

Issues and Challenges of Aviation Maintenance Repair and Overhaul in Southeast Asia

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Abstract

Southeast Asia faces considerable issues and challenges due to their competitive advantage on their geographical location and population, lack of skilled workers with competitive low labor wages, lack of globally recognize certification, policy reform on taxes and investment in Aviation Maintenance, Repair, and Overhaul (MRO). These factors make challenges for Southeast Asia to be Aviation Hub. This paper proposes the feasibilities of establishing Southeast Asia as the best hub for Aviation MRO by using data from existing academic sources and secondary data carried out by the authors using systematic review to analyze.

Keywords

Aviation, Maintenance, Repair, and Overhaul (MRO), Southeast Asia

1. Introduction

The aviation industry covers all types of air travel and operations enable these services, which include the entire airline industry, aircraft manufacturing, aircraft maintenance, research companies, military aviation, and many others. For example, the airline industry delivers air transportation for passengers and cargo utilizing aircraft, such as using airplanes and helicopters. The aviation industry is a gigantic key enabler of many other economic activities worldwide, providing jobs to millions of people throughout the world and transporting billions of passengers yearly. Prior to 2020, air transportation is growing increasingly accessible and sought after as the results of the advancement in information, communication, and technology (ICT) facilitating the interconnected global community and the thriving tourism sector as well as the strong aviation safety record. However, the pandemic COVID-19 since the beginning of 2020, has brought a dramatic drop in demand in terms of air transport passengers and freight especially due to movement control order and containment measures, thus threatening the viabilities of many airlines and cargo industries and other related organizations, Maintenance, Repair, Overhaul (MRO services included, causing employees being laid

off or terminated. But many believe that the aviation industry, including the aviation MRO, is slowly climbing its way out of the crisis's deepest depths and looking forward to a brighter future after global efforts of COVID-19 vaccinations.

In the aviation industry, Maintenance, Repair, Overhaul (MRO) concerns the repair, service, or inspection of an aircraft or aircraft components, which encompass all the aircraft maintenance activities, to guarantee the safety and airworthiness of all aircraft according to the international standards. MRO, or maintenance in general, is a major contributor to aircraft operating costs, flight delays, and cancellations where airlines are more likely to spend more on maintenance than on fuel or crew. Thus, efforts to keep assets operationally available while cutting MRO costs are a pressing issue. Since the aviation industry is highly regulated, this means that airlines and other commercial airline companies must practice continuous inspection programs established by aviation authorities. Aircraft maintenance is vital in ensuring product availability, reliability, and quality in which airline operators rely on MRO for safety and compliance with regulations and policies set by the international aviation authorities.

Regular and systematic planning (scheduled or periodical) aircraft maintenance is compulsory to prevent component and system failures during operations (Deng et al., 2021). This maintenance is normally set for the aircraft to save costs and achieve greater efficiency as airlines must prevent lost travel time as much as possible for financial and reputational reasons. The regular maintenance may comprise of flight line maintenance checks and also four different types of higher-level maintenance, which are the A Check (performed approximately every certain number of hours depending on aircraft type), B Check (performed approximately every 6-8 months), C Check (performed approximately every 20–24 months), and D Check ("heavy maintenance visit" (HMV), the most comprehensive and demanding check for an airplane) (Kinnison & Siddiqui, 2011; Qantas, 2021; AviationPros, 2021). A and B checks are lighter checks, while C and D are considered heavier checks. These A, B, C, and D checks are also parts of preventive maintenance. Besides these, certain authorities also use a 3C Check or Intermediate Layover (IL), for light structural maintenance, including checks for corrosion, crumbling of explicit pieces of the airframe, or on specific high-load parts of the airframe. This 3C Check can be included under C Check or D Check and used for cabin upgrades, for example, new seats, entertainment systems, and carpeting, to shorten the time the aircraft is out of service, by performing multi-tasks simultaneously.

