SUPPLIER SELECTION CRITERIA IN C-CHECK MAINTENANCE SERVICE PROVIDERS

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Field of Study	Industrial Management
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CHOTE LIMSINTAROPAS: SUPPLIER SELECTION CRITERIA IN C-CHECK MAINTENANCE SERVICE PROVIDER. ADVISOR: ASST. PROF. CHARK TINGSABHAT, (DOCTOR OF MANAGEMENT, P.E.), 90 PP.

The objective of this study is to establish criteria for aircraft C-check maintenance supplier selection including to identify their weight and demonstrating tool to be used. Qualitative research was conducted. Criteria are created based on the empirical study of 10 journals, which are related to the aviation industry, the weight and its rational are derived from an in-depth interview with management level officers in the airline. The in-depth interview was conducted during December 2016.

The study shows that there are four important criteria which are cost, quality, delivery, and compatibility. Quality is a must for C-check maintenance service provider. Conforming to specification or standards are the top priority and could not be compromised. The C-check is a high cost process that could impact airline cash flow. Delivery could have severe impact on operation.

Graduate School Student's Signature……

Field of study Industrial Management Advisor's Signature……

Academic Year 2016

Acknowledgement

This study has many people involved. The most important person, who spend times and share knowledge, cannot be anyone else but an advisor of this study, Asst. Prof. Dr. Chark Tingsabhat. The knowledge and advices shared by Asst. Prof. Dr. Chark Tingsabhat are invaluable. These precious guidance will be recognized and applied to the author's profession and life.

Author's family and friends have been providing kindest support during the composing of this study. Without their encouragement, this study could not be accomplished.

Chote Limsintaropas

Table of Contents

Table of Contents (Cont.)

List of Tables

List of Figures

Chapter 1

Introduction

Background Reasoning and Problems

Aviation industry is full of competition.. As seen from Michael E Porter's Five Forces Model (Brian Pearce. 2013 : 17), four out of five forces are considered as high to very high. In another word, airlines face many challenges from all directions and have to struggle to remain in business.

- The bargaining power of suppliers is high, oligopolies in aircraft and turbine engine manufacturer, monopolies at local airports and increasing concentration in the supply of services.

- Buyer bargaining power is also high, largely because of the perceived commoditization of air travel and small price difference among budget airlines.

- The threat of substitute services is at medium level and rising, with improving technology for web-conferencing and competition from high-speed train on short haul markets.

- The threat of new entrants is high, with easy to entry into many markets, easy to access to distribution channels and limited incumbency advantages.

- Rivalry among existing competitors is high, partly because of the economic factors (steep depreciation of aircraft, low marginal profit per passenger, perishable products, limited economy of scale) and also because of the government constraints restricting consolidation through exit or cross-border merger. Last but not lease, because of indirect distribution channels currently encourage commoditization and competition on price and schedule alone.

In 2015, The International Civil Aviation Organization (ICAO) audited Thai Department of Civil Aviation (Thai DCA) as part of ICAO's Universal Oversight Audit Programmed (USOAP). ICAO is responsible for standardizing aviation safety which the member, including Thai DCA, are subject to regular audited. The outcome was ICAO downgraded Thai DCA from Category 1 to Category 2 due to the findings found during the evaluation had a significant impact on the safety matter. Many Civil Aviation Authorities among various countries in the world responded to the down gradation.

Japan and Korea had not issued a license for new operators from Thailand allowing them flying to their country. As the license has an expired date, those country won't allow to extend the license until ICAO promote Thai DCA to Category 1. This event suffers operators in Thailand since Japan and Korea are considered as one of biggest air transportation market from Thailand. Operators who suffered from this event has to struggle for their existence.

In order to survive and competes with competitors, companies are forced to lower the cost as much as possible. One of the best way is to focus on procurement activities. Procuring process includes but not limited to buy/lease airplanes, air to ground data transferring services, maintenance services, ground handling services. Airplane acquisition comes with a steep price tag as much as hundreds of million USD depending on the type of airplane. However, maintenance cost is also considerably high. The airline which has limited resources and small airplane ordering number are not in a good position to bargain with manufacturer and lessor. These airlines end up with high acquisition cost. Figure 1 below illustrates the airline cost structure (Klemen Ferjan. 2014 : 12). It shows that the acquisition cost is only a fracture higher than maintenance cost at around 10 per cent each. However, fuel cost is the highest cost responsible for a third of total cost. This cost could be managed by financing activity such as hedging.

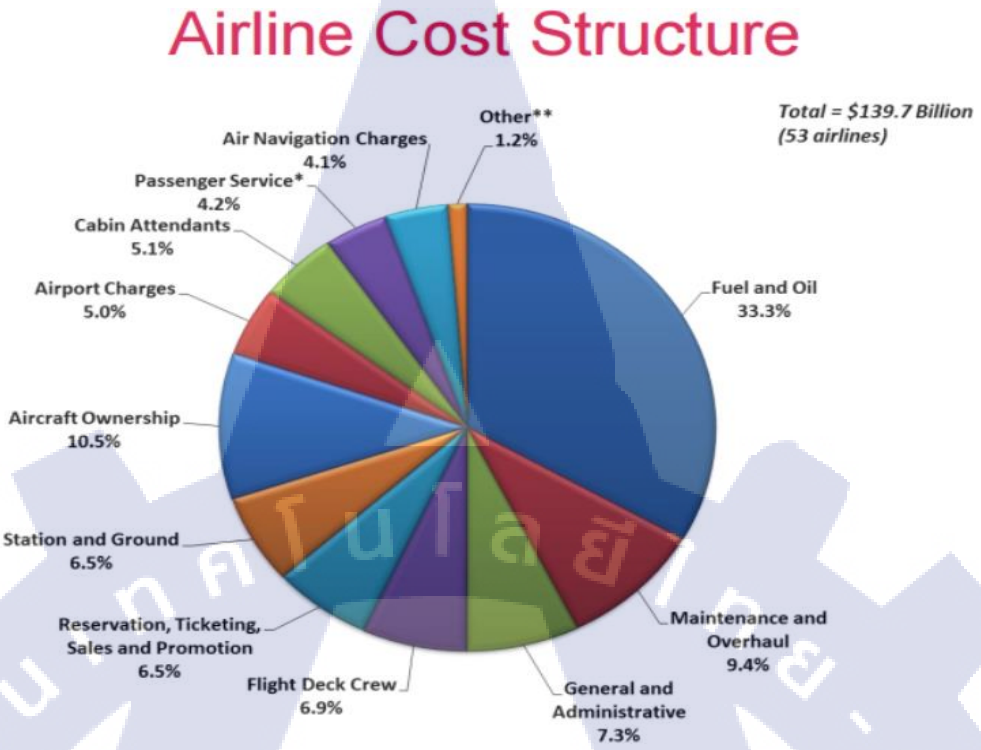


Figure 1 Airline Cost Structure

Source : Klemen Ferjan. (2014). **Airline Cost Conference, Geneva : Airline Cost Management Group.** p. 12.

Since maintenance cost is the 3rd largest of the airline cost structure, it is considered as a significant cost. Low-cost carriers have not developed maintenance function as its core competence. Therefore, they outsource a variety of maintenance services such as heavy maintenance, components maintenance and may include line maintenance. These outsourcing activities have to go through company procurement process. In order to achieve procurement goal (David N. Burt; Seila D. Petcavage; and Richard L. Pinkerton. 2012), the process of getting parts or services at lowest possible cost at appropriate time while maintaining a quality and the effective supplier selection criteria are needed to be defined.

Maintenance is a must for the airline. The maintenance of an aircraft provides assurance of flight safety, reliability, and airworthiness. Moreover, there are rules and regulations, with regards to maintenance, for the airline to comply. For example, the airline must have an operating certificate (OC) which is issued by airline's authority (Civil Aviation

Authority of Thailand for Thailand case or FAA for USA). To obtain an operating certificate (OC), the airline must pass Airline Operator Certificate Requirements (AOCR) which contains requirements for maintenance. The airline must identify maintenance and inspection program applicable to a specific aircraft model. The program consists of scheduled maintenance, reliability, aircraft aging, and others. It is responsible for the airline to maintain aircraft in accordance with approved maintenance program.

In maintenance program, there are thousands of maintenance task to perform. is the program could be roughly classified into line maintenance check and heavy maintenance check. The line maintenance check consists of tasks which are frequently performed from daily to quarterly. While the heavy maintenance check are less frequent.. For example , C-Check usually perform every 1-3 years depending on its maintenance program.

The C-Check cost varies depending on aircraft type and maintenance program. For Boeing 737NG, average cost for C-Check varies from $222,000 to $272,000 (Jeff Fraga. 2013 : 9). There are also hidden costs such as the cost of delay. If the C-check turn around time is planned as 14 days but the actual turnaround time takes longer then the airline may, in the worst case, end up canceling the flights. Therefore, it is more important to have several selection criteria for choosing the right service provider than considering only the price quote. The importance of each criterion should be quantified and does not have to be the same value

Objective

1. To identify supplier selection criteria for the C-Check service provider
2. To set the weighing factor for supplier selection criteria

Conceptual Framework

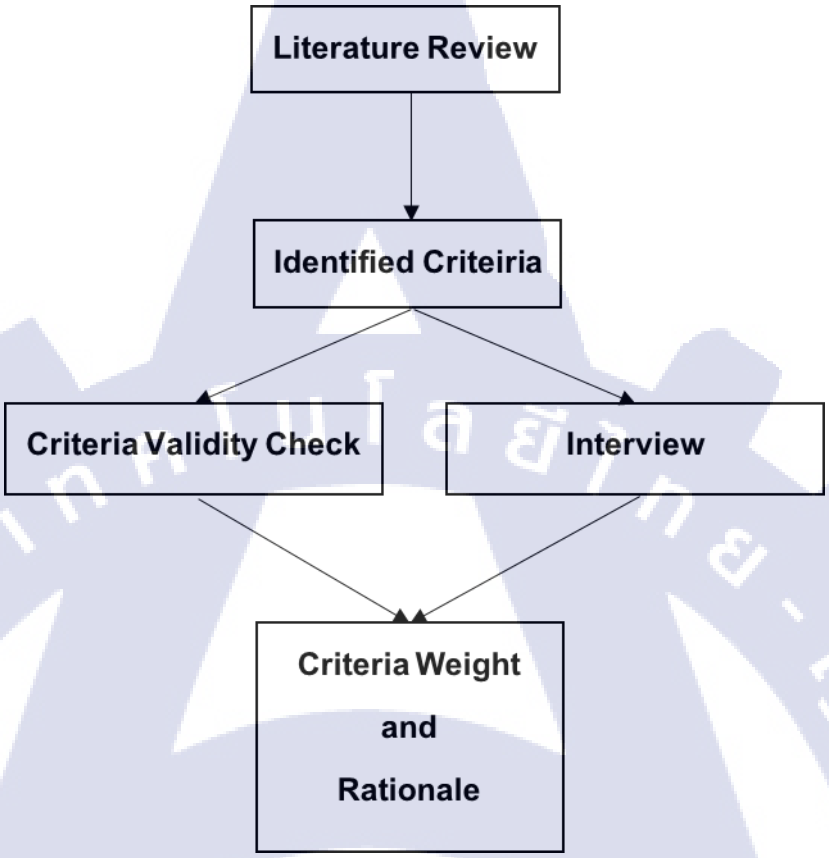


Figure 2 Conceptual Framework

This paper is organized as the figure above. Criteria are initially established by literature review through numbers of papers. Those papers are related to the aviation industry. Once created, the criteria will be validated and interviewed. The weighing factor will be established in order to understand the level of importance. More importance is the reasoning. The reasoning enables to get an insight of each criterion.

Significance of Study

Airlines or other related industries may apply the methodology and outcomes of this study as part of their supplier selection process to achieve their business goal.

Schedule and time of study

Table 1 Schedule and Time of Study

NO.	Process	Year 2016			Year 2017	
		Oct	Nov	Dec	Jan	Feb
1	Literature Review in supplier selection					
2	Literature Review in research methodology					
3	Interview					
4	Analyze collected data and conclude the research					

Operation Definition

C-Check is an aircraft maintenance package defined by aircraft's maintenance program coordinator. The aircraft maintenance is classified as line maintenance and heavy maintenance. The line maintenance is a maintenance package which can be performed and without interrupting an operation. While heavy maintenance is a maintenance package in which an operation will be interrupted for days. C-Check is considered as a heavy maintenance.

Chapter 2

Literature Review

The aim of this chapter is to gain insights of supplier selection process, maintenance concept, C-Check, and supplier selection in aviation industry. There are a few steps in supplier selection, from sourcing suppliers through managing them. Decision making in choosing suppliers has to be aware of concerned factors or criteria. In order to understand what C-Check is, maintenance concept is required. The aircraft maintenance program development will be reviewed from one of aircraft manufacturer. The maintenance program, in each operators, will indicate the C-Check maintenance package.

Empirical study will be conducted in ten papers which concerned in aviation industry. Lastly, criteria will be established as a result of empirical study.

Supplier Selection

1. Strategic Sourcing Plan

Selecting supplier is one of the most important task. If selecting weak supplier there will be supply problem whether poor product/service, high price or unable to deliver product/service on timely manner. Company may end up deliver poor product/service to customer or unable to compete pricing to competitors or unable to deliver product/service on time. Solving problem afterward will be difficult and may not able to solve.

