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# TQM DIMENSION IN THE RMAF INTERNAL SUPPLY CHAIN MANAGEMENT: ANALYSIS ON CENTER FOR AEROSPACE AND ENGINEERING SERVICE (CAESE)

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## ABSTRACT

The Royal Malaysia Air Force (RMAF) depends on external and internal supply chain to support its operation. One of the important organisations in RMAF is the Centre of Aerospace Engineering Services (CAESE) that functioned as the center of expertise for Research and Development. The RMAF depends on CAESE for sustainable design and development to lessen the dependencies on the foreign aircraft and system manufacturer, for specialized support and modernization. CAESE provides the technical support, maintenance support and predictive maintenance to RMAF squadrons to ensure that RMAF's aircraft will always meet with operational requirement and readiness. As demands grows due to the progressive nature of aircraft ageing, and increasing of operational requirement, CAESE had been challenged by the limited resources of personnel, materials, and equipment in continuing supporting RMAF's squadrons with efficient and effective technical solutions. The RMAF supply support was threatened with disruptions, delays, inaccuracy and substandard quality of products and services, that caused the RMAF sustainable design and development support degradation, that further reduced RMAF capacity and capability. This research paper seeks to analyse the issues of supply support in CAESE focusing on the supply chain management and the application of total quality management principles and dimensions to help mitigate and find innovative solutions. The qualitative study had analysed the documented data from CAESE's records and supported by interviews and substantiate with secondary data from available literatures and journals. The results showed a significant and positive relation of total quality management dimensions consist of leadership commitment, customer focus, employee participation, continuous improvement and innovation, and training and education, towards improvement in the supply chain flexibility, efficiency, performance, and cost reduction, with compliance to the airworthiness regulatory standards. These findings may help RMAF to identify the important factors in assisting future policy and regulatory development for a better supply supportability in its organisations.

## ABSTRAK

Tentera Udara Diraja Malaysia (TUDM) bergantung pada rantaian bekalan luaran dan dalaman untuk menyokong operasinya. Salah satu organisasi penting dalam TUDM adalah Pusat Perkhidmatan Kejuruteraan Aeroangkasa (CAESE) yang berfungsi sebagai pusat kepakaran untuk Penyelidikan dan Pembangunan. TUDM bergantung kepada CAESE untuk reka bentuk dan pembangunan lestari untuk mengurangkan kebergantungan pada pengeluar pesawat dan sistem asing, untuk sokongan dan pemodenan khusus. CAESE memberikan sokongan teknikal, sokongan penyelenggaraan dan penyelenggaraan ramalan kepada skuadron TUDM untuk memastikan bahawa pesawat TUDM akan sentiasa memenuhi keperluan operasi dan kesiagaan. Ketika permintaan semakin meningkat kerana faktor penuaan pesawat yang progresif, dan peningkatan keperluan operasi, CAESE telah dicabar oleh sumber tenaga kerja, bahan dan peralatan yang terbatas dalam terus mendukung skuadron TUDM bagi terus memberikan penyelesaian teknikal yang efisien dan efektif. Sokongan bekalan TUDM telah berhadapan dengan ancaman gangguan, kelewatan, kualiti produk dan perkhidmatan yang tidak tepat dan tidak berkualiti. Ini telah menyebabkan kemerosotan dalam sokongan reka bentuk dan pembangunan TUDM yang selanjutnya telah mengurangkan kapasiti dan kemampuan TUDM. Penyelidikan ini bertujuan untuk menganalisis isu-isu sokongan bekalan di CAESE yang memberi tumpuan pada pengurusan rantaian bekalan dan penerapan prinsip dan dimensi pengurusan kualiti total untuk membantu mengurangkan dan mencari penyelesaian inovatif. Kajian kualitatif telah menganalisis data yang didokumentasikan dari rekod CAESE dan disokong oleh wawancara dan pembuktian melalui data sekunder dari literatur dan jurnal. Hasil kajian menunjukkan hubungan yang signifikan dan positif dari keseluruhan dimensi pengurusan kualiti terdiri dari komitmen kepemimpinan, fokus pelanggan, penyertaan pekerja, peningkatan dan inovasi berterusan, dan latihan dan pendidikan ke arah peningkatan fleksibiliti, kecekapan, prestasi, dan biaya rantai bekalan dengan piawaian peraturan kelayakan udara. Penemuan ini akan dapat membantu TUDM untuk mengenal pasti faktor-faktor penting dalam membantu pembangunan dasar dan polisi masa depan untuk sokongan bekalan yang lebih baik.

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## ACKNOWLEDGEMENT RECEIPT FOR FINAL PROJECT PAPER

This final project paper titled, "**TQM DIMENSION IN THE RMAF INTERNAL SUPPLY CHAIN MANAGEMENT: ANALYSIS ON CENTER FOR AEROSPACE AND ENGINEERING SERVICE (CAESE)"** produced by **LT KOL SAMSURI BIN ABU BAKAR RMAF** Matric No **3201308** has been accepted as having fulfilled the partial requirements for the Master of Business Administration (Supply Chain and Logistics).

(Signature of Supervisor)
**Lt Kol Hamzan bin Abdul Jamil (Retired)**

Date: 01 MAC 21

## DECLARATION

I have read and understood the rules on cheating, plagiarism and appropriate referencing as outlined in my handbook and I declare that the work contained in this paper is my own, unless otherwise acknowledged. No substantial part of the work submitted here has also been submitted by me in other assessments for this or previous degree courses, and I acknowledge that if this has been done an appropriate reduction in the mark I might otherwise have received will be made.

Signed candidate:

You are required to justify your submitted Project Paper against the degree definition for which you are registered.

Project definition for my degree:

The project should normally be related to supply chain and logistics environment. It could address many different aspects such as business, administration, and management issues. My project relates to this definition in the following way:

1. The project is centered on TQM dimensions related to supply chain management.

2. This project addresses the aspect of supply support in Center of Aerospace Engineering Services (CAESE).

3. The intention of the project is to assist and improve Royal Malaysian Air Force – CAESE Supply Chain Management.

4. The recommended improvements in this project are based on the best practices taught in the MBA modules.



The above shows the relevance of the work to the degree for which it is submitted.

| | Signed | Agree (√) | Disagree (√) |
|---|---|---|---|
| Supervisor: Lt Kol Hamzan bin Abdul Jamil (Retired) | | | |

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## ABBREVIATION

| | |
|---|---|
| AMO | Aircraft Maintenance Organisation |
| AEO | Authorised Engineering Organisation |
| ASIP | Aircraft Structure Integrity Program |
| CAESE | Centre Aerospace Engineering Services Establishment |
| CBM | Condition Based Maintenance |
| DGTA | Directorate General Technical Airworthiness |
| FMEA | Failure Mode and Effect Analysis |
| ILS | Integrated Logistics Support |
| MCY | Malaysian Commercialization Year |
| MRO | Maintenance Repair and Overhaul |
| MTO | Military Transport Officer |
| RMAF | Royal Malaysian Air Force |
| SC | Supply Chain |
| SCM | Supply Chain Management |
| TQM | Total Quality Management |
| QMS | Quality Management System |

# CHAPTER 1

# INTRODUCTION

## 1.1 INTRODUCTION

Supply chain management include series of activities in a system that integrate all the suppliers and manufacturers through a network of connection, transportation and warehouses that linked the products to the final users. The supply chain may be long or short, massive or simple depending on the products or the services. The chain of entities involves along the path of the product create a map that describe the total journey of materials from one part to another. To ensure the chain of entities meet with the user requirement in term of time and cost, it is important that the supply supportability consideration is given attention. Supply supportability involved the supply chain resources planning and designing, to meet with the operational requirement.

As the supply chain management and supply supportability becoming an important subject of thoughts, the Total Quality Management and its principle had been included to improve the organisations supply chain with the objective of cost reduction, quality improvement and productivity enhancement. Integration of the TQM in the supply chain management had created a more superior performance and termed as supply chain quality management. Today, TQM had become as an important tools and standards across the organisations to promote customer satisfaction and competitiveness of the organisation. The efforts that tailored to the TQM principles had created a conducive environment that promoted continuous improvements in delivering high quality products and services to the customers.



## 1.2 BACKGROUND OF THE STUDY

The Royal Malaysian Air Force is an organisation that ensures the integrity and security of the Malaysian airspace as well as supporting humanitarian aid and disaster relief missions by providing strategic airlift capabilities. The range of aircraft that are being used by the organisation had created a wide network of supply chain involving assets that were intended to fulfil the

fighting capabilities, maritime surveillance, strategic and tactical airlift and airspace monitoring and control systems. In order to ensure the quality of the products and services, RMAF had adapted the related TQM principles in the internal supply chain that cover establishments such as the aircraft squadron, airspace monitoring facilities, maintenance, engineering and logistic support organisations, warehouses and the transportations entities. The main aim of TQM in RMAF is to ensure the cost effectiveness and productivity of the organisation remain at a competitive range due to the strict expenditure control by the government. The elements of TQM principles had been published in the RMAF quality manuals, that act as a guidance to the implementations. However, the application parts of the TQM principles in the organisation are still open for improvements to allow effective supply chain and ensure the continuation in cost reduction and productivity improvement. In order to gauge the success of TQM implementation in the RMAF organisations, a study need to be carried out to ascertain the effectiveness and to identify the gaps and shortcomings in the RMAF supply chain organisations.

## 1.3 PROBLEM STATEMENT

One of the important organisations in RMAF is the Centre of Aerospace Engineering Services (CAESE) that functioned as the centre for Research and Development in RMAF that provides and supply the technical support, maintenance support and predictive maintenance to RMAF squadrons. As demands grows due to the progressive nature of aircraft ageing, and increasing of operational requirement, the limited resources of expertise, materials and equipment had challenged CAESE in supporting RMAF's squadrons with efficient and effective technical solutions that had caused delays, inaccurate and unairworthy products and services. Faced with limited resources beyond its control, CAESE had to find, develop and execute alternative and innovative measures to support the demand through systematic and structured resource planning and supply chain management to avoid disruptions in the supply support.

The scope of CAESE in the RMAF supply chain is focused on providing engineering technical solutions to the aircraft squadrons and therefore it is very important to ensure that the product quality meet with requirement through a control process. Some of the services provided by CAESE are as follows:

a. **Design and Technical Support.**

CAESE is the only organisation in the RMAF that can alter or modify aircraft maintenance procedures, parts, and components. Some of the project involved alteration, modification, productions and certification of aircraft parts and changes to aircraft maintenance instructions. In recent years CAESE had been able to produce several aircraft parts such as the carrier system for laser guided bomb LGB on Su30-MKM fighter aircraft, fabricating of aircraft brake parachute system for Su30-MKM, produced the launch platform for Aircraft Combat Maneuvering Instrumentation ACMI pods onboard Su30-MKM and produced the alternative overhaul procedures for Su30-MKM.

This segment of service in CAESE had offered RMAF the alternative supportability without depending on the external supply chain and thus, allowing for a certain degree of flexibility to lower the dependability on the upstream supply network. The important factors that contributed to the success in this service segment is the assets, including human resources, equipment, process and data management in CAESE and its support network.



This segment of design and technical support services required the presence of CAESE's team with their related equipment at the RMAF squadrons in Air Bases across Malaysia. The efficiency of transportation is important to avoid delays in providing services that are increasing in frequency. The ground transportation that connects CAESE to its long-distance supply chain network ranging from 560 km away in RMAF Gong Kedak, 436 km to RMAF Alor Setar, 350 km to RMAF Butterworth and 250 km to RMAF Kuantan had faced with the issues of shortage of divers that caused delays in providing technical services to the squadrons. Without efficient transportation, CAESE supply chain network will face with delays and subsequently will cause negative impact to the RMAF operational capabilities and readiness. Thus, this issue needs to be analysed and improved since the performance of transportation management is critical for CAESE to deliver technical service within the fastest time required.

b. **Maintenance Support**

The maintenance support provided by CAESE is in the area of Non-Destructive Testing (NDT), Aircraft Metallic Structure Repair and Aircraft Weighing. The data from the NDT and weighing activities will be used to verify and validate the status of the aircraft, the structure and its systems.

The quality of the maintenance support provided by CAESE depends on the quality of the equipment used and the accuracy of the information given by the squadrons. The correct information on the structural defects found on the aircraft at the squadrons will allow accurate diagnostic procedure to be carried out in CAESE. This includes preparing the right repair plates for the structure repair scheme before the repair work can be carried out on the aircraft at the squadrons. This is because metal forming capabilities currently only available in CAESE.



The information of the defect's categories, dimension, shapes, and locations (with pictures) are passed through defect reports from the squadron to CAESE via the internet. However, the information often has inaccuracies to the dimensional measurement that had jeopardized the repair services. The situation had caused unwanted delays and prolonged of 'aircraft on ground' status. Thus, the quality of the defect reporting and communicating procedures need to be analyzed and improved to ensure that the quality and efficiency of CAESE in delivering the correct products and services on time.

c. **Predictive Maintenance**

Predictive maintenance is part of preventive maintenance under the concept of condition-based maintenance. CAESE is the only organisation in RMAF that provide predictive maintenance in form of Spectrometric Oil Analysis Program (SOAP) and Aircraft Structure Integrity Program (ASIP).

The Aircraft Structure Integrity Program (ASIP) used flight and maintenance data from the aircraft in the squadrons that is gathered daily and analyse in CAESE. The data will form as the basis for the predictive maintenance of the structure that are customised according to the aircraft type and flight profile, that are reported on monthly basis to the RMAF Air Support Command. RMAF Air Support Command will then use the predictive data to plan for maintenance activities that include aircraft modernisation, structure life extension and to acquire the maintenance support from the aircraft manufacturer. The ASIP program is tasked to CAESE because the program required special technical knowledge, engineering expertise and database control processes.

RMAF Air Support command managed the supply support for all the squadrons with high dependencies on aircraft manufacturer in the upstream supply chain due to the airworthiness regulatory requirements. However, when disruption occurs in the upstream supply chain, RMAF had to turn to CAESE as the internal resources to provide alternative solutions.



In 2017, the Russian aircraft manufacture Rosoboronexport through official correspondence, had stated that all the Su-30MKM need to be overhauled after reaching 10 years in service with a cost projection of RM2.2 billion. The overhaul is mandatory or RMAF will face a critical risk of flying with unworthy condition.

Facing with the sudden disruptive situation in RMAF supply chain, CAESE had to depend on the ASIP data to analyse and to propose alternative structure life extension program with a cheaper cost. Thus, the quality, validity, and reliability of the ASIP data gathering and analysing processes need to be justified to ensure that the alternative solution in structure maintenance proposed by CAESE will meet with RMAF airworthiness requirement. Without the justification process, the alternative maintenance solution may not be accepted by RMAF Air Support Command as the customer, or in the worst case if it is accepted due to negligence, then there is a fair chance that the structure will catastrophically fail in the air. Thus, the ASIP data is very crucial for the

sustainability of the RMAF supply chain and thus the quality and reliability need to be validated to ensure success.

In order to deliver the products and services mentioned above, CAESE had to ensure that the assets inclusive of human resources, equipment, processes and the technical data are managed effectively. TQM principles may help CAESE to achieve the desired products and service quality, with effective cost and delivered perfectly within the planned time range. By engaging the TQM principles in those areas, CAESE may achieved:

a. Efficient technical and maintenance support provider.

b. Better services and products quality.

c. Better process management that promotes effective cost and productivity.

d. Improvement in data management capability to ensure product quality and safety.

## 1.4 RESEARCH OBJECTIVES



The research objectives are as follows:

a. To identify the TQM dimension that are important to the supply support in RMAF Centre of Aerospace Engineering Services (CAESE).

b. To analyse each of the TQM dimensions in related to the supply support in RMAF Centre of Aerospace Engineering Services (CAESE).

c. To identify benefits of the TQM best practises applications to the supply support in the RMAF Centre of Aerospace Engineering Services (CAESE).

## 1.5 RESEARCH QUESTIONS

The research question for this paper are as follows:

a. To what extend does the Total Quality Management dimensions being implemented in the management of human resource, equipment, processes and data management in CAESE.

b. What are the impacts of Total Quality Management dimensions to the human resource, equipment, process and data management in CAESE and the results benefits.

c. How can the Total Quality Management best practices be implemented in CAESE to support the products and services.



## 1.6 CONCEPTUAL FRAMEWORK

The research will cover the Total Quality Management dimensions currently being implemented in CAESE to deliver the products and services. The preventive maintenance, predictive maintenance and design support services provided in CAESE depend on its assets, inclusive of human resources, equipment, processes and data management that formed the important factor for CAESE to deliver efficient and effective products and services in the RMAF supply chain, thus providing supportability to the aircraft fleet. The TQM practices in focus are the leadership and managerial commitment, customer focus, employee participation, continuous improvement and innovation, and training and education.

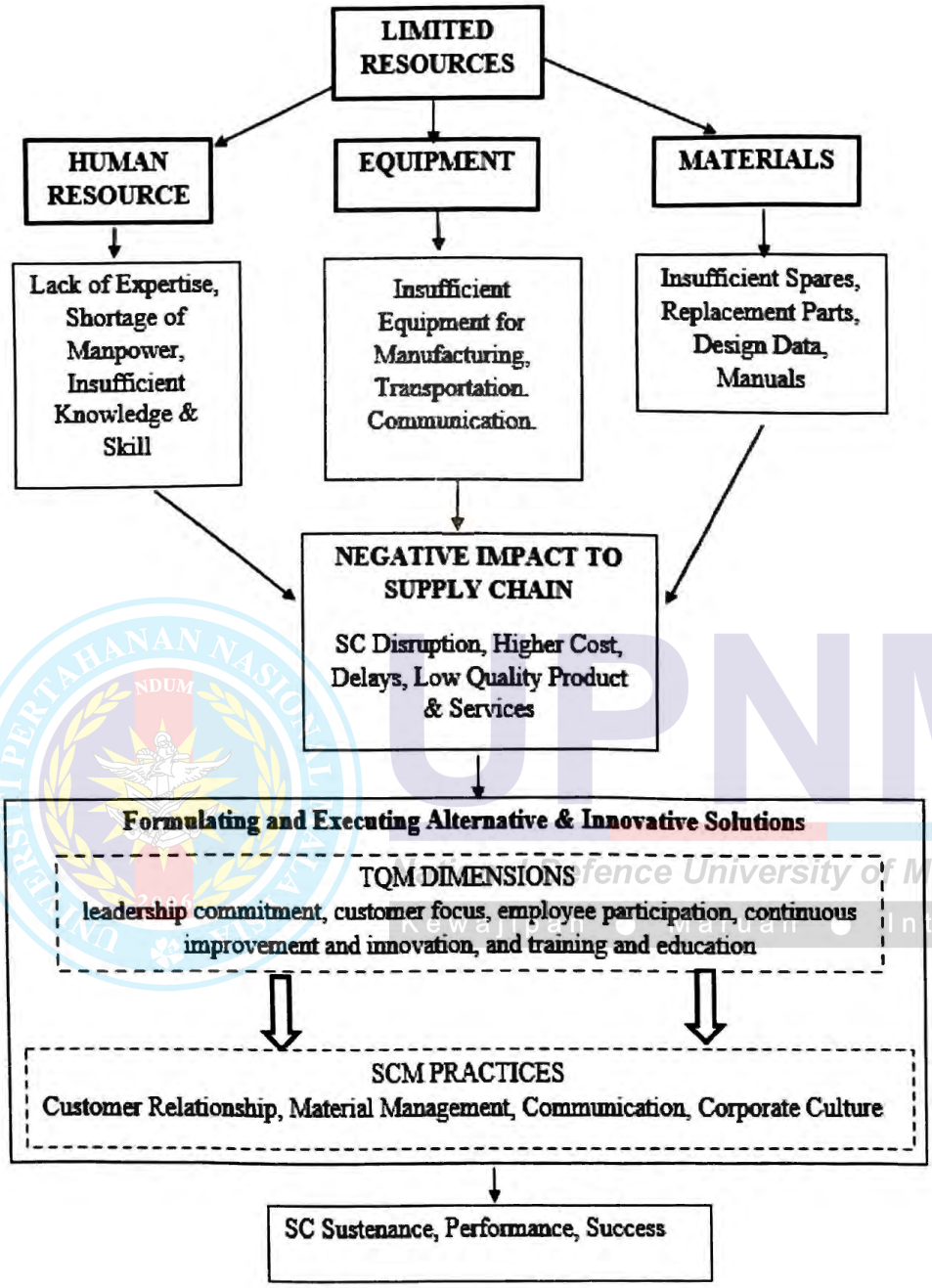


Figure 1.1: Conceptual Framework

## 1.7 SIGNIFICANCE OF THE STUDY

The RMAF supply supportability depends on the effectiveness of the organisations in its supply chains, to deliver the services effectively at the right time, quantity with acceptable quality. The unavailability of services in its organisation such as CAESE will cause a significant amount of financial burden and lost of operational capability in all the squadrons being supported by CAESE as customers. Results from the study will enable RMAF to improve the productivity and quality of its supply chain through implementation the TQM dimensions in CAESE's assets such as human resources, equipment, process and data management. Thus, RMAF will be able to sustain a credible force through supply chain quality management.

The efficient and effective products and services provided by CAESE through the implementation of TQM principles and dimension, may become the measurement standards in setting up a better Research and Development centre in RMAF. The quality of the preventive, predictive and design support services provided will ensure RMAF will remain as a formidable and competitive air force in the region. As few of the services and products delivered by CAESE have high commercial value, the implementation of improvement in the TQM dimension may increase the potential.



## 1.8 OPERATIONAL DEFINITION OF TERMS

### Data Management

Data management in RMAF is an organizational method that requires the acquisition, authentication, storage, security and processing of necessary data in order to ensure that the data is available, accurate and timely for its users. It refers to the data that RMAF are using to make strategic decisions and obtain comprehensive insights into aircraft health, operational behaviour, flight patterns, supply chains activities that are utilised for the opportunity to generate effectiveness in management of the internal supply chain organisation.

## Supply Supportability

In this study, supply support is referring to the support system that enable a requirement at the RMAF internal supply chain being fulfil accordingly. Analysis of supply supportability involves the techniques and methodologies undertaken to carry out the preparation, development, engineering systems, manufacturing and management that are necessary to ensure the supportability of aircraft systems and equipment operated by users. Supply support covers all the requirement needed to execute the given task, mission or objectives and are subjected to the type of requirement. It may involve assets, spares, human resource, facilities, equipment or data that are needed in order to accomplish the given task.

## Human Resource

Human resource includes the people in the organisation with the ability, skills and talent that formed as the organisation work force. The internal human resource may be positioned according their expertise and skill level that are synergized to achieve the organisational objective. With the intention to improve the organisation, any person that are willing to exchange their labour, expertise, or time for pay is considered a human resource. Human resource is part of the organisation assets along with capital equipment, supplies or facilities and are considered the most significant assets. It is important to recruit, satisfy, inspire, grow, and retain employees. A department of human resources is the office that oversees the human resources in the organisation. Humans need more support and a different strategy than most assets, so it is beneficial to have a department dedicated to human resource.

## Total Quality Management (TQM)

Total Quality Management or in short TQM, is a constant and sustain management and employee's effort to achieve their specified organisation objectives in ensuring and securing a long-term trust from the customer in meeting the customer expectation (Saxena & Srinivas Rao, 2019). Performance or quality may be evaluated with respect to reliability, efficiency,

implementation and several other criteria. Total quality management is a systematic approach and initiative by the staff and management through sufficient reviews and analysis to continuously enhance the quality of their goods and services through teamwork and collaborative efforts (Sahoo, 2020). Implementing TQM in organisations are always related and connected to the quality management system or QMS.

**Quality**

Quality has become an important terminology which defines a collection of features most required in the manufacturing and service industry. Each business strives to produce its goods and make high quality of its services. This can be translated as stating that the prices of these services are greater than the average, to the degree that consumer needs are met. Product quality refers to a collection of the specific destination and operation-related functionality in accordance with the criteria defined by clients or customers. Consequently, consistency characteristics are the result of product social usage referring to the time period within which the product performs properly (Botezatu et al., 2019).



**Quality Management System (QMS)**

According to Soare & Militaru, (2018), QMS standard EN 9100: 2016 / AS 9100D is a known quality management standard for the aerospace industry that currently being adapt by leading aerospace companies, and it covers the entire supply chain process including design, manufacturing, maintenance and distribution in which will ensure of a controlled processes for continuous improvement. Implementation of AS9100 will further define the important roles and responsibilities of staffs that in return it will improve efficiency and productivity. It will also help in meeting with the customer expectations. leads to better operations, improved on the organization's performance, increase the profit and the most important it will meet the requirement of applicable law and regulations of the aviation industries (Tomic et al., 2012).

Ramdass & Nemavhola, (2018) mentioned in their study, that the QMS ISO 9000 series is considered as the basic elements identified in a quality system and regarded as a tool to ensure

the conformity of the elements in an organization and this was supported by Oschman, (2019), that stated there is evidence that an AS9100 QMS framework is required for service quality assurance. Meanwhile, (Homolka et al., 2019) also stated that the QMS will be able to prevent failure to the maintenance and logistics due to human factors, by implementing concept such as the failure reporting system, that is considered as crucial requirement to the airworthiness regulation.

# CHAPTER 2
# LITERATURE REVIEW

## 2.1 INTRODUCTION

In this literature review the concept of Total Quality Management TQM and Supply Chain Management SCM will be explored and established. The relation and interaction between TQM concept and the fundamentals of SCM will form a basis of understanding of the Authorised Engineering Organisation framework (CAESE) and the requirement to solve the issues faced by CAESE. The characteristic of Quality management System QMS will be further elaborate trough the philosophy and methodology of previous researcher. In order to give a better perception on QMS several past studies on the achievement and scope of QMS applications in several aviation related industries. The theories and models of TQM will be described through the journal and article related to the famous TQM scholars that will become the basis for the conduct of this study in order to answer the research questions and also solving the issues faced by CAESE.



### 2.1.1 Airworthiness Concept

According to De Florio, (2011) airworthiness is define as the features or characteristic that represent the necessary requirement for a safe flight conditions within the allowable tolerance. Three distinct consideration of airworthiness are: safe for flight conditions, having the necessary requirements, and the allowable limits (De Florio, 2016).

According to definition stated in the Technical Airworthiness Management Manual TAMM, the airworthiness is defined as an applied concept that will specify the condition of aircraft that represent the basis in judging the suitability for flight of that particular aircraft with the evidence that it had been design, manufactured, maintained and operated according to the approved standards within the design limitations, by the approved and competent person under

an approved organisation that are certified by the authorised body acting on behalf of the Government of Malaysia (RMAF, 2015).

### 2.1.2 **Airworthiness and Quality**

According to Peri (2010) airworthiness is not the same compared to quality. He argues that the quality requirement set forth in the regulations are subjective and very general in the implementation. Therefore, the quality assurance system of aviation organisation had to be individually furnished with further important scope of work that specific to their need of their quality control system, to supplement the requirement of the regulations. Peri (2010) also stated that the organisation still needs to set up and maintain a quality control system that is acceptable to the airworthiness authority and ensure the airworthiness state of the article.

From the literature it can be summarised that the regulation for continuing airworthiness cover a wider scope of safety, reliability and quality that need to be specified further in order to be accepted by the airworthiness authority. The requirement to establish a quality system is part of the regulation directives to ensure airworthiness, however the thorough implementation of quality policy, quality planning, quality controls, quality assurance and quality improvement need to be further analysed and documented separately by the organisation based on their nature of work process. The difference in airworthiness and quality had been established.



### 2.1.3 **Quality Requirement in the Airworthiness Regulations**

According to TAMM (RMAF, 2015) every airworthiness approved organisation must implement the quality system or the framework, within the scope and area of which the engineering activities is being conducted. The specific quality standard had been mentioned that is the SIRIM ISO 9001 that is regarded as basic requirement and supplementary to the Engineering Management System or EMS. Both of the management system (QMS and EMS) is required in the regulation 3.2.6 of the TAMM, and the EMS is considered an extension from the basic QMS management system. The TAMM later explained in sub para (a) that the QMS certification or "equivalent system" is the minimum standard of QMS required.

According the regulation 4.4.4 of Quality Management System, all Approved Engineering Organisation AEO must be accredited with the ISO 9001 certification but consensus is given to an uncertified quality system that are "acceptable to DGTA". The lesser Quality System must be evaluated for a sufficient range and characteristics that suit the application and maintenance standard to allow indication of quality level and measurement of the effectiveness. The term acceptable have a minimum requirement that are:

a. Documented processes of the system operation
b. The processes must be reviewed by the senior management.
c. Analysis of quality measurement and improvement (for example, internal quality audits, corrective and preventative action procedures).
d. Must be compliance to the organisation's Maintenance Management plan.

Under regulation 4.5.4 TAMM further mentioned on the requirement to have a Quality Manager that will be responsible to report on quality matters. The quality manager must also have the appropriate qualification, training and experience to handle the responsibility.



In Part 3 Chapter 2 para 7 (a) of the TAMM (RMAF, 2015) the Quality System in an Approved Engineering Organisation AEO must be maintained by the Senior Design Engineer SDE. The SDE is to be responsible for the continuation of the QMS certification of ISO 9001 or equivalent in which it will cover the services provided.

From the literature above it is understood that the QMS certification is not a mandatory requirement but considered as good to have. The uncertified but acceptable quality system to DGTA, is considered a measure to balance between quality requirement and the impact to the cost and effort to the RMAF for certification and continuation processes of all the maintenance and design organisation, from the researcher perspective. However, the lesser but acceptable quality management system need to be studied further.

### 2.1.4 **Quality Management System (QMS)**

According to Saxena & Srinivas Rao, (2019) quality is very important for an organisation to stay in business that highlighted the requirement to focus on the service quality and also the quality of the manufactured products. Some of the quality standards being used and implemented such as the ISOs series will help to measure, analyse, monitor and also enhance the specified processes to gain the consistency and conformity of the manufactured product or services. This concept has been formed, configured and known as the quality management system to enhance the productivity, quality and effectiveness (Nair & Gayatri, 2019).

According to Hussain et al., (2014) the ISO 9000: 2000 had defined quality as the extent and level that represent a set of features and characteristics that meet the requirement. The quality and safety have similar interpretation that include the management activities such as strategic planning, human resource, organisational setup, and the command and control of TQM activities. They also stated that the quality inspection is a very important activity to measure conformity to the standards that may be in term of testing, examine and comparative measurement. The quality control in the hand is the techniques and strategies that are implemented to ensure the quality requirement. They have cited Moosa (2000) that define quality assurances as the actions and measures taken to prevent defects and unconformities that will increase the chances of the required quality standard will be realised. The Total Quality management is the most prominent standards in quality that able to integrate all related features, functions and procedures within the business environment to attain the continuations in improvement of the product and service quality to meet the customers' needs and satisfaction.

It is found from the literature, that the QMS certification is essential to prove that the organisation had implemented a quality system in accordance with the Total Quality Management concept and philosophies that will give the benefits of reducing the probability of defects to achieve quality.

## 2.2 PREVIOUS STUDIES

In this section several various studies will be analyse to create a better picture of the benefits, challenges and issues regarding the implementation of the QMS in aviation organisation.

### 2.2.1 QMS applications in aviation industries

a. Gališanskis, (2004) had conducted a study of the main attributes and evaluation of a quality assurance system QMS focusing to the management of aviation organisation in general. He had found that the quality management is important that have impact to the aircraft maintenance and technical system in achieving the best quality standard that will ensure the aircraft airworthiness. He had stated that Total Quality Management TQM is important for aircraft maintenance organisation to be able to maintain the survival and to be competitive in the industries. The direct interaction between TQM and the ISO 9000:2000 series standard instrument encompasses important attributes such as the person qualification, training and experience or QTE. The element of control such as the compliance audits may be carried out by an external independent agency and also internally by themselves. For civil aviation the organisational quality assessment and evaluation is carried out by adhering to the US Federal Aviation Administration FAA and the European Joint Aviation Authorities JAA regulations that include the ISO 9000 standards for maintenance organisation. Gališanskis, (2004) had also produce a statistical models and method to evaluate and measure the results from the compliance audits by using statistical models that enable to represent the quality into quantitative indexes.

b. Woźny & Blachinio, (2015) had published a study on the efficiency of the aircraft maintenance and repair centres that depends on the diagnostic results to troubleshoot in finding the cause of failure in cases of malfunctions. They had carried out the analysis to measure and monitor the relations between the task implemented and the test equipment being used, and the impact to the quality of the sub system operations.

They had highlighted the vital importance to measure and monitor the quality of the sub system operations that have been identified as requirements in the PN-EN ISO 10012:2003 standard that supported the previous study by Muślewski, (2010). They have stated, The Allied Quality Assurance Publication or AQAP imposed a strict requirement to observe and monitor the equipment used for measurement and also the measuring process, that include the management of metrological aspects and compliance to the measuring and testing guidelines.

c. In another study, Zhang et al., (2014) had mentioned that in order to gain customer loyalty, the aviation engineering company must set up its own quality control program to indicate their ability to deliver and continually develop safe and reliable products that reaches or exceeds customers' expectations. They have also related the requirement of the quality standards in ISO such as the QMS to the regulatory requirement to obtain the certification as design organisation approval DOA from the aviation authority. They have concluded through supporting evidence and analysis, that it is necessary for aviation organization to establish effective QMS such as AS9100, that will cover all the functional policies, guidelines, rules and regulations in ensuring the effectiveness of the Engineering Quality Management System, in order to acquire for the Design Organization Approval from the aviation authorities, which will legally approved their organization.



d. Wang & Zhang, (2020) had stated in their study that commercial airplane registration is a mechanism that shows whether or not the aircraft configuration compliant with the airworthiness requirements. Requirement and specifications management has been increasingly introduced in the civil aircraft design system and architecture in recent years. The requirement management had demonstrated a framework that can be incorporated into a variety of associated demands or standards, including airworthiness, that highlighted the importance of specifications, verification, testing and evaluation. However, they had argued that the nature of requirements is hierarchical, or classify according to the needs at different stages of the process, that the technical aspect of the regulation had unable to correlate between the requirement and

regulations (Wang and Zhang, 2020). They have studied and introduced the application of engineering methods that introduced the requirement into the design and manufacturing of aircraft to address the issue of the requirements needs along with the life cycle of the aircraft development. This had resulted in implementation of a comprehensive regulatory requirement that effectively ensure a more through interactions between requirement and the system development.

e. Woźny & Blachinio, (2015) mentioned that the aircraft usage inclusive of maintenance and repair activities involve processes that need a standard of quality. They had conducted the study of the quality management in the aircraft maintenance and repair by analysing the related technical documents and comparing to standards and regulations that influenced the quality. Their study had developed the measurement management mechanism within the evaluation sub-system that was described in the form of a model built on the basis of standard items in the PN-EN ISO 10012:2004.

## 2.3 THEORIES AND MODELS

This section will explore the theories and model related to quality that had been develop since the beginning of industrialisation and at the end of this section the relationship between the theories and model will be formed to assist in the research.

### 2.3.1 Total Quality Management

TQM includes the creation of a performance environment that every employee of the organization strives to satisfy its customers. Hellsten and Klefsjo (2000) regard TQM as a continuously improving management system made up of methods, tools and merits. The terms "total" meaning "entire," "Quality," meant to refer to the extent of exceptional service and "Management" as a conduct of actions and a way of dealing and assisting.

Brun (2011) describes TQM as an incorporation mechanism that includes all members of the organisations involving departments of accounting, engineering and manning collaborating

in accomplishing the organisational objectives and also meeting the customer requirement. He stated that the effort of total involvement is to achieve the customers requirement and organisational objectives.

Ngambi and Nkemkiafu (2015) had incorporated the element of management strategies in TQM to achieve the desired quality and productivity. They had added that TQM is inclusive of management principles that further furnished the TQM concept that involve internal and external from employee, department, suppliers, customers and users to achieve the quality objectives. This had been supported by Patyal and Madduley, (2015) that mentioned the purpose of TQM is a long-term strategic process that benefit the customers, employees, departments, suppliers and users.

### 2.3.2 **TQM Principles**

According to Alghamdi, (2016) the key aspect in implementing TQM is to pin point the important principles. He added that the contributing factors is very wide but cited that Sallis (1993) had scope down to five, that are the leadership, employee empowerment, teamwork, training, and culture change. Even though there are several other factors that being studied in the past and differs in implementation processes between organisations, most of the researcher agreed that TQM is an acceptable fundamental in all organisation (Juran, 1986 as cited in Alghamdi, 2016).



#### a. **Leadership commitment**

Alghamdi (2016) mentioned that leadership quality is the most important factor in implementing TQM in an organisation that was agreed by Deming (1994) and Juran (1986) in their studies. Management decision is usually the key factor for the failure in implementing TQM (Deming, 1994). Crosby had also agreed on this fact, and later introduce a program that include leadership commitment to improve and built effective TQM processes. Vora (2000) in his studied also mentioned that TQM implementation will not be successful if the top management leaders did not participate. The leadership

commitment is very important and plays the role that leads to the successful execution of TQM program.

b. **Employee empowerment**

One of the main leadership objectives is to inculcate workers' confidence and commitment. Spanbauer (1992) had provided a framework for motivation in the field of education. He stated that in order to inspire employees, managers should: engage all employees in problem-solving exercises and make use of core research strategies and quality methodologies; employee should be given the chance to actively participate in problem solving voluntarily and not by directives; the employee may be given the freedom to solve quality issues in their own work responsible area; quality training should be offered to the employee to broaden their knowledge in team building, management and corresponding; the model encourage close observation and listening to the employee and also customer; leaders should adapt the coaching technique rather than rules of power; give freedom and autonomy to employee; the skill in resolving conflict and problems, critical thinking and negotiations should be improved; there should be a balance in internal consideration from employee and also the external quality requirement by customers.



c. **Teamwork**

Teamwork is also another critical part of creating and implementing a successful TQM programme. Crosby (1979) said that one need to be trained to become effective members because it is not naturally common in daily human routine. According to Sallis (1993), the main mechanism that drives quality development is teamwork that will allow members to participate actively, giving ideas and proposed solutions in the process of quality development and improvement. Due to that, Crosby had introduced a development program that consist of a team development to improve the quality and mentioned that it is the most crucial part for an effective quality improvement program. Kouzes and Posner (2002) had also listed the teamwork as one of their five lead by examples principles, that they had stated teamwork is more effective than individual efforts to achieve higher

outcome. They mentioned that achieving the impossible vision is more likely to happened in a collaborative and cooperative effort. There are four stages of teamwork improvement according to Tuckman, (1965) that was the forming, storming, norming and performing.

*Forming* is the initial stage where the team try to understand and work together to achieve the goal. It coincides with Deming's 14 points where fear is driven out so that the team will become effective, and to eliminate the obstacles and barrier between departments. Forming usually involve massive discussions to create and effective environment where active members will participate together. The directions will be given by the most senior member of the group.

*Storming* stage happens when the members come to know each other and understand the situation and the challenges that they were facing. Disagreement and dispute will arise at this stage and the team leader has to be wise to resolve the issues. The storming process is related to creating a clear objective and developing new ideas as mentioned in Deming's 14 points theory.



*Norming* is the third step that is necessary to finalize the decision that had been developed ear to improve the process, regulations and the members responsibilities in the organisations. This stage is where members will be ensured that they had understood the methods and regulations clearly and properly.

*Performing* is the final stage where all participants will start to form and create their methods and processes that will be implemented by them. At this stage participant will have to focus and solved the disparities among them in developing the procedures. This stage related to Deming's 14 points number five and seven that mentioned on constant and permanent improvement of the service and production system, and also implementation of leadership quality.

d. **Training and Education**

According to Alghamdi (2016) in order to ensure a successful implementation of quality culture improvement, training is the important factor to be considered. He mentioned that the training is a vital and significant motivational element in an organisation. The training objectives is important to the development of TQM that have been identified to have appositive impact on the performance of the operation (Parast & Adams & Jones, 2011). This has been stressed out by Deming (1994) that the key criteria to the implementation of TQM is to institute on job training with application of new methodology. Crosby's improvement process had also included the training to successfully achieved TQM. The training will educate the employee to strengthen their roles and function in the quality enhancement process. Sallis (1993) also believed that in the first stage of the development, every participant has to be educated with the concept of TQM. The training will enhance the awareness and understanding of critical approaches that include the process of decision making, evaluation methods, teamwork and solving of problems. He also iterated that on job training such as field visit to the institution with a success in TQM may be beneficial. Catalin et al. (2014) mentioned that without proper training and education the TQM program will be difficult and hard to succeed.



e. **Customer Focus**

According to Evans, (2017) businesses and organization should identify the future and current customer needs, meet and follow the requirements, and try to exceed the expectations because the businesses depend on their customers. According to Goetsch and Davis (2016), "The consumer is the driver in a complete quality environment." In order to achieve customer loyalty, the organisation has to meet the needs and demands of its clients (Ahmad et al., 2019). Customer emphasis is an important element in the progress of an organisation and it is the starting point of any quality effort, it is encouraged to do analysis in the service industry and to specify the long-term effect of customer focus on other organisational results (Sousa, 2007; Cai, 2009). Service efficiency is the most important thing in assessing customer loyalty and is the secret to corporate survival. (Endara et al.,

2019). Customer focus is one of four components of the TQM that has made a major improvement to both operational and financial efficiency (Abusa and Gibson, 2011). Measures of customer focus in this research include customer orientation, customer relationship strategies, and customer satisfaction (Cai, 2009).

### f. Cultural change and Continuous improvement

According to Algamdi (2016) Another important principle of TQM is the change of organisational behaviour or culture that will assist in giving a positive and encouraging atmosphere to ensure an effective implementation of the quality development program (Corbett & Rastrick, 2000). Sallis (1993) had stressed out that shifting in culture of an organisation may involve change in leadership, operating methods and behaviours. Based on citation on Sallis (1993) by Alghamdi (2016), there are two important matter for employee, that are the work environment and motivation. Work environment consist of a clear task with an assisting system, and the motivational factor consist of appreciation and gratitude for the accomplishment and success of their effort. This comes from the role of leadership in acknowledging and appreciating the contributions of workers that inevitably contribute to higher efficiency. Catalin, Bogdan and Dimitrie (2014) also agreed with the Sallis opinion that absence of inspiration, fulfillment, appreciation of employee performance were obstacles to the introduction of TQM. Staff members are the organisation's most vital aspects of achievement.



The quality specialist Ishikawa (1985) claimed that the corporation's first interest in administration is the satisfaction of those who have associated with it. When employees aren't happy and can't be satisfied, the business doesn't deserve to live and the first priority of company is to develop a sufficient income for the workers.

Other important concepts of effective TQM practices beyond the aforementioned essential values are: performance measurement, employee focus, productivity assessment, supplier interaction and consumer focus (Saraph et al., 1989).

From the literature above it can concluded that the TQM theories and models will be the basis of understanding for the measurement of organisational quality, that will be later relate to the supply chain in this study. The elements and key factors that become the principles of TQM has an in-depth analytical model and can be taken into consideration in this study. The principles will be tested and evaluated in CAESE by qualitative methods in order to be able to understand the current situation in order to produce an outcome that in Allah willing will solve the stated problems.

## 2.4 TQM and SCM principles and the relation

Organizations often face the demand from the govemment regulatory requirement and also the the global competition beside the customer demand (Diabat et al., 2014). In order to adapt to this dynamic market period, manufacturing companies have started to understand that, in order to achieve and retain the competitive edge, they must offer the highest consumer service at the lowest possible cost and time (Hudnurkar et al., 2014). This problem, in essence, drive businesses to move their business operations to various vendors and partners, depending on their abilities to manufacture and distribute high-quality goods at the lowest possible time and make them responsible for a large portion of the finished product (Kumaret al., 2014, 2015). Furthermore, ensuring the efficiency of the entire supply chain at a top standard includes integration, teamwork, interaction, involvement and exchange of knowledge between supply chain stakeholders. One way of fulfilling this goal is to apply quality management (QM) strategies to facilitate the operations of the supply chain.

Companies have also highlighted the importance of implementing diverse improvement techniques, such as Total Quality Management (TQM) and Supply Chain Management (SCM), on a synergistic basis, to enhance corporate efficiency (Kaur et al., 2019). It is the reason why researchers have redirected their resources to investigate the idea of QM and SCM synergies in order to increase supply chain efficiency (Flynn and Flynn, 2005; Robinson and Malhotra, 2005; Kannan and Tan, 2007; Foster and Ogden, 2008; Kaynak and Hartley, 2008; Kueiet al., 2011; Quang et al., 2016; Zhong et al., 2016; Gu et al., 2017; Fernandez et al., 2017; Kaur et al., 2019).

Supply Chain Management (SCM) has been recognized as a dominant inter-organizational activity to gain strategic advantage, primarily through networking with suppliers and consumers (Rungtusanatham et al., 2003; Janvier-James, 2012). SCM is among the most productive ways for businesses to boost their productivity (Ou et al., 2010). In the same way, TQM appears as a mechanism to help different companies achieve high quality criteria for goods and services that will pleased consumers and encourage the performance of business organisations.

TQM is a corporate initiative to create an environment that is conducive to continual growth in the delivery of high-quality goods and services to consumers (Ooi et al., 2011). Companies are implementing TQM to enhance sales, market share, competition, collaboration, efficiency, product quality and customer loyalty (Kumaret al., 2011). TQM is regarded as a key method for enhancing the efficiency of companies (Mensah et al., 2012) in terms of operational excellence (Goetsch and Davis, 2013).

TQM seeks to boost competition in the global economy (Altayeb and Alhasanat, 2014) by reducing costs and improve efficiency (Psomas et al., 2014) of technological and social organisational properties (Silva et al., 2014). The literature indicates that quality management (QM) techniques and SCM methods balance each other and need to be combined in order to achieve high financial and market efficiency (Kaynak and Hartley, 2008; Terziovski and Hermel, 2011). Recently, however, researchers have transferred their attention to synergies both QM and SCM in order to increase supply chain efficiency.

According to a study carried out by Talib et. Al. (2010), the five mostly practiced TQM are as follows:

a. Top management commitment.
b. Customer focus.
c. Training and education.
d. Continuous improvement and innovation.
e. Employee involvement

Talib et al. (2010) also found that six major SCM practices identified are:

a. Customer relationship
b. Material management
c. Strategic supplier partnership
d. Information and communication technologies
e. Corporate culture
f. Close supplier partnership.

Talib et. Al. (2010) had also discovered that the combination between TQM and SCM practices will results in the benefits in performance of the supply chain as shown in the diagram below:

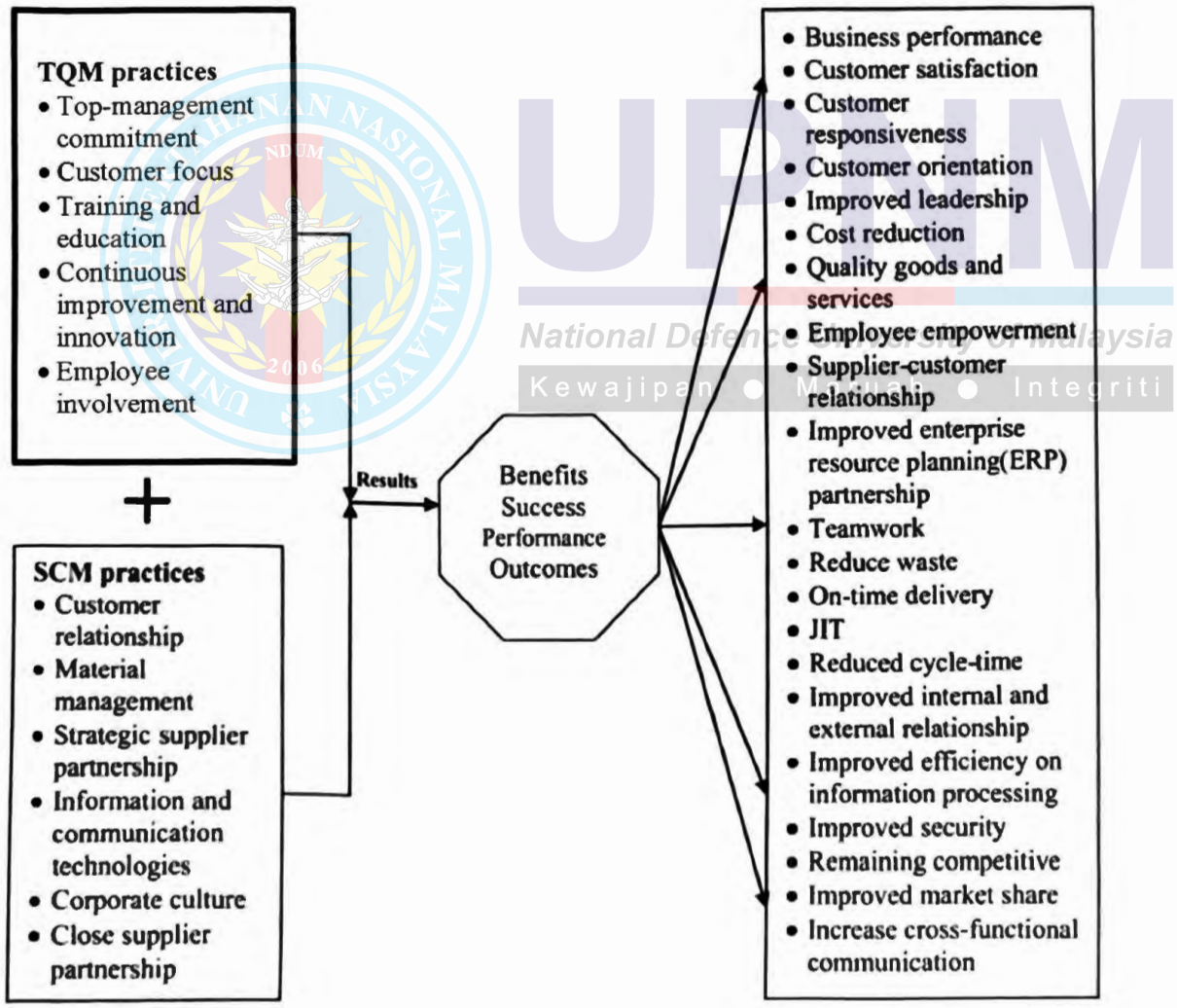


Figure 2.1: The relation between TQM and SCM in the success of the supply chain by literature review (Talib et al. (2010)

## 2.5 SUMMARY

From the literature review it can be summarised that the airworthiness regulations cover a wide scope of safety, reliability, and quality. Therefore, there is a need for the quality management system in the organisation to be more specified and include the implementation of quality policy, quality planning, quality controls, quality assurance and quality improvement. It is also being established that the concept of airworthiness and quality is different but compensating to each other. RMAF organisation must have a quality system acceptable to DGTA that ensure the airworthiness continuation processes in all the maintenance and design organisation. The QMS in RMAF may be focused on both the requirement towards maintaining the airworthiness and achieving the benefits of the supply chain management SCM. It is also established that, the QMS certification is a prove that the organisation had implemented a quality system in accordance with the Total Quality Management concept and philosophies that will give the benefits of reducing the probability of defects to achieve quality. Thus, the TQM theories and models will be the basis of understanding for the measurement of organisational quality and in this study that will be focusing on the SCM and the success factors.

# CHAPTER 3
# RESEARCH METHODOLOGY

## 3.1 INTRODUCTION

In this chapter the research technique and methodology will be explained in order to study the Quality System of TQM and its application in CAESE that will help to answer the research objectives and research questions. All the elements involved in this study will be mentioned in this chapter including the population and sampling methods for interviews. At the end of this chapter the analysis and data collection methods will be explained.

## 3.2 RESEARCH METHODS

For this study, the paper will use the qualitative methods that was applied and adopted in social sciences and business studies to study the phenomena of feelings, thoughts, behaviours and human quality such as leadership, teamwork and organisational culture. Some example of qualitative research includes grounded theory that was originated by Glaser and Strauss (1967) that involve data collection through human action that interact with time by interviewing and listening to them. Qualitative data sources are gathered through observation, experimentation, interviews, participation, texts, documentation and also the researcher views and reactions.



## 3.3 RESEARCH DESIGN

According to Punch (1998), research design in general is a framework of plan structure and execution of a research. The research design is important part of the research that include important subjects of consideration such as the master plan strategy, the conceptual foundation, distinguishing the person, subject matter, methods and procedures that will be used in data collection and analysis.

In this study, data information from various records and document will be analysed to evaluate the TQM dimensions, awareness and implementation in CAESE. The method of

wording and data coding will be used to identify important subject of focused and attention. This paper had able to gather extensive amount of data and record that is very important in order for the researcher to comprehend and understand the situation, processes, condition and pattern of the assets involved within and outside of the organisation.

This study will also explore the success and challenges in the implementation of TQM concept to be applied in an organisation dealing with airworthiness. Further exploration on the issues and challenges regarding human resource, equipment, processes, and data management will determine the causal factor that affecting the organisational achievement in TQM. This will help in finding the best solution to overcome the issue in skort term and long term that can be offered as the strategic plan for CAESE.

This research is the continuation of the previous research that was conducted in No 11 Squadron by the method of quantitative. However, in this study the qualitative method is used to amplify the understanding of the awareness and acceptance of the people working in CAESE to the concept of TQM since the organisation offered more crucial technical services compared to the No 11 Squadron due to the wider scope of work that covered the whole RMAF aircraft inventory (DGTA, 2015). The interviews will also give an insight of the future expectation of CAESE by the higher authority that have direct impact on the organisations strategic planning.



## 3.4 DATA COLLECTION METHODS

In this study there will be two type of data collections methods that is adequate to address the situation and answer the research objectives through qualitative methods. The exploration into this study will gather data through these following methods:

### 3.4.1 Library Research

The library research is described as an action that uses the technique to analyse the documentations, evidences, reports, transcripts and files that are to be gathered from reliable and credible sources such as the online library, scholar's website, conference

papers, journals, theses, previous studies and also the organisational documentations that are not classified (Ramesh, 2008). The data that are compiled and collected through the Library Research is considered as secondary data. The categorisation of secondary data means that the data is already available and can be extracted for use by anyone. The data is not collected through this research but rather are gathered and accessed from published and unpublished originator or authors.

In this project paper, part of the data had been used in the literature review that form the foundation in determine the concept of airworthiness, quality management system, the fundamentals of TQM and their relations towards the determination of critical success factor of this study.

### 3.4.2 Field Research (Records, Statistical Data and Observation)

Field research comprises of several techniques in collecting data through records, observation and case study, in order to find the answer to the research questions (Walliman, 2011). In this study, the researcher will gather all the data from the appropriate records, manuals, policies and reports. The data from the records, minutes of meetings, audit reports, certificates, serviceability reports, customer satisfaction records and project reports will be used as evidence to strengthen the findings. The records available inclusive of management records, procedures, maintenance record, capability listings, projects reports and annual reports are considered as primary data that is collected while conducting this study.

Due to the airworthiness requirements all activities conducted in any RMAF organisation are meticulously recorded as evidence of compliance and, will help the researcher in gathering all the information that are accessible to the researcher. All the records and data obtained from CAESE are either 'unclassified' or classified as 'confidential'. In the case of classified document, the researcher will extract only the certain important parts that are substantial in supporting the foundation for analysis under the permission from CAESE.

### 3.4.3 Interviews

The interview method is considered as one of the primary data to support the statistical and documented data that is collected while conducting this study. Individual to individual interviews will be carried out for this purpose in which a set of questions will be prepared and written for the person to look and answers in a structured manner. The interview will follow protocols and specific to the objective and arrange in order suitable for the person. The questions will be prepared and planned according to the objective of this study that will encourage the person to become open and have a better and accurate respond to the questions. The persons that will be interviewed are the Director of CAESE, Head of Departments in CAESE and relevant officers and that are directly involved in the research objective that enable a view of the principles of TQM and SCM in CAESE.

The questionnaire will be written in formal and technical English Language, but clarification and verbal session will be conducted using mixed Malay and English. This is in order to avoid misconception in some of the aviation and aircraft terminologies that are often described in English Language. This will encourage the person to be actively participate in the interviews.

## 3.5 RELIABILITY AND VALIDITY

The reliability and validity of a qualitative study are based on the researcher's comprehension ability to analyse the data through method of listening, readings and observation. According to Lincoln and Guba (1985), the researcher must understand the trustworthiness, conveying ability, authority and explain ability are crucial in achieving the reliability and validity. They have further explained that to have the trustworthy and conveying ability the researcher has to established that the person being interviewed have the opportunity to discuss the subjects being studied for clarifications.

The general themes and concept of the study need to be pictured in the interviews conducted (Leedy & Ormrod, 2013). The explain ability need to be free from bias to the researcher, and to achieve this the researcher must transcript the entire interviews and manually coding to avoid bias in interpretation. In the case of interviews being conducted through phones and internet communication, the researcher will have be vigilant and aware of the verbal communication to avoid missing the gestures and non-verbal cues (Birks and Mills, 2011), In this study, the person to person interviews will be the first priority.

## 3.6 RESEARCH ETHICS

The ethics of research will be considered as highest priority in this study. This study will follow the rules and methods outlined to ensure the reliability and validity of this study. The researcher will ensure that the interviews conducted will follow the procedures where consent from the person being interviewed will be seek for approval. The person being interviewed will have the privilege for fair explanation on the expected risk, benefits, procedures and inquiry without prejudice and have the option to volunteer or retreat (Nachmias, 2008). All the person interviewed will be older than 18 years and did not have any impaired ability to understand the risk and will be based on the military health certification classified as fit for duty. All recorded interviews are suggested to be eliminated and erased after 5 years to minimise the future risk on confidentiality.



## 3.7 DATA ANALYSIS

The most important part of the qualitative study is the data analysis and according to Drew et al. (2008) the qualitative data analysis will have the probability of negative suggestions and connotations due to fact that the interview uses the medium of language, words, opinions, perceptions, and confessions rather than representation in numerical numbers. The data analysis is different between qualitative and quantitative in sense that the researcher will have to segregate and arrange the data, in an orderly manner depending on the code or keyword that had been used. This will help to distinguish and interpret the knowledge of the subjects being studies to be presented as meaningful data to others (Donald et al., 2006). Another scholar, James (2004)

also suggested that data analysis consist of data arrangement and refining that will segregate it into efficient units or codes, according to the subjects being studied.

This study will adapt the basic concept and methods used to analyse the data from the person being interviewed that consist of segregation of data, data refinement, transcription write up, data presentation and finally to draw conclusions (Drew, 2008). The data will be arranged according to coded definition and explanation that in turn will give a meaningful outcome and findings. The data from the interviews will be classify and organised into themes and categories that will include, leadership, cultural change, training, teamwork and employee empowerment. In later part, the data will be evaluated and investigated by the researcher to suit the study objectives.

At the end of the analysis the following relations between TQM principles of leadership, customer focus, employee participation, continuous improvement and innovation, and training and education in the supply chain management practices will become the success in performance outcome as shown in figure below.



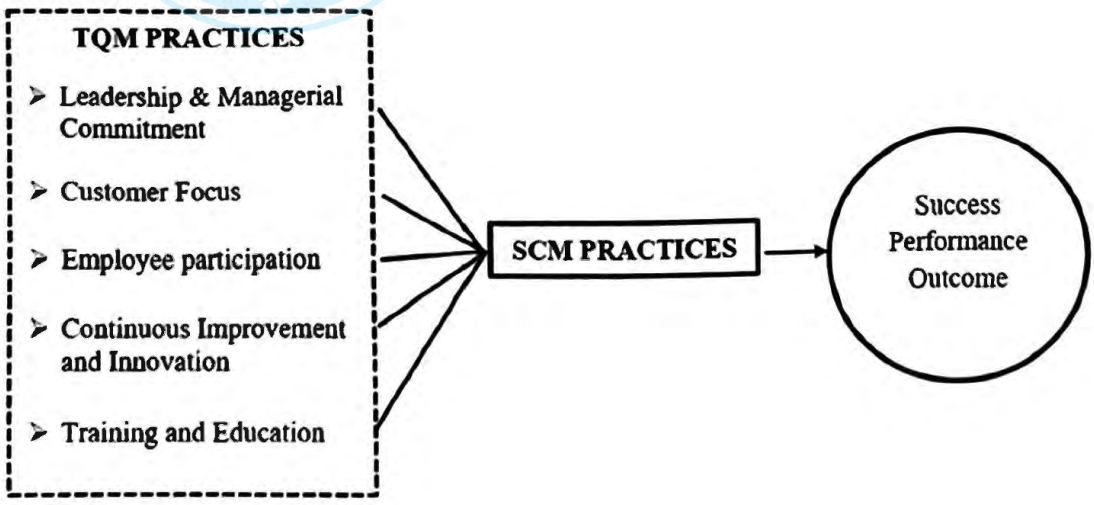


Figure 3.1: Relation between TQM, SCM and success

## 3.8 SUMMARY

In this chapter the research methods and design had been elaborated and presented inclusive of the data gathering processes and data analysis that will become the most important part of this study. This chapter provides all necessary and fundamental approach to keep this study reliable, valid and accepted as the project paper for this research objective. As being mentioned, the qualitative data will be analysed through a proper means that shall be formed into findings and solutions for this research purpose to evaluate the TQM principles applications in CAESE.

# CHAPTER 4

# ANALYSIS AND FINDINGS

## 4.0 INTRODUCTION

The analysis of the research will be focused on the situation faced by CAESE in ensuring the performance of its supply chain through effective use of TQM practices and the relations to the SCM practices. There are three (3) cases that will be studied and analyzed, one is the transportation problem, secondly is the problem in maintaining quality of products delivered and thirdly is meeting the RMAF needs in the case of supply chain disruption situation. The framework for this study will be based by data taken from interviews, minute of meetings, audits reports, defect reports, surveys statistical reports, aircraft usage and condition data, internal documents, innovation reports and project reports. This research framework will focus on five (5) TQM practices that were imparted into SCM practices in CAESE to produce successful results in the supply chain and business performance.



### 4.0.1 RMAF Centre of Aerospace Engineering Services (CAESE)

CAESE is one of the organizations in the Royal Malaysian Air Force (RMAF) that provides engineering and technical services to the squadrons in RMAF. It is located in Subang Air Base and manned by 30 engineers and 100 technicians and staffs. CAESE internal organizational structure is shown in the diagram below. The internal structure and the expertise departments were designed to support the RMAF maintenance and engineering activities and had formed as the basis for technical and engineering support service for RMAF. The main customers for CAESE include the RMAF aircraft squadrons. There are totally 14 aircraft Squadrons across Malaysia, operating 148 aircraft of all types.

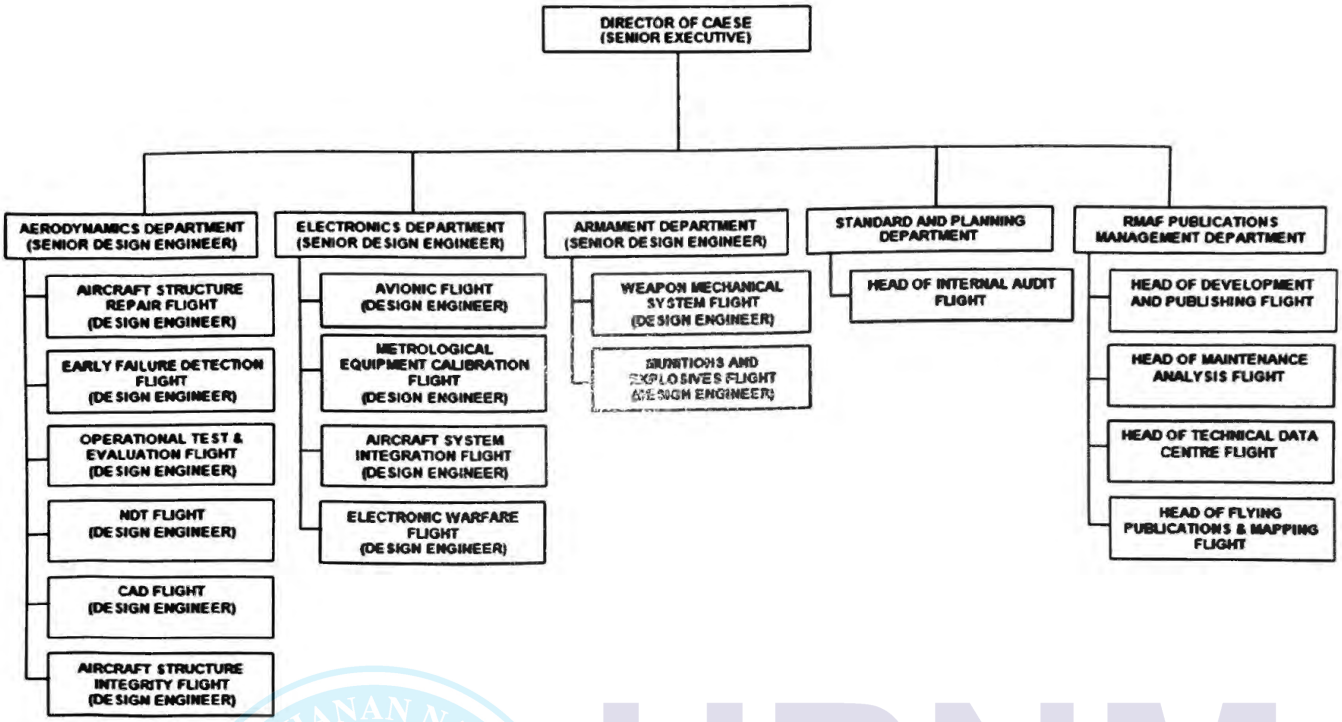


Figure 4.1: CAESE Internal Organization's Structure



### 4.0.2 CAESE in RMAF Supply Chain

Based in RMAF Subang, Selangor, CAESE is one of the RMAF Organization in the supply chain to provide engineering support services to all RMAF squadrons operating in Air Bases across Malaysia. The engineering support services required a network of connection in term of transportation and communication between CAESE and the squadrons. CAESE had been certified with ISO 9001:2015 and received the airworthiness certification from Directorate General of Technical Airworthiness DGTA. DGTA had approved CAESE as Authorized Engineering Organization AEO, an endorsement to the airworthiness quality system in CAESE. From legal perspective, CAESE had been approved to provide engineering and technical services under the airworthiness regulations based on the airworthiness process. According to the Director, CAESE depends on the transportation via the roads and highways that connect CAESE to other Air Bases in Peninsular Malaysia to deliver the services.


Figure 4.2: CAESE Engineering Support Service Network to RMAF Bases Peninsular Malaysia

### 4.0.3 Providing Services to East Malaysia.

CAESE depend on RMAF air mobility service to deliver the technical service to East Malaysia. According to the Director, RMAF had maintain a constant once a week military aircraft logistic run between Subang Air Base to/from Labuan Air Base and Kuching Air Base via military transport aircraft Hercules C-130. According to the Head of Department, CAESE had to request for the military air transportation service from the RMAF Center of Operation not less than 12 hours before the flight to deliver the technical services.

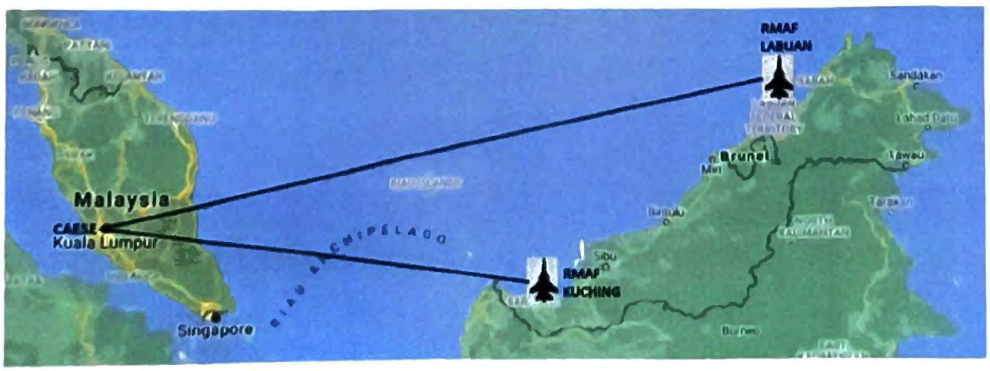


Figure 4.3: CAESE Engineering Support Services to RMAF Bases East Malaysia

## 4.2 CASE 1: GROUND TRANSPORTATION ISSUE

In supply chain, it is importance to have a well-planned ground transportation for logistic support. With the increasing demand from the Squadrons, managing transportation flows is one of success factors in CAESE. According to the Director, CAESE is supported by internal transport unit, that have 3 utility cars, 1 utility van, 1 pick-up truck and two drivers. The unit is responsible to transport the engineers and technicians with appropriate equipment to the RMAF Air Bases around Peninsular Malaysia to complete the engineering task. CAESE covers the technical services to Air Bases include RMAF Alor Setar, RMAF Butterworth, RMAF Kuantan and RMAF Gong Kedak (border of Terengganu and Kelantan).

### 4.2.1 Issue in Ground Transportation

The Director of CAESE stated that, the shortage of drivers in CAESE had become an important subject of consideration in providing the technical service to the squadrons. The delay in service to the squadron had caused concerns from the squadrons because it had prolonged the aircraft time grounded awaiting for the service. Besides that, the vehicles available in CAESE had been underutilized.



According to the RMAF policy, drivers are considered as a specific trade where they are trained to drive, handle, and manage the vehicle fleet as their main job function. Only certified and trained RMAF drivers can drive the RMAF vehicle.

CAESE's Military Transport Officer (MTO) mentioned that, currently there are four (4) drivers in CAESE. One (1) had been attached and dedicated to the Director and the other one (1) is put as in charge or supervisor of the vehicle fleet leaving only two (2) active drivers. According to CAESE's MTO, the shortage of drivers in CAESE are due to heavy tasking from everyday request of logistic support requirement around Klang Valley and the increase in long distance transport requirements. The ratio of active drivers to manpower in CAESE is 2 to 130 (2:130) and the ratio of active drivers to departments in CAESE is 2 to 7 (2:7).

The Director of CAESE stated that, the numbers of drivers in CAESE are based on the organizational structure establishment that are formulated in 1992 and had not anticipated the growing demand for technical services recently with the establishment of new air force base such as RMAF Gong Kedak in Kelantan border with Terengganu about 10 years ago and the increasing requirement due to the aircraft ageing factor.

### 4.2.2 The Implications

According to the Director, the shortage of drivers had caused delays in the technical service support to the RMAF bases. The delay time is between 4 to 7 days upon request submission by the squadrons. The situation often had also caused the issuance of transport *Not Available* to the transportation request, that permit a self-drive using own transportation and thus led to additional milage claim. The process for milage claim must go through external process of justification since CAESE did not have the financial approval or cost center. According to the CAESE's MTO, the very strict yearly budgets had caused a lengthy process where all claims must be justified before approval by the Executive Officer of Subang Air Base. The milage claim request form inclusive a series of bureaucratic administrative sequence for approval that need to be done before departure. Thus, the shortage of driver had caused delays and financial impact to the RMAF supply chain.



### 4.2.3 Frequency of Transport Usage and Demand Pattern

The frequency of long-distance transportation requirement for technical service duration more than 1-day to deliver the technical service are shown in table below:

| Year | 2018 | | 2019 | | 2020 | |
|---|---|---|---|---|---|---|
| Transport Out (days) | 1-4 days | >4 days | 1-4 days | >4 days | 1-4 days | >4 days |
| Frequency | 72 | 18 | 69 | 7 | 59 | 23 |
| Total Frequency | 90 | | 76 | | 82 | |

Table 4.1: CAESE Transportation Long Distance Usage Frequency from 2018 to 2019 (CAESE,2020)

Based on the table above, the pattern of transport usage for long distance, depends on the requirement and subjected to the nature of technical service provided by CAESE. The long duration in number of days transport out, (include the journey until the engineering job completion) in which the driver will be attached together to the engineering team until they returned to CAESE, had worsen the driver shortage condition in CAESE. Most of the above 4 days outstations are due to the job requirement of maintenance support to the squadrons that depend on the aircraft serviceability factors including ageing. Thus, the fluctuation in the demand of transport therefore is highly unpredictable and hard to manage (MTO, 2021).

### 4.2.4 Improvement

The possibilities and alternatives solutions were discussed in several of the Directors Quarterly meetings and had come out with three possible solutions as follows:

| Alternative Options | Challenges | Probability of Success |
|---|---|---|
| Request for Additional Driver from RMAF HQ | The position of drivers in the establishment had been filled. | New establishment need to be resubmitted. Longer time need justification for additional drivers. Involve the financial implication and approval from outside agency (Public Service Department and Finance Ministry) |
| Request for back up driver from Subang Air Base | The Subang Air Base had their own establishment, and the numbers of drivers position in their organization had been tailored to meet with the Air Base requirements. Back up | Subjected to Subang Air Base approval (External Organization under different Command). Not suitable for efficient transport management. |

| | | |
|---|---|---|
| | drivers from the Air Base will put strain the transport management of Subang Air Base | |
| Train and authorized internal human resources (Technical personnel to be authorized as drivers) | Need justification and approval from RMAF HQ. Additional risk and workload to the technical personnel. | Internal resources training and authorization is within the Director control and jurisdictions. |

Table 4.2: Alternative solutions to Transportation Problem (CAESE,2020)

Observation on the CAESE's Director minutes of meeting suggested evidence of leadership commitment and employee participation in solving the shortage of drivers issues through brainstorming amongst employees. As an alternative, in 2018 CAESE had taken steps of giving the authority to drive RMAF vehicle to the engineers and technicians. This action was taken so that technical personnel could drive on their own, using RMAF vehicles to carry out the engineering job. The justification and plans were submitted to the RMAF Headquarters Logistics for approval and was approved with limitations.

Seven (7) engineering personnel had been authorized with proper training on the RMAF vehicle handling procedures in CAESE, and it was evidently conducted by the CAESE's Transport Department. The authorization is fixed to the personnel and are not transferable, the military license must be renewed every 6 months and the engineering personnel had to be tested and signed the RMAF driver standing instructions for prove of compliance. The person will be fully liable and responsible for any misconduct, mismanage or accidents to the RMAF vehicle. The records of training are well kept for the yearly audits from RMAF IGTU for continuous improvement.

### 4.2.5 The measure of Success

| | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|
| Frequency of unfulfilled transports demand classified as Not Available (N/A) in the transport request form from CAESE's MTO records | 37 | 42 | 4 | 3 |

Table 4.3: Record of transport unavailable to be provided in CAESE (CAESE, 2020).

The increase in active drivers from two (2) to nine (9) with the introduction of the new arrangement, had improved the transportation efficiency. Although the 'drivers trade' is still important, the overwhelming situation arise from job requirement to satisfy the customer (Squadrons) and meet their expectation, had exceeded the driver's capacity. The transportation management had to look at alternative by assigning technical staff to become drivers to meet with the supply chain requirement. The new arrangement had improved the transportation availability and the situation can been clearly indicated by the reduction in frequency on transportation unavailability as shown in the table above and the graph below.



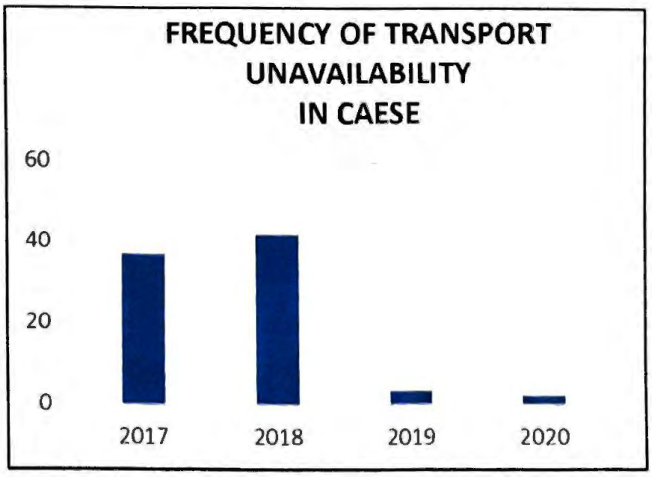


Figure 4.4: Frequency of Transportation Not Available (N/A) in CAESE from 2017 to 2018 (MTO, 2021)

According to the Director, the issue of driver shortage had been effectively solved as the number of transport unavailability had been reduce to three (3) in 2020. All the three records of unavailability are not related to providing services to the squadrons. Referring to the records in the transport department MTO, there are no offences or accidents reported since the program first introduced proving that the approach is reliable. This is supported by the yearly audits from RMAF Inspectorate General as shown in the table below:

| | 2019 | 2020 |
|---|---|---|
| Traffic Offences Reported | 0 | 0 |
| Misconduct (Against Driver's Standing Instructions) | 0 | 0 |
| Accidents | 0 | 0 |

Table 4.4: IGTU Audit Reports on CAESE Transport Department 2019 and 2020



According to the Director, the average waiting time for technical service had now reduced to 24 hours from previous 4 to 7 days. The Head of Armament Department who is one of the approved drivers, had stated that, the cross functional and competence held by technicians and engineers had allowed the engineering team to prepare and ready for travel within 24 hours. It had also increased the seat capacity to the engineering personnel to the optimum number for a vehicle.

### 4.2.6 Observation and Findings Case No 1

Observation and analysis of the minutes of meeting suggested evidence of leadership commitment and employee participation in solving the shortage of drivers issues through brainstorming amongst employees. The records of training for technical personnel to be authorized as drivers became the evidence of knowledge and training being imparted in CAESE organization. The records of training are well kept for the yearly audits from RMAF IGTU. Further observations on the documentation revealed the evidence in continuous improvement and innovation where the results from the action, were kept and analyzed to measure the improvement and suggest additional measures.

As overall observation throughout the problem-solving process revealed evidence of all five (5) major TQM practices being imparted that include leadership & managerial commitment, customer focus, employee participation, continuous improvement & innovation, and training & education, The TQM practices imparted into the SCM practices that include Change of Corporate Culture which allowed cross functional in job expertise, and the management control of transportation service to the squadron had resulted in the benefits of cost reduction, delay time reduction, and increased in business performance. These findings had confirmed to the studies carried out by Talib F. et. All. (2010) that stated combination of TQM practices with SCM practices will attain benefits to the organization.

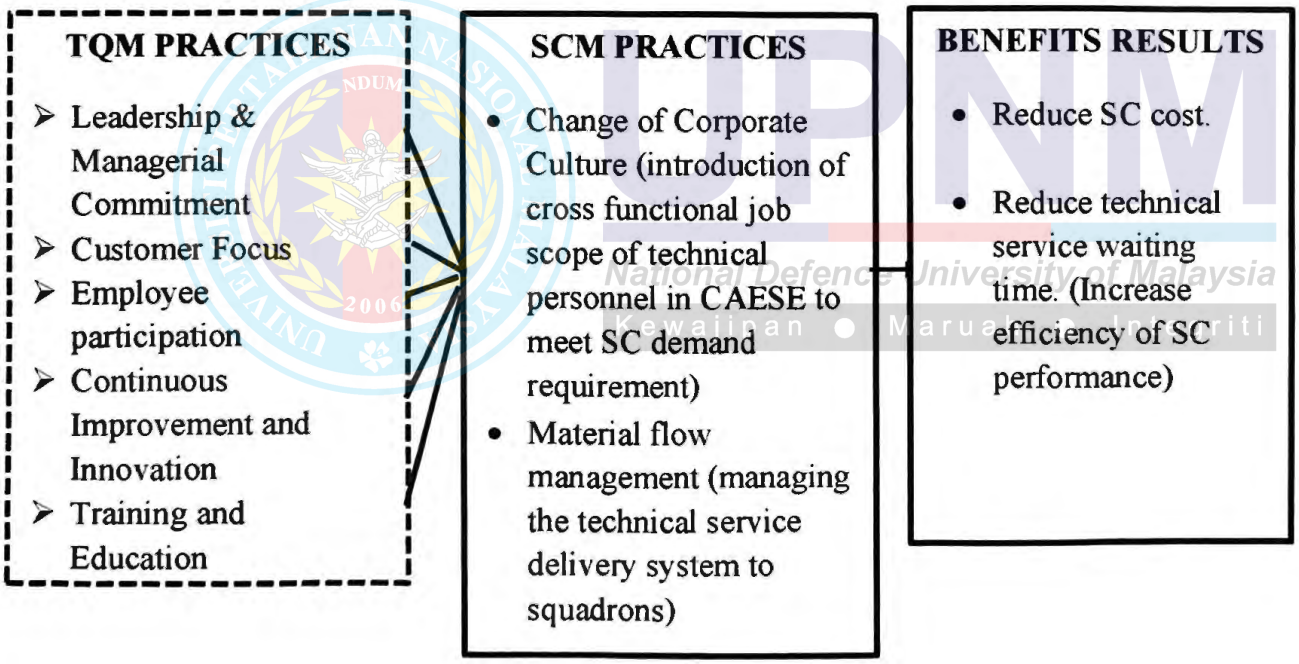


Figure 4.5: Findings of relation between TQM and SCM practices Case No 1.

## 4.3 CASE 2: MAINTENANCE SUPPORT: AIRCRAFT STRUCTURE REPAIR

The RMAF engineering policy had stated that CAESE is the center of expertise for aircraft structure repair and is responsible to repair all metallic structure defects for RMAF aircraft throughout Malaysia. The structure repair experts are maintained in CAESE, and currently there are four (4) technicians and one (1) engineer in the structure repair flight under the Aerodynamic Department. In the RMAF supply chain, CAESE is the only supplier for structure repair services for RMAF aircraft.

According to the Director of CAESE and the Head of Structure Repair Department, due to the limited resources in RMAF Air Bases, CAESE had to prepare the correct repair plate that are critical in term of thickness, size and shape of the cut-out metal plate patching materials. The preparations were based on the defect reports prepared by the squadron's technicians and engineers. The repair plate for the structural repair needs to be fabricated in CAESE before going to the Squadron due to the unavailability of structure repair shops equipment in RMAF bases.



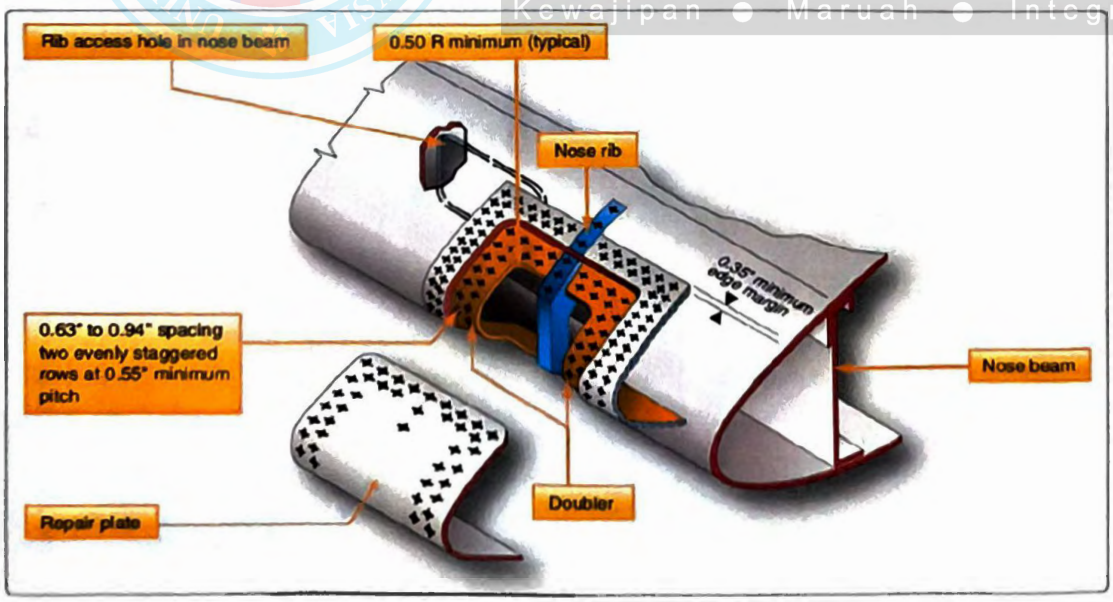


Figure 4.6: Example of repair plate (bottom left) for leading edge that need to be formed and shaped according to the surface (SRM,2020)

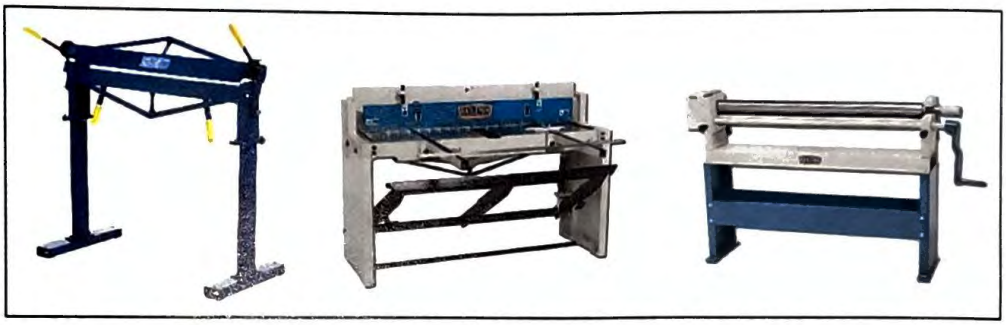

Figure 4.7: Metal Forming Machines that are only available in CAESE. From left, Bending, Shear and Rolling Machine (CAESE, 2020)

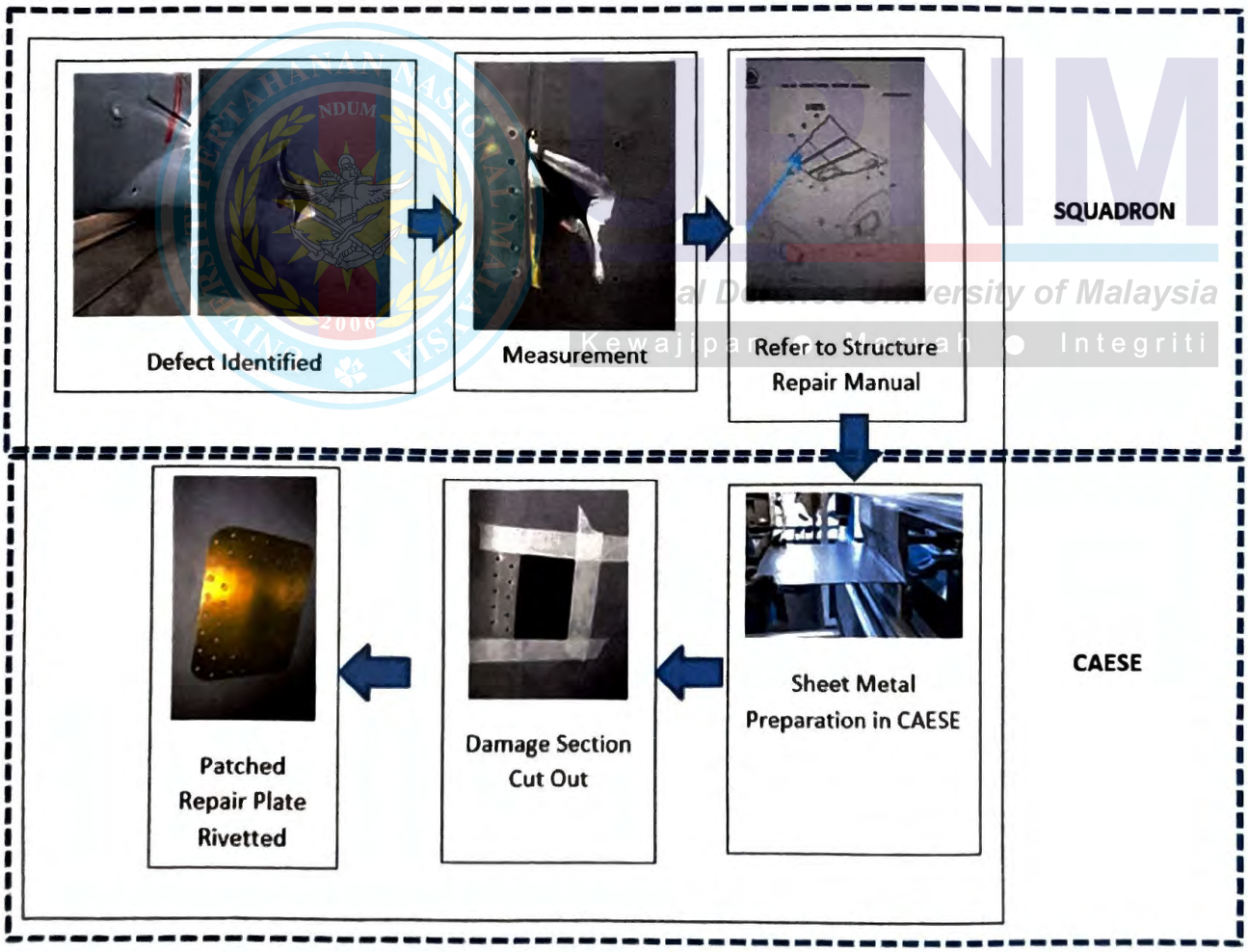


Figure 4.8: Process flow for structure repair (CAESE,2020)

### 4.3.1 Issues and Challenges

The repair plate is very critical to ensure that the repair meet with the specification. A properly measured, cut, and formed plate will ensure that the metal patch repair will be able to support the damage structure without flaws such as gaps, distortion, unflushed and unmatching. The strength of the repaired structure may also be compromised that leads to air disaster if deviated from the specification (Structure Repair Manual, 2020).

In supply chain, the flaw in measurement and dimension causes delivery of incorrect repair plate to the squadrons causing delays. The delays of repair had impacted on the duration of the aircraft status being unserviceable and the fact that the aircraft cannot be used to complete RMAF mission. The cost of aircraft grounded in RMAF are usually unaccounted in term of financial impact since it is in a military environment but for commercial aircraft it may cost up to USD 150,000 per hour.

> *When an aircraft is grounded – known as an AOG or Aircraft On Ground because of a technical malfunction, it can cost an airline up to US$150,000 an hour. (Kotoky et.al., 2020)*

From the Structure Repair Records between 2016 to 2018 there are 13 incidents or 9.6% from total work, resulted from the inaccuracy in the squadron defect reports that caused the wrong measurement and misinterpretation of defects. The reporting error of the defect had caused the mistakes in repair plates preparation and subsequently causing fabrication of inaccurate repair plates for the structure.

The frequency of services request for Aircraft Structure Repair and the Misled Diagnostic Procedure from 2016 to 2018 are showed in the table below:

| | 2016 | 2017 | 2018 |
|---|---|---|---|
| Aircraft Structure Repair (Frequency of work carried out) | 37 | 58 | 41 |
| Error in Cut Out Plate (Frequency) | 4 | 6 | 3 |

Table 4.5: Frequency of Error in Information events between CAESE and Squadron that lead to mistakes in fabrication of repair plates (CAESE, 2020)

The preparation of the repair plate depends on the accuracy of the squadron's report and exact cross reference to the structure repair manual in CAESE. According to the Head of Structure Repair, since the technician working in the squadron have limited knowledge in structure repair, the communication and exchange of data often inaccurate and misleading causing the fabrication of inaccurate repair plate.

The Head of Structure Repair stated that, the repair team from CAESE will only realize the error once they are about to do the structural repair in-situ causing interruption where the repair plate cannot be fitted and rivetted due to mismatched. As temporary measure CAESE's team sometimes had to travel twice to the squadron, first is to identify the exact location and took correct measurement so that repair plate can be fabricated in CAESE, and then back again to the Squadron to complete the repair. Another setback to the supply chain in term of delay in services.

In RMAF policy, structure repair only allowed to be carried out by specialist technician and engineers in CAESE. According to the Director, the limited knowledge on structure repair job of technicians and engineers in RMAF Squadrons had become a barrier for them to convey the correct information to CAESE Structure Repair Team in RMAF Subang.

### 4.3.2 Improvement

The problem was analyzed by CAESE and the breakdown of the problem is shown in the table below (CAESE, 2018).

| Issues | Root Cause | Factor |
|---|---|---|
| Repair Plate Forming Issues | Measurement inaccuracy in defect report | Human Resource – Limited knowledge to use measuring Equipment in Squadron |
| | Mistakes in making correct reference to the Structure Repair Manual (Reference error) | Human Resource –limited knowledge of Structure Repair Manual in Squadrons |
| | Identification of exact location (Location mismatched) | Human Resource – Limited knowledge in using the correct identification method (location indexing). |
| | Miscommunication between CAESE and Squadron (defect clarification) | Human Resource – Barrier in skills and knowledge between CAESE and Squadrons |

Table 4.6: Investigation into root cause of incorrect repair plate conducted by CAESE (2018).

Since the cause for error in delivering correct repair plates to the squadron had been identified as limited knowledge and skills of the technicians in the Squadron, CEASE had forwarded the situation with proposal to the RMAF HQ. As a result, in 2018, CAESE had able to conduct a two-weeks structure repair course for RMAF engineers and technicians in CAESE. The class was managed and trained by CAESE structure repair technicians and engineer using internal facilities with the administrative support from RMAF headquarters. The class had a capacity of 20 students per class.

According to the Head of Structure the course is tailored to deliver the knowledge and skill for structure repair to the technicians and engineers in RMAF squadrons. Although they will not be authorized to carry out the repair on their own, but the course will narrow the gap of knowledge between CAESE and the Squadron and had become useful as a helping hand to CAESE in preparing of the structure repair and leads to better reporting, measuring, identification and reference indexing that meets with CAESE basic requirement to produce the repair plates.

The structure repair course module is tailored and involve 80 hours of theory and practical session and covers the following training scope (CAESE, 2020)

| TRAINING SESSION | HOURS |
|---|---|
| Workshop Practice | 8 |
| Organize work activities | 8 |
| Aircraft structure inspection | 8 |
| Metal corrosion treatment | 8 |
| Aircraft structure repair method | 24 |
| Manufacture part/Compartment | 8 |
| Secure component/structure | 12 |
| Course Examination and Conclusion | 4 |
| Total | 80 |

Table 4.7: Structure Repair Training Session and Hours Allocations (CAESE, 2020)

Picture 4.1: Structure Repair Course (CAESE, 2020)

### 4.3.3 Measure of Success

| | Excellent | Good | Satisfactory | Unsatisfactory | Poor |
|---|---|---|---|---|---|
| The course had achieved the objectives | 0.02 | 0.60 | 0.38 | 0 | 0 |
| The Course Meet Expectation and Requirement | 0.03 | 0. 65 | 0.32 | 0 | 0 |

Table 4.8: Course critics Results from Students Attending Structure Class conducted by CAESE in 2019 and 2020 (72 students of 72 students).

From the course evaluation carried with respondents attending the class in 2019 and 2020 by CAESE, it can be defined that all the students agree that the course had achieved the target with 38% of the student are satisfied, 60% says that the course is good and 2% says that it was excellent. In the fact that the course had meet with the expectation and requirement 32% says that was good, 65% believed that the course is good and 3% says that it is excellent. As an overall evaluation this course had achieved the objective of imparting the technical knowledge to carried out the aircraft structure repair to the students and become the basis of judgement that the skills and knowledge had improved in communicating the defects to CAESE.

| Score | <60 | 61-65 | 66-70 | 71-75 | 76-80 | 81-85 | 86-90 | 91-95 | 96-100 |
|---|---|---|---|---|---|---|---|---|---|
| Student Percentage | 0 | 0 | 0 | 7 | 11 | 40 | 35 | 7 | 0 |

Table 4.9: Percentage of student score range from 2019 and 2020 class (72 of 72 students) (CAESE, 2020)

The scores of students attending the course in 2019 and 2020 are above 70% and considered as satisfactory by the standards given by the course syllabus (CAESE, 2020). This had indicated that all the students had able to comprehend the class subjects theoretical and practical sessions.

From the structure bay records, the frequency of Misled Diagnostic Procedure had been none since 2019 until 2020. According to the Director, the Structure Repair course conducted by CAESE had improved in better communication between the Squadrons and CAESE, promoted accurate identification technique and reinforced in using the right referral indexing system that had contributed to the success.

| | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|
| Aircraft Structure Repair (Frequency of work) | 37 | 58 | 41 | 33 | 35 |
| Misled Diagnostic Procedure | 4 | 6 | 3 | 0 | 0 |

Table 4.10: Structure repair frequency and defects in repair plate fabrications (2016-2020)



### 4.3.4 Observation and Findings Case No 2

Observation on the detailed records of defective items showed evidence of customer focus element in CAESE. The problem was detected, analyzed and solved by full involvement of the structure bay personnel with the support from management. Records obtained from CAESE had suggested the evidence of employee participation and leadership commitment in quality management and supply chain management. The training that had been carried out to impart knowledge showed the element of TQM practices (Training and Education). The element of continuous improvement is being evidenced by the student evaluations carried out as an audit measure to facilitate the action of improving the course syllabus and to ensure the continuation in supply chain efficiency.

As overall observation throughout the problem-solving process revealed evidence of all five (5) major TQM practices being imparted that include Leadership & Managerial Commitment, Customer Focus, Employee participation, and Training & Education. The TQM practices imparted into the SCM practices that include change of corporate culture which transform and

integrates the technical staff function to become trainers, maintaining a good relationship with the customer, and employing effective information sharing with the customer had resulted in the benefits of improved RMAF internal facing supply chain relationships, elimination of inaccuracy of product and services delivery, improve efficiency in information processing., reduce SC cost, and achieving the customer satisfaction. These findings had confirmed to the studies carried out by Talib et. al. (2010) that stated combination of TQM practices with SCM practices will results in benefits to the organization.

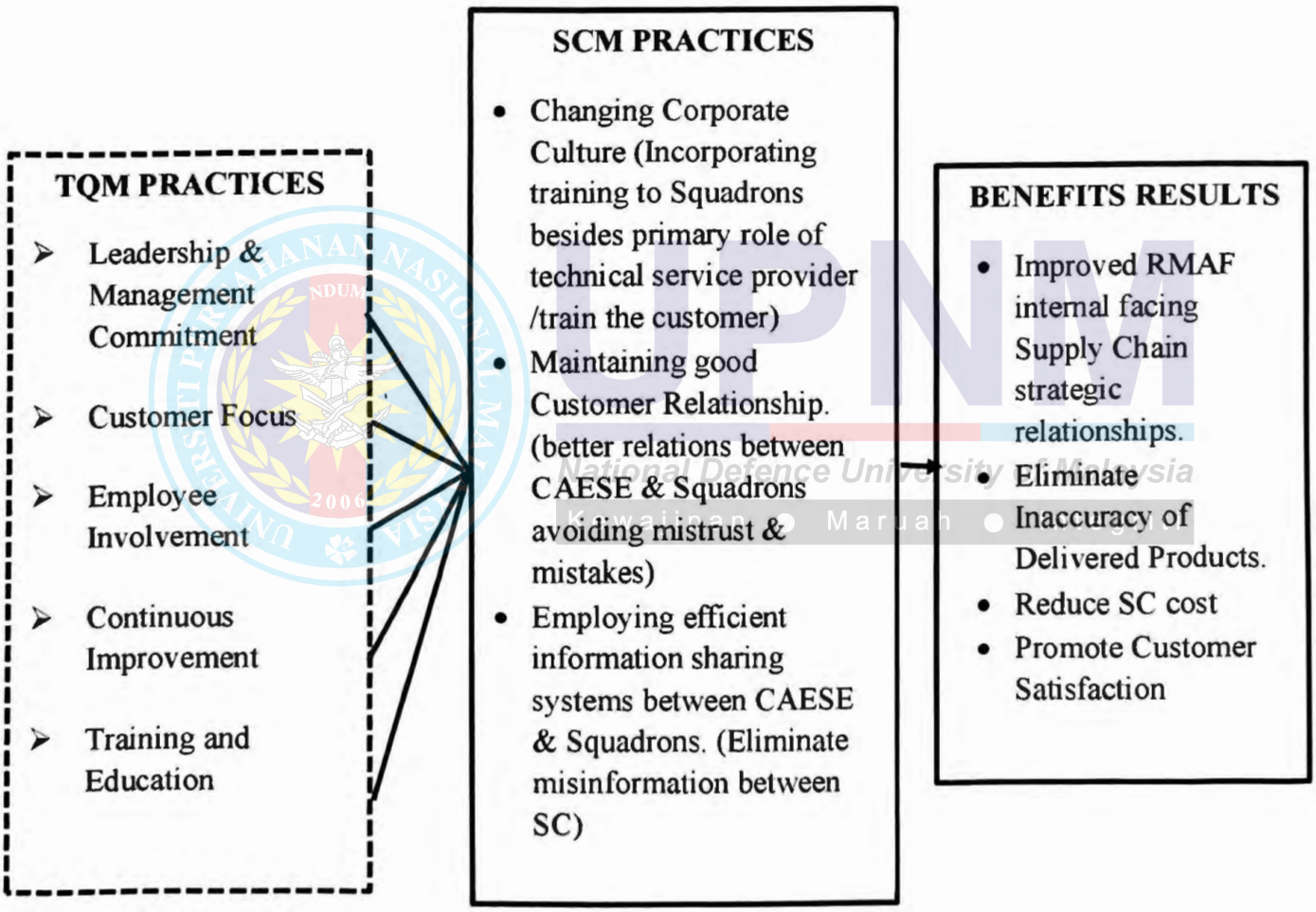


Figure 4.9: Findings of relation between TQM and SCM practices Case No 2.

## 4.4 CASE 3: ENGINEERING SUPPORT: CAESE AIRCRAFT STRUCTURE INTEGRITY PROGRAM (ASIP)

In providing the Engineering Support to RMAF, one of CAESE main function is to manage aircraft structure data from the squadrons and analyzing the structure health through the Aircraft Structure Integrity Program (ASIP). ASIP is under the responsibility of the Head of Aerodynamics Department that report directly to the Director of CAESE. Under the ASIP, there are 6 engineers that monitor the program and reported to the ASIP officer under the Head of Aerodynamic Department. The data is kept in the main server located in CAESE's ASIP office.

ASIP structural health index will be compared to the index limits given by the manufacturer as standards reference and used to gauge the structure life health conditions. Currently only aircraft fitted with appropriate in-flight data recorder and have manufacturer given ASIP program had the opportunity for ASIP such as the C130, A400M, Hawk, EC725 and Su30MKM.

*Maintenance of ASIP is dependent upon an assurance that structural strength remains at an acceptable level (DGTA, 2015)*



The output from ASIP process will enable RMAF to plan the aircraft withdrawal date, manage the structure life extension program, carried out the environmental degradation management and plan for aircraft upgrade effectively (ASIP, 2020). Reports of the structure health analysis by CAESE will be submitted on monthly basis to the RMAF Air Support Command Headquarters for the strategic planning which is the important part of RMAF Supply Chain Management.

### 4.4.1 Aircraft Structure Integrity Program and Supply Chain Management

The ASIP processes are standards practices by modern aircraft manufacturers. RMAF depends on these analyzed data to plan and maintain the supply chain of maintenance support from the aircraft manufacturer. These information are used to predict the spares and technical services required to maintain the aircraft, and as accurate prediction of remaining usable life limit of the aircraft structure (ASIP, 2020).

The data from ASIP is important for planning of maintenance requirement, spares and technical services and procurement of new aircraft as replacement. Any discrepancies in the ASIP data will cause the adverse effect in the RMAF supply chain, such as overestimate data will cause procurement of new aircraft too early before expiry and may result in over servicing where the aircraft structure modernization took place earlier than it were supposed to (Director CAESE, 2020). Based on the accurate ASIP data, strategic planning of the supply chain management may be carried out to support the maintenance required for structure life extension, aircraft upgrade and modernization planning, and the procurement of new replacement aircraft. The maintenance support requirement that includes of spare support, technical support and training support will be forwarded to the aircraft manufacturer based on the output from the ASIP program. The flow of supply chain processes is shown below.

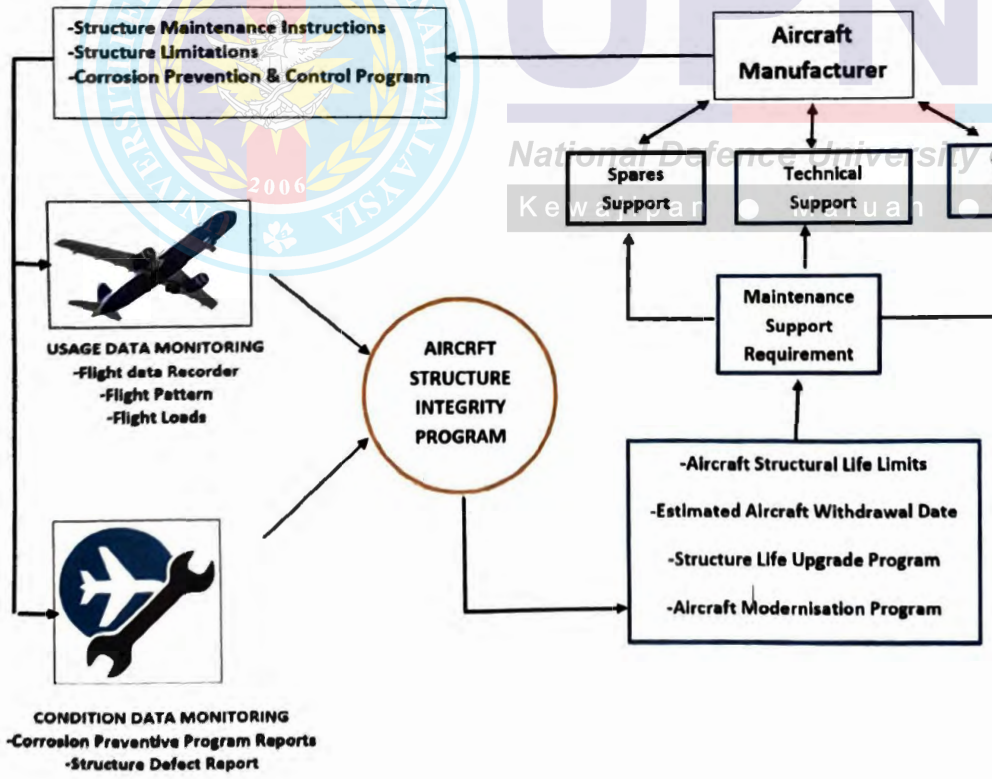


Figure 4.10: Flow Diagram of Aircraft Structure Integrity Program and relation to the Maintenance Support Requirement (CAESE, 2020)

### 4.4.2 Important Factors in Aircraft Structure Integrity Program

Based on the ASIP, (2020), there are two important factors that contributed to the aircraft structure health index. First are the loads, that consist of dynamic loads in flight and the static loads on ground. The loads exerted will caused metal bending, stretching, compress, and twist in the aircraft structure until it reaches a limit that may cause damage in term of fatigue cracks and permanent deformation. The second factor is the environmental effects, that contributes to corrosions due to chemical reactions with the atmospheric condition. Both the loads data and environmental degradation data will be synchronized and analyzed to produce Aircraft Structural Health Index (ASIP,2020).

According to the Head of Aerodynamics Department, aircraft manufacturer provides the mathematical algorithm unique to their aircraft to monitor the structure health based on the loads factor. The loads data are collected daily by CAESE from the squadrons via secured internet connection. During aircraft development program, manufacturer gathered information from prototypes aircraft, that were used to benchmark the loads exerted on the structure during flight maneuvers.



The Head of Aerodynamic Department stated that, the profile of inflight maneuvers will give the life cycle prediction of the airframe structure subjected to the dynamic loads, and it is measured as gravitational force or 'G Force'. A typical fighter aircraft usually can withstand from minus -2G to positive +8 G with a given limit in frequency of such loads or known as load cycle. The loads data must be kept and analyze from the beginning of the aircraft life until the aircraft decommissioned to have accurate structure health index (ASIP, 2020).

The recorded flight profile that is downloaded after each flight from the aircraft data recorder are termed as *usage data*. The environmental factors and the presence of corrosion, defects or cracks found during inspections are termed as *condition data*. Both data are analyzed to produce accurate structure health index for every aircraft (Engineering Management Plan, 2020).

*Defining primary or safety of flight structure will vary between aircraft types, such that individual ASIPs will provide the necessary definitions... effective fatigue management requires both usage and condition data as inputs. (DGTA, 2015)*

### 4.4.3 ASIP Challenges and Opportunity

According to the CAESE's Head of Aerodynamic Department, the predictive maintenance such as ASIP depends heavily on the data management that involve processes, human resource, and equipment. This is because the data needs to be downloaded from the aircraft and extracted from maintenance report, that will be updated daily into the system, there is some probability of missing data and mistakes due to human or equipment error causing wrong analytical output (DGTA, 2020).

According to the 2018 ASIP records in CAESE, a random audit on Su-30MKM aircraft revealed that there are 51 sorties that accumulated to 58.2 flight hours with unknown or missing flight data from 2007 until 2018, representing 0.6% from total data. The missing 0.6% data was due to the transition between the manufacturer and RMAF (CAESE, 2018). The missing and unknown data causes a deviation or inaccuracy to the aircraft structural health index and had been corrected using statistical methods after the audits (CAESE, 2018).

The fact that deviation may occur in the system had prompted the governing airworthiness organization, Directorate General of Technical Airworthiness (DGTA) in paying their attention into the ASIP department and had issued 4 (four) Corrective Action Request in 2019 and 3 (three) Corrective Action Request in 2020 audit. The minor CARs were issued towards training, competence, and process controls. The CARs had been corrected accordingly and CAESE is keeping the ASIP department as reliable as possible through the Engineering Management Plan process control (CAESE, 2020).

According to the Director, the reliability and consistency of the data in the ASIP program were challenged in 2016., when the Russian Su-30MKM aircraft manufacture Sukhoi Design Bureau (SDB) had contacted RMAF through their delegation's visits, stating that all RMAF Su-30MKM

fighter aircraft will be due for 10 years overhaul starting from 2018 for the first batch (6 aircraft), in 2019 for second batch (6 aircraft) and 2020 for the third batch (6 aircraft). The 10 years overhaul program were quoted at RM 159 Million (2016 exchange rate) for each aircraft not including the cost of dismantling and sending the aircraft to Russia. Total estimated cost is RM2.862 Billion for 18 aircraft and the whole program will took 15 years to complete (CAESE, 2020).

According to the Director, these requirements was found to be contradicting to the CAESE's ASIP report on the aircraft health conditions, that stated the RMAF Su-30MKM structure usage were below the limit given by the manufacturer itself. However, Sukhoi Design Bureau had dismissed this fact and tried hard to convince RMAF and Malaysian government to embark on the overhaul program through series of separate meetings with the Minister of Defense, Chief of Air Force, Chief of Air Support Command and RMAF staffs including the team from CAESE (CAESE, 2017).

According to the Director of CAESE, the RMAF higher authority and logistics command does not anticipate on the requirement of 10 years overhaul because it was not mentioned in the aircraft maintenance manual. However, cross reference to the Indian Air Force (IAF) counterpart had revealed that IAF had had also carried out the overhaul on their Su-30MKI and IAF suggested that RMAF to comply with the requirement for safety and airworthiness (CAESE, 2020). It was later found that Indonesian Air Force TNI-AU had also sent their two Su-30 in 2017 for overhaul in Russia with a cost of USD 75 Million.

### 4.4.4 Improvement

In 2017 RMAF HQ had instructed CAESE to investigate into the matter by issuing a commitment order (MTU, 2017). According to the Director, there was a possibility that RMAF aircraft did not required the overhaul program. This assumption and prediction were due to the fair chance that RMAF Su-30MKM may have lower usage and less severe flight profile compared to the Indian Air Force, Russian Air Force and the Indonesian Air Force (TNI-AU) aircraft, but there were political and security barriers to get the actual usage data from the foreign Air Forces for

comparison. Since assumption is not enough to support any strategic supply chain decision, either to follow the manufacturer recommendation or not, and if not, what are other alternative does RMAF have to overcome the aircraft structure degradation issues, RMAF had to clearly justify the aircraft structural health condition without the help from aircraft manufacture.

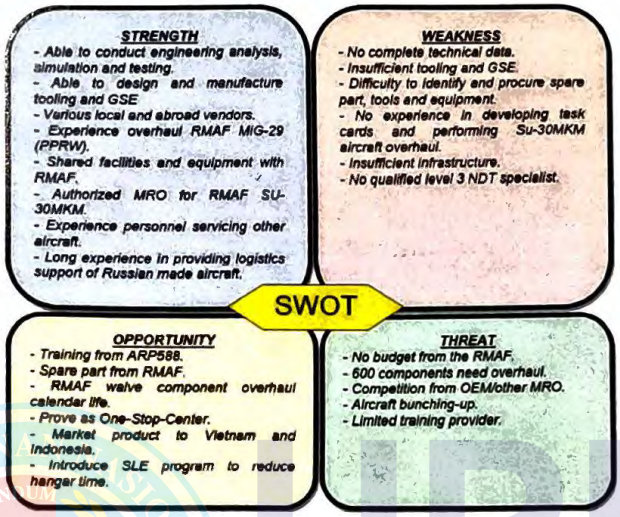


Figure 4.11: SWOT Analysis carried out by CAESE to identify the best strategy to overcome the Su-30MKM overhaul issue (CAESE, 2020)

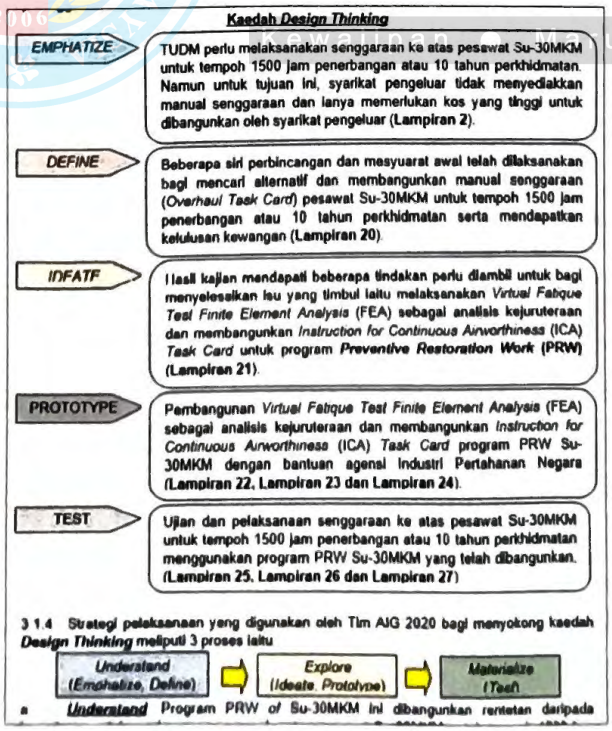


Figure 4.12 Design Thinking Process carried out by CAESE to understand, explore, and identify strategy to materialize the objective in the Su-30MKM overhaul Issues (CAESE, 2020)

After feasible study by CAESE and eight presentations to the Chief of Air Force Boards that took almost one year, improvements to the ASI program were suggested and approved to be carried out. The improvement was to add 3 (three) processes as justification the aircraft structure health condition ASIP program as presented by the figure below.

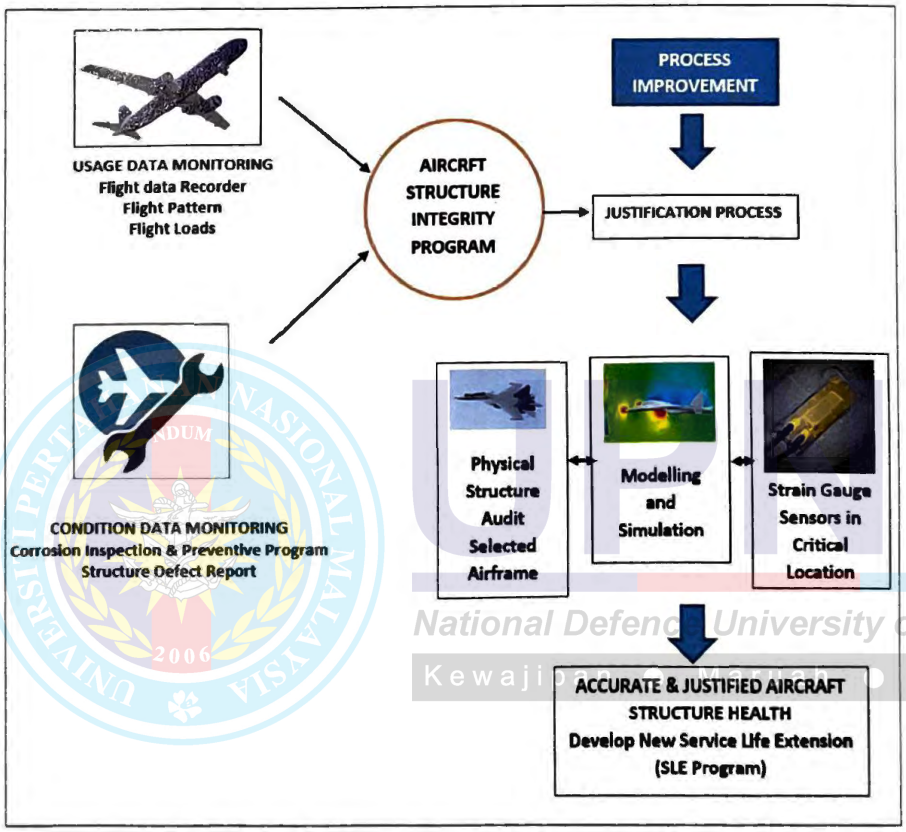


Figure 4.13: Schematic Presentation of Improvement process to the ASIP program that resulted in development of SLE Program.

The improved processes to the ASIP had been achieved by adding the justification processes as follows (CAESE, 2020):

a. Performed structural audit on a sample Su-30MKM aircraft that will be subjected to a teardown inspection. The sample aircraft will be dismantled and break down to the last pieces and to record, map and analyse any damage in term of corrosion or cracks at critical locations, that will be identified through computer aided simulations.

b. Fitting the Su-30MKM aircraft with Structure Health Monitoring SHM sensors at structure critical locations and to record the load inclusive of bending, twisting, compression and tension of the structure during flight. This will create actual profiling on the loads for predictions.

c. Modelling Su-30MKM aircraft into the Computational Fluid Dynamic using Computer Aided Engineering processes and to run simulations. The results from simulation will be compared to the actual aircraft stress and strain sensors fitted and flown at specific flight profile for accurate structural damage prediction and to find linearity to the actual flight conditions.

Picture 4.2: Su-30MKM tear down inspections carried out with assistance from ATSC Sdn Bhd (2018)

According to the report, through these process CAESE will be able to:

a. Identify each type of material and the protective coatings used by Sukhoi Design Bureau to build the aircraft. This is to get a better overview on the structural build and actual strength for reverse engineering (CAESE, 2020).

b. Getting and using the right technology to predict the corrosion due to the structure and material climatization with Malaysian weather environment and RMAF aircraft storage and usage pattern (CAESE, 2020).

c. Justification of the Su-30 MKM actual remaining structural life from the ASIP data, tear down inspections results and the simulation analysis.

d. Provide alternative maintenance solution to prevent failure on the aircraft structure without depending on the aircraft manufacturer (CAESE, 2020).

cording to the Project Report (2020), the improvement to the ASIP program involved several tions and processes that includes:

a. Upgrading of new computer hardware and adding new simulation software for flight simulation, structure finite elements analysis, crack growth analysis and corrosion simulation program in CAESE.

b. Engaging with internal organization and government agencies such as No 11 Squadrons, DGTA, MPBU, STRIDE, SIRIM and universities and Non-Government agencies such as ATSC Sdn Bhd and Caidmark Sdn Bhd through Non-Disclosure Agreement as design support, maintenance support and financial support.

c. Training of engineers and technician in the field of Computer Aided Engineering, strain gauge fitment, finite element analysis, data capture and analysis, defect detections and Non-Destructive testing. The training also involved CAESE, No 11 Squadrons, ATSC Sdn Bhd and Caidmark Sdn Bhd as joint effort and technology transfer initiatives.

d. Financial commitment from RMAF Air Support Command and the RMAF HQ. RMAF that had committed RM 40 Million for the improvement in ASIP and to produce alternative maintenance solution to replace the Russian aircraft manufacturer 10 years overhaul program. The cost included purchase of hardware and software, training, tear down inspections on a Su-30MKM and reassembly processes.

| Serial | Item / Description / Activity | Duration (Month) | Month | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 1 | *Structural Health Monitoring* (SHM) | 10 | | | | | | | | | | | | | | |
| 2 | Su-30MKM 3D *Scanning and Modelling* | 6 | | | | | | | | | | | | | | |
| 3 | Aircraft Structural Intergrity | 14 | | | | | | | | | | | | | | |
| 4 | *Database Management System* | 12 | | | | | | | | | | | | | | |
| 5 | *Simulation Services* (CFD *and* FEA) | 12 | | | | | | | | | | | | | | |
| 6 | *Corrosion Analysis* | 12 | | | | | | | | | | | | | | |
| 7 | *Crack Growth* | 14 | | | | | | | | | | | | | | |
| *Phase* | | | 1st and 2nd | | | | | | 3rd | | | | | | 4th | |

Table 4.11 Project Milestone Chart (CAESE, 2020)

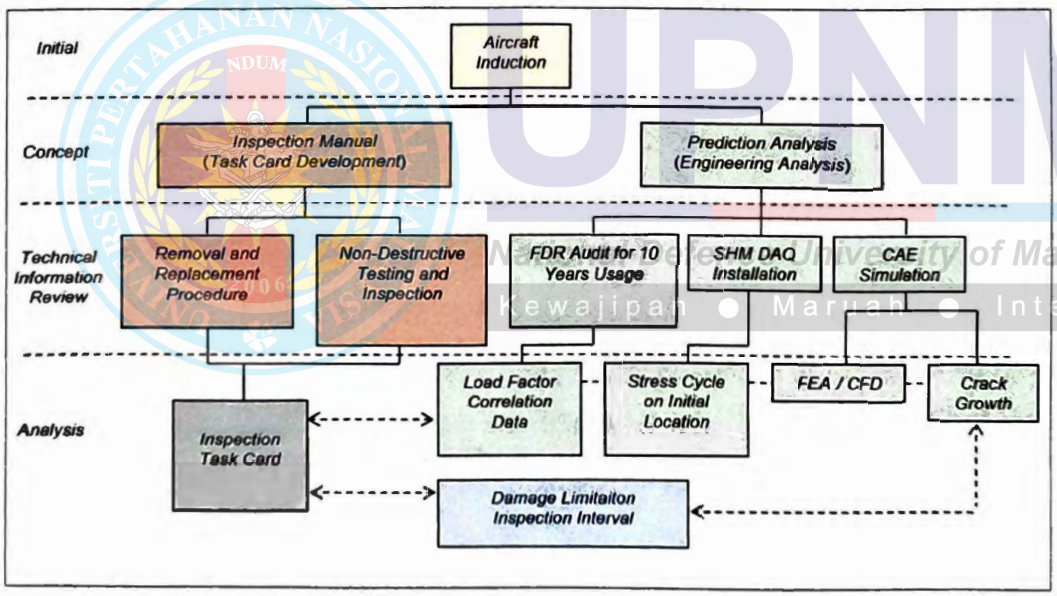


Figure 4.15 Process Flow for Structural Life Extension SLE (referred as Inspection Task Card) development phases (CAESE, 2020)

The Director had stated that the Aircraft Structure Integrity Program (ASIP) process improvement had increased CAESE capability to conduct a thorough structure analysis and justify the ASIP program. As a result, the new improved Aircraft Structure Integrity Program process had revealed that the Su-30MKM aircraft structure is still safe and intact, and therefore the 10 years overhaul program insisted by the manufacturer had been classified as *over servicing with misleading structural data* by CAESE, and this finding was accepted by RMAF higher

command. Thus, the manufacturer proposal for 10 years overhaul program had been denied by RMAF based on the analysis results (CAESE, 2018).

Using the results and data from the new improved ASIP processes and adding the reverse engineering process, CAESE had able to develop the Structure Life Extension (SLE) program for the aircraft, to compliment the denied manufacturer overhaul program. This had ensured that the Su-30MKM structure integrity remained intact until 2035, and at the same time replacing the manufacturer costly 10 years overhaul requirement. The SLE program had been a success with a huge cost saving and had been implemented to Su-30MKM since 2019 without any issues (CAESE, 2020).

### 4.4.5 Measure of Success

The measure of the success is being evidence by the following events:

a. The RMAF Air Command Headquarters is the immediate customers to CAESE in term of the ASIP analysis and the Structure Life Extension (SLE) program. The SLE program will only be accepted to be used in RMAF supply chain, after passing rigorous quality assurance and quality control processes that are documented in the *Design Approval Procedure Manuals* that are as follows (CAESE, 2020):

i. Preliminary Design Review.
ii. Independent Design Review.
iii. Maintenance Review Board I (Intermediate)
iv. Maintenance Review Board II (Higher Level)
v. Design Approval.
vi. Design Acceptance.

The Structure Life Extension Program develop by CAESE was accepted by the Air Support Command Headquarters to be implemented on all the Su-30MKM on 08 Aug 2018 after 14 months of development and passing all the requirements through the

issuance of Technical Approval Certificate (TAC, 2018). The Structure Life Extension Program was approved in the Maintenance Review Board I chaired by the Air Support Command Chief of Staff in 08 Sep 18 and Maintenance Review Board II chaired by the RMAF Assistant Chief of Staff Engineering in Nov 18.

b. The Directorate General of Technical Airworthiness (DGTA) is the governing body for the airworthiness regulatory standards. DGTA is the highest authorization and independent body that audited the processes in CAESE throughout the program. After proving compliance to the DGTA standard airworthiness regulatory requirement, the Structure Life Extension Program develop by CAESE was approved by the Airworthiness Board series 37/2019 chaired by the Deputy Chief of Air Force acting as the Chief of Air Force, with the Director General of DGTA as the secretariate (DGTA, 2019).

c. The Service Life Extension Program is carried out by ATSC Sdn Bhd as the contractor and end user that executed the program. The first Su-30MKM aircraft that had completed the Structure Life Extension program was handed over to the Chief of Air Force at a special ceremony in Langkawi International Maritime and Aerospace (LIMA) 2019 exhibition and witnessed by the then Prime Minister Tun Dr Mahathir Mohamad and the Defense Minister YB Mohamad Sabu. (NST, 2019; CAESE, 2020). Until this date, there are total of 10 Su-30MKM had undergone the SLE program develop by CAESE. The program was designed and carried out under the SLE continuous improvement program that will study and analyze any defects or findings during the execution of SLE, through Failure Mode, Effect and Criticality Analysis, FMECA. (CAESE, 2020).

d. The project final report had stated that the program had achieved saving in government international cash flow transfer of RM 2.862 Billion, development of local aerospace industries capabilities, supply chain sustenance for Su-30MKM and the possibilities of using similar process and technology to other RMAF aircraft for supply chain benefits (CAESE, 2020). Customer satisfaction survey conducted by CAESE in their report, stated that 96% of the respondents were satisfied with the technical services

and achievements (CAESE, 2020). This innovation had also won the Malaysian Commercialization Year (MCY) 2019 awards from the Ministry of Science, Technology and Innovation. According to the Prime Minister at that time, the success of the Structure Life Extension program developed by CAESE had resulted in reevaluation and cancelation of the government's plan to procure new Multi Role Fighter Aircraft (MRCA) to replace the Su-30MKM which saved the government coffer for other important needs. The last but important success was when the Sukhoi Aircraft Manufacturer had finally recognized and accepted that the development of SLE program had met with international standard and was recorded in the minutes of meetings at Gong Kedak Air Base on the 18th of January 2019.

**2.4. The Russian side acknowledged and is convinced in the progress achieved by the Malaysian side in developing of overhaul and service life extension program in accordance with the respective international MRO standards.**

Picture 4.3: Meeting with the Russian Su-30MKM Manufacturer in Gong Kedak Air Base on the 18th of January 2019 and the extract from the minutes of meeting showing the Russian acceptance of the SLE (MCY Report Exhibits, 2019)


Picture 4.4: The media coverage Prime Minister comment on Structure Life Extension (defenseworld.net, 2019)


Picture 4.5: MCY 2019 Awards at KLCC Convention Center received by the Chief of Air Force with the attendance of DGTA, RMAF Chief Engineer, CAESE, No 11 Squadrons, and ATSC Sdn Bhd as a team in the supply chain process.

Picture 4.6: The Structure Life Extension Manuals for Su-30MKM developed by CAESE (CAESE, 2020)

### 4.4.6 Observation and Findings

Observation on the detailed records of meetings between CAESE and their customers (RMAF Air Support Command, DGTA and the squadrons) revealed the evidence of customer focus and leadership commitment in CAESE to fulfill the RMAF supply support demands requirements. The acceptance of the proposed SLE program through rigorous quality acceptance and assurance processes at multiple levels is the evidence of customer's focus requirement and satisfaction. Continuous improvement and innovation had been observed in the records of improvements throughout the SLE development program from the beginning until the completion of the project. The innovation to the ASIP process had proven on the supply chain management cultural change from the routine CAESE's work scope and responsibility as data analyzer into designing of structure life extension program to meet the demand requirement. The numerous training records was observed and became evidence of the skill and knowledge as one of the success factors of the program. Employee involvement had also been observed in meetings between the leadership and the team that had been tasked to analyze and provide solutions.



As overall observation throughout the problem-solving process in this case, revealed evidence of all five (5) major TQM practices being imparted that include Leadership & Managerial Commitment, Customer Focus & Satisfaction, Employee participation, Continuous improvement & innovation, and Training & Education, The TQM practices imparted into the SCM practices that include change of corporate culture which add the justification processes to the ASIP program to meet with the SC demand, re-engineering of support flow from OEM to CAESE, and improvement in the RMAF SCM decision-making capability had resulted in the benefits of improved RMAF internal facing supply chain capability, delivery of quality product and services, improve efficiency in information processing. reduce SC cost, customer satisfaction, and improve RMAF resource planning. These findings had therefore confirmed to the studies carried out by Talib F. et. all. (2010) that stated combination of TQM practices with SCM practices will results in benefits to the organization.

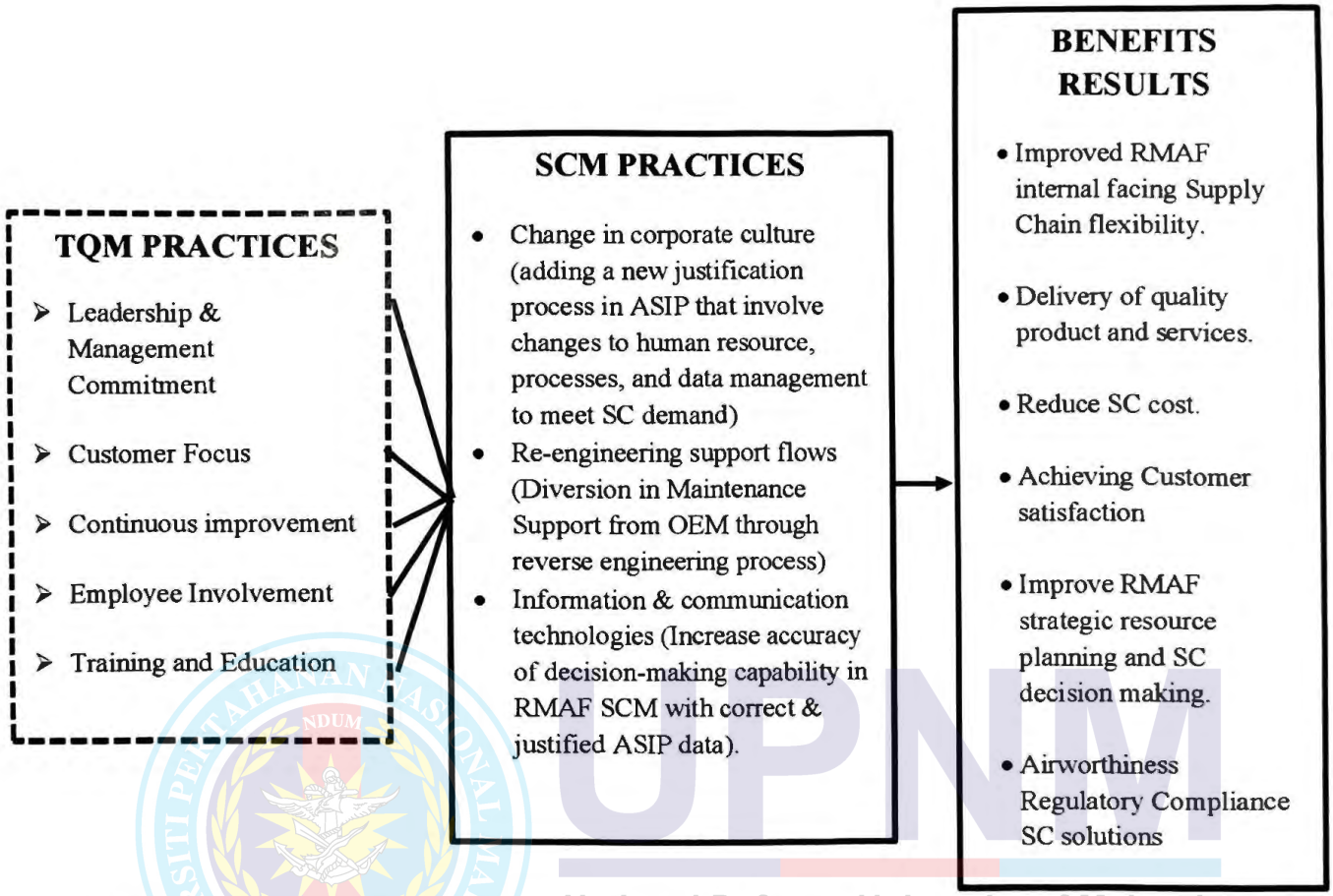


Figure 4.16: Findings of relation between TQM and SCM practices Case No 3.



## 4.5 OTHER FINDINGS

It is observed that CAESE had been implementing the TQM principles in the organization and gaining the benefits of success in the SCM. The TQM principles had been observed from several documents and data as follows:

a. Mission and vison statements. *Menjadi Sebuah Pusat Kecemerlangan Ilmu dan Perkhidmatan Kejuruteraan Aerospace Angkatan Tentera Malaysia pada 2024.* To become the center of excellence in knowledge and engineering services in the RMAF in 2024. *Untuk Menyediakan Perkhidmatan Kejuruteraan Berkualiti dan Berkesan melalui Pengurusan Sumber yang Efisyen bagi Mendokong Pembangunan Berterusan TUDM.* To provide quality and effective engineering services through efficient management the resources to support the continuous improvement of the RMAF. The statements revealed

the commitment from the leaderships, customer focus, continuous improvements, knowledge, and employee involvement.

b. Minutes of meetings and records of meetings had emphasized, supported and showed the leadership commitment from the RMAF higher authority, the Director until the Head of Departments into achieving the objective statements in the mission and vision. The documents revealed important characteristic of the organization. Being a military establishment, the directives are clearly from the top to bottom. However, CAESE had implemented a team system that are termed as the *Sistem Pengurusan Unit* SPU or Unit Management System that consist of between 5 to 10 technicians that meets every month. The records of the SPU meetings will be read, commented, and signed by their immediate officer, Head of Department, and the Director that indicate a process of employee participation where ideas and issues are discussed within a smaller group of people from the bottom upwards. The supply chain challenges and problems faced in CAESE had been discussed and channelled through the organizational means of management that involved all employee, including the Director's quarterly meetings, weekly meetings, head of departments meetings and the SPU meetings.



c. CAESE had been implementing a weekly continuation training and keeping the all the records, complete with the skill level of every individuals as required by the RMAF policy (RMAF, 2015). CAESE had also documented innovation and improvement to the RMAF supply chain by developing new capabilities for the aircraft and local development of aircraft replacement parts that wins several innovation awards at RMAF levels and Ministry of Defense levels, such as development of Laser Guided Bomb carrier for Su-30MKM, Brake Parachute System for Su-30MKM, Aircraft Static Discharge for Su-30MKM, Gatling Gun Station for Nuri S61 and Russian Adaptor for Weapon testing (CAESE Innovation Reports, 2019, 2018, 2017). Thus, these documents and data had further supported CAESE's implementation of TQM principles inclusive of leaderships commitment, customer focus, continuous improvements, training and education and employee involvement.

d. The quality system certification QMS ISO 9001:2015 held by CAESE had imparted some of the TQM characteristic where the progress and problems encountered will be discussed in the monthly meetings. The customers satisfaction reports, audits reports, and internal defect and inconsistencies reports are tabled and discussed to ensure the most appropriate solutions will be achieved for continuous improvement in the system.

e. CAESE had also certified as the Authorized Engineering Organization (AEO) from the Directorate General of Technical Airworthiness (DGTA) and are subjected to annual audits from the authority (DGTA, 2021). The compliance to the AEO certification become another evidence that TQM principles which includes leadership commitment, customer focus and satisfaction, employee involvement, continuous improvement, and training and education that are documented in the Engineering Management Plan (EMP, 2020). All the characteristics of the TQM principles are well documented and published in the CAESE's Engineering Management Plan (EMP) as the framework for resources control and airworthiness management. The TQM principles are related to the EMP due to the airworthiness regulatory requirements that emphasized on a quality system (DGTA,2015).




Picture 4.7: CAESE's Certificate of Authorised Engineering Organisation and ISO 9001:2015

f. Interviews of the Director, Head of Departments and personnel involved had strengthen the observation on the documents, data and findings that supported the TQM practices in CAESE had contributed to the achievement and success in all three cases.

## 4.6 CONCLUSION

From the observation in all the three cases and other findings analyze in this chapter, it is found that the elements of TQM dimensions Leadership & Managerial Commitment, Continuous improvement, Customer Focus & Satisfaction, Employee Involvement and Training & Education were evidence in all three cases.

The imparted TQM practices into the SCM practice had enabled CAESE to achieve an increase in business performance. The efficiency of the SC had been improved by the success in SC cost reduction, SC flexibility, delivery of quality products and services, efficient SC relationship, customer satisfaction, improve in resource planning, efficient information processing between SC and reduce in the waiting time for technical services.



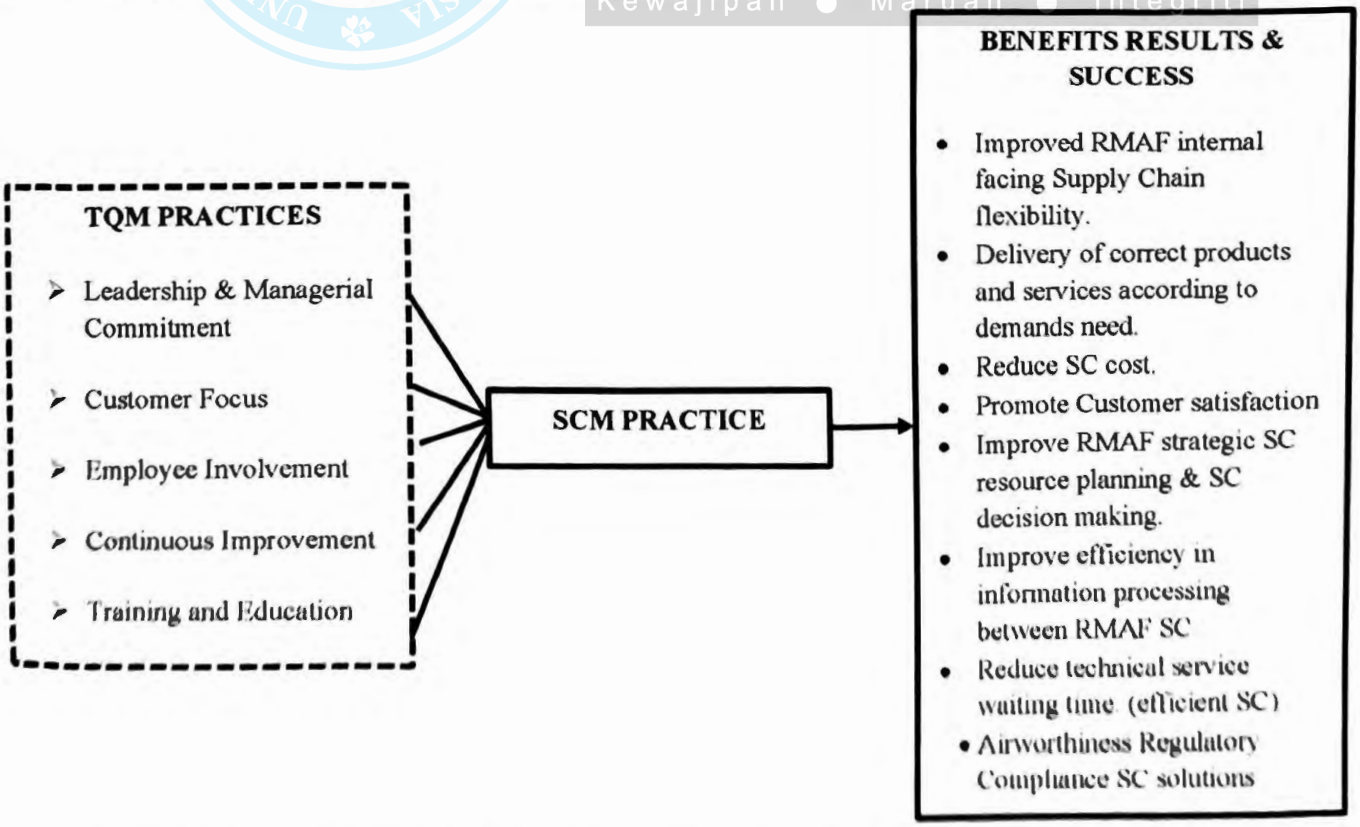


Figure 4.17 Total Success of All Three Cases from TQM principles implementation

# CHAPTER 5
# SUMMARY, CONCLUSION AND RECOMMENDATION

## 5.0 INTRODUCTION

This chapter provides a summary, conclusions and recommendations from the paper. The research findings indirectly can assist the supply chain management of RMAF maintenance organization to improve further on implementing TQM in the SCM to achieve benefits and success in the RMAF maintenance organizations.

## 5.1 SUMMARY OF FINDINGS

Three research objectives were identified in Chapter 1 and in this section, the results will be summarized, discussed and conclusions will be drawn. The conclusions and recommendations were made from the analysis and data collected in Chapter 4 to address the pre-set objectives. The statistical data from reports and interviews with the Director and officers from CAESE as determined by the qualitative research method. The conclusions made in this study will have the overarching imperative of bringing out how the supply chain could be improved by implementing and integrating TQM and SCM in RMAF Center of Aerospace Engineering Services (CAESE).

The prime goals of the paper were to identify the TQM principles of Leadership Commitment, Customer Focus, Continuous Improvement, Employee Involvement, and Training and Education in CAESE and to identify the relationship between Leadership Commitment, Customer Focus, Continuous Improvement, Employee Involvement and; Training and Education with the success in increasing the supply chain performance with integration of SCM at the Centre of Aerospace Engineering Services CAESE, Subang Air Base and lastly to propose a recommendation to improve the TQM at CAESE.

On the first objective, it is established that the data from documents, interviews and observation had satisfied that all the five elements of TQM principles that are the Leadership Commitment, Customer Focus, Continuous Improvement, Employee Participation and Training and Education is being evidence in three cases, and it is also being observed that it had contributed to the success of supply support performance at CAESE. This paper had also established that Leadership

Commitment, Customer Focus, Continuous Improvement, Employee Participation and Training and Education had contributed to ensuring the proper implementation and success of Supply Chain Management practices in the organization. All the five TQM principles had been the key factors of success in supply supportability in the three cases analyzed. It had supported the findings that customer satisfaction in terms of product availability, delivery of services, innovation, and quality dimensions can be achieved by the implementation of TQM and SCM strategies (Sharma and Modgil, 2015).

On the second objective of identifying the relationship between the TQM and SCM with the success in supply chain performance at CAESE, it was found that there is a positive relationship between the TQM principles and the SCM principles that had benefited CAESE in achieving a better performance. On the third objective, it is identified that the benefits of the TQM best practises applications to the supply support will improve the internal facing Supply Chain flexibility and relationship; Delivery of correct products and services according to demands need; Reduce SC cost; Promote customer satisfaction; Improve strategic resource planning & SC decision making; Improve efficiency in information processing between RMAF SC; and Reduce technical service waiting time for efficient SC.



The most beneficial outcome was found to be the saving of RM 2.862 Billion in supply chain cost and creating the flexibility of RMAF supply chain and self-sustenance capability. These had increased the internal supply chain capability and in correspondence to the Malaysia Aerospace Industry Blueprint 2030 (CAESE, 2020). The other tangible benefits achieved were time reduction and cost savings achieved from improvement of product quality and the transportation management system. The intangible benefits include the improvement in supply chain relation, communication, and the exchange of information between RMAF internal supply chain. This showed that the integration of TQM and SCM had been as an approach and process that will improve product quality, customer service (Kannan and Tan, 2007; Cao and Zhang, 2011), organizational performance (Ou et al., 2010) and SC performance (Flynn and Flynn, 2005; Vanichchinchai and Igel, 2010).

As highlighted in the literature review, Alefari et al., (2017) had stated that senior management commitment is required for any initiative to be successful. It is observed that top management dedication is responsible for setting particular, attainable, measurable, reasonable and thorough

focused targets, and is therefore the most important variable in the consistent application of TQM. CAESE top administration had demonstrate their responsibility by administrating the resources according to TQM principles and support the necessary change in SCM that had effectively enabled the organization's supply chain performing better and mitigated the problems and issues in transportation, delivering the correct structure repair services and also relief the disruption in the RMAF supply chain. Customer Focus, Employee Involvement, Training and Education; and Continuous Improvement were also found to be affecting factors of success in combination to the SCM practices in CAESE. The problems faced by CAESE in the three cases and the steps taken to improve on the situation had showed that these challenges can be addressed through various improvement strategies such as total quality management (TQM) and supply chain management (SCM). This supported the literature that applying TQM will increase profitability, competitiveness, teamwork, productivity, product quality and customer satisfaction (Kumar et al., 2011).

The integration of TQM and SCM is important as both TQM and SCM share ultimate goal which is "customer satisfaction," their integration enhances the influence of both, resulting in enhanced organizational customer satisfaction levels (Mahdiraji et al., 2012). Further, the effect on supply chain performance is observed through TQM principles and continuous improvement concepts deployment across the supply chain network (Terziovski and Hermel, 2011). It is found that CAESE had combined the TQM with SCM principles that emphasis on cultural changes, re-engineering of support flow and, using information and technologies to achieve the desired performance and overcoming the challenges. Such challenges faced by organizations can be addressed through the synergy of TQM and SCM, because quality-related issues are addressed by TQM, while other factors such as cost of inventory management, services to the customer, timely delivery, etc., are addressed by SCM (Kaur et al., 2018)

The literature review thus assists, the findings of the paper by showing that leadership commitment, employee involvement, customer focus, continuous improvement and assumption of new technology in training and education are critical factors that ensure the success in mitigating challenges and issues faced in the organization's supply chain through integration between TQM principles and SCM principles.

## 5.2 CONCLUSION

In can be concluded that this paper had able to establish the positive relations between TQM principles that include leadership commitment, employee involvement, customer focus, continuous improvement and training and education, with the SCM principles that resulted in gaining success in the organization's supply chain performance. The study showed that with the integration of TQM and SCM principles the RMAF organization such as CAESE may achieved the improvement of supply chain flexibility and relationship; delivery of correct products and services according to the demands need; reduce SC cost; promote customer satisfaction; improve strategic SC resource planning & SC decision making; improve efficiency in information processing between RMAF SC; reduce the waiting time for service support: and airworthiness regulatory compliance SC solutions.

The implementation of TQM into SCM had able to relief the supply chain disruption situation in the monopolistic nature of the Su-30MKM combat aircraft supply support that depends on the manufacturer for the airworthiness support. With the combination of TQM and SCM principles RMAF able to reduce the supply chain cost at a very substantial amount and it is therefore recognized that TQM practices are important comprehensive improvement paradigm in the modern economy (Slack et al., 2010) for organizational excellence (Goetsch and Davis, 2013). TQM and SCM principles integration can end up being a powerful and wide technique for rendering association steady improvement in execution regarding accomplishing efficient supply chain performance (Vigneshwaranp et al., 2015).

This paper had supported the theory that TQM will further build up the principles in achieving of effective supply chain performance by including all efforts of departments and individuals in the organization. Thus, it shows that, the TQM principles can be elaborated in several ways that encompassed of management philosophy to integrate the functions, continuous improvement, quality of product and services, customer satisfaction and the efficiency measurement. (Deming, 1986; Polo and Padhi, 2005).

Therefore, leadership commitment, customer focus, continuous improvement, employee participation and training and education are critical to gain the benefits of supply chain

performance with the integration to SCM principles that will results in increase of the business and supply chain performance.

## 5.3 RESEARCH CONTRIBUTIONS

That findings of such a paper come with certain results and effects that can be categorized into three main areas: accomplishments to theories, contributions to research methodology's solidity and contributions to organizational professionals.

### 5.3.1 Contribution to Theories

This paper had supported the theory of TQM and SCM that formed the basis for supply chain quality management SCQM. The relation of TQM and SCM principles to the success in the business and supply chain performance had been studied, analyzed and presented through three different cases with justification from interviews, statistical data, records, minutes, reports and other documented evidences. The result had supported the theories from several scholars such as:

a. There is a strong correlation between TQM and SCM practices (Vanichchinchai and Igel, 2009; Talib and Rahman, 2010).

b. TQM and SCM are management philosophies that play an important role in terms of improving organizational competitiveness (Talib and Rahman, 2010)

c. Through the implementation of practices shared among QM and SCM, such as continuous improvement and leadership, organizational performance is improved (Azar et al., 2010; Fernandes et al., 2017; Kaynak and Hartley, 2008).

Thus, this qualitative study had supported a conceptual model in exploration of the concept of SCQM in terms of its practices, with shared key domains of both TQM and SCM in the scope of the Royal Malaysian Air Force organization at the Center of Aerospace Engineering Services CAESE.

### 5.3.2 Contributions to Robustness of Research Methodology

This Paper had integrated the data from interviews with statistical and documented data obtained from various departments at CAESE to support the qualitative research findings. The endless

support given by CAESE in giving direct excess to the sources for interviews with statistical and supporting data from internal and external records, minutes of meetings, reports, documents, pictures, and details of evidence had contributed to the robustness of the research methodology. This research has had the full cooperation from the CAESE's top management, officers at departmental levels and the technicians into getting all the required information to support the course of this paper and to identify the organizational operating systems and implementation of the TQM and SCM. CAESE's cooperation comes with the good faith of finding the truth and to address the achievements in view of academics and the fundamental theories.

### 5.3.3 Contributions to Organization Practitioner

This paper had studied the TQM and SCM practices in the RMAF organization which is considered unique since it involve agencies that deals with limited and rigid supply chain due to the airworthiness regulatory requirement and the niche market of military aircraft. The findings of this paper may provide improvement to the TQM and SCM practices and help RMAF or similar organizations into achieving a better performance in future. The success of integrating TQM and SCM practices may become the basis for RMAF policy makers into developing and embedding the concept to increase the organization supply chain performance with the consideration of the airworthiness regulatory requirements such as in CAESE that had achieved the Approved Engineering Organization status from DGTA. The framework of CAESE's success in integrating the TQM and SCM principles and achieving the performance in supply chain may be translated into a policy or standard practices across RMAF organizations.

Practitioners in other RMAF organizations may adapt the concept and practices of TQM and SCM to relief and mitigate issues and challenges faced in the supply system. The supply chain flexibility and supportability may be increased through innovations with leadership strong commitment. The increased in supportability developed through integrating both TQM and SCM principles in RMAF supply chain created options in facing with the monopolistic and rigid nature of RMAF external facing supply chain. Thus, the concept may reduce the dependability on aircraft manufacturers and will benefit the organization in the long run. With a proper, tailored, and focused strategic planning based on the findings, RMAF highest levels policy makers may have a better and clearer understanding of the effectiveness of TQM and SCM principles to mitigate issues in the RMAF internal facing supply chain.

## 5.4 RECOMMENDATION TO IMPROVE THE IMPLEMENTATION OF TQM AND SCM IN RMAF AND CAESE

Supply chains are generally highly vulnerable to the internal and external weaknesses that are different between each supply chain, making one supply chain unique from the other. The cumulative result of multiple obstacles that are either internal or external to the supply chain will form the barrier to achieve TQM and SCM synergistic benefits. It is therefore important for RMAF and CAESE to define and measure the effects of the multiple obstacles in their supply chains. The instability of the supply chain may be minimized by properly defining, assessing and evaluating the obstacles and barriers to achieve successful supply chains. The identification of these obstacles will allow managers to recognize the key barriers related to integration of TQM and SCM practices.

Scholars had identified barriers in integrating the TQM and SCM practices that include lack of commitment to the vision, values and quality objectives of the supply chain, lack of cooperation with suppliers and customers, lack of trust between supply chain partners, lack of job development, lack of coordination policies, lack of top management commitment to better coordination of the entire supply chain, and lack of adequate information sharing with supply chain members (Kaur et al., 2019).

It is therefore recommended that:

a. RMAF and CAESE to investigate the integration of TQM and SCM principles into the management policies of the internal organizations and suppliers. This is to promote a clear requirement and execution framework in the RMAF's policies, publications and regulations such as the Technical Airworthiness Management Manuals TAMM and the RMAF Quality Manual. The adaptation of TQM and SCM principles into TAMM may results in a better airworthiness regulations framework to achieve faster and better solutions in managing issues in the supply chain. This is to instigate the entire RMAF supply chain to be more focused and working into achieving the integration of TQM and SCM principles for success. The contract management that deals with suppliers or contractors such as Performance Based Contracts may include the TQM and SCM dimensions to allow for a dynamic continuous improvement.

b. The suppliers to the RMAF and CAESE need to be audited in term of supply chain performance by giving a clear indexing system such as Supply Chain Operations Reference model framework or SCOR model system. This is better than just auditing for the QMS and airworthiness compliance, that are currently being practiced without integrating the SCM dimensions. The SCOR model will enable RMAF internal and external supply chain to be transparent and achieved a mutual agreement to the performance measures and standards between agencies. This will help identify weak areas of contract implementations and enforcement in the supply chain.

c. The suppliers and customers in RMAF internal facing supply chain need to have a better communication interface that are transparent and user friendly to replace the ageing and limited *Sistem Pengurusan Komputer Bersepadu* (SPKB) system. The system needs to have a performance monitoring that can clearly display any delays in delivery or non-performing agencies along the internal and external facing supply chain that will trigger alerts and become evidence in contracts enforcements. The analysis on non-performing or non-improving agencies in the supply chain will help RMAF to strengthen and achieve a better business performance.



d. The achievement showcased by CAESE in the integration of TQM and SCM may be modelled for future development of RMAF policies that should be incorporated to other organizations in RMAF supply chain.

e. The cultural change to support the SCM in CAESE had caused additional work scope and responsibility to the personnel such as in the case of transportation issue, structure repair and the Aircraft Structure Integrity improvement. CAESE is recommended to conduct a study on the impact to the personnel morale towards the extra responsibility.

## 5.5 RECOMMENDATIONS FOR FUTURE STUDY

This research paper has provided insight into the integration of TQM and SCM principles in Center of Aerospace Engineering Services CAESE Subang Air Base. However, it has also created opportunities for further research. Recommendation for future research are as follows:

a. Study can be conducted at the other RMAF organization in the internal supply chain that faced similar issues and challenges in the performance to deliver the services, spares or technical support. The collaboration of several studies within the RMAF internal supply chain will give a better picture of the weaknesses and strength to overcome the common challenges face by the internal supply chain and to identify whether the cases in CAESE is unique or similar in terms of integration framework between TQM and SCM practices. The total outcome from several studies may allow the RMAF policy maker to identify, verify, classify, and rectify the weaknesses in the organizations.

b. The RMAF policy maker may also do research on other organization with similar background such as other Air Forces or aircraft operators to see the integration of TQM and SCM practices from different perspectives. This may allow RMAF to generate a more universal understanding of political, economic, social, and technological influences on the integration of TQM and SCM at strategic level for future planning.

c. This focus of study can be extended for the maintenance organizations of army and naval assets in MAF. This will create a better understanding on the issues and challenges faced to achieve a better performance in the Malaysia Armed Forces supply chain.

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**APPENDIX A**

**RESEARCH QUESTIONNAIRE**

| **PART A: BACKGROUND OF RESPONDENT** | |
|---|---|
| **MILITARY NUMBER** | |
| **RANK** | |
| **NAME** | |
| **ACADEMIC QUALIFICATIONS** | |
| ○ PMR/SPM<br>○ Diploma<br>○ STPM<br>○ Bachelor's Degree<br>○ Master<br>○ PHD | |
| **WORK EXPERIENCE** | |
| ○ 3-5 Years<br>○ 6-10 Years<br>○ 11-15 Years<br>○ 15 Years and Above | |
| **TRED** | |
| | |
| **CURRENT WORKPLACE** | |
| | |
| **POSITION** | |
| | |

| PART B: QUESTIONS ABOUT CASE OF TRANSPORATION ISSUE |
| --- |
| **1. Why did the transportation is considered as big issue to CAESE?** |
| |
| **2. What are the issues and challenges faced by CAESE's transportation management?** |
| |
| **3. How did CAESE resolve the transportation problem?** |
| |

| 4. What are the alternatives being considered while resolving this issue? |
| --- |
| |
| **5. How does CAESE mitigate the risk such as road accidents in solving this issue?** |
| |
| **6. What are the involvement of higher authority in solving this issue?** |
| |

| |
|---|
| **7. How does CAESE measure the effectiveness and success in the innovation to solve the issue?** |
| |
| **8. In your opinion, did this innovation involved the leadership, personnel, training, customer focus and continuous improvement?** |
| |
| **9. How do you describe the relation between the leadership, personnel, training, customer focus and continuous improvement to the CAESE supply chain?** |
| |

| PART C: QUESTIONS REGARDING ISSUES IN QUALITY OF AIRCRAFT STRUCTURE REPAIR |
| --- |
| **7. Why did the quality of aircraft structure repair is considered as one of the big issues to CAESE?** |
| |
| **8. What are the issues and challenges faced by CAESE's structure repair product quality?** |
| |
| **8. How did CAESE resolve the issues in structure repair problem?** |
| |

| |
|---|
| **9. How did this issue being analyzed and what are the root cause of this issue?** |
| |
| **10. In your opinion how can CAESE solved this issue and what are the consideration factors?** |
| |
| **11. How does this problem solved and what are the processes involved?** |
| |

| |
|---|
| **12. How does CAESE measure the effectiveness and success in solving the issue?** |
| |
| **13. In your opinion, did this innovation involved the leadership, personnel, training, customer focus and continuous improvement?** |
| |
| **9. How do you describe the relation between the leadership, personnel, training, customer focus and continuous improvement to the CAESE supply chain in this issue?** |
| |

| PART D: QUESTIONS ABOUT CAESE AIRCRAFT STRUCTURE INTEGRITY (ASI) PROGRAM |
| --- |
| **10. What and Why did the quality of aircraft structure integrity program is important to the RMAF?** |
| |
| **11. What are the issues/challenges in maintaining the ASI program?** |
| |
| **12. How did this issue being analyzed and what are the root cause of this issue?** |
| |

| 13. How does this problem solved and what are the processes involved? |
| --- |
| |
| **14. How does CAESE measure the effectiveness and success in solving the issue?** |
| |
| **15. In your opinion, did this innovation involved the leadership, personnel, training, customer focus and continuous improvement?** |
| |

| **16. How do you describe the relation between the leadership, personnel, training, customer focus and continuous improvement to the CAESE supply chain in this issue?** |
| --- |
| |

## LIST OF INTERVIEWEES

1. Kolonel Ir. Azhar bin Idris TUDM - Director of CAESE
2. Leftenan Kolonel Ir. Mohd Shahrul Nizam bin Mohd Hedzir TUDM – CAESE's Head of Aerodynamic Division
3. Mejar Dr Ir. Mohd Fuad bin Koslan TUDM – CAESE's Head of Structure Repair
4. Mejar Ir. Arvinthan Venugopal TUDM – CAESE's Head of Aircraft Structure Integrity
5. Kapten Muhammad Hafiz bin Tanzizi TUDM – CAESE's Military Transport Officer

**APPENDIX B**

## LIST OF DOCUMENTS

1. CAESE Annual Reports 2018, 2019 and 2020
2. CAESE Innovation Reports 2018, 2019 and 2020
3. CAESE Engineering Management Plan 2020
4. Relevant Minutes of Meetings
    a. CAESE Inovation Meetings
    b. CAESE Director Meetings
    c. CAESE Safety Meetings
    d. RMAF Innovation Committee Meetings
    e. Chief of Air Force Forums Meetings
    f. Air Support Command HQ Design Review Meetings
5. Relevant Commitment Orders issued by the RMAF HQ to CAESE
6. CAESE's Structure Defect Reports, Analysis, and Statistics
7. CAESE's Structure Repair Course (Student Reports, Questionaire, Results, Syllabus)
8. CAESE's Customer Survey Results
9. Audits Reports and Corrective Action Request issued by DGTA to CAESE
10. CAESE's Transports Documents (Request Statistics and Classification, Drivers Training Instructions and Drivers Standing Orders)

TERHAD

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14 Dis 20

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Lihat Agihan

**MINIT MESYUARAT JAWATANKUASA PEMANDU INOVASI (JKPI) TUDM SIRI 1/2020 PADA 24 NOV 20 JAM 1120 DI BILIK MESYUARAT RAJAWALI**

Hadir:

| | | |
|---|---|---|
| Lt Jen Dato' Mohd Asghar Khan bin Goriman Khan TUDM | TPTU | Pengerusi |
| Lt Jen Dato' Mohammad Salleh bin Hj Osman TUDM | Panglima Operasi Udara | |
| Lt Jen Dato' Muhamad Norazlan bin Aris TUDM | Panglima Bantuan Udara | |
| Mej Jen Mohd Shahada bin Ismail TUDM | PPLU | |
| Mej Jen Dato' Shamsudin bin Kassim TUDM | PANGWILUD 2 | |
| Mej Jen Dato' Zulkifli bin Hamid TUDM | AKS Operasi & Strategik | |
| Mej Jen Dato' Muhammad Tarminzi bin Hj Mustapha TUDM | AKS P&P | |
| Mej Jen Dato' Noor Akmar bin Mohd Dom TUDM | AKS Sumber Manusia | |
| Mej Jen Ir Mohamad Razip bin A. Samad TUDM | AKS Kejuruteraan | |
| Brig Jen Zainal bin Abdul Manaf TUDM | AKS Materiel | |
| Brig Jen Hj Mohd Suhaimi bin Hj Sahri TUDM | AKS Tadbir | |
| Brig Jen Mohd Kahar bin Mohd Kassim TUDM | IJTU | |
| Brig Jen Abdul Halim bin Abu Hassan TUDM | Wakil PANGWILUD 1 | |
| Kol Tan Chee Kee TUDM | Pengarah Inspektorat | |
| Lt Kol Rosli bin Hashim TUDM | PS 1 Inovasi | |
| Lt Kol Mohammad Raznudeen bin Abdul Jabar TUDM | PS 1 Kes B | |
| Mej Hairul Zaimy bin Ibrahim TUDM | PS 2 Inovasi | |
| Kapt Rohayu binti Shahrudin TUDM | PS 3 Inovasi | Setiausaha |

Turut hadir:

| | |
|---|---|
| Kol Ir Azhar bin Hj Idris TUDM | Pengarah PUSPEKA |
| Lt Kol Shabani bin Saad TUDM | Ketua Bahagian Elektronik PUSPEKA |
| Mej Norazlin binti Nakin TUDM | Ketua BPPT PUSPEKA |
| Mej Mohd Shawal bin Idris TUDM | Ketua Flait MEC PUSPEKA |
| Mej Muhammad Hazwan bin Abd Lateb TUDM | Ketua Flait Avionik PUSPEKA |
| Mej Mohd Haziq Izzat bin Sulaiman TUDM | Ketua Flait ICT PUSPEKA |



TERHAD

| | |
|---|---|
| 7. **Keputusan**. Pengerusi mewakili ahli mesyuarat merakamkan ucapan terima kasih kepada Sekretariat Inovasi TUDM kerana berjaya melaksanakan program-program inovasi yang telah dirancang walaupun berdepan dengan cabaran pandemik COVID-19. | Semua |
| 8. **Implikasi Kewangan Aktiviti Inovasi dan KIK Tahun 2020**. PS 1 Inovasi membentangkan implikasi kewangan untuk semua aktiviti yang telah dianjurkan sepanjang tahun 2020. Jumlah perbelanjaan keseluruhan adalah berjumlah RM **91,482.00** berbanding peruntukan yang diluluskan berjumlah RM **126,772.00**. Butiran terperinci perbelanjaan adalah seperti di **Kembaran B**. | |
| 9. **Keputusan**. Ahli mesyuarat mengambil maklum dengan butiran perbelanjaan yang telah dibentangkan. | Semua |
| 10. **Pembentangan Perancangan Cadangan Program Inovasi/KIK Tahun 2021**. Seterusnya PS 1 Inovasi membentangkan cadangan program Inovasi dan KIK bagi tahun 2021. Butiran cadangan program adalah seperti di **Kembaran C**. | |
| 11. **Keputusan**. Mesyuarat bersetuju dan meluluskan cadangan tersebut. | Semua |
| 12. **Pembentangan Cadangan Peruntukan Kewangan Aktiviti Inovasi dan KIK TUDM Tahun 2021**. PS 1 Inovasi seterusnya membentangkan cadangan peruntukan kewangan bagi setiap aktiviti inovasi dan KIK TUDM sepanjang tahun 2021. Terdapat 3 x cadangan yang telah diusulkan seperti di **Kembaran D**. | |
| 13. **Keputusan**. Mesyuarat sebulat suara bersetuju dengan cadangan kedua iaitu sebanyak **RM 91,322.00**. | AKS Materiel |
| 14. **Pembentangan Calon Fasilitator KIK TUDM Tahun 2021**. PS 1 Inovasi membentangkan pencalonan fasilitator untuk aktiviti pertandingan KIK TUDM bagi tahun 2021. Cadangan calon fasilitator adalah seperti di **Kembaran E**. | |
| 15. **Keputusan**. Mesyuarat bersetuju dan meluluskan cadangan tersebut. | Semua |

**PERKARA 4. PEMBENTANGAN STATUS PROJEK BERIMPAK TINGGI OLEH PUSPEKA**

16. **Status Semasa Projek-Projek Berimpak Tinggi bagi Tahun 2020**. Pengarah PUSPEKA membentangkan status semasa projek-projek berimpak tinggi bagi tahun 2020, berdasarkan Minit Mesyuarat Jawatankuasa Pemandu Inovasi (JKPI) TUDM Siri 1/2019 (Rujuk: MTU/IJTU/100-13/7/4 bertarikh 24 Dis 19) seperti berikut:

a. **Perlaksanaan Projek *Digital Tool Control System***. Pengarah PUSPEKA memaklumkan bahawa pihak PUSPEKA telah diarahkan untuk menjalankan kajian penggunaan *Digital*

TERHAD

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Selangor

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Faks 03-78472560

Jan 21

PUSPEKA R&P 100-6/1/3

Lihat Agihan

**MINIT MESYUARAT INOVASI PUSPEKA SIRI 1/2020 PADA 30 DIS 2020 JAM 1430 DI BILIK MESYUARAT INDUK PUSPEKA**

Hadir

| | | |
|---|---|---|
| Kol Ir Azhar bin Idris TUDM | Pengarah | Pengerusi |
| Lt Kol Ir Mohd Shahrul Nizam bin Mohd Hedzir TUDM | Ketua Bahagian Aerodinamik (KBA) | |
| Lt Kol Shabani bin Saad TUDM | Ketua Bahagian Elektronik (KBE) | |
| Lt Kol Roslimizal bin Kamarozaman TUDM | Ketua Bahagian Senjata (KBS) | |
| Mej Mohd Shawal bin Idris TUDM | Ketua Flait EMC | |
| Mej Mohd Azlan bin Hashimi TUDM | Ketua Flait Senjata | |
| Mej Muhammad Hazwan bin Abd Lateb TUDM | Ketua Flait Avionik | |
| Mej Haziq Izzat bin Sulaiman TUDM | Ketua Flait ICT | |
| Mej Norazlin binti Nakim TUDM | Ketua R & P | Setiausaha |

1 Pengerusi melafazkan salam dan memberikan kata-kata aluan kepada semua yang hadir. Beliau melihat PUSPEKA pada masa kini mempunyai komitmen kerja yang tinggi dan setiap bahagian mempunyai kekangan masing-masing dalam merealisasikan amanah yang diberi. Justeru, beliau berharap melalui perbincangan sebegini dapat membantu kelancaran tugas sekaligus memastikan tugas yang diberikan dapat dilaksanakan dengan baik dan sewajarnya.

| **PERKARA 1. TAKLIMAT MAKLUMBALAS MESYUARAT JKPI SIRI 1/2020** | **TINDAKAN** |
|---|---|

2 **Status Semasa Projek-Projek Berimpak Tinggi bagi Tahun 2020.** Perkembangan status semasa projek-projek yang terlibat adalah seperti berikut:

a **Perlaksanaan Projek *Digital Tool Control System* (DTCS)**
Mej Hazwan TUDM memaklumkan proses perlaksanaan di unit-unit terlibat masih tidak dapat dijalankan sepenuhnya kerana masih menunggu peruntukan kewangan. Melalui mesyuarat JKPI TUDM Siri



TERHAD

berimpak tinggi yang dibincangkan dalam mesyuarat JKPI TUDM Sri 1/2020 kepada IJTU secara *quaterly*

8 **Keputusan.** Pengerusi mengarahkan supaya setiap bahagian menggunakan template hampir sama seperti taklimat projek PUSPEKA. Template jadual status projek inovasi berimpak tinggi adalah seperti di Kemberan A. Ketua R&P dikehendaki menyediakan *template* ini ke dalam share folder supaya setiap bahagian boleh membuat kemaskini di dalam taklimat mingguan PUSPEKA juga. — Semua

9 **PERKARA 3. PROJEK INOVASI PUSPEKA**

8 **Projek Inovasi PUSPEKA.** Saban tahun PUSPEKA telah menjadi peserta peringkat akhir pertandingan AITUDM. Malah, prestasi PUSPEKA sebagai pemilik podium memang tidak dapat dinafikan berdasarkan rekod kemenangan yang pernah diperolehi selama ini. Bagi tahun 2021, PUSPEKA masih perlu memberikan komitmen yang sama dengan memajukan projek inovasi bagi keperluan KIK TUDM.

9 **Keputusan.** Berdasarkan perbincangan, Pengerusi bersetuju supaya 2 x projek inovasi dari PUSPEKA dicalonkan untuk KIK TUDM bagi 2021. Projek yang terlibat adalah: — KBA KBE

a *Service Life Extension Program* (SLEP) Su-30MKM (Kategori KIK Penyampaian Perkhidmatan – Penciptaan) -Bahagian Aerodinamik

b *Sky Tracking Information Display* (S-TiD) (Kategori KIK Penyampaian Perkhidmatan - Penambahbaikan) -Bahagian Elektronik

**PERKARA 4. PROJEK KPI PUSPEKA**

10 **Projek KPI.** Ketua R & P memaklumkan bahawa KPI ini adalah berdasarkan Pelan Strategik TUDM iaitu dalam meningkatkan dokongan operasi. Bahagian Kejuruteraan TUDM perlu mempunyai sekurang-kurang 2 x projek yang mempunyai unsur meningkatkan dokongan operasi TUDM. PUSPEKA perlu memaklumkan perkembangan projek secara bulanan kepada MTU-Kejuruteraan untuk *desk officer* yang terlibat mengemaskini maklumat KPI.

11 **Keputusan.** Mesyuarat telah bersetuju supaya Projek *Service Life Extension Program* (SLEP) Su-30MKM dan Projek Sky Tracking Information Display (S-TiD) dijadikan KPI 2021 kepada MTU-Kejuruteraan. Ketua R & P dikehendaki berhubung dengan R&P MTU-Kej untuk keperluan koordinasi selanjutnya. — KBA KBE Ketua R&P

**PERKARA 5. HAL-HAL LAIN**

12 ***Hologram Gimmick.*** KBE memaklumkan kebelakangan ini Sel ICT di

No Salinan ..... drpd .....

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Faks: 03-2071 6607

22 Jan 16

MTU/KEJ/120

Lihat Agihan

**MTU/COMMITMENT ORDERS/01/2016: PEMBANGUNAN SKOP KERJA *SAFETY BY INSPECTION OF AGEING AIRCRAFT* BAGI PESAWAT SU-30MKM**

Rujuk:

A. KP/PERO-3/UDARA/E/04/2003(P/24581121010).
B. MTU/RANUD/S.405/4 Bhg 4(51) bertarikh 31 Dis 15.

**PENDAHULUAN**

1. Berdasarkan kepada kandungan kontrak di Rujuk A, pesawat Su-30MKM mempunyai konsep senggaraan *safe life* di mana pesawat perlu memasuki fasa *overhaul* pada 1500 jam penerbangan atau pun 10 tahun mengikut *calendar date*. Ini menyebabkan pesawat Su-30MKM perlu menjalani penyelenggaraan *10 years overhaul* bermula pada Julai 2017 bagi 6 buah pesawat untuk kumpulan pertama, walaupun jumlah jam penerbangan berada di antara 200 hingga 500 jam sahaja.

2. Sehingga kini pihak TUDM tidak dibekalkan sebarang manual bagi melaksanakan program ini kerana ia masih belum dibangunkan lagi. Daripada maklumat yang diperolehi, proses *overhaul* ini akan melibatkan *total refurbishment* ke atas semua sistem serta struktur pesawat di mana kesemua komponen, sub komponen termasuk kesemua bahagian struktur yang keseluruhannya berjumlah 593 *line items*, perlu dihantar kembali ke OEM bagi tujuan *overhaul* yang akan menelan belanja yang besar dengan anggaran kasar USD27 juta (RM 116 juta) bagi sebuah pesawat.

3. Oleh yang demikian, satu cadangan telah dibentangkan di dalam mesyuarat Jawatankuasa Pembangunan Keupayaan (JPK) Siri 16/2015 seperti di Rujuk B bagi menghasilkan satu konsep senggaraan yang baru dengan menggunakan pendekatan *safety by inspection* yang akan menggantikan konsep *10 years overhaul* yang asal.

Air Support Command Headquarter
d/a KUALA LUMPUR AIR BASE, JALAN LAPANGAN TERBANG LAMA
50460 KUALA LUMPUR

**DOC ID: MPBU-TAC-M52-2018-001**

## TECHNICAL APPROVAL CERTIFICATE

### Product Details

| | |
|---|---|
| **Description:** | Su-30MKM Preventive and Restoration Works (PRW). |
| **Item:** | Technical Task. |
| **Document Identification:** | Su-30MKM PRW. |
| **Revision No:** | Initial Issue. |

### Statement of Confirmation

I, the undersigned hereby approve the above Instruction for Continuous Airworthiness (ICA) document, and authorize its applicability onto Su-30MKM.

| | | |
|---|---|---|
| **Name** | Zamzuri Bin Talib | **Signature** |
| **Rank** | Lt Col RMAF | |
| **Service No** | 372430 | |
| **Appointment** | SO 1 System Group A | |
| **Date** | 08 Aug 18 | |

**PRAKATA PENGARAH**
**PUSAT PERKHIDMATAN KEJURUTERAAN *AEROSPACE* TUDM (PUSPEKA)**

Demi menyahut aspirasi Panglima Tentera Udara dalam membudayakan *distruptive innovations mindset* di kalangan warga TUDM bagi menyokong Pelan Rancangan Pembangunan Keupayan TUDM 2055 yang selari dengan konsep budaya ilmu yang menggalakkan pembaharuan, kreativiti dan dinamik, PUSPEKA sekali lagi berpeluang serta komited untuk menjayakan Horizon Baharu KIK peringkat TUDM tahun 2020 dengan menghantar penyertaan dalam bidang Inovasi Penyampaian Perkhidmatan dalam kategori Penciptaan. Pada kali ini, projek yang di angkat adalah program *Preventive Restoration Works* (PRW) *of* SU-30MKM.

Inovasi program *Preventive Restoration Works* (PRW) *of* SU-30MKM bermula pada awal April 2017 yang mana ianya adalah manual senggaraan (*Overhaul Task Card*) untuk tempoh 1500 jam penerbangan atau 10 tahun perkhidmatan pesawat Su-30MKM yang kemudianya dikenali sebagai program *Preventive Restoration Works* (PRW) of Su-30MKM. Inovasi ini membolehkan pelaksanaan *overhaul* pesawat Su-30MKM apabila pesawat mencapai tempoh 1500 jam penerbangan atau 10 tahun perkhidmatan seterusnya meningkatkan kadar kebaikan pesawat dan keslagaan Tentera Udara DiRaja Malaysia.

'Mengangkasa' adalah frasa meletakkan sesuatu pada kedudukan yang tinggi, nun jauh di angkasa. Frasa 'Mengangkasa Inovasi' bermaksud mengangkat budaya inovasi kemartabat tertinggi supaya kedudukan dan kepentingannya dapat dihargai dan dihayati oleh semua pihak, terutamanya warga TUDM. Oleh yang demikian, PUSPEKA melalui kesinambungan kecemerlangan kumpulan KIK, akan terus mengangkasa budaya inovasi keperingkat yang lebih tinggi.

**MUHD AZHAR BIN HJ MD GHAZALI**
Kol TUDM
Pengarah PUSPEKA

**BAHAGIAN B: RINGKASAN PROJEK**

| MAKLUMAT PROJEK | |
|---|---|
| Tajuk | Program *Preventive Restoration Works* (PRW) *of* SU-30MKM |
| Bidang & Kategori | Bidang Inovasi: Penyampaian Perkhidmatan<br>Kategori Inovasi: Penciptaan |

**RINGKASAN PROJEK**

**SIGNIFIKAN PEMILIHAN PROJEK**

Kerajaan Malaysia telah memperoleh 18 buah pesawat pejuang *Multi Role Combat Aircraft* (MRCA) jenis Su-30MKM secara berperingkat daripada Rusia pada tahun 2007 hingga 2009. Berpandukan kepada *Aircraft Log Book*, pesawat perlu menjalani *overhaul* apabila telah mencapai tempoh 1500 jam penerbangan atau 10 tahun perkhidmatan.

Ketiadaan manual senggaraan (*Overhaul Task Card*) untuk tempoh 1500 jam penerbangan atau 10 tahun perkhidmatan menyebabkan pesawat tidak dapat diterbangkan. Bagi mengatasi kekangan yang dihadapi, program *Preventive Restoration Works* (PRW) *of* SU-30MKM telah dibangunkan oleh *Aerodynamic Innovation Group* (AIG) 2020 bagi membolehkan *overhaul* pesawat Su-30MKM untuk tempoh setiap 1500 jam penerbangan atau 10 tahun perkhidmatan dilaksanakan.

**TINDAKAN PENYELESAIAN**

Pihak OEM telah menawarkan dua cadangan penyelesaian kepada TUDM bagi membolehkan *overhaul* ke atas pesawat Su-30MKM dilaksanakan iaitu:

a. Menghantar dua pesawat Su-30MKM ke premis pengeluar untuk tujuan kajian dan penilaian teknikal bagi penghasilan *Overhaul Task Card* Su-30MKM yang memerlukan masa selama 26 bulan dan melibatkan anggaran kos sebanyak RM 20.4 juta sebelum *overhaul* bagi setiap pesawat dilaksanakan dengan anggaran RM 116 juta bagi setiap pesawat. Manakala kos untuk *overhaul* adalah dianggarkan antara RM 110 juta hingga RM 159 juta bagi setiap pesawat.

b. Syarikat pengeluar akan melaksanakan kajian bagi menilai keupayaan Malaysia terhadap kemudahan dan fasilitas bagi kerja-kerja *overhaul* yang memerlukan pembiayaan sebanyak RM 3.57 juta.

Berdasarkan pilihan yang diberi, didapati kedua-dua opsyen adalah tidak memihak kepada kewangan semasa kerajaan Malaysia. Justeru, dengan mandat yang diberikan oleh pengurusan tertinggi TUDM kepada Bahagian Aerodinamik, Pusat Perkhidmatan Kejuruteraan Aerospace TUDM (PUSPEKA) untuk menyediakan PRW *Task Card*, Tim AIG 2020 telah menggunakan analisis SWOT (*Strength, Weakness, Opportunities and Threats*) bagi mengenalpasti kekuatan dan kelemahan sedia ada bagi merialisasikan program PRW pesawat SU-30MKM. Kaedah *Design Thinking* telah digunakan bagi mendapatkan penyelesaian ketiadaan *Overhaul Task Card* untuk tempoh setiap 1500 jam penerbangan atau 10 tahun perkhidmatan.

## CADANGAN PENAMBAHAN BILANGAN PEMEGANG LESEN BAT D 41 BAGI PEGAWAI DAN ANGGOTA ATAU MENAMBAH BILANGAN PEMANDU DARI PPK

1

## LATAR BELAKANG

- Rujuk mini mesyuarat keselamatan PUSPEKA bagi penggal keempat pada 18 Dis 2020.
- Perkara – Beban kerja pemegang lesen BAT D 41.
- Kekurangan rehat (fatigue) semasa pemanduan akan meningkatkan risiko kemalangan dikalangan Pegawai atau anggota. Hal ini kerana Pegawai atau anggota tersebut juga terlibat dengan tugas-tugas samada tugas kaji selidik atau senggaraan.

2

## TUJUAN

- Membincangkan sama ada perlu atau tidak penambahan pemegang lesen BAT D 41 bagi pegawai dan anggota ATAU membuat penambahan bilangan pemandu dari PPK.

3

## SENARAI PEMEGANG LESEN BAT D 41

4

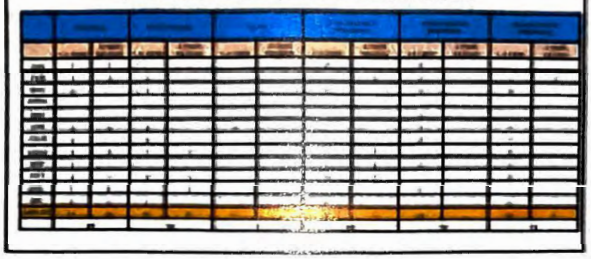
## SENARAI PEMEGANG LESEN MEMANDU ATM BAT D 41 (PENUH) BAGI PPK

5

## KEPERLUAN KENDERAAN MENGIKUT BAHAGIAN BAGI TAHUN 2019

6

## KEPERLUAN KENDERAAN MENGIKUT BAHAGIAN BAGI TAHUN 2020



7

## CADANGAN

- Tambahan pemegang lesen BAT D 41 sebanyak seorang bagi Bahagian Senjata, Bahagian Elektronik dan Bahagian Aeronautamik (Rangkut) disebabkan oleh keterapan keperluan kenderaan bagi penggerakan kuar tambah ciang.
- Bagi anggota PPH juga dicadangkan penambahan sebanyak 1x kali anggota.

8

## SEKIAN TERIMA KASIH

9

TERHAD

Pusat Perkhidmatan Kejuruteraan Aerospace (PUSPEKA)
d/a Pangkalan Udara Subang
40000 SHAH ALAM

Tel: 03-78444555 Samb 4860
Faks: 03-78472560

22 Dis 20

PUSPEKA/SAFETY/223/3

Lihat Agihan

**MINIT MESYUARAT KESELAMATAN PUSPEKA BAGI PENGGAL KEEMPAT DI BILIK MESYUARAT INDUK PUSPEKA PADA 18 DIS 2020 JAM 1510**

Hadir:

| | | |
|---|---|---|
| Kol Ir. Azhar bin Idris TUDM | Pengarah | Pengerusi |
| Lt Kol Ir. Mohd Shahrul Nizam bin Mohd Hedzir TUDM | Ketua Bahagian Aerodinamik | |
| Lt Kol Roslimizal bin Kamarozaman TUDM | Ketua Bahagian Senjata | |
| Kapt Hijrahtul Sakinah binti Abdul Razak TUDM | Ketua Flait Materiel | |
| Kapt Wan Norkamilah binti Wan Ismail TUDM | Ajutan | |
| Lt Navaneetam a/p Maniam TUDM | Wakil Ketua BPPT/R&P | |
| PW U I Muneer bin Kunhi | PW PUSPEKA | |
| PW U I Zakaria bin Senawi | PW Bahagian Elektronik | |
| PW U I Mohd Shanizal bin Zainudi | PW Bahagian Senjata | |
| PW U II Zulkifli bin Mohd Shariff | PW Bahagian BPPT | |
| PW U II Mohd Irwan bin Mohamed Hashim | PW Bahagian Aerodinamik | |
| Sjn U Tengku Ahmad bin Tengku Awang | PTTK Keselamatan | |
| Mej Mohd Shawal bin Idris TUDM | Peg Keselamatan/Wakil KBE | Setiausaha |

Tidak Hadir Dengan Sebab:

| | | |
|---|---|---|
| Lt Kol Shabani bin Saad TUDM | Ketua Bahagian Elektronik | Kursus |
| Mej Norazlin binti Nakim TUDM | Ketua BPPT/R&P | Kuarantin |

1. Pengerusi memulakan mesyuarat dengan mengucapkan salam sejahtera dan ribuan terima kasih kepada hadirin yang hadir bagi menjayakan Mesyuarat Keselamatan PUSPEKA Penggal Keempat bagi tahun 2020. Beliau juga memberi penekanan ke atas kepentingan menjaga *Standard Operating Procedure* (SOP) ketika menghadapi penularan pandemik Virus COVID-19. Justeru itu, semua peringkat anggota dikehendaki mengamalkan budaya kesihatan yang tinggi dalam usaha menghentikan penularan wabak tersebut. Seterusnya Pengerusi memulakan mesyuarat pada jam 1515.

**PERKARA 3. STATUS *SAFETY RISK MANAGEMENT* (SRM)** — **TINDAKAN**

11. Peg Keselamatan membentangkan status penyata SRM bagi setiap bulan penggal keempat untuk tahun 2020. Semua bahagian telah memberikan kerjasama yang baik dalam melaksanakan SRM bagi aktiviti yang berkaitan. Status SRM adalah seperti di Kemboran A.

12. **Keputusan**. Semua yang hadir maklum. — Peg Keselamatan

**PERKARA 4. RINGKASAN LAPORAN KEADAAN BAHAYA (*HAZARD REPORT*) DAN LEMBAGA PENYIASATAN (BOI) KENDERAAN TENTERA (MT).**

13. ***Hazard Report***. Tiada *hazard report* yang dimajukan bagi penggal keempat tahun 2020.

| BIL | *HAZARD REPORT* | TARIKH HANTAR | STATUS |
|---|---|---|---|
| 1. | - | - | - |
| 2. | - | - | - |

14. **BOI Kenderaan Tentera**. Tiada BOI kenderaan tentera dimajukan.

15. **Program Keselamatan**. Pegawai Keselamatan memaklumkan bahawa beberapa program keselamatan yang dirancang bagi penggal ketiga pada tahun 2020 telah berjaya dilaksanakan. Manakala program keselamatan yang dirancang bagi tahun 2020 adalah seperti berikut:

| BIL | AKTIVITI | BULAN |
|---|---|---|
| 1. | Mesyuarat Keselamatan Penggal Keempat | Dis |
| 2. | Gotong Royong Perdana | Dis |

16. Peg Keselamatan juga telah membentangkan program keselamatan bagi tahun 2021 seperti di Kemboran B.

17. **Keputusan**. Mesyuarat mengarahkan Ketua Bahagian Aerodinamik untuk mengetuai aktiviti Gotong Royong Perdana di PUSPEKA pada minggu keempat bulan Dis 20 sebelum Cuti Krismas. — Ketua Bahagian Aerodinamik

**PERKARA 5. HAL-HAL LAIN**

18. **Beban Kerja Pemegang Lesen BAT D 41**. Pengerusi mengutarakan kerisauan beliau ke atas beban kerja yang tinggi oleh pemegang lesen BAT D 41 dari kalangan pegawai dan anggota PUSPEKA. Pegawai dan anggota tersebut akan membuat pemanduan semasa pergi dan balik ke destinasi yang diarahkan dan akan terlibat dengan tugas-tugas samada tugas kaji selidik atau penggambaran. Kekurangan rehat (*fatigue*) semasa pemanduan akan meningkatkan risiko kemalangan di kalangan pegawai dan anggota. Justeru itu, keselamatan pemandu dan kenderaan perlu diberikan.

FOR OFFICAL USE ONLY

**ROYAL MALAYSIAN AIRFORCE**

**CURRICULUM**

**AIRCRAFT STRUCTURE REPAIR COURSE**

**PU 2501-033**



**Curriculum Approval Date** :07 Dec 18

| | | |
|---|---|---|
| **Training Development Authority** | : | Markas Pendidikan dan Latihan Udara |
| **Conduct of Training** | : | Pegawai Memerintah ITAS |
| **Curriculum Approval References** | : | LPPLU SERIAL NO: 91/18 dated 7 Dec 18. |

Curriculum Approval Date: 07 Dec 18

## FOREWARD

Aircraft Structure Repair Course is intended to make all participants aware of their responsibilities as aviation maintainers, thus ensuring the quality application of aircraft structure repair techniques, training and maintenance of the inspection records. This course also is a part of a continuing effort to improve the quality of education for participants. Specific information on application procedures of a product should be obtained from the manufacture through the appropriated maintenance manual.

To ensure the execution of this course, proper instruction of basic engineering knowledge must be emphasized, and high level of achievements is required to cater for operational needs.

Curriculum shall be review continuously to accommodate training and operation requirements. Any proposal for amendments and updating of the course curriculum shall be channeled to Panglima Pendidikan Udara through the Commandant of ITAS for review and improvement.

**January 2020**

**Director of CAESE**





Curriculum Approval Date: 07 Dec 18

**Course Description**

1. **Course Aim.** To educate and graduate student so that student are able to perform aircraft structure repair and improve the quality of education and the jobs done.

2. **Course Location.** The course will be conducted at PUSPEKA.

3. **Course Design Strategy.** The course will provide theory and practical instruction covering the aircraft structure repair procedures ad its application on the aircraft. Attitudinal outcomes also will be assessed during course session.

4. **Entrant Qualification.** Candidates are airmen/airwomen RMAF engineering trade, doing the maintenance work on aircraft and/or Juruteknik JLJ.

5. **Other RMAF Course.** Candidates must complete Perajurit Muda (PRAMUDA) training at RMAF training center.

6. The Aircraft Structure Repair Course consists of the following training sessions:

| | TRAINING SESSION | ABBREVIATION | HOURS |
|---|---|---|---|
| a. | Pre-Course Administration/General | GEN | 3.00 |
| b. | Workshop Practice | RT | 8.00 |
| c. | Organize work activities | WA | 8.00 |
| d. | Aircraft structure inspection | ACI | 8.00 |
| e. | Metal corrosion treatment | MCT | 8.00 |
| f. | Aircraft structure repair method | ACRM | 24.00 |
| g. | Manufacture part/Compartment | MPC | 8.00 |
| h. | Secure component/structure | SCS | 12.00 |
| i. | Course Examination and Conclusion | CEC | 4.00 |
| | | **Total:** | **80.00** |

KEMBARAN A KEPADA
PUSPEKA/KEJ/100/8/1
BTH SEPT 2020

**END OF COURSE REPORT**

**TRAINING UNIT: CENTER OF AEROSPACE ENGINEERING SERVICES ESTABLISHMENT**

| | | | |
|---|---|---|---|
| 1. | **COURSE NAME** | **AIRCRAFT STRUCTURE REPAIR** | |
| 2. | **Series** | **02/2020** | ~~OFFICER~~ / OTHER RANKS / ~~MIX~~<br>*Strike if not relevant |
| 3. | **Authority and Ref No.** | **MPLU/LAT/519/2020 KTW 221648H JUL 2020** | |
| 4. | **Course Start and End Date** | Plan Date : Start : 01 Jul 20<br>End : 19 Jul 20<br>Actual Date : Start : 02 Sept 20<br>End : 20 Sept 20<br>If the plan and actual date is differed, state the reason why?<br>Instructor for this course had to repair C-130H aircraft structure.<br>(Use attachment if necessary) | |

| ASSESSMENT RESULTS | | | | | |
|---|---|---|---|---|---|
| 5. | **No of Course Participants** | Start of Course: 16<br>Graduated: 16 | | Course Max No: 20<br>Course Min No: 15 | |
| 6. | **If the total number of course participants is more than the stipulated approved curriculum participants, state the reason why? Who approved it?** | | | | |
| | (Use attachment if necessary) | | | | |
| 7. | **No of Course Participants involved in this evaluation:** | | | **16 Participants** | |
| 8. | **Performance of Course Participants** | **Course results average in percentage (%). (Attach the name of all course participants and course results)**<br>Theory = Rujuk Lampiran A<br>Practical: -<br>Last 3 Series of course results average in percentage: | | | |
| | | Series No: 01/2019 — Theory: 86.3% — No of course participants: 18 — Practical: 77% | | | |
| | | Series No: 02/2019 — Theory: 88% — No of course participants: 15 — Practical: 74.6% | | | |
| | | Series No: 01/2020 — Theory: 87.8% — No of course participants: 20 — Practical: 75.3% | | | |

**CONCLUSION**

**Conclusion and recommendation are to be filled by Executive Officer (EXO) or Chief Instructor.**

| | |
|---|---|
| 14. | **Overall course achievement and performance summary.**<br><br>14.1 Pencapaian keseluruhan. Hasil analisa data dari penilaian kursus mendapati pencapaian keseluruhan kursus adalah 83.9 %. Ini menunjukkan bahawa peratusan kursus ini telah meningkat daripada kursus sebelumnya. |

**RECOMMENDATION**

**Recommendation might include:**
a. Further investigation of the finding.
b. Maintaining the current program as it stands.
c. Decreasing / increasing the number of course participants.
d. Terminating the program.
e. Changing the content of program.
f. Improvement on the current program to meet the new demands.
g. Creation of additional training course.

| | |
|---|---|
| 15. | 15.1 Berdasarkan analisa yang telah dibuat, berikut merupakan beberapa cadangan yang perlu diambil perhatian:<br><br>a) Pencapaian penuntut telah meningkat daripada siri yang terdahulu. Penuntut juga telah menunjukkan minat dan ketekunan yang mendalam semasa kelas teori dan amali.<br><br>b) Tentatif kursus adalah menepati dan memenuhi keperluan penuntut.<br><br>c) Pengisian kursus juga telah dipelbagaikan dengan perbincangan terbuka dan latihan kendiri yang mencukupi.<br><br>d) Peralatan yang sedia ada di PUSPEKA telah memberi ruang kepada penuntut mempelajari teknik-teknik Pembaikan Struktur Pesawat berpandukan Aircraft Structure Repair Manual. Akan tetapi peralatan yang sedia ada memerlukan penambahan dari segi kuantiti supaya sesi praktikal dapat dilaksanakan mengikut masa yang ditetapkan.<br><br>**Signature:**<br><br>**Rank and Name: Maj Dr Ir. Mohd Fuad Koslan** **Date: 20 Sep 2020** |

**LAPORAN AKHIR TAHUN 2018 BAHAGIAN AERODINAMIK PUSPEKA**

Rujuk:

A. PU 2302, Prosedur Manual Organisasi Kejuruteraan, Bahagian 1, Risalah 22.

## PENDAHULUAN

1. Bahagian Aerodinamik adalah merupakan salah satu bahagian utama yang terdapat di PUSPEKA. Bahagian Aerodinamik dipertanggungjawabkan untuk menyediakan bantuan kepakaran kejuruteraan (*engineering specialist support*) kepada skuadron-skuadron penerbangan dalam TUDM dan unit-unit aviasi *State Aircraft Operator* (SAO) yang lainnya, terutamanya yang berkait rapat dengan aspek mekanikal dan aerodinamik.

2. Bahagian Aerodinamik diterajui oleh seorang Pegawai Kejuruteraan berpangkat Lt Kol TUDM. Ia dipecahkan kepada lapan bahagian yang lebih kecil dengan fungsi yang lebih spesifik dan dirujuk sebagai Flait. Setiap Flait diketuai oleh seorang Pegawai Kejuruteraan berpangkat samada Mejar TUDM atau Kapt TUDM.

## TUJUAN

3. Laporan ini akan membentangkan pencapaian serta cabaran yang dihadapi oleh setiap flait yang berada dalam organisasi Bahagian Aerodinamik bagi tahun 2018.

## SKOP

4. Skop laporan adalah merangkumi perkara-perkara berikut:

a. Pencapaian tugas yang berjaya dilaksanakan bagi tempoh Januari 2018 hingga November 2018.

b. Cabaran serta kekangan yang dihadapi dalam pelaksanaan tugas bagi tempoh yang sama.

## PERANAN DAN FUNGSI

5. Menerusi Rujuk A, peranan serta khidmat kejuruteraan yang ditawarkan oleh Bahagian Aerodinamik adalah seperti berikut:

a. ***Non-Destructive Testing* (NDT)**. Menawarkan perkhidmatan bantuan teknikal dan khidmat nasihat berhubung pemeriksaan NDT yang meliputi beberapa kaedah seperti *Visual Optical Inspection* (VOI), *Liquid Penetrant Inspection* (LPI), *Magnetic Particle Inspection* (MPI), *Eddy Current Inspection* (EC), dan *Ultrasonic Inspection* (UT).

b. ***Aircraft Vibration Analysis***. Perkhidmatan *Propeller Dynamic Balancing, Rotor Track and Balance,* dan analisa getaran pesawat disediakan untuk pesawat *rotary wing* atau *fixed wing* dengan penggunaan peralatan RADS-AT dan juga *Honeywell VXP Chadwick-Helmuth*. Selain itu, perkhidmatan verifikasi peralatan RADS-AT turut disediakan dengan menggunakan peralatan *Critical Frequency Accelerometer Tester* (CFAT).

c. ***Aircraft Weighing***. Perkhidmatan timbang pesawat juga ditawarkan untuk kedua-dua jenis pesawat *rotary wing* serta *fixed wing*, melalui penggunaan samada peralatan *jacking type* atau pun *platform type*, bergantung kepada berat pesawat.

d. ***Aircraft Structure Repair***. Perkhidmatan membaikpulih struktur pesawat adalah meliputi pembaikan struktur pesawat *primary, secondary* dan *tertiary*. Walau bagaimanapun, keupayaan baikpulih pada ketika ini adalah terhad kepada pembaikan struktur *metallic* pesawat sahaja. Keupayaan pembaikan struktur komposit pesawat sedang diusahakan dengan perolehan peralatan pembaikan komposit dan *bonding*. Pihak PUSPEKA juga berkeupayaan untuk melaksanakan pembaikan struktur *metallic* secara *Standard Repair* dan juga *Non-Standard Repair*, di mana ianya terhad kepada maklumat yang boleh diperolehi pada *Structure Repair Manual* (SRM) bagi setiap pesawat. Selain daripada itu, Flait Pembaikan Struktur juga berkemampuan untuk memfabrikasi kit modifikasi berdasarkan kepada lukisan teknikal yang diberikan.

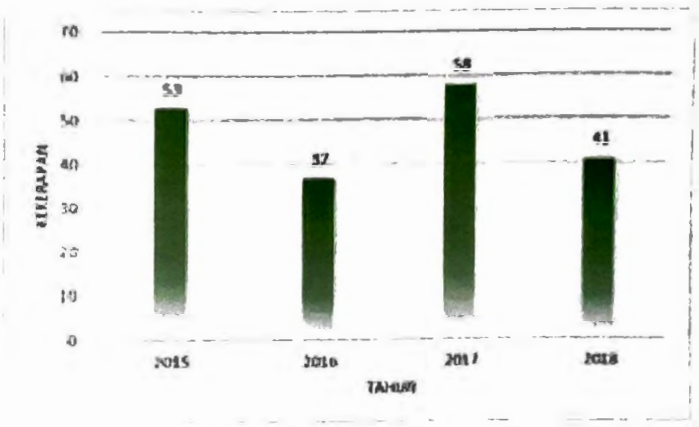
e. ***Oil Analysis***. Perkhidmatan *oil analysis* adalah dengan menggunakan kaedah *Spectometric Oil Analysis, kinematic viscosity, particle count, water-in-oil monitoring* dan *Fourier Transform-Infra Red* (FT-IR) terhadap minyak injin, minyak *gearbox*, cecair hidraulik dan pelincir.

f. ***Aircraft Modification***. Merekabentuk, membangunkan serta menghasilkan modifikasi bagi sistem persenjataan dalam TUDM.

g. ***Engineering Drawing***. Menghasilkan lukisan kejuruteraan dan simulasi analisa statik bagi sesuatu rekabentuk. Pada ketika ini, tugasan ini dilaksanakan dengan menggunakan perisian SolidWorks dan NX Siemens.

h. ***Aircraft Structure Integrity (ASI)***. Mentadbir perihal ASI bagi pihak TUDM terhadap lima jenis pesawat iaitu F/A-18D, C-130H, MiG-29, Hawk Mk 108/208, dan A400M melalui pengurusan kontrak yang dijalankan oleh syarikat Caidmark Sdn Bhd (CSB).

i. ***Operational Test and Evaluation (OT&E)***. Perkhidmatan OT&E adalah sangat meluas meliputi pelaksanaan ujian dan penilaian terhadap sistem yang sedang dinaiktaraf atau dimodifikasi, mahu pun melibatkan perolehan aset baru. Ia juga merangkumi sistem pesawat dan juga peralatan serta kenderaan sokongan darat.




**Gambarajah 16**: Graf Aktiviti Flait Struktur Pesawat bagi Tahun 2015-2018

(7) Gambarajah 16 menunjukkan perbandingan dari segi pencapaian tahun 2015 hingga 2018. Peningkatan dan penurunan tugasan adalah bergantung kepada pengarahan penugasan yang diterima daripada markas-markas dan MPBU.

(8) **Cabaran**.

(a) ***Sheet Metal***. Pembaikan struktur di PUSPEKA adalah terhad kepada pembaikan struktur *metallic* sahaja dan terdapat beberapa isu berhubung kesilapan dalam penghasilan *Repair Plate* akibat dari kesilapan pihak Squadron dalam melaksanakan pengukuran yang tepat, ketidaktepatan dalam rujukan yang diginakan serta kekurangan di dalam Teknik melapor kerosakan.

(b) **Kursus Lanjutan**. Tiada kursus lanjutan ditawarkan kepada juruteknik Pembaikan Struktur Pesawat. Adalah dicadangkan supaya:

i. Menghantar anggota untuk kursus lanjutan agar ilmu dan kemahiran dapat dipertingkatkan supaya pembangunan modal insan tidak terbantut.

ii. Meningkatkan tahap kemahiran dan pengalaman anggota-anggota.

(c) **Kawasan Tanggungjawab**. Pada ketika ini, PUSPEKA bertanggungjawab untuk melaksanakan pembaikan struktur pesawat bagi seluruh unit di Lembah Kelang. Adalah dicadangkan supaya: