected and found wrong. Controls related to aviation safety include:

1. Maintenance process that is not in accordance with the guidance manual or in the absence of work implementation guidance documents
2. There is a deal with the customer related to the acceleration of work so that it violates the rules of aircraft maintenance
3. The possibility of using un-approval parts or components on an aircraft solely to make the project cost efficient
4. The existence of the work carried out by workers who do not have authorization.
5. The use of GSE tools that are not calibrated and documents that are not updated.

To anticipate all types of nonconverting activities, an objective monitoring must be carried out by the backup regulator.

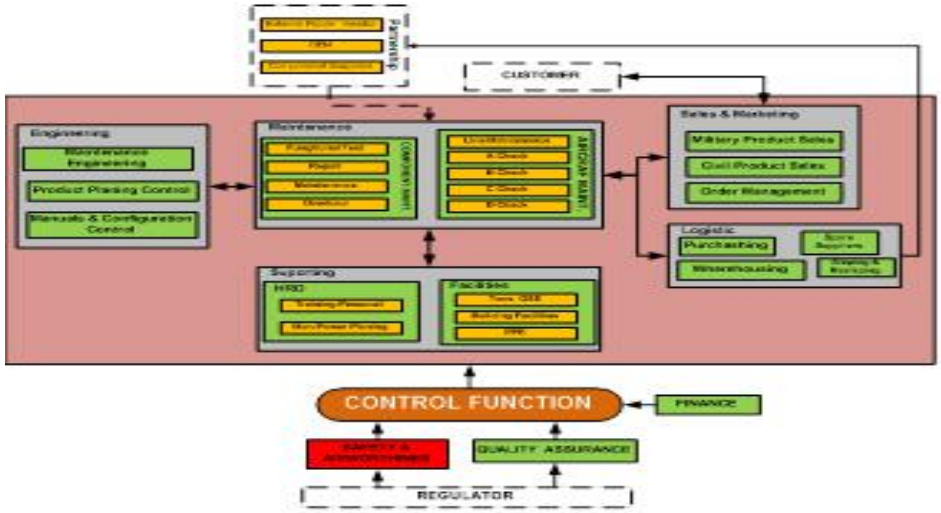

Figure 10 The ideal AMO business process

X. Conclution

Accidents in the aviation industry can cause negative effects on each flight operation, and lead to loss of equipment growth, company reputation, and customer confidence. In the MRO company or the Aircraft Maintenance Organization, resource management has a very important role because it involves a variety of ways in which management of resources can go well and according to plan. The operation of the safety system depends on joint commitment starting from the leadership of the company to the operational level workers. The safety management system starts from the company's initiative to implement safety management that is triggered and motivated by safety leadership. Ideally, the interests of the aviation safety function and MRO business functions should be carried out moderately where each other supports each other so that the maintenance process can run well without ignoring the safety aspects.

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