Before start sourcing for supplier, companies are normally make decision by whether employ in-house or outsourcing by analyze its own core competencies. If product or service company pursued match with the core competencies, it makes sense to do in-house. In the other hand, if not match with the core competencies, outsource will be deployed. Sourcing stage can be generally defined in figure 2

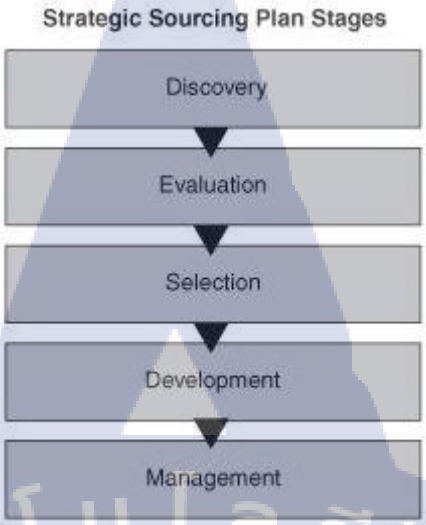


Figure 3 Strategic sourcing plan stages.

Source : David N. Burt; Sheila D. Petcavage; and Richard L. Pinkerton. (2012). **Proactive Purchasing in the Supply Chain.** p. 1.

2. State: Discovering Potential Suppliers

Information Technology these days makes discovering supplier convenience. Most of suppliers have their own website where we can search via search engine such as google. However, there are other ways to explore suppliers which cannot be ignored. List below provide source where we can discover potential suppliers.

- Supplier Web Site. Suppliers' website usually provides their basic information such as their product, services and contact. The website becomes one of primary way to discover potential suppliers due to the convenience.

- Supplier Information Files. For long time established companies, they normally keep list of their supplier. The list includes name, product/service, and their previous performance. It is important to keep list of suppliers and detail due to repetitive product/service may be required over and over. This will save time wasting to discover potential suppliers again

- Supplier Catalogs. Catalogs are good source of supplier information. Some company may have catalogs library either in electronic or hard copies.

- Trade Journal. Suppliers' advertisements are contained in trade journal.

For example, Aviation Week contains suppliers in aircraft industry.

- Phone Directories. Back in the old days, phone book is a good start to look for local suppliers.

- Sales Personnel. Sales personnel are excellent sources of information about suppliers and materials. They are well informed on their products and services. And they may suggest alternate products and services which may highly benefits.

- Trade Shows. New product or its latest modification are normally launched at Trade show. Therefore, it is good opportunity to update suppliers' products and services. Trade shows are normally gather many suppliers. Supply manager is able to get many suppliers contact from trade show event.

- Company Personnel. Colleague in other departments can be helpful sometime. Through their associations in professional organization, civic association, and social groups, these employees often learn about outstanding suppliers.

3. State: Evaluation Potential Suppliers

Once has listed all potential suppliers, next step is to evaluate each supplier individually. The evaluation is to determine supplier capability, criticality, complexity, and dollar value of the purchase to be made. In case such as low value of the purchase, evaluation may not be necessary. The following step is guidelines for supplier evaluation whether an assessment is necessary or not.

- Is the supplier strategically important? If the supplier provides a product or access to a future product that is critical to the buying company's success, take the time.

- Is the product of service being procured considered strategic? If yes, then take the time to perform evaluation. If yes, then take the time to perform the evaluation

- Are there other short-term alternatives available? If supply management can modify the request (with the concurrence of the internal customer) to allow another product, service, or supplier to be quickly substituted, then they can reduce the thoroughness of the evaluation.

For critical or high value purchases assessment will include surveys, financial condition analysis, third-party evaluators, evaluation conferences, plant visits, and the selected capability analyses. Financial condition usually comes first. Suppliers who has

healthy financial condition will be further assess. The approaches and analyses are discussed in greater detail in the following.

- Supplier Survey. The survey should be able to gain wide knowledge of suppliers in order to make decision whether will keep them for further consideration or not. The survey include series of question covering the following area. Principal officers and titles, bank references, profit/loss statement for last five years, credit reference, number of employee, a referral list of customers, expansion plan, current production defect rate for similar products, quality control method, list of equipment and tools that would used to produce goods/service.

- Financial Condition Analysis. Professional of finance department is involved in this assessment. Financial stability is essential for suppliers to assure continuity of supply and reliability of product quality. For example of getting supplier who has weak financial condition and unable to perform overtime to meet a promised delivery date.

- Third-Party Evaluators Independent. If they have enough database, this can be benefit since they have all required data to analyze such as supplier's size, financial condition, performance, facilities and other public record information. As third-party evaluator continue, they will improves over time.

- Facility Visits. This allows sourcing team to gain fresh information concerning suppliers' technological, distribution capability, and technical know-how. The sourcing team may include several professionalism as required.

- Quality Capability Analysis. Potential suppliers have to pass buyer quality standard otherwise supplier will not be further analyze. However, if suppliers who can deliver sourced product/service are limited, both company will have to work together to improve quality standard.

- Capability. It is important to carefully analyze potential supplier's capability If low capability supplier is chosen, part shortage may occur and putting operation at risk. Therefore, making sure that chosen supplier having enough capability to support is crucial. Salespeople may not aware that its own company capability and trying to sell their product/ service.

- Service Capability Analysis. Good service means on time performance,

treating special orders specially, filling back orders promptly, settling conflict quickly and fairly. In general, good service means that supplier will take every reasonable action to ensure smooth flow of operation between supplying and buying company.

- Flexibility Capability Analysis. Supplier with flexibility to adjust production volumes with short notice and remove inventory out of the chain has big advantage. As order volume may varies due to external environment with unforeseen, buyer company will need to inform supplier instantly. If supplier has low flexibility to adjust, either buyer or supplier will suffer from inventory volume.

- Lead Time. Lower lead time supplier has advantage over higher. Lead time include with order processing time, production control scheduling time, set-up time, manufacturing and assembly time, inspection time, packaging time, receiving and inspection time.

A common approach to summarize the analyses or to conduct them on an individual basis is weighted-factor analysis which will be discussed next.

4. State: Selecting Suppliers

Potential suppliers who pass the evaluation in previous step will be invited to submit bids or proposals. Either bid or proposal is decided by buyer. Bidding is normally used by private industry. Request for bids are sent to more than three potential suppliers depending on value and complexity. Request for bids ask suppliers to quote price in which they will provide product or service in accordance with buyer terms and conditions. The potential supplier who bid lowest will be award by order. The prerequisites to Bidding are as following;

- The value of purchase is large enough.
- The specification of the item or service to be purchased must be clear to both buyer and suppliers.
- The market must have enough suppliers.
- Suppliers in market must eager to get order.
- Time for bidding must be sufficient.

In addition to decide whether will use method or not, following criteria must not be presented.

- Cost is unable to estimate due to uncertainty. For example, high-Techno logy requirements since it will take uncertain time to develop.

- Price is not the only important factor but also quality, schedule and service are significant.

- Buyer see needs to adjust specification.

- Setup costs and special tooling are major factor.

If mentioned conditions are met, competitive bidding will turn out in lowest price. In the other word, competitive bidding would be the best method.

However, W.E. Deming advise that organizations should end the practice of awarding business on the basis of price tag alone. There are arguments that suggest to use negotiation over competitive bidding for critical procurement as following:

- Negotiation process can lead buyer to understand all issues in procure-ment. This would can reduce problems in quality and schedule problems.

- As competitive bidding awards order to lowest bidder supplier. This will increase pressure to awarded supplier to reduce cost which may result in lower quality.

After selecting method is settle to use either competitive bidding or negotiation, invitation for bids (IFB) or a request for proposal (RFP) is prepared. The IFB or RFP consists of a purchase description of the item or service required, information on quantities, required delivery schedules and terms and conditions.

While preparing RFP where estimate cost is established, buyer should learn appropriate cost of potential suppliers. Buyer may request cost data from suppliers or even gain access to cost data. Understanding potential suppliers cost is enable buyer to establish reasonable proposal.

Factor Rating Technique Factor Rating Technique

In some case that buyer found that there's outstanding potential supplier, decision making is easy. However, in many cases found that there is not outstanding potential supplier but few of them. Weighted-factor analysis is recommended to be deployed. Factor Rating Technique requires four activities as below;

1) Identify factor that serve as the selection criteria and their weighting.

2) Identify performance factors or sub-factor within selection criteria and their weighting.

3) Developing scoring factor to evaluate potential suppliers.

4) Evaluating suppliers.

The first activity, identification of the key factors to be considered in the selection decision, along with their respective weights. The second activity of sub-factors and weights are accomplished by a committee of individuals involved in the purchase. Factors to consider are specific to particular buy and could include technical, financial, managerial, quality, or capability factors. Weight are assigned in accordance with the importance of each factor. If technology outweighs cost in a particular buy, technical factors would be given more weight.

The sub-factors indicated activities under each main factor. As shown in Table 2, Sub-factors of the technical factor would include understanding the problem, the technical approach to the product, the level of technology in the production facilities, the operator's' technical capabilities, and the maintenance requirements. Weights for these sub-factors would result from assigning a portion of the total weight for the overall factor.

Table 2 An Illustration of the Weighted-Factor Rating Approach

Factors	Weight and Sub-weights	Score 0-10	Weight Score (Supplier A)	Score 0-10	Weight Score (Supplier B)
Technical	40				
- Knowledge of the problem	10	9	9	7	7
- Approach	20	9	18	8	16
- Production facilities	5	8	4	6	3
- Operators	3	6	1.8	6	1.8
- Maintenance	2	10	2	10	2
			Sum 34.8		Sum 29.8
Delivery	20				
- Requested date	10	10	10	8	8
- Leadtime	10	10	10	8	8
			Sum 20		Sum 16
Price	20				
- Cost structure available	10	8	8	10	10
- Value analysis efforts	10	8	8	10	10
			Sum 16		Sum 20
Managerial Capability	10				
- Labor relations	5	10	5	8	4
- Financial strength	5	9	4.5	8	4
			Sum 9.5		Sum 8
Quality	10				
- Quality control processes	5	9	4.5	8	4
- Acceptable defect rate	5	9	4.5	8	4
			Sum 9		Sum 81.8
RATING TOTALS			89.3		81.8

Source: David N. Burt; Sheila D. Petcavage; and Richard L. Pinkerton. (2012). **Proactive Purchasing in the Supply Chain.** p. 27.

Step 3 requires the developing of a numerical rating system with which to evaluate each supplier on each factor and sub-factor. Generally, a scale to assess these issues would be a 5 to 10 points scale, clearly defined to reduce subjectivity in the process, Clearly defined would include a defined rating of 0 to 5 where 0 may be “not able to conform” to 5 being “supplier meets all needs of customer.” The better defined the factors and rating system, the more optimum the decision outcome.

The last step requires the assignment of numerical rating for each of the competing companies. These assessments are based on the collective judgements of the evaluators after studying all the data and information provided by the potential suppliers, as well as that obtained in field investigations.

In effect, a weighted-factor rating system breaks a complex problem down into its key components and permits analysis of each component individually. The approach is widely used in practice and generally leads to a fair and reasonably objective result.

It is important to be aware that responsibility for source selection is not only for purchasing department but a cross functional team consisting purchasing, engineer, quality, finance and etc.

5. State: Developing Suppliers

Suppliers are getting to be aware that in order to be competitive, they need to continuously improve on cost, quality, timeliness, and service. Not all of supplier needs assistance. However, working together between buyer and supplier can yield benefits to both. Knowledge sharing would play critical role to improve both of buyer and supplier.

In some case, buyer company is unable to employ world class supplier due to various reasons such as unable to afford or full capability. Buyer will need to develop supplier to meets buyer’s requirement in term of cost, quality and timeliness.

6. State: Managing Supplier

Buyers has to analyze their suppliers on a periodic basis to ensure that supplier has abilities to meet the company's long-term needs. Long-term suppliers will need to align with buyers in term of capacity and financial in order to support growth of buyers.

If supplier may not be able to align with the buyer, buyer may to give hands to supplier in terms of financial support, technological assistance and etc. Or suppliers have options to source for new supplier or increase capability internally.

Maintenance

1. Maintenance Concept

Maintenance is to provide safety assurance, reliability and airworthiness. It is responsibility for maintenance to performed maintenance tasks as requirements or developed maintenance program. One concept of Thermodynamics stated that there's no perfectionist. The concept is being called "Entropy".

In the ideal situation, input energy should equal to output energy which the system is meant to have. However, in fact, output energy is less than input energy due to several reasons such as heat loss through friction. Therefore, there is imbalance of energy. Entropy can be defined as "unavailable energy" of a system.

Engineer normally intends to design systems or components as perfect as possible. However, there's limitation to do so. There may be technology constraints, ability or economics. Designer is willing to build systems as best as he/she can under given constraints (Harry A. Kinison; and Tariq Siddiqui. 2013 : 1).

Not only that entropy exists in every systems, it is also increasing from time to time. That means the nearly designed system is always deteriorate. In the other words, the imperfection always decrease. System deteriorate from use, lack of use, misuse and others. Deterioration represent the increasing entropy. Therefore, it is system's user/operator best benefits to maintain the level of perfectionist as much as possible (David N. Burt; Seila D. Petcavage; and Richard L. Pinkerton. 2012 : 1).

Above paragraph can be described in figure 3. It shows system's levels of perfection. Y-axis illustrates level of perfection while X-axis illustrated time being. As you can see in time is nearly zero, the level of perfection is not at 100% due to entropy. As time increase, the level of perfection decrease due to natural deterioration of the system.

In order to restore the level of perfection to its desired level, maintenance such as adjusting, tweaking, servicing or other is required. Maintenance is to reduce the entropy. This kind of maintenance is called preventive maintenance and performed at set interval. It helps preventing deterioration of system and, in worst case, deterioration may cause unsafe or unusable of the system.

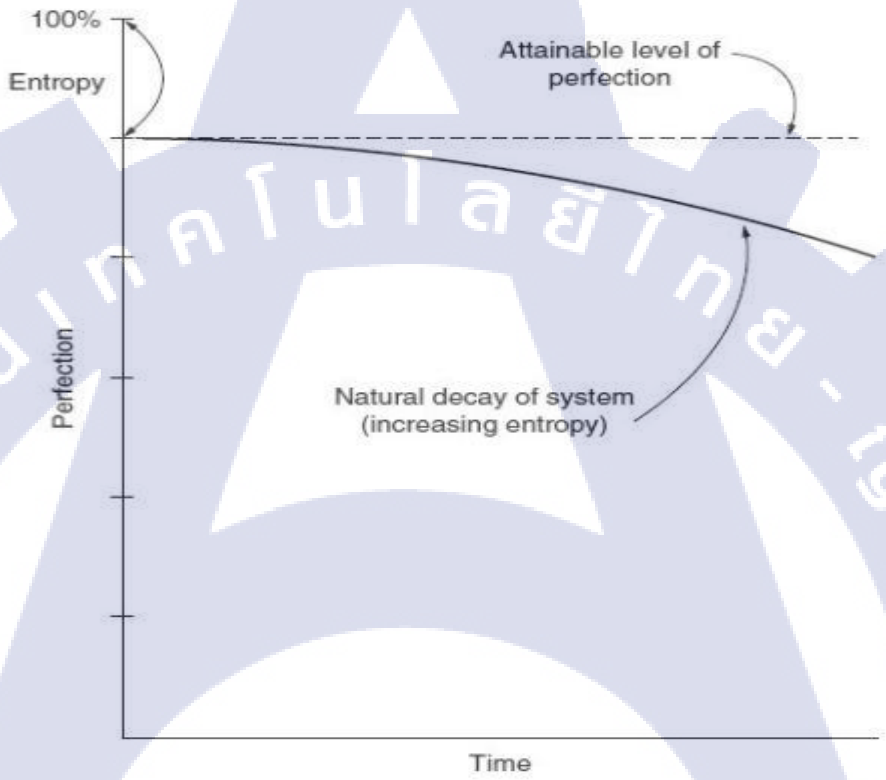


Figure 4 The Difference between Theory and Practice.

Source : Harry A. Kinison; and Tariq Siddiqui. (2013). **Aviation Maintenance Management Second Edition.** p. 6.

Deterioration of each components or systems may have difference rate of deterioration. Figure below shows 4 rates of deterioration. Curves a and b are deteriorate at normal rate where preventive maintenance is scheduled to perform and increase level of perfection. Curve c shows higher rate of deterioration and this may interrupt operation. In such curve d, systems is breaking down and require to perform unscheduled maintenance. Troubleshooting, replacing part, repair or completely overhaul is required.

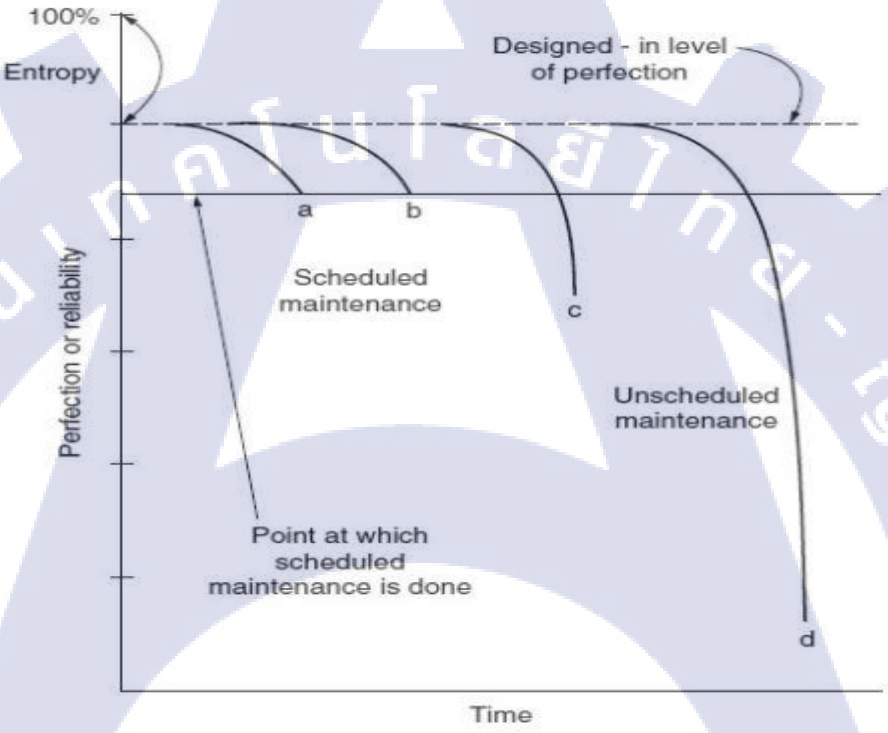


Figure 5 Restoration of System Perfection.

Source: Harry A. Kinison; and Tariq Siddiqui. (2013). **Aviation Maintenance Management Second Edition.** p. 6.

The level of perfection can be referred in term “reliability”. The designed level of perfection is known as the inherent reliability of the system. It is not possible to increase inherent reliability by doing maintenance, even though doing maintenance more often. In order to increase inherent reliability, redesign of the system is needed. In some case, entropy is reduced by applying tighter tolerance, new production technology, better

designer skills or changing the architect. However, even redesigning the system makes inherent reliability increase, entropy is still exist. In the other word, maintenance is still required. At different rate of deterioration, interval of maintenance may be difference.

The aviation industry has developed techniques to increase reliability. There are currently three techniques which are equipment redundancy, line replaceable units, and minimum aircraft dispatch requirement. Equipment redundancy is primary and backup. If one fail, the other will take over the function. The redundancy concept is used during aircraft design. For example, there are 2 systems of hydraulic pump, one energized by engine mechanical work and another one energized by electricity.

Line replaceable unit (LRU) is a component that can be removed/installed quickly. This allows quicker corrective maintenance and allows operation to continue without or with lowest interruption.

The minimum aircraft dispatch requirement is known as minimum equipment list (MEL) in aviation industry. As one system of many system break down, it may not impact operation seriously. MEL defined that if a system failed, aircraft can be dispatched to operation or not.

2. Maintenance Programs (Use BOEING MPD SECTION 1 to Describe)

Airlines develop their own maintenance program from manufacturer guideline. For example, Boeing provide airline a publication called “Maintenance Planning Data” (MPD). Each aircraft type has its MPD. MPD list all Boeing recommended scheduled maintenance tasks. Boeing obligate by FAA law to provide MPD to airline. Maintenance tasks in MPD includes, but not limited to, the following documents (Boeing Commercial Airplanes Group. 1995)

- FAA Maintenance Review Board (MRB) Report - Latest Revision
- Boeing Service Bulletins (SB)
- Boeing Service Letters (SL)
- FAA Airworthiness Directives (AD’s)
- Certification Maintenance Requirements (CMRs)
- Structural Airworthiness Limitations.

Boeing develops MPD based on Maintenance Review Board (MRB) Report which derived from Maintenance Requirements Review and Proposal Document. During aircraft type design, airlines and manufacturer forming group to develop maintenance program. The group uses guidelines of the ATA Airline/Manufacturer Maintenance Program Planning Document (MSG-3).

The airline maintenance program development can be easily understand by following flow per figure 5 below

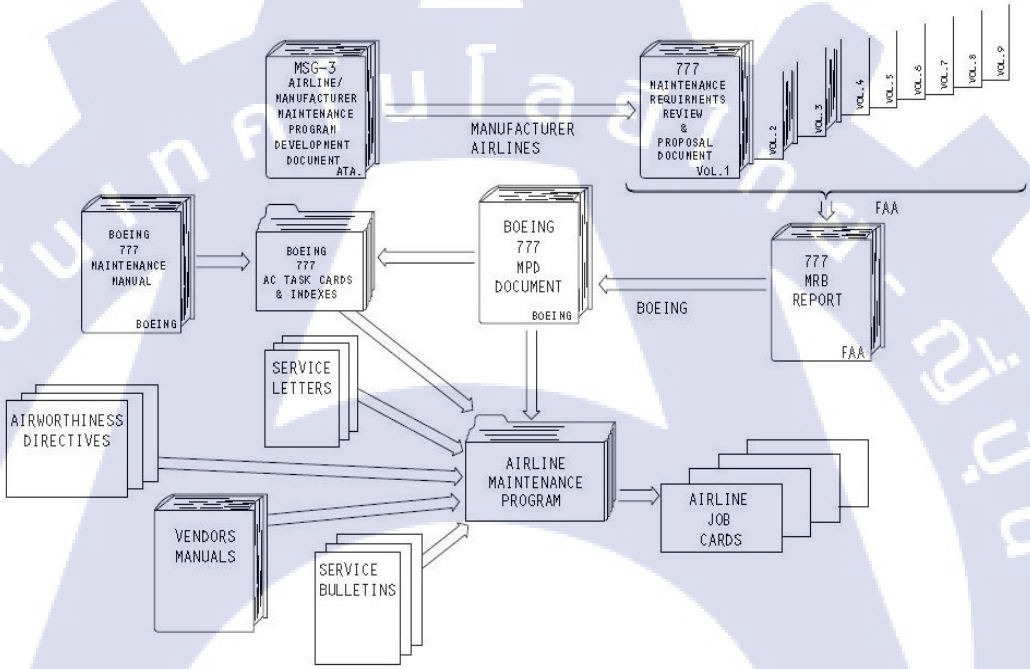
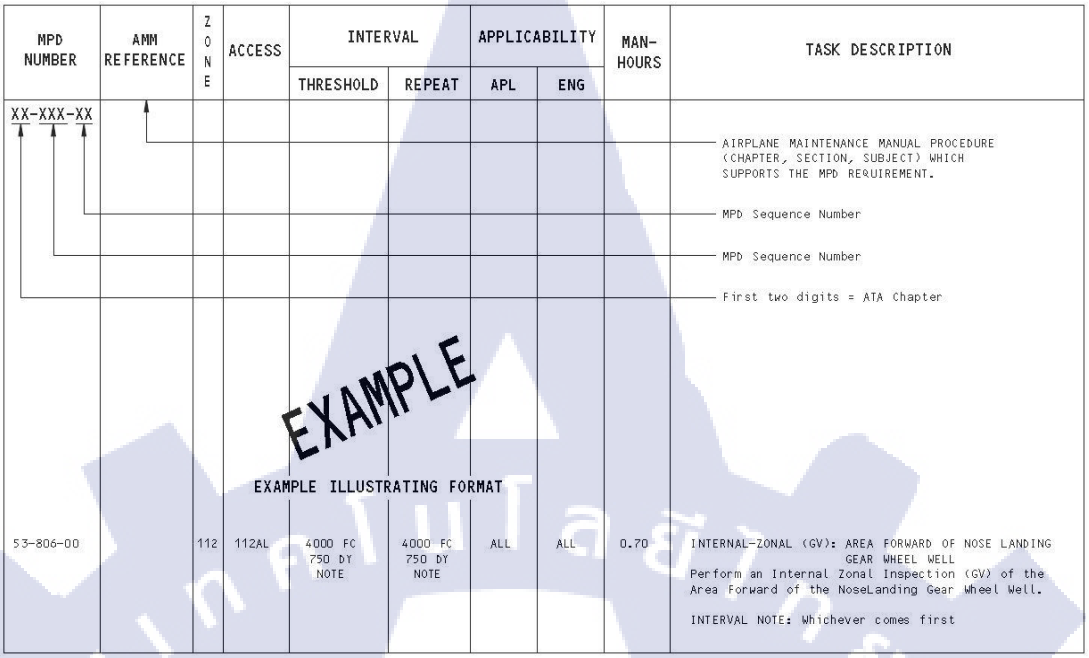


Figure 6 Maintenance Program Development

Source : Boeing Commercial Airplanes Group. (1995). **Maintenance Planning Document : Introduction.** p. 6.

Maintenance task listed in maintenance program provide interval in terms of Flight Hour (FH), Flight Cycle (FC), and Calendar Day. FH is time between take-off and landing. FC is counted one from taking-off to landing. Task are considered as due whenever reach the interval FH or FC or Calendar Day whichever comes first. Example of maintenance task listed in maintenance program can be found below;



MPD NUMBER	AMM REFERENCE	ZONE	ACCESS	INTERVAL		APPLICABILITY		MAN-HOURS	TASK DESCRIPTION
				THRESHOLD	REPEAT	APL	ENG		
XX-XXX-XX									
									AIRPLANE MAINTENANCE MANUAL PROCEDURE (CHAPTER, SECTION, SUBJECT) WHICH SUPPORTS THE MPD REQUIREMENT.
									MPD Sequence Number
									MPD Sequence Number
									First two digits = ATA Chapter
53-806-00		112	112AL	4000 FC 750 DY NOTE	4000 FC 750 DY NOTE	ALL	ALL	0.70	INTERNAL-ZONAL (GV): AREA FORWARD OF NOSE LANDING GEAR WHEEL WELL Perform an Internal Zonal Inspection (GV) of the Area Forward of the NoseLanding Gear Wheel Well. INTERVAL NOTE: Whichever comes first

EXAMPLE

EXAMPLE ILLUSTRATING FORMAT

Figure 7 Maintenance Program Example Page

Source : Boeing Commercial Airplanes Group. (1995). **Maintenance Planning Document : Introduction.** p. 7.

Each task has a specific interval which will fall into specific phase as determined by applicable utilization. When developing maintenance program, utilization of aircraft is normally defined in accordance with operator's plan. Phase check are also defined in term of flight hour, flight cycle and calendar day. For example, A check is at every 1,000 flight hour and C check is at 1000 Days.

For those tasks where the interval is less than A-Check may be considered as Out Of Phase (OOP). OOP tasks are normally performed during available ground time between each phase check.

Beside phase check and OOP, maintenance program also defines transit check and/or departure check and/or daily check. Transit check is performed every flight. Departure check is performed before 1st flight of the day. While daily check perform every day.

Tasks listed in maintenance program is grouped into defined phased check. Below is the example of defined phase check.

Model 777

Flight Hour/Cycle 5.6

Flight Hour/Day 14

Phase	Interval FH	Interval FC	Interval Day
A Check	1000	178.57	71.43
C Check	14000	2500	1000

Skyline chart per figure below provided labor intensity sense in each phase check. Vertical axis is labor-hour required to complete checks while x axis is phase check counted.

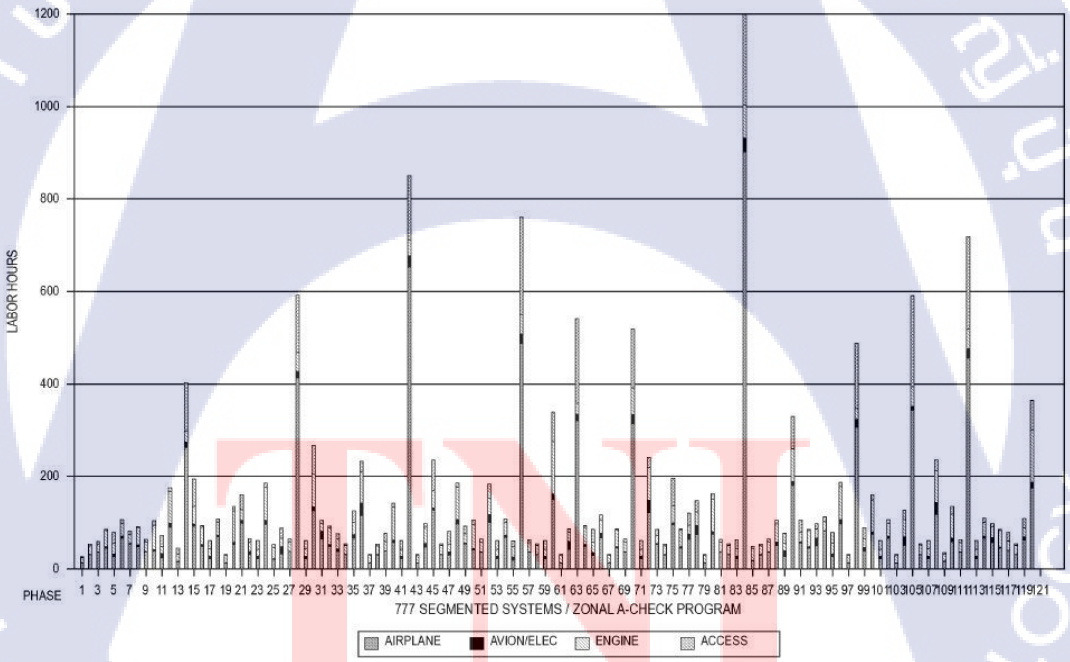


Figure 8 Skyline Chart

Source : Boeing Commercial Airplanes Group. (1995). **Maintenance Planning Document : Introduction.** p. 8.

C-Check, as described in section 2, is a maintenance package defined by aircraft operators. In example, it is defined by interval in term of flight hour or flight cycle or calendar day which ever come first. C-check requires period of times to complete. The period is depending on labor hours required. Referring to figure 7, spikes of labor hours are normally C-Check maintenance package.

Aircraft Maintenance Selection

Chao-Che Hsu; and James J.H. Liou (2013 : 43) has developed supplier selection criteria based on series of discussions with the case company's managers including from literature reviews. Decision making criteria is classified into four dimensions: compatibility, risk, quality and cost. Each criteria is divided into several sub-criteria as indicated in table below. These criteria help sourcing manager avoiding price tag trap where cost is being considered as only deciding factor.

Table 3 Dimensions and Criteria of the Supplier Selection Criteria

Dimensions	Criteria	Explanation
Compatibility	Relationship	Includes shared risks and rewards, ensuring cooperation between the airline and ground service provider.
	Flexibility	Flexibility when dealing with abnormal situations, such as flight delays, overbooking, incidents, etc.
	Information sharing	Compatibility of computer systems and information-sharing, such as new information/regulations at a destination airport.
Quality	Knowledge and Skills	Facilities of the service provider for airplane maintenance and their knowledge of manpower are essential.

Table 3 Dimensions and Criteria of the Supplier Selection Criteria (Continued)

Dimensions	Criteria	Explanation
	Customer satisfaction	Average customer's level of satisfaction regarding ground services such as check-in and luggage handling.
	On-time rate	Ratio of airplanes delivered on time.
Cost	Cost Saving	Total cost of the outsourcing activities.
	Flexibility in billing	Flexibility in billing and payment conditions, increasing goodwill between airlines and the provider.
Risk	Labor Union	Outsourcing may be accompanied by the possibility of layoffs and disturbances within the airline. Striking outsource provider employees could disrupt flight schedules.
	Loss of management control	Poor management of the provider may not provide good service and may cause potential flight safety problems.
	Information security	Mutual trust-based information sharing between the airline and the provider is necessary for both the continuance of the agreement and also for the security of confidential information.

Source : Chao-Che Hsu; and James J.H. Liou. (2013). **An Outsourcing Provider Decision Model for the Airline Industry.** p. 43.

In the past, many organizations tended to use quantifiable factor (i.e. delivery, cost) in selecting suppliers. Recently, research has shown that relationship has become

one of factor being used (F.T.S. Chan.; H.K. Chan; R.W.L. Ip; and C.W. Lau. 2006 : p. 2). Chan has identified performance assessment for supplier selection as per figure below.

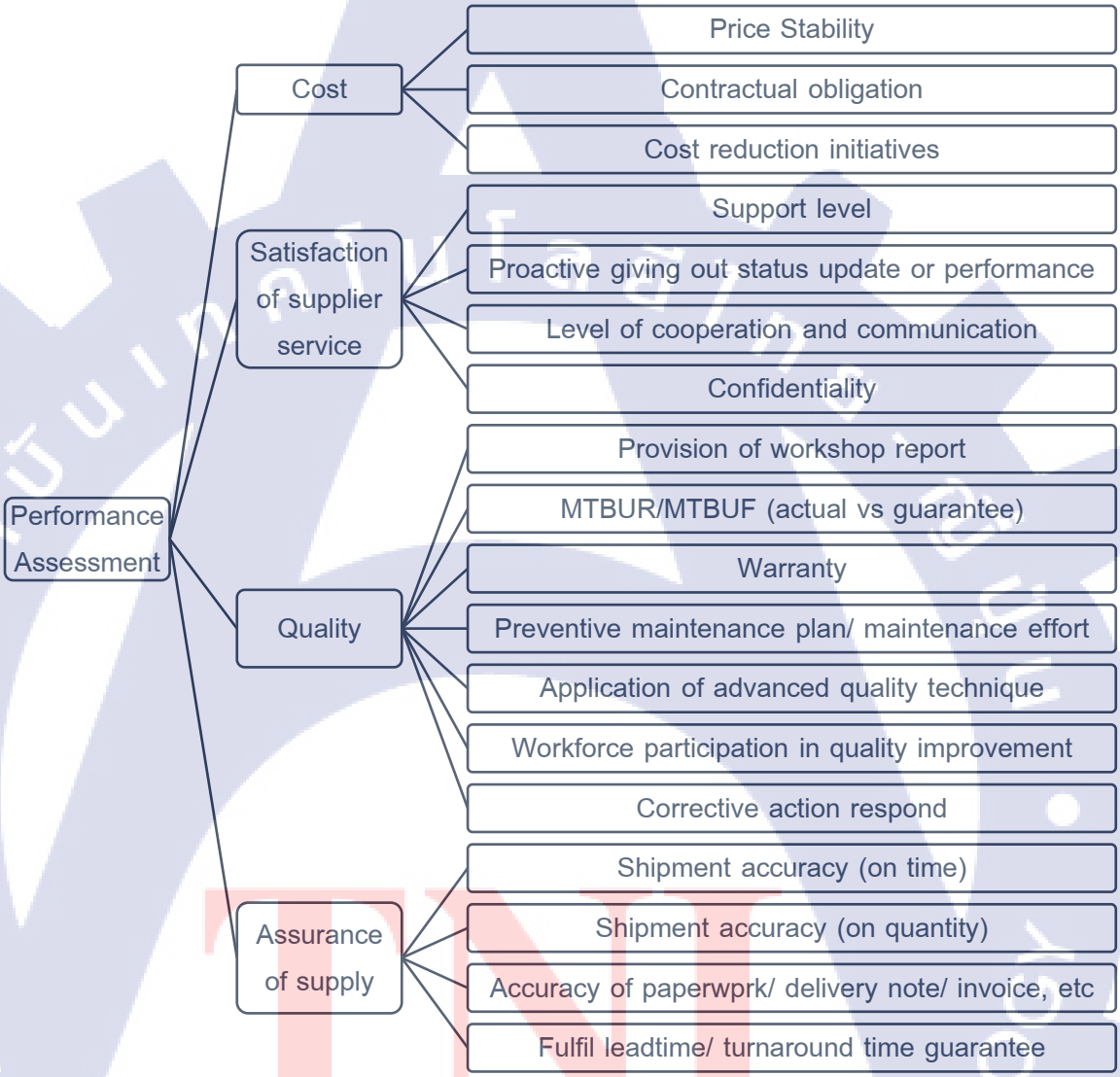


Figure 9 Hierarchy Process Model

Source : F.T.S. Chan; H.K. Chan; R.W.L. Ip; and H.C.W. Lau. (2006). **A Decision Support System for Supplier Selection in the Airline Industry.** p. 4.

Yuqi Wang (2009 : 3) summarize supplier selection of maintenance and repair parts into figure below;

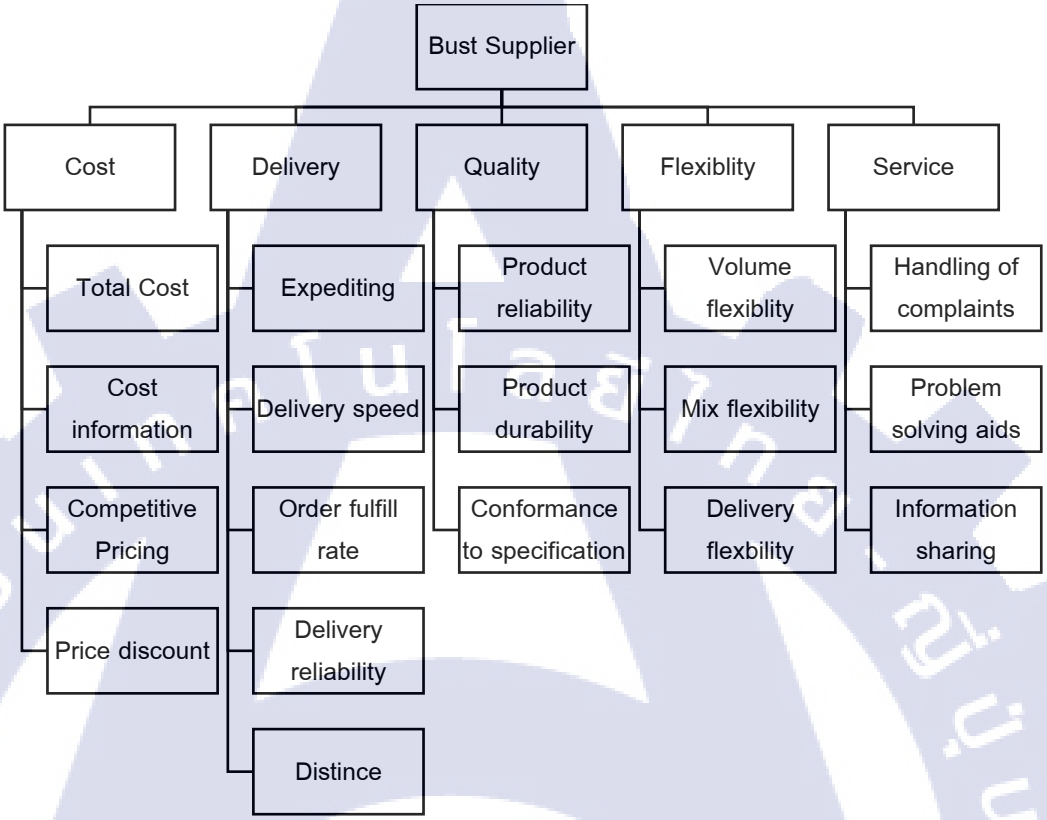


Figure 10 Hierarchy Model for Supplier Selection in MRO

Source : Yuqi Wang. (2009). **An Application of the AHP in Supplier Selection of Maintenance and Repair Parts.** p. 3.

Jian (2014 : 5) has developed supplier selection index in accordance with aviation industry as table below. By consultation and carries out questionnaire.

Table 4 The Evaluation Index and The Index Weights of Aircraft Supplier Selection

First class index and weight	Second class index and weight	weight
Quality (0.25)	The qualified rate	0.24
	Reputation	0.1
	With perfect quality control system	0.2
	The ability to support the airworthiness certification	0.2
	Control ability of sub supplier	0.26
Cost (0.19)	Research and development costs	0.23
	Unit cost	0.26
	Logistics cost	0.17
	Price stability	0.19
	Payment of preferential	0.15
Delivery (0.16)	On time	0.64
	Flexible	0.36
Cooperation (0.1)	Credit	0.36
	Information exchange	0.32
	Cooperation intention	0.32
Competitiveness (0.15)	Professional R&D personnel	0.18
	The R & D funds	0.15
	The invention patent number	0.12
	Market share	0.23
	Advanced technology	0.16
	Technology maturity	0.16
Service support (0.12)	Quick response ability	0.3
	Spare parts support	0.24
	Training capacity	0.17
	Technical support ability	0.29

Source : Jian Lirong; and Zhao Huanhuan. (2014). **Civil Aircraft Suppliers Selection based on Grey Target and Grey Cluster Decision Method.** p. 5.

Yuttapong Pleumpirom; and Sataporn Amornsawadwatana (2010 : 4) provides factors for aviation performance benchmarking as following. They may be considered in supplier selection criteria as well.

- Costs is are the expenses of work task which may be in-source or outsource for materials, man power, to process.

- Quality Assurance is system engineering discipline which embodies to process of quality control, inspection, management, policies and oversight procedure which will instill understanding.

- Reliability is the probability that a system will perform its intended function for a specified interval under stated condition.

- Maintainability is the ease and speed with which any maintenance activity can be carried out on an item of equipment, may be measured by Mean Time to Repair. It is a function of equipment design, and maintenance task design (including use of appropriate tools, jigs, work platforms etc.)

- Time is referred as the lead-time since service requested by customer until completely fulfills that requirement.

- Availability is defined as the percentage of time that a system is available to perform its required function(s).

- Flexibility/Replaceability is ability of production plant or service provider to switch the planed operation to other process or solution and then meet the customer expectation.

Meng Zhao; and Rong-rong Ren (2013 : 5) used attributes or criteria of the supplier selection by the research of SF aviation enterprise. Those attributes can be found in below table

Table 5 Supplier Selection Attributes

Target	Attributes	Factors
The supplier selection of aviation projects	Technology capabilities	The capabilities of common research and development, technology program is complete and reasonable
Target	**Attributes**	**Factors**
	Management experience	The capabilities of industrial experience, and a good performance in the industry
	Facilities assurance	Facilities fully and advances, program reasonable
	Quality and airworthiness	The high quality of the product, perfect quality assurance system; airworthiness program integrity
	Customer service	Customer support program is complete and reasonable

Source : Meng Zhao; and Rong-rong Ren. (2013). **The Decision-Making Model for Aviation Project's Supplier Selection based on Improved TOPSIS**. p. 5.

Saman Hassanzedeh Amin; Jafar Razmi; and Guoqing Zhang (2011 : 4) categorize supplier selection criteria in accordance with SWOT analysis by dividing criteria into internal and external. Internal criteria are controllable by supplier whilst external criteria is uncontrollable.

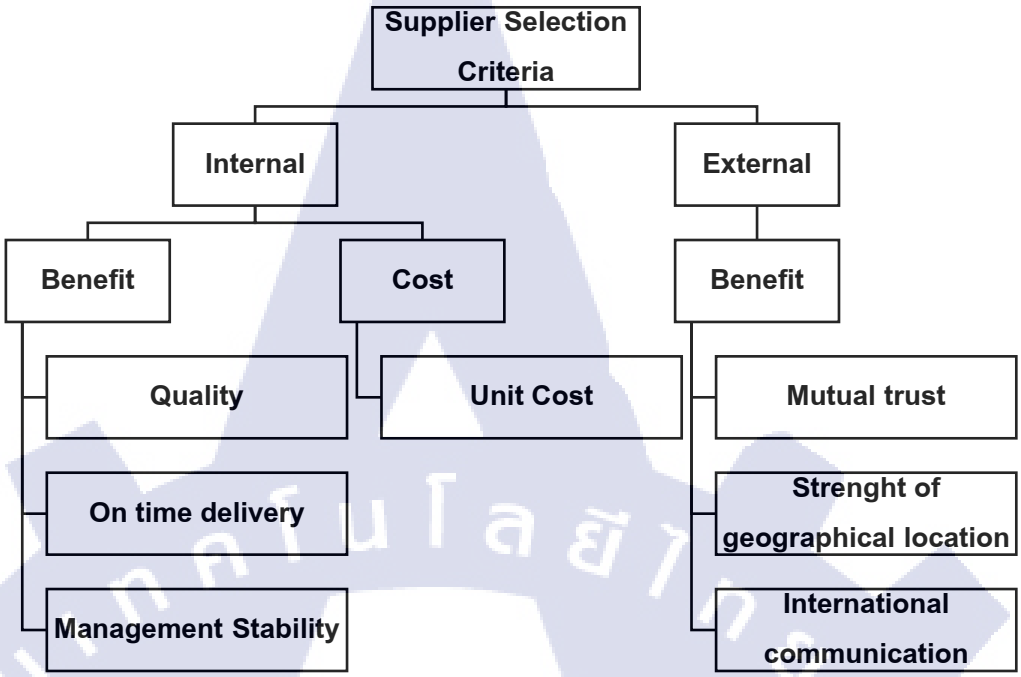


Figure 11 Supplier Selection Hierarchies

Source : Saman Hassanzadeh Amin; Jafar Razmi; and Guoqing Zhang. (2011). **Supplier Selection and Order Allocation based on Fuzzy SWOT Analysis and Fuzzy Linear Programming.** p. 4.

Babak Daneshvar Rouyendegh; and Turan Erman Erkan (2012 : 3) identified supplier selection criteria as below table

Table 6 Supplier Selection Criteria

Criteria	Definition
Cost	Defined as the summation of net price after discount (if any) for purchased materials by the manager of department.
Quality	Includes the material terms of use suitability, use time and duration. Can be determined considering these sub-criteria.
Payment Flexibility	The company attaches the importance to the payment in terms of delay or installment. These are preferred more if available.

Table 6 Supplier Selection Criteria (Continued.)

Criteria	Definition
Delivery	Important especially for time based companies. Defined sum of time required for the necessary materials and how many days or hours it takes to supply these materials.
Variety	Sometimes the requirements can be changed up to daily conditions, therefore suppliers are able to provide changing demands.

Source : Babak Daneshvar Rouyendegh; and Turan Erman Erkan. (2012). **Selecting the Best Supplier Using Analytic Hierarchy Process.** p. 3.

Jafar Rezaei; and Patrick Badredin Maximilian Fahim (2014 : 19) provide supplier selection criteria via a literature review and interviews with KLM Royal Dutch Airlines. The following six main criteria were established

- Cost/Price
- Product quality
- Delivery
- Financial stability
- Corporate social responsibility (CSR); and
- Assortment.

Cost/Price, Product quality, and Delivery have been key supplier selection criteria overtime. Financial stability and CSR are also received attention by KLM. Supplier's financial stability helps minimizing financial risks and its supply risk. In addition CSR can be used as a marketing tool as it could damage reputation if supplier has bad image. Assortment is ability to supply a large number of products and volume. It can minimize using too many suppliers and, consequently, lower administration cost.

Edward Czepiel (2003 : 14) reveals that airlines are not simply considering maintenance service in basis of lowest price, but rather overall operation. The survey shows that most important criteria is quality of work. Other important criteria are short turn around time, range and capabilities, depth of experience, and the ability to assure highest aircraft utilization.

Table 7 Empirical Study Summary

No.	Paper	Compatability (Coorperation, Mutual Trust)	Quality	Cost (Price)	Risk	Service	Delivery (Assurance of supply, Time)	Flexibility (Variety, Assortment)	Competitiveness	Reliability	Maintainability	Availability	Technology capabilities	Management	Facilities Assurance	Location	International Communication	Financial stability	Copporate Social Responsibility
1	Chao-Che Hsu and James J.H. Liou, 2013	O	O	O	O														
2	F T S Chan, H K Chan, R W L Ip, and H C W Lau, 2006		O	O		O	O	O											
3	Yuqi Wang, 2009		O	O		O	O	O											
4	Jian ,2014	O	O	O		O	O	O	O										
5	Yuttapong Pleumpirom and Sataporn Amornsawadwatana ,2010		O	O			O	O		O	O	O							
6	Meng Zhao and Rong-rong Ren, 2013		O			O							O	O	O				
7	Saman Hassanzedeh Amin, Jafar Razmi, Guoqing Zhang, 2011	O	O	O			O							O		O	O		
8	Babak Daneshvar Rouyendegh and Turan Erman Erkan, 2012		O	O			O	O										O	O
9	Jafar Rezaei and Patrick Badredin Maximilian Fahim, 2014		O	O			O	O						O					
10	Edward Czepiel, 2003		O	O			O	O											
	Total	**3**	**10**	**9**	**1**	**4**	**8**	**5**	**1**	**1**	**1**	**1**	**1**	**3**	**1**	**1**	**1**	**1**	**1**

It appeared that quality is chosen, for supplier selection criteria, from all ten reviewed papers whilst cost has nine choses and delivery has 8 choses. These three criteria are undoubtable. Next following items are flexibility, service, compatibility and management respectively.

Considering flexibility, service and compatibility, they are very close in term of practical. For example, good service supplier usually gives kind cooperation to customer and flexible to mutually solve problem. Therefore, flexibility and service and compatibility can be combined into one criteria using “compatibility” while service and flexibility are considered as sub-criteria. Whilst “management” is not considered into one of criteria because it is not related to “compatibility” in term of definition.

Other criteria in tables can be categorized into four main criteria which are quality, cost, delivery and Compatibility. The following figure provides relationship between main criteria and sub criteria.

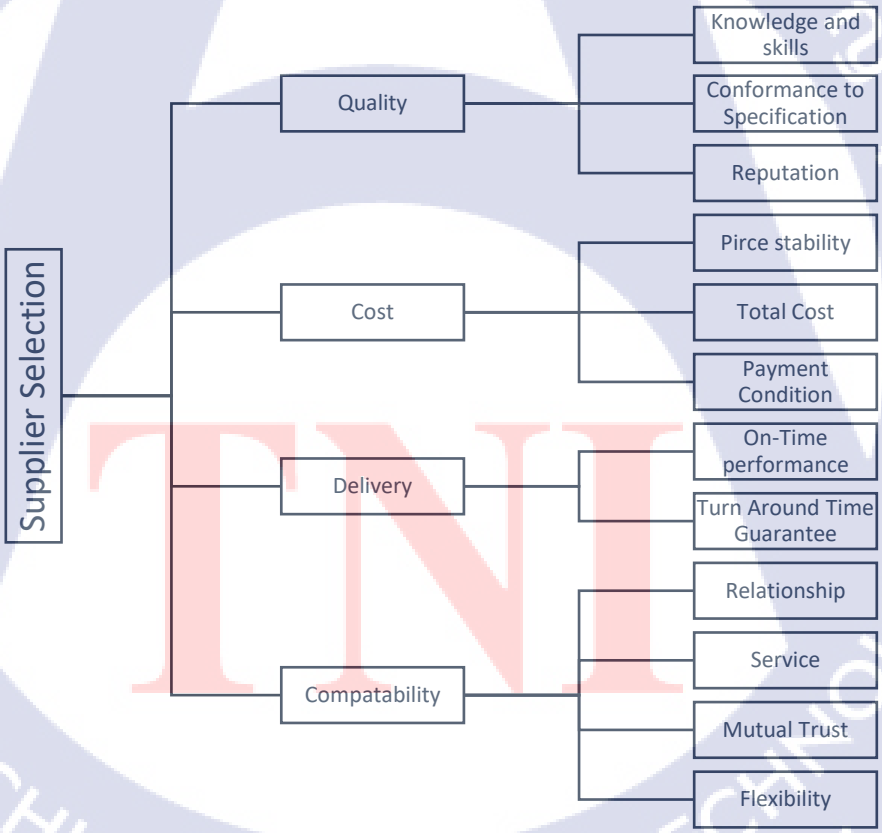


Figure 12 Empirical Study Result of Supplier Selection Hierarchies

Quality is considered very important in aviation industry. As one failure may lead into severe incident. In fact, aircraft is a complex product which require high level of knowledge and skill to repair and maintain.

- Knowledge and skills: As aircraft maintenance is labor intensive and complex, it requires man power possessing knowledge of aircraft and necessary skill to perform maintenance. Knowledge in terms of aircraft maintenance is insight of aircraft system to understand the maintenance instruction while skill is ability to transform knowledge into activities.

- Conformance to specification: The airline industry is one of the highest regulated industry. For aircraft maintenance organization, the related regulation is FAA Part 145 and EASA Part 145. The aircraft maintenance organization must comply with such regulation in order to run the business.

- Reputation: Reputation is what people opinion, in the industry. They may have good or bad experience with such service provider and share among industry.

Cost is, without a doubt, one of the most important criteria in supplier selection.

- Price stability : In aircraft maintenance service agreement usually mentioned the price of the service with inclusive of services. However, there're some unexpected service to carry out during the maintenance. The unexpected service will be charged and it may not be budgeted before. It could damage the cash flow.

- Total Cost : In this study case, cost is used resource to achieve C-check maintenance event.

- Payment condition : Payment condition is how to pay service provider in term of, not limited to, credit term and amount to pay before and after complete service. Including to payment type such as flat rate or power by the hour.

Delivery refers to the ability of a supplier to offer what its customers need at the right time with the right quantity, with right documentation, and within its guaranteed turn around time.

- On time performance : On time performance is the rate that service provider able to release aircraft back to service within guaranteed turn around time.

- Turn around time guarantee : In each service providers may unable to provide the same guaranteed turn around time depending on their capability and risk taking.

Compatibility is how well between service provider and customer working together.

- Relationship : Includes shared risks and rewards, ensuring cooperation between the airline and ground service provider.

- Service : The way service provider practice with customer.

- Mutual Trust : Both service provider and customer believes in each other to achieve mutual goal.

- Flexibility : Flexibility when dealing with abnormal situations, such as delays, unforeseen defect, incidents, etc.

Chapter 3

Research Methodology

This study employs qualitative research to figure out supplier selection criteria in C-Check maintenance service provider. The qualitative research incorporates the study through individuals, who are in management level and having different roles. The role consists of technical, operation, finance and quality. In-depth interviewed is used to collects information. Criteria for supplier selection will be observed and analyzed by using content analysis to determines weighing factor in each criterion. The study process will be as following;

1. Methodology
2. Example to be used in the study
3. Tool
4. Information Collecting
5. Information Analyzing

Methodology

As mentioned, this study focus on qualitative research. Both domestic and international journals related to the study subject are reviewed are extracted information to support and use as a guideline conducting this research. The methodology is represented in the flow chart in figure 12

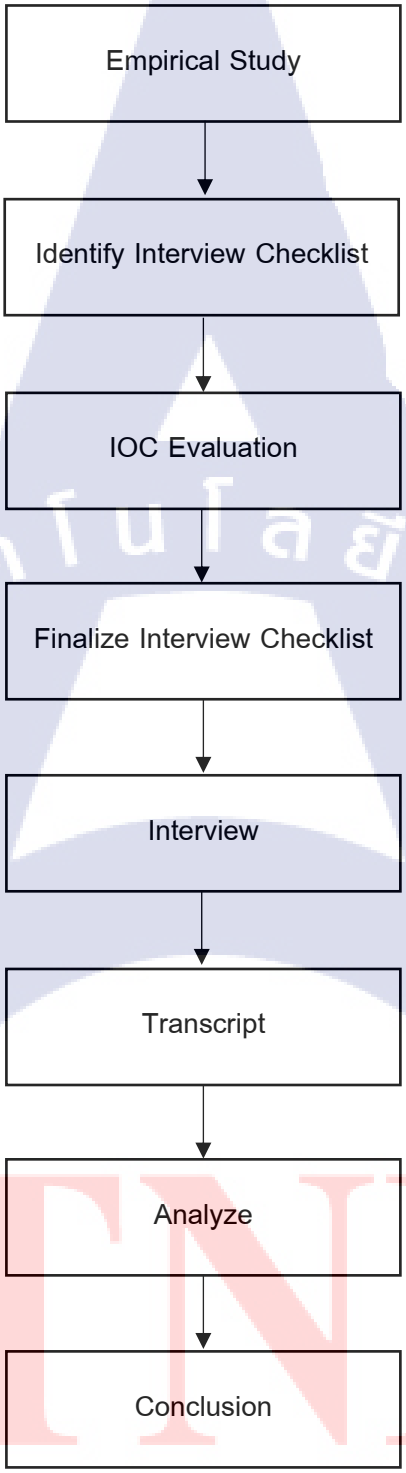


Figure 13 Research Methodology

Population and Sample

This study incorporates an in-depth interview with key informants. Key informants are senior management level officer who are in principal positions which are finance, engineering, flight operation and quality. The purposive sampling technique is used to selected the informants.

Research Tools

1. Tools

This study employs the Semi-Structure Interview Checklist developed from empirical study of supplier selection journals, especially from the airline industry. Checklist structure is developed based on the reviewed literature.

2. Tool Methodology

2.1 Empirical study on supplier selection journal, especially relating to the airline industry, to identify supplier selection criteria. The empirical study can be found in Chapter 2 aircraft maintenance selection.

2.2 Identify question within semi-structure interview checklist which will be asked during interview. Questions will be arranged to ensured that they will cover objectives of this study. Semi-structure interview detail can be found in Appendix A.

2.3 Consult with advisor and test semi-structure interview checklist through Index of Item Congruency (IOC) in order to evaluate content validity of the checklist. Index of Item Congruency (IOC) result can be found in Appendix C

2.4 Finalized semi-structure interview checklist from 2.3 finalized version can be found in Appendix B.

2.5 Interview chosen key informants by using finalized semi-structure checklist.

2.6 Interviews will be recorded and transcripted. The transcript can be found in Appendix D. Then, supplier selection criteria in C-Check maintenance service provider is identified.

2.7 Analyze the recorded interview by using taxonomy technique to find out rational behind interview result.

2.8 Conclude the study

Information Collection from Interview

The in-depth interview is conducted and transcripted. The interview transcript can be found in Appendix D. This section provides the summary from the in-depth interview in term of conclusion. The in-depth interview is conducted among management level officers of an airline which includes the following departments, Fleet management and engineering, Finance and account, Flight operation, and Safety security and quality

Chapter 4

Conclusion and recommendation

Chapter 3 provides the interview transcript in detail, and it will be used for analyzing and concluding the study. The analysis and conclusion covers the following topics

1. To identify supplier selection criteria for C-Check service provider
2. To set the weight supplier selection criteria

Study Result

This study began with literature review in supplier selection, maintenance concept, and aircraft maintenance selection. The article in the supplier selection was reviewed to gain insight on sourcing process to supplier selection. The review in the maintenance concept helped answer the question why maintenance s required an also explains what C-check is. Lastly, the review in the aircraft maintenance selection was an important part as it summarized supplier selection in airline industry. 10 studies were reviewed and criteria were identified as figure 11

In-depth interview is conducted to identify weight on each criterion. Key informants are senior management level officers of the airlines who are directly involved with C-check maintenance activity. The interview script can be found in Appendix D. The main criteria and their sub-criteria weighing factors are identified as the following section.

Question 1: What is the main concern with regarding supplier selection in your point of view?

Key Informant 1: - Compliance to the regulation. Meets authority regulations

Key Informant 2: - Quantitative relating to numbers that being paid

- Qualitative relating to service and quality
- Auxiliary cost
- Total cost
- The location of service provider. Closer is better. Alternatively, location that can be a revenue flight.

Key Informant 3: - Delivery is directly affected the role of this key informant.
- Quality cannot be compromised operation could be at risk and consequently higher cost.
Too expensive is not preferable but too cheap is also suspicious.

Key Informant 4: - Quality is directly affect the role of this key informant.
- Other criteria are also in concerned but not as much as quality.

Similarity: - Quality is being concerned.

Difference: - Cost is mainly concerned by 1 key informant.

Key Point - Quality is concerned by every key informant.

Question 2: For main criteria which are resulted from the empirical study, please assist to evaluate them in term of percentage

Key Informant 1: - Quality is the most important following in order by cost and delivery and compatibility.

Key Informant 2: - None are equally important.
- Quality is the most important for airline.
- Following in order by delivery, cost and compatibility

Key Informant 3: - Quality and delivery are the most important.
- Following in order by delivery and compatibility.

Key Informant 4: - Quality is the most important following in order by cost delivery and compatibility

Similarity: - Quality is the most important.
- Flexibility is the least important.

Difference: - Delivery and cost.

Key Point - As an airliner, every informant emphasize on quality.

Question 3: How's it (most percentage) impact your operation. Please explain.

Key Informant 1: - Experience on an aircraft type is necessary.
- Compliance to authority is a must.

Key Informant 2: - With robust quality system, operation interruption can be less than poor quality system. Cost of operation interruption is high.

Key Informant 3: - Anything could happen if the quality compromised, you'll put operation at risk.

- Reputation can be ruined if quality is compromised. Reputation is a key competitiveness for airlines.

Key Informant 4: - The most important for maintaining aircraft is the airworthiness standard.

- Quality and cost need to be balanced.

Similarity: - None

Difference: - Each key informant has different reason.

Key Point - Even though the reasons are different, the quality is the most important.

Question 4: What about the rest, why they're rated lower.

Key Informant 1: - With a good quality system in place, the rest will follow through,

- The airline is cost driven.

Key Informant 2: - As contract exist and counter party respected each other, flexibility or compatibility is less important.

Key Informant 3: - Compatibility is intangible.

- For delivery, if it's delayed, penalty shall be applied.

Key Informant 4: - Quality is a must.

- As we pay for the service, compatibility is less important.

Similarity: - Compatibility is less important due to contract is exist between counter parties.

Difference: - Each key informant has their own point of view.

Key Point - With a good quality system, other are followed through.

Table 8 Main Criteria Weighing Factor for C-Check Supplier Selection

Main Criterion				
Key Informant	**Quality**	**Cost**	**Delivery**	**Compatibility**
No. 1	50%	30%	10%	10%
No. 2	40%	20%	30%	10%
No. 3	40%	40%	10%	10%
No. 4	35%	30%	30%	5%
Average	41%	30%	20%	9%

Table 8 provide criteria weight by four key informants and average in lowest row. The quality has the highest value following by cost, delivery and compatibility respectively.

Question 5: For sub-criteria “Quality”, please assist in ranking them.

Key Informant 1: - The most important is specification conformance, following in order by knowledge and skills and, lastly, reputation.

Key Informant 2: - The most important is knowledge and skills, following in order by specification, conformance, and reputation.

Key Informant 3: - The most important is specification conformance, following by reputation and knowledge.

Key Informant 4: - The most important is specification conformance, following by reputation and knowledge.

Similarity: - 3 out of 4, Specification conformance is the most important.
- Reputation is the least important.

Difference: - One of key informant ranks knowledge and skill as the most important.

Key Point - Specification conformance is a must.

Question 6: Please explain why they're rated differently.

Key Informant 1: - Aviation industry has a very high standard that needs to be followed.
- Complying aviation standard is legitimate.
- Without specification conformance and knowledge and skills, reputation cannot be perceived

Key Informant 2: - Specification conformance is important due to aircraft lease agreement.

Key Informant 3: - Specification conformance is nonnegotiable.
- Reputation can reflect in the way vendor works whether they strictly comply with the regulations or not.
- Knowledge and skills is the least important because it can be built from specification conformance and a good system. With good knowledge but no control, an output can be unacceptable.

Key Informant 4: - A supplier needs to ensure that they can work with aircraft by complying regulation, in other words, by having specification compliance.
- Passed an audition, which comparing to specification, automatically that show the knowledge and skills is satisfied.

Similarity: - Specification compliance could assure that suppliers have a certain level of knowledge and skills, and reputation.

Difference: - Lease agreement requires specification compliance.

Key Point - Specification compliance is considered most important by each key informants.
- Reputation is the outcome from specification compliance.

Table 9 Quality Sub-Criteria Weight for C-Check Supplier Selection

Sub-Criterion Quality			
Key Informant	**Knowledge and skills**	**Specification Conformance**	**Reputation**
No. 1			
Rank	2	1	3
Weight	33%	50%	17%
No. 2			
Rank	1	2	3
Weight	50%	33%	17%
No. 3			
Rank	3	1	2
Weight	17%	50%	33%
No. 4			
Rank	2	1	2
Weight	25%	50%	25%
Average Weight	**31%**	**46%**	**23%**

Table 9 provides ranks of quality sub-criteria. The sub-criteria are ranked by four key informants. The rank is converted into the percentage which demonstrates weighing factor of each sub-criterion. The bottom row provides an average weight. The specification conformance has the highest weight following by knowledge and skills, and reputation.

Question 7: For sub-criteria “Cost”, please assist in ranking them.

Key Informant 1: - Total cost is the most important following in order by payment condition and price stability.

Key Informant 2: - Total cost is the most important following in order by payment condition and price stability.

Key Informant 3: - Total cost is the most important following in order by price stability and payment condition.

Key Informant 4: - Total cost is the most important following in order by price stability and payment condition.

Similarity: - Total cost is the most important.

Difference: - Price stability and payment condition are ranked differently

Key Point - Total cost is the most important.

Question 8: Please explain why they're rated differently.

Key Informant 1: - Total cost is the most important due to the C-Check high cost nature that could impact airline's cash flow.
- Price stability is uncontrollable.

Key Informant 2: - Price stability, if agreed, it has been agreed.

Key Informant 3: - Total cost impacts the airline's cash flow.
- Price stability will affect budgeting.

Key Informant 4: - Total cost means overall of every cost including scheduled and unscheduled.

Similarity: - Total cost impacts cash flow.

Difference: - Price stability is agreed.

Key Point - Cost of C-check impacts the airline's cash flow.

Table 10 Cost Sub-Criteria Weight for C-Check Supplier Selection

Sub-Criterion Cost			
Key Informant	**Price stability**	**Total cost**	**Payment Condition**
No. 1			
Rank	3	1	2
Weight	17%	50%	33%
No. 2			
Rank	3	1	2
Weight	17%	50%	33%
No. 3			
Rank	2	1	3
Weight	33%	50%	17%
No. 4			
Rank	2	1	2
Weight	25%	50%	25%
Average Weight	**23%**	**50%**	**27%**

Similarly, to table 9, table 10 provide the weight, in term of percentage, for each cost sub-criteria. The total cost has the highest weight following by payment condition and price stability respectively.

Question 9: For sub-criteria “Delivery”, please assist in ranking them.

Key Informant 1: - On time performance is the most important following by turn-around time guarantee.

Key Informant 2: - On time performance is the most important following by turn-around time guarantee.

Key Informant 3: - On time performance is the most important following by turn=around time guarantee.

Key Informant 4: - On time performance is the most important following by turn=around time guarantee.

Similarity: - On time performance is the most important following by turn-around time guarantee.

Difference: - Non item listed.

Key Point - On time performance is the most important.

Question 10: Please explain why they're rated differently.

Key Informant 1: - If the delay happen, it could affects operation and revenue.

Key Informant 2: - Since turn-around time committed, it shall be on time.

Key Informant 3: - The agreement need to be followed.

Key Informant 4: - It is important to keep the agreement.

Similarity: - Agreement shall be followed.

Difference: - Delay could impact operation.

Key Point - Agreement is to be kept. Otherwise there will be penalties.

Table 11 Delivery Sub-Criteria Weight for C-Check Supplier Selection

Sub-Criterion Delivery		
Key Informant	**On time performance**	**TAT Gurantee**
No. 1		
Rank	1	2
Weight	67%	33%
No. 2		
Rank	1	2
Weight	67%	33%
No. 3		
Rank	1	2
Weight	67%	33%
No. 4		
Rank	1	2
Weight	67%	33%
Average Weight	**67%**	**33%**

Similarly, Table 11 provides weight, in term of percentage, for delivery sub-criteria. On time performance has higher weight than turn-around time(TAT) guarantee.

Question 11: Fore sub criteria “Compatibility”, please assist to rank them.

Key Informant 1: - Relationship is the most important following in order by flexibility, service, and mutual trust.

Key Informant 2: - Service is the most important following in order by mutual trust, relationship, and flexibility.

Key Informant 3: - Mutual trust is the most important following in order by relationship, service, and flexibility.

Key Informant 4: - Flexibility is the most important following in order by mutual trust and service and relationship.

Similarity: - None

Difference: - All key informants rank differently.

Key Point - All key informants rank differently.

Question 12: Please explain why they're rated differently.

Key Informant 1: - The way Asian company do business. Long term relationship is very important.

Key Informant 2: - Flexibility is the outcome from the relationship, service, and mutual trust.

Key Informant 3: - Mutual trust is the starting point where relationship and service follow through. With mutual trust, relationship and service are in place and flexibility can be established.

Key Informant 4: - Flexibility is important since we cannot predict the future. It may require special support from supplier

- Relationship is just a little important since the airline pay for the service

Similarity: - Flexibility is the outcome from relationship, service, and mutual trust.

Difference: - Long term relationship is important for the Asian company.

- Relationship is not important because these are paid services

Key Point - There is a relationship between each sub criterion.

- Culture may affect the evaluation of this sub-criteria.

Table 12 Compatibility Sub-Criteria Weight for C-Check Supplier Selection

Sub-Criterion Compatibility				
Key Informant	**Relationship**	**Service**	**Mutual Trust**	**Flexibility**
No. 1				
Rank	1	3	4	2
Weight	40%	20%	10%	30%
No. 2				
Rank	3	1	2	4
Weight	20%	40%	30%	10%
No. 3				
Rank	2	3	1	4
Weight	30%	20%	40%	10%
No. 4				
Rank	4	3	2	1
Weight	10%	20%	30%	40%
Average Weight	**25%**	**25%**	**28%**	**23%**

Similarly, the mutual trust has the highest score following by relationship, service, and flexibility. However, the percentage of each sub-criterion are very close.

Question 13: Are there any other criteria to be considered? If there is, why it should be considered?

Key Informant 1: - Listed criteria are answered.

Key Informant 2: - A hangar slot.

Key Informant 3: - Listed criteria cover all areas.

Key Informant 4: - Listed criteria are the complete scope.

Similarity: - Listed criteria are sufficient.

Difference: - Hangar slot.

Key Point - Listed criteria are sufficient.

Question 14: As environment changed (e.g. fleet expand, higher competition within service provider, company is making profits) how it will impact weighting of supplier selection criteria?

Key Informant 1:	- Next time, the cost will become the most important because we have satisfied suppliers in place. They'll need to bidding.
Key Informant 2:	- The basic factors will not change. - The competition will be reflected by price. Some supplier may able to identify ways to reduce cost.
Key Informant 3:	- As we gain more experience, this theory might be invalid. It will need to be validated again.
Key Informant 4:	- If our fleet increased, it might affect the cost wise.
Similarity:	- Most likely, there will be changes.
Difference:	- Non item listed.
Key Point	- Reviewing criteria evaluation will need to be performed.

Table 13 C-Check Supplier Selection Criteria Weight

C-check supplier selection criterion weight					
Criterion	**Key Informant**				**Average**
	No. 1	**No. 2**	**No. 3**	**No. 4**	
Quality	**50%**	**40%**	**40%**	**35%**	**41%**
Knowledge and skills	17%	20%	7%	9%	13%
Specification Conformance	25%	13%	20%	18%	19%
Reputation	8%	7%	13%	9%	9%
Cost	**30%**	**20%**	**40%**	**30%**	**30%**
Price stability	5%	3%	13%	8%	7%
Total cost	15%	10%	20%	15%	15%
Payment Condition	10%	7%	7%	8%	8%
Delivery	**10%**	**30%**	**10%**	**30%**	**20%**
On time performance	7%	20%	7%	20%	13%
TAT Gurantee	3%	10%	3%	10%	7%
Compatibility	**10%**	**10%**	**10%**	**5%**	**9%**
Relationship	4%	2%	3%	0.5%	2%
Service	2%	4%	2%	1.0%	2%
Mutual Trust	1%	3%	4%	1.5%	2%
Flexibility	3%	1%	1%	2.0%	2%

Table 13 provides a summary of C-check supplier selection criteria weight. Main criteria and sub-criteria are listed in the table. Sub-criteria weights are calculated by pro rata of their weight, in Table 9 to Table 12, to main criteria weight in Table 8. The result is average, in last column, providing weight in each criteria.

As weights are obtained, factor rating can be applied as a tool for supplier selection. Table 13 is being applied to table 14. Table 14 is an example of using factor rating technique to select suppliers. Example suppliers are supplier A, B, and C. As scored on criteria table, those scores are calculated with weights resulting on weighted score. Weighted scores are summarized in the bottom row. It appeared that supplier B has the highest weighted score. Therefore, supplier B will be chosen.

Table 14 Example of Factor Rating Evaluation for C-Check Supplier Selection Criteria weight

Criteria	Weight	Score (1-100)			Weighted Score		
		A	B	C	A	B	C
Quality							
Knowledge and skills	13%	80	60	40	10.4	7.8	5.2
Specification Conformance	19%	100	80	50	19.0	15.2	9.5
Reputation	9%	90	50	30	8.3	4.6	2.8
Cost							
Price stability	7%	30	80	100	2.2	5.8	7.3
Total cost	15%	40	100	100	6.0	15.0	15.0
Payment Condition	8%	20	80	100	1.5	6.2	7.7
Delivery							
On time performance	13%	80	70	40	10.7	9.3	5.3
TAT Gurantee	7%	80	70	60	5.3	4.7	4.0
Compatibility							
Relationship	2%	80	50	100	1.9	1.2	2.4
Service	2%	90	60	100	2.0	1.4	2.3
Mutual Trust	2%	90	70	100	2.1	1.7	2.4
Flexibility	2%	100	70	100	1.8	1.2	1.8
Total Score					**71.3**	**74.0**	**65.6**

Conclusion

Supplier selection criteria, in C-Check maintenance service provider, are identified in 4 sub-criteria; cost, quality, delivery, and compatibility. Quality has the highest importance weight following in order by cost, delivery, and compatibility. All key informants agreed that the quality is the most important criteria as it is considered necessary. The better quality system allows the lower operation risk. The cost of operation interruption is high as the airline has to pay for an extra fuel, penalty and accommodation to the customer, and revenue loss. In the worst case, damaging the airline reputation. For example, the customer lost confidence in airline safety and decided not to fly with the airline anymore.

In quality, specification conformance to regulation is a must. In aviation industry, compliance is the most critical part. If the supplier has an acceptable standard, reputation and knowledge and skills are expected to be acceptable. Even though supplier has good knowledge and skills, without specification conformance, output is not always reliable.

The airline is like other business; cost is an important factor. At the end of the day, owner or investor need to have profits. However, it is important to be cautious on extra low price quotation since it could impact quality. There is an industry standard where the cost could not get any lower. The lower price than the industry standard could mean that the supplier has a shortcut way, in other words not following standard procedure unless the supplier can prove that they have a shortcut way without compromising the quality.

The total cost of C-check maintenance is considered the most important as it is a high cost process. If the cost is too high, it could impact company's cash flow.

Delivery delay could impact the operation. Operation are planned months ahead and resource are allocated to support operation. Moreover, tickets are booked by the passenger. Delaying aircraft delivery means that planned flight could be cancelled and airline has to pay the penalty to solve this problem.

Compatibility is the least important in all criteria. With a good quality system and existing contract, the compatibility is less important.

Recommendation from Study

From this study, the recommendations are determined as following

The quality is a must for C-check maintenance service providers. Without quality, especially regulation compliance, it is recommended not to consider such supplier for further evaluation.

1.Total cost of C-check on each supplier should be studied carefully. There are two types of cost in this event which are scheduled and unscheduled. Scheduled is cost that foreseeable. On another hand, unscheduled is the cost of extra works beyond the normal C-check package. Unscheduled cost is unpredictable and difficult to budget it.

2. Even supplier promise a low turn around time of C-check event, it is strongly recommended to ensure that supplier can keep their promise. As explained, the operation is being planned in months ahead. Operation interruption could result in high penalty.

3. Factor rating is recommended to be used for C-check supplier selection, as demonstrated earlier in this chapter. Not only before supplier selection, once C-check is completed is recommended to re-evaluate to see supplier performance.

4.The supplier selection and weighing factor should be reviewed annually because a business environment could change and also, with higher experience, the way criteria being weighted could change.

Recommendation for Next Study

1. The quantitative research should be applied on criteria in this study in order to compare the weight result.

2. Due to the limited numbers of research on criteria compatibility, it is recommended to do further research in order to make it more rigid and more acceptable. Quality, cost, and delivery are solid as evaluated by an in-depth interview result.

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Appendices

Appendix A

Index of Item Congruency (IOC)

Objective of the Study

1. To identify supplier selection criteria for C-Check service provider
2. To set the weight supplier selection criteria

Criteria Introduction

Refer to figure 11, quality is considered very important in aviation industry. As one failure, may lead into severe incident. In fact, aircraft is a complex product which require high level of knowledge and skill to repair and maintain.

- Knowledge and skills: As aircraft maintenance is labor intensive and complex, it requires man power possessing knowledge of aircraft and necessary skill to perform maintenance. Knowledge in terms of aircraft maintenance is insight of aircraft system to understand the maintenance instruction while skill is ability to transform knowledge into activities.

- Conformance to specification: The airline industry is one of the highest regulated industry. For aircraft maintenance organization, the related regulation is FAA Part 145 and EASA Part 145. The aircraft maintenance organization must comply with such regulation in order to run the business.

- Reputation: Reputation is what people opinion, in the industry. They may have good or bad experience with such service provider and share among industry.

Cost is, without a doubt, one of the most important criteria in supplier selection.

- Price stability: In aircraft maintenance service agreement usually mentioned the price of the service with inclusive of services. However, there're some unexpected service to carry out during the maintenance. The unexpected service will be charged and it may not be budgeted before. It could damage the cash flow.

- Total Cost: In this study case, cost is used resource to achieve C-check maintenance event.

- Payment condition: Payment condition is how to pay service provider in term of, not limited to, credit term and amount to pay before and after complete service. Including to payment type such as flat rate or power by the hour.

Delivery refers to the ability of a supplier to offer what its customers need at the right time with the right quantity, with right documentation, and within its guaranteed turn around time.

- On time performance: On time performance is the rate that service provider able to release aircraft back to service within guaranteed turn around time.

- Turn around time guarantee: In each service providers, may unable to provide the same guaranteed turn around time depending on their capability and risk taking.

Compatibility is how well between service provider and customer working together.

- Relationship: Includes shared risks and rewards, ensuring cooperation between the airline and ground service provider.

- Service: The way service provider practice with customer.

- Mutual Trust: Both service provider and customer believes in each other to achieve mutual goal.

- Flexibility: Flexibility when dealing with abnormal situations, such as delays, unforeseen defect, incidents, etc.

Table 15 Criteria Index of Item Congruence (IOC) Evaluation

Criteria Index of Item Congruence (IOC)				
No.	**Criteria**	**Congruent (+1)**	**Questionable (0)**	**Incongruent (-1)**
1	**Quality**			
1.1	Knowledge and skills			
1.2	Specification conformance			
1.3	Reputation			
2	**Cost**			
2.1	Price stability			
2.2	Total cost			
2.3	Payment condition			
3	**Delivery**			
3.1	On time performance			
3.2	Turn around time guarantee			
4	**Compatibility**			
4.1	Relation ship			
4.2	Service			
4.3	Mutual trust			
4.4	Flexibility			

Table 16 Criteria Index of Item Congruence (IOC) Result

Criteria Index of Item Congruence (IOC) Result		
No.	**Criteria**	**IOC Score**
1	**Quality**	
1.1	Knowledge and skills	
1.2	Specification conformance	
1.3	Reputation	
2	**Cost**	
2.1	Price stability	
2.2	Total cost	
2.3	Payment condition	
3	**Delivery**	
3.1	On time performance	
3.2	Turn around time guarantee	
4	**Compatibility**	
4.1	Relation ship	
4.2	Service	
4.3	Mutual trust	
4.4	Flexibility	

Appendix B

Interview Check List

Table 17 Interview Check List

Introduction Key	
• Thank you • Objective • Duration • How interview will be conducted • Opportunity for question	First of all, thank you for your presence and your time to meet with me today. I would like to talk to you about your thought and your experience in C-Check supplier selection. Even though you may or may not have been involved in such event, but your opinion will be very valuable to this topics since C-check, as a major maintenance event, has relationship somehow with your operation. The interview should take approximate 30 minutes. I will be recording the audio during the interview as I don't want to miss any of your comment. Once recorded audio is paraphrased, it will be provided to you for your concurrence. Criteria which are used in this interview are from empirical study over 10 journals which concern supplier selection in aviation industry. They're as following ******* Provide Empirical study result of supplier selection hierarchies ********* Before conducting the interview, If there's any question, please feel free to let me know.

Table 17 Interview Check List (Continued)

Key Point	
Questions • Evaluation of each criteria • Evaluation of each sub-criteria • Use open-ended question • Ask factual before opinion Use probes as needed	1. What is the main concern with regarding to supplier selection in your point of view? 2. For main criteria which are resulted from the my empirical study, please assist to evaluate them in term of percentage. 3. How's it (most percentage) impact your operation. Please explain. 4. What about the rest, why they're rated lower. 5. For sub criteria "Quality", please assist to rank them. 6. Please explain why they're rated differently. 7. Fore sub criteria "Cost", please assist to rank them. 8. Please explain why they're rated differently. 9. For sub criteria "Delivery", please assist to rank them. 10. Please explain why they're rated differently. 11. Fore sub criteria "Compatibility", please assist to rank them. 12. Please explain why they're rated differently. 13. Are there any other criteria to be considered? If there is, why it should be considered? 14. As environment changed (e.g. fleet expand, higher competition within service provider, company is making profits, etc.) how it will impact weighting of supplier selection criteria?

Appendix C

Index of Item Congruency (IOC) Result

Table 18 Criteria Index of Item Congruence (IOC) Evaluation (No.1)

Criteria Index of Item Congruence (IOC)				
No.	**Criteria**	**Congruent (+1)**	**Questionable (0)**	**Incongruent (-1)**
1	**Quality**			
1.1	Knowledge and skills	X		
1.2	Specification conformance	X		
1.3	Reputation	X		
2	**Cost**			
2.1	Price stability	X		
2.2	Total cost	X		
2.3	Payment condition	X		
3	**Delivery**			
3.1	On time performance	X		
3.2	Turn around time guarantee	X		
4	**Compatibility**			
4.1	Relation ship	X		
4.2	Service	X		
4.3	Mutual trust	X		
4.4	Flexibility	X		

Table 19 Criteria Index of Item Congruence (IOC) Evaluation (No.2)

Criteria Index of Item Congruence (IOC)				
No.	**Criteria**	**Congruent (+1)**	**Questionable (0)**	**Incongruent (-1)**
1	**Quality**			
1.1	Knowledge and skills	X		
1.2	Specification conformance	X		
1.3	Reputation	X		
2	**Cost**			
2.1	Price stability	X		
2.2	Total cost	X		
2.3	Payment condition	X		
3	**Delivery**			
3.1	On time performance	X		
3.2	Turn around time guarantee	X		
4	**Compatibility**			
4.1	Relation ship			X
4.2	Service			X
4.3	Mutual trust			X
4.4	Flexibility	X		

Table 20 Criteria Index of Item Congruence (IOC) Evaluation (No.3)

Criteria Index of Item Congruence (IOC)				
No.	**Criteria**	**Congruent (+1)**	**Questionable (0)**	**Incongruent (-1)**
1	**Quality**			
1.1	Knowledge and skills	X		
1.2	Specification conformance	X		
1.3	Reputation	X		
2	**Cost**			
2.1	Price stability	X		
2.2	Total cost	X		
2.3	Payment condition	X		
3	**Delivery**			
3.1	On time performance	X		
3.2	Turn around time guarantee	X		
4	**Compatibility**			
4.1	Relation ship	X		
4.2	Service	X		
4.3	Mutual trust	X		
4.4	Flexibility	X		

Table 21 Criteria Index of Item Congruence (IOC) Result from Evaluation

Criteria Index of Item Congruence (IOC) Result		
No.	**Criteria**	**IOC Score**
1	**Quality**	
1.1	Knowledge and skills	3
1.2	Specification conformance	3
1.3	Reputation	3
2	**Cost**	
2.1	Price stability	3
2.2	Total cost	3
2.3	Payment condition	3
3	**Delivery**	
3.1	On time performance	3
3.2	Turn around time guarantee	3
4	**Compatibility**	
4.1	Relation ship	1
4.2	Service	1
4.3	Mutual trust	1
4.4	Flexibility	3

Appendix D

Interview

Key Informant 1

Interviewer : Thank you very much for allowing me to interview today. Before we go through the question, I'm going to ask you the first question that is very open. What is your concern regarding to supplier selection, in your point of view.

Key Informant 1 : The most important thing regarding to supplier selection on maintenance tasks is conformance. You have to comply with standard and with authorities. In other words, you have to meet authorities' standard. Compliance is the most important thing. You cannot work with the aircraft without compliance.

Interviewer : Okay. So that's sound like one of the most important thing. So, if you weight cost, quality, delivery and compatibility. How much percentage you give for each of them? Please take your time.

Key Informant 1 : (Taking evaluation) OK. The quality takes halve of the total weight, 50 percentage. Because if you talk about quality, knowledge and skills, they have to have experience on this particular aircraft type. You have to have compliance to the authority requirements. So the quality becomes number one. The second one will be the cost. As you know, running airline is cost driven. Anything has to do with cost. Cost of engineering is almost 50 percentage of airline total cost. So, cost become number two concern, I give 30 percentage.

Interviewer : Why delivery is not as important as quality and cost?

Key Informant 1 : You have to go back to quality. If you have quality knowledge and skills, you can maintain the delivery time. As I told earlier, these two are related (quality and delivery). If you have high standard, you'll know exactly what you have to do with C-Check then you can maintain the delivery date. It comes together. You can commit the C-Check with certain period but you don't have the know how. 1 or 2 days can be committed but it's never going to happen. So you go back to quality first. That's why I give delivery 10 percentage because the quality of the company is right you get the rest coming in. So as flexibility as well, when they have high standard or quality there'll be many sector that keep monitoring the work process. So when you have the good quality system the rest will follow through.

Interviewer: Okay. So I think this is quite clear for the main quality on how each of them importance and why it's not. So moving on to quality section which includes knowledge and skills, conformance to specification and reputation. How would you give prioritize to each of them?

Key Informant 1 : The most important for me is specification conformance. Back to my previous explanation conformance, standard and authority. You have to comply with authority or standard like FAA or EASA. Those are the basic. I think aviation standard are being set up as high standard. You cannot get away with using supplier without conformance. One of these day you're going to get caught anyways. No way you can get away with it. Because like you always know that authorities like FAA, EASA or local country authority continuously to audit what we're doing. To comply with standard is a legal for airline.

Interviewer : How about reputation? Is that even important in your point of view?

Key Informant 1 : Out of these three, reputation is lowest importance. If you don't have the first two (Specification Conformance and Knowledge and skills), you cannot have a reputation. If you don't conform with standard and airline catch you later, the reputation is ruined. That's why priority becomes specification conformance.

Instructor : Reputation is the outcome.

Key Informant 1 : So if you don't pass the first two, the reputation will be ruined anyways. In the airline business is a small world. Everyone know each other. So reputation goes fast.

Interviewer : The next is going to be cost. Can you again help us prioritize?

Key Informant 1 : (Taking evaluation) This will be difficult because each of ones are important. When it comes to cost, everything is important.

Interviewer : But not equally?

Key Informant 1 : The most important is total cost, cost of the whole C-Check. Because when you talk about one C-check, you talk about millions for dollars. As an airline, airline is a cash flow market. We have to be sure that we manage our cash flow well in order to cover the cost of this C-Check. If you go beyond budget that we plan where we can find the money and this has to plan 1 year in advance. So the total cost becomes very important. And the second one is payment condition because I think every business in the world is running on credits. Everyone has to have credits either short or long credits. It depends on how we negotiate. It's important because if affect cash flow as well. The price stability becomes least important out of this three because sometimes it's beyond our control and supplier's control.

Interviewer : The next one is delivery. There're two of them, on time performance and turn around time guaranteed. Can you help us prioritize them again?

Key Informant 1 : On time performance will be the more important one. To do one C-check, you need to cancel a lot of flights. Grounding aircraft for a period. The time that we ground the aircraft has to be committed strictly. Because if the on time performance does not meet the agreement. It will affect our commercial and operation sides. Once we set the time to do C-Check, we expect it comes back when we agreed. If we keep extending it will affect the whole operation. If you commit 30 days or 40 days, you have to deliver in agreed turn around time.

Interviewer : The last one is compatibility. Please help us prioritize.

Key Informant 1 : Relationship will be the first one. It's just the way Asian company is doing work. They go by relationship. Compare Asia to European or USA, they deal business differently. The American or European, business is business. But for us, Asian culture, a lot of talking and negotiating are behind the scene including with friendly relationship. To have a good partnership, you have to have a good relationship.

Instructor : Because we look into long term relationship, not a short term.

Key Informant 1 : Right! That's how the Japanese run things. They depend on each other in win-win situation. That's the relationship we've been talking about. So relationship is number one. The flexibility is number two because in airline business we need flexibility. Anything can change all the times. The supplier has to help us as well. Sometimes we commit something but things are changed in the next day. It can be easily change just like that so the flexibility they have is important as well. Service will be the least important thing. Because service can come in later stage. For the mutual trust, what can I say.

Interviewer : For the mutual trust. If we have C-Check in one of the service provider and trust each other. We don't have to go to the aircraft and check everything they do on the aircraft. But go to aircraft few hours per day and assured that they're doing a good job.

Key Informant 1 : Right. But don't forget why we do the double work. When we depend on their quality system. If they have a good quality system they would have good tracking systems. If everything go by a check list then mutual trust becomes less important because we don't have to try to catch them again. They have their own system to catch their faults.

Instructor : So the quality becomes the first in this case. And if you have good quality system installed in services, the rest of them will follow.

Key Informant 1 : It will be easier for us as well if they have good quality standard. That's acceptable by every accredit.

Interviewer : Beside these criteria and sub-criteria, is there any criteria you would recommends to be considered.

Key Informant 1 : I think these four major criteria are pretty much answered what we look at supplier, not just C-check but any supplier because these four conditions anyways.

Interviewer : And last question, as you know when we operating, things may change. For example, we're making more profits, more loss, more competition in service provider and we have more choice. Will there be any change to your criteria weighing and prioritize?

Key Informant 1 : If you do it once and we use this to start. The next time cost will becomes number one.

Interviewer : Why cost becomes number one?

Key Informant 1 : Because they have competitions, and just like airlines, they compete on the price.

Interviewer : It sounds like quality is a must that everybody must have?

Key Informant 1 : Even the first supplier selection the quality become number one and if we have suppliers with the same quality then we go to the second one, looking at cost. The next year is the same thing, the quality is there. Now we look at cost again.

Interviewer : That was my last question.

Instructor : It means that no matter what quality comes first and other decision comes later.

Key Informant 1 : Right.

Instructor : In airline business quality has to come first because safety of passenger has to come first.

Interviewer : Thank you very much.

Key Informant 2

Interviewer : Thank you very much for allowing me to interview today. I'm going to start first question. It's a very open question. What is your concern in regarding to supplier selection, in your point of view.

Key Informant 2 : From accounting and finance perspective, I think we have two major factor which are qualitative factor and quantitative factor. Quantitative factor is relating to numbers as what you pay. Qualitative factor should be done by Engineering as a front line. For example evaluate MRO quality of service directly. In term of accounting and finance, I'd like to see warranty that MRO offer to the airline. Because these relate to

consequence of expenses as well. The reputation of MRO is important too. Because it's their quality of work people talking about. The qualitative factor, first thing is warranty. If there's nothing happen after turn around time, it should be better. But if it happens, the warranty they give us, for example how many flight hours or time length. Those are very important in term of qualitative. And another qualitative is offering that they provide to the airline staff who are at the field work. For example, are office space or office appliance that staff need to use during the work including to facility between accommodation and hangar because it turns into money as well. Not only convenience to our staff but if they offer this kind of thing, it will save our money as well. And for quantitative, the major is package that they offer. I understand that the scope of work we give them to the MRO.

Interviewer : Yes, from engineering.

Key Informant 2 : From that scope of work we provide, how much they give for the whole package, for the routine work. Another is non-routine or over and above things that they will charge us. For example, the man-hour rate, markup from OEM catalogue price and ancillary cost they might charge us when they find extra works and number of hours that they will spend if they find this kind of job. I'm not sure that in reality they can guarantee or estimate time spending for this kind of job base on their experience. This thing should be considered in the calculation as well.

Interviewer : To calculate total cost?

Key Informant 2 : The total cost. So their offer should make us the total cost estimate as well. Because sometime the over and above is equal to the routine work. So if routine work is 200,000, the total C-check might be 400,000. Not only the routine package but over and above as well. You have to be careful with that. Another one is location of MRO because we need ferry our plane to their location and this turned into money. If our pilot fly to their location they might need to lay over at that location before they fly back. That consume their working hours not only the expense we have to pay on their ferry flight.

Instructor : And that's empty flight.

Key Informant 2 : Yes, not a revenue flight. If the location is not far from our homebased, that should be good comparing to the far away from here.

Interviewer : What if the location is in Taipei? Since Nokscoot flies to Taipei as well.

Key Informant 2 : It's not a ferry flight. We can have a revenue flight to that location. That would be much better. It's ideal