Southeast Asia experiences tremendous growth in Aviation Industry. Based on research was done by the Centre for Asia Pacific Aviation (CAPA), air travel across Southeast Asia is growing by around 10 percent a year, contributed by growing travelers from the middle class in the region, continuous efforts to liberalize air traffic regulations, and price competition between airline carriers (The ASEAN Post, 2019). In 2018, the Southeast Asia aviation industry has reached a new milestone in the number of commercial aircraft by surpassing the figure of over 2000 aircraft and has nearly as many aircraft on order (mostly from LCCs) (CAPA, 2019). Indonesia as the largest country in terms of size and population in Southeast Asia has significantly contributed to growth in the aviation industry with more than 500 commercial aircraft operated by Indonesian airlines operator. Along with the growth of the aircraft number in Southeast Asia the requirement on aviation MRO become more significant to ensure the aircraft's runs in perfect condition and safe to fly.

This paper focuses on the aviation MRO within the Southeast Asian region, which includes Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Vietnam. The objective of this paper is to address the issues and challenges in the aviation MRO in Southeast Asia, in the view of making Southeast Asia the best hub for aviation MRO. The remaining of this paper is organized as follows: 2. Review of Past Studies, 3. Methodology, 4. Issues and Challenges in Southeast Asia Aviation MRO, 5. Potential Scopes for Future Studies in Aviation MRO of Southeast Asia, and 6. Conclusion.

2. Review of Past Studies

As described in Deng et al. (2021), aircraft MRO involves a series of activities including various types of maintenance, inspection, or modification of an aircraft or aircraft systems, components, and structures, and aircraft repairs including overhaul, to make sure that an aircraft retains an airworthy condition or simply can perform its required function. For a commercial aircraft, regular maintenance is crucial in preventing component and system failures while the aircraft is in operations. The flight hours (FH), flight cycles (FC), or calendar days (DY) represent the usage parameters as an indicator to aircraft utilization to be used in deciding inspection intervals or when the aircraft maintenance activities should take place. Since the airframe Original Equipment Manufacturers (OEMs) focus mainly on aircraft development and production, excluding the aftermarket, then MRO became an indispensable business in the aviation industry. Many commercial airlines have to rely on the options of either partially or fully outsource MRO services to repair shops and system suppliers. However, MRO accounts for a major chunk of the aircraft operating costs and one of the major factors to flight delays and cancellations. Aircraft operators have to seek

for better decision-making model, faster maintenance tasks planning solution, automated aircraft inspections using robots and drones, optimized parts and procurement management, and quicker and more effective MRO to reduce aircraft downtime. Airline operators view the aircraft MRO as imperative in maintaining service availability and reliability and to uphold customers' trust and the company's reputation.

In general, maintenance is usually associated with 'fixing' broken items (Tsang et al., 2006) and involved required actions to retain or restore a piece of equipment, machine, or system to the specified operable condition to achieve its maximum useful life (Monageng et al., 2018). Specifically, Jardine and Tsang (2005) perceived maintenance as "All activities aimed at keeping an item in or restoring it to, the physical state considered necessary for the fulfillment of its production function", thus considering proactive tasks such as routine maintenance, periodic inspection, preventive replacement, and condition monitoring. According to Ayeni (2015), the main objectives of aircraft MRO are to ensure or restore the safety and reliability of equipment, to obtain the product and process information necessary to optimize maintenance when these inherent safety and reliability levels are not met, to obtain the information necessary for component repair and tooling design for those items to be fully repaired or replaced during overhaul process, and to accomplish these objectives within the required time limits and at a minimum total cost, including the costs of maintenance and the cost of residual failures. Therefore, the ultimate goal of the aircraft MRO is to minimize the time an aircraft is taken out of service. Apart from this, airlines' operators are also concern with minimizing unplanned or unscheduled aircraft maintenance because these would disrupt operations and create logistic and resource problems.

Table 1
MRO Type Functions

Sector	Examples
Line Maintenance	Scandinavian Aircraft Maintenance (Norway); SIA Engineering (Singapore)
Hanger (Heavy) Maintenance Visit	AAR Corporation (Global, HQ Illinois, USA); SR Technics (Global HQ Zurich, Switzerland); ST Aerospace (Global, HQ Singapore); GE (HQ USA)
Engine Overhaul	Lufthansa Technique (Hamburg, Germany); Rolls Royce (HQ, UK).
Component Overhaul	Hawker Pacific Aerospace (UK/USA); APPH (UK); Ameco (China)
Avionics	Honeywell (Global); Selex Galileo Global (Italy/UK)
Major Modification/ Retrofits/ Conversion	Aeronautical Engineers (USA); Airbus (Dresden, Germany), Haeco (Hog Kong, China)

Source: (Ayeni, 2015)

Based on Ayeni (2015), MRO can be divided into six (6) categories: Line Maintenance, Hanger (Heavy) Maintenance, Engine Overhaul, Component Overhaul, Avionics, and Retrofits and Conversions. Due to the nature and types of overhauls required, MRO firms are usually specialized and specific in the type of overhaul they perform. The roles or types of maintenance by which MRO organizations are classified are presented in Table 1. Line Maintenance represents routine maintenance of aircraft that requires the MRO organization to conduct a frequent inspection of the aircraft to ensure it is safe for in-service use. Line maintenance entails work such as the A-Check and B Check which inspections include checking the brakes, oil levels, condition of cargo door seals, and wing surfaces for obvious damage or oil leakage (FAA). MRO organizations of this category can also carry out minor repairs as advised/required by OEM. Hanger (Heavy) Maintenance Visit covers scheduled checks, modifications of aircraft or aircraft systems by an airworthiness directive or engineering order, special inspections mandated by the airline, the FAA, or other regulations, painting of aircraft, and aircraft interior modifications. During hangar maintenance, the aircraft is out of service. This usually involves the disassembly of major components of aircraft for detailed inspection and repairs.

Meanwhile, Engine Overhaul ranges from routine service checks to local repairs and complete overhaul of engines. It is considered the largest sector within the MRO industry and depending on the nature of repair carried out, this can either be done whilst the engine is still mounted on aircraft (on-wing services) or at an approved maintenance facility (off-wing). The Auxiliary Power Units (APU), which provide electrical power and compressed air to aircraft whilst on the ground without the need of using main engines or an external ground power unit) also, fall within this category. Component Overhaul involves an overhaul of all other parts not categorized under the heavy maintenance category, ranging from Landing Gear to Fuselage overhauls. All tasks exceeding advised remit of Line Maintenance will usually require more detailed investigation and work input, rendering components unserviceable until required maintenance operation(s) have been correctly carried out. MRO organizations within the Avionics category specialize mainly in the overhaul of aircraft avionics and associated components. Avionics are typically various electronic

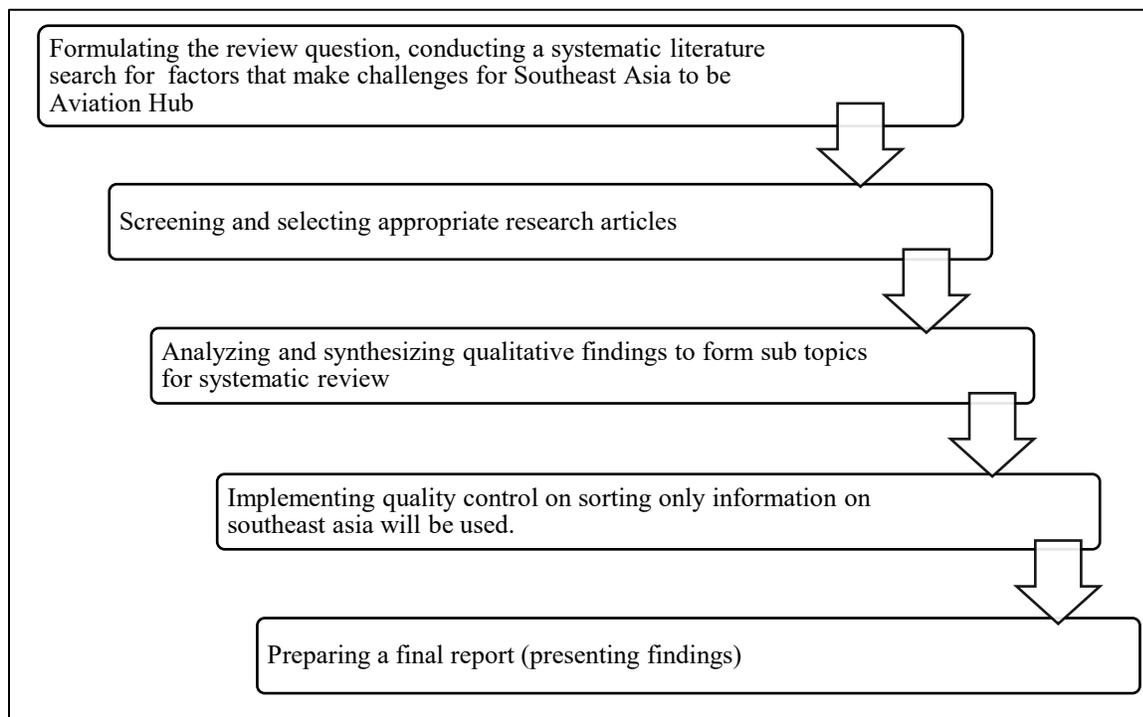
components and systems developed under various types of disciplines (both military and commercial) into a cohesive working master system that would increase the overall efficiency of aircraft. Retrofits and Conversions MRO is responsible for major and minor design retrofits and conversion of passenger aircraft to freighter aircraft.

3. Methodology

The data collection of this research is by using the secondary systematic review method through searching articles on the internet. The obstacle for the researchers is a way to obtain the secondary data as many studies may not have been published or not discussed earlier, table 2 show the number of issues and challenges found in the articles. In our research, a systematic review is employed to summarize the results of secondary data to present more comprehensive and balanced facts. The qualitative systematic review, as described in Siswanto (2012) includes the following steps (figure 1):

- i) formulating the review question, conducting a systematic literature search,
- ii) screening and selecting appropriate research articles,
- iii) analyzing and synthesizing qualitative findings (analyzing and synthesizing qualitative findings),
- iv) implementing quality control (maintaining quality control), and
- v) preparing a final report (presenting findings)

Figure 1
the summary of the systematic review on Issues and Challenges of MRO in Southeast Asia.



In conducting meta-synthesis (synthesis of qualitative data), researchers are using meta-aggregation approaches, to answer research questions (review questions) by summarizing various research results. In this research, topics are elaborated into certain themes to produce a conceptual framework. Then, within certain themes, a search for relevant research articles is carried out and compared and summarized between one and the other in an attempt to aggregate the results or relevant research. Therefore, the meta-aggregation synthesis method must be made first, then a research conceptual framework that describes interrelated (related) themes, followed by the results of the study which are plotted on the identified themes. In other words, the presentation of the results is more about doing the aggregate (descriptive).

Table 2
Number of articles on Challenges and Issues of MRO in Southeast Asia

Topics of Systematic Review	Articles Found, n
Regulatory issues on high taxes	23
Shortage of space at major airports to increase capacity	14
Long-term contract of airlines with foreign MRO Service providers.	22
Lack of globally recognized certification.	15
Aviation MRO Capability.	26
Labour Cost.	10
Skills.	13
Competitive Services.	17

4. Issues and Challenges in Southeast Asia Aviation MRO

The existence of Low-Cost Carrier (LCC) began in 1978 when the United State of America (USA) started the liberalization of air travel and generating Southwest Airlines as the first recognized and successful LCC in the aviation industry and the concept followed by European airlines 1990s (Taumoepeau et al., 2017). In Southeast Asia LCC begun with the introduction of AirAsia as the first Malaysian LCC in 2001 (Srisook & Panjakajornsak, 2017). In 1999 Indonesian government deregulates the aviation industry by removing the restriction on airlines entering the Indonesian market, this act resulting in the number of new airlines in Indonesia (Fahriza & Willey, 2018). The presence of AirAsia in Indonesia forces all new airlines in Indonesia to accept the LCC business model into their operation. LCC continuously grows in Southeast Asia and has become the market leader in the aviation industry. At the end of 2019 more than 2,050 (CAPA Centre For Aviation, 2019). The rapid growth of aircraft population and geographic characteristics of the region impose unique problems which are not generally experienced by Aviation MRO in North America and Europe, it makes Southeast Asia a significant and interesting subject for academic study.

4.1 Regulatory issues on high taxes

Thailand experience high taxes on Aviation MRO industry which make this industry less attractive for the investor. This sector needs Thailand Government's support to clearer the policy on easing and rationalizing taxation and providing incentives to companies which will help in developing and promoting the aerospace sector (*MRO Industries Park*, 2016). Singapore as the leading on Aviation MRO in Southeast Asia become modeled (Ono, 2018) for the Thai government to respond to the issues by offering generous investment incentives of eight years income tax exemption and another five years exemption of 50% reduction on corporate income tax exemption (*Thailand Positioned to Become the Leader of MRO in Southeast Asia*, 2019).

The Philippines is another country in Southeast Asia forced to do tax reform on added custom duty and value-added tax (VAT) on the imported spare part to avoid cease operation of the Lufthansa Technik operation in the Philippines as the company struggling with terribly high costs frustrating its plans (*Lufthansa Technik Philippines May Cease Operations Due To Tax Reform*, 2019). Indonesia also going to implementing tax holidays and removes add customs duty tax to increase its competitiveness among South Asian countries. Singapore still leading in the Asia Pacific as the friendliest tax regimes for business and investor, transparent common law legal systems, efficient and cost-effective on incorporating a new company, Singapore will remain the ideal destination for the foreign investor to expand their Aviation MRO in Southeast Asia (Malvenda, 2019).

4.2 Shortage of space at major airports to increase capacity.

Shortage of space at the major airport in Southeast Asia is challenged to expand the Aviation MRO. To respond to the problems, Thailand Aviation MRO setting up Aviation MRO Park at secondary Airport is becoming an option (*MRO Industries Park*, 2016). Malaysia setting up Subang Skypark as Aviation Hub in Malaysia (Maintenance & Repair, 2012) to supporting KLIA Aeropolis. In Indonesia GMF AeroAsia, the maintenance subsidiary of Garuda Indonesia opens the world's largest maintenance hangar for narrow-body (Ono, 2018) at Soekarno Hatta Airport in Jakarta and expands its capacity by setting up a new facility at Batam Airport just next to Singapore (Tan, 2018).

Singapore as the leading aviation hub in Southeast Asia was initiated ahead among others by setting Seletar Aerospace Park.

4.3 Long-term contract of airlines with foreign MRO Service providers.

Aviation MRO contracts providing higher availability levels to airlines due to capacity constrain at the Aviation MRO facilities (Wibowo et al., 2016). Airlines in Thailand and other countries in Southeast Asia going into long-term agreement contracts with foreign MRO service providers to maintain their aircraft (*MRO Industries Park*, 2016). This practice creates new entrance struggling to penetrate the market while there is demand is adequate.

4.4 Lack of globally recognized certification.

Under annexure 6 set by International Civil Aviation Organization (ICAO) for aviation standards for aircraft maintenance. All United Nations state members need to adapt standard mutual acceptance of aviation products and services. Federal Aviation Administration (FAA) and European Aviation Safety Agency (EASA) are model regulations adopted by many countries and their certification has become the most recognized (Shanmugam & Paul Robert, 2015). The need to obtain globally recognized certification for Aviation MRO becomes a major barrier to enter the market. Boeing as (Original Equipment Manufacturer) OEM required third party Aviation MRO to get certified by Boeing itself and civil aviation authorities (Cizmeci, 2005). In Thailand Aviation MRO companies currently lack globally recognized certification either from EASA and the FAA, which results in not being able to service leased airlines of domestic and international airlines (*MRO Industries Park*, 2016). Similarly, to Indonesia, many leased aircraft and foreign leasing companies required their aircraft to be maintained with FAA or EASA certified MRO companies to keep the highest residual value for their assets and GMF AeroAsia was the only Aviation MRO holding recognized certification from EASA and FAA. GMF (Francis, 2015). While Malaysia and Singapore Aviation MRO company mostly holding FAA & EASA certification and make both countries currently the leading in Southeast Asia.

4.5 Aviation MRO Capability.

All Aviation MRO in Indonesia are third-party Aviation MRO, to adding capacity is another issue as its required huge investment and certification from (Original Equipment Manufacturer) OEM and civil aviation authorities such as FAA and EASA (Franciscus, 2019). In Thailand, the major player of Aviation MRO are subsidiaries of airlines such as Thai Airways, Air Asia, Bangkok Airways, and Nok Air have established their own MRO teams and have adequate maintenance capability to maintain the aircraft they operate (*MRO Industries Park*, 2016).

4.6 Labour Cost.

Manpower or Labour costs are a direct component cost and the most essential portion that form maintenance cost (Permatasari et al., 2019). Heavy Maintenance is labor-intensive by offshoring into lower wages countries such as Eastern Europe and Asia and its offers an opportunity to reduce cost (Vieira & Loures, 2016). Delta Airlines takes this opportunity by sending the majority of its wide-body for Heavy Maintenance Visit (HMV) to MRO facilities in the far east to take advantage of lower labor costs (McFadden & Worrells, 2012). Labor wages in Southeast Asia are varied among the countries. Singapore as the leading hub for aviation maintenance, repair, and overhaul (MRO) spends higher wages while neighboring countries Indonesia, Malaysia, and Thailand offering low-cost labor in the industry (Silviana & Setboonsang, 2017). Indonesia, Malaysia, the Philippines, and Thailand are actively promoting foreign investment by emphasizing their advantage on low labor costs (Sugime, 2019), (Finnegan, 2019), (Lee, 2019).

4.7 Skills.

Contractors may offer access to specialized skills that are not available within the principal organization and economics of scale may produce by the creation of a hub of skilled workers, job creation, and knowledge generation for innovation (Vieira & Loures, 2016). Singapore government have moved forward ahead of other Southeast Asian countries by introducing the Aerospace Industry Transformation Map (ITM), Skills Framework for Aerospace and

Skills Future Enhanced initiative to equip Singaporean with relevant skills in the aviation industry to boost the aviation industry and creating 1,000 new jobs by 2020 (Frederic, 2019).

Boeing forecast by 2035 Southeast Asia will need 60,000 new technicians (Francis, 2015). Indonesia has a lot of demographic advantage with a huge population and workforce with low labor costs about one-sixth of labor cost in Singapore (Ono, 2018). Unfortunately, Indonesia faces a shortage of its skilled worker due to its skilled personnel to work overseas for higher wages while local aviation schools are unable to fulfill current demand to generate more skill worker (Francis, 2015).

Thailand is currently pushing to move from traditional thinking and unskilled labor to smart thinking and highly skilled labor (Finnegan, 2019). Having a labor force with precision engineering in the automotive and electronics sector can be a solid base to develop a strong skilled worker in the aviation industry (*Southeast Asia's Emerging Aerospace Sector Southeast Asia's Emerging Aerospace Sector*, 2017).

Malaysia is assigning a specific high priority to train in the aviation industry, which has seen numerous new academic institutions and aerospace curriculums in recent years. Establishing the Advanced Composite Training Centre and the advanced Aeronautics Technology Centre at Kuala Lumpur University Institute of Aviation Technology and investing in Aerospace Malaysia Innovation Centre a research center for optimal algae strain to produce jet fuel (ASEAN, 2017). The aviation industry is projected to create 32,000 high skilled jobs in Malaysia (*Southeast Asia's Emerging Aerospace Sector Southeast Asia's Emerging Aerospace Sector*, 2017).

Vietnam bump into skill gaps and need to invest more in education to grow workplace productivity and up skills worker, this is the challenge for Vietnam to compete with Thailand which has advanced the automobile manufacturing industry to support Aviation MRO (*Vietnam Aerospace Industry Taking Off*, 2019).

4.8 Competitive Services.

Singapore is dominating the Aviation MRO market in Southeast Asia, Singapore known as the most efficient workforce nation that generates high-quality work, those are the advantage on helping Singapore to offset the higher labor cost to fronting threat from neighboring which is competing with low-cost labor (Frederic, 2019).

5.4 Validation

The validation process has carried out by reading the material using the peer review method carried out by each author on reading material read by other authors. To minimize errors in interpretation, each reviewer crosschecks the results of the others. Then, the reviewer mapped out several possible differences in research results obtained from the same method.

5. Conclusion

Aviation MRO is a promising industry in Southeast Asia. Host governments like Indonesia, Malaysia, the Philippines, Thailand, and Vietnam need to relax or reform their policy especially on duty tax for Aviation MRO operation and investment. Promoting foreign investment and collaboration with OEM and among aviation MRO in southeast Asia. As the number of aircraft continuously increasing in this region adding capacity is essential to cope with the demand, Aviation MRO is currently located at a major airport and may experience a lack of space to increase capacity, and a secondary airport near a major airport seems to be the best location for the aviation MRO to expand their capacity. Even though acquiring globally recognized certification is not an easy task and costly but it's still compulsory for Aviation MRO in Southeast Asia to capture the market and adding capability to ensure the work quality standard. Labor will remain the competitive advantage of Aviation MRO in Southeast Asia but still needs to be improved by establishing more aviation academy especially in Indonesia. Singapore will remain to dominate the aviation MRO industry not only in Southeast Asia but the Asia Pacific despite its higher labor cost. The author of this paper believes that the issues and challenges discussed above, the Aviation MRO will continuously grow in Southeast Asia. Countries in Southeast Asia may duplicate Singapore as the success model for developing Aviation MRO and making a significant contribution to the economics of the region.

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Biography

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Adibah Shuib is an Associate Professor in Mathematics at the Faculty of Computer and Mathematical Sciences (FSKM) in Universiti Teknologi MARA (UiTM). She graduated from Johor Bahru Technical Secondary School majoring in Mechanical Engineering before pursuing her bachelor degree in the USA. She received her BSc. (Mathematics) in 1987 and MSc. (Computational & Applied Mathematics) from the Old Dominion University, USA in 1988, when she was 22 years old. She pursued her PhD study in United Kingdom in which she received her PhD (Mathematics and Statistics) from the University of Birmingham in 2007. Assoc. Prof. Dr. Adibah Shuib is currently the Deputy Director (Research & Education) of the Malaysia Institute of Transport (MITRANS), UiTM. She is also the President of the Management Science / Operations Research Society of Malaysia (MSORSM) since 2015 and currently, the Secretary of the Asia Pacific Operations Research Society (APORS). She had also been the Honorary Treasurer of the Confederation of Scientific and Technological Associations in Malaysia (COSTAM) from 2016 to 2019. Her deep research interests lie in mathematical programming and optimization modelling, simulation and decision-making models, involving various areas of applications such as network and vehicle routing problems, transport scheduling, workforce scheduling, machines scheduling, diet planning, budget planning, portfolio investments, warehouse management, network optimization and Halal supply chain traceability systems.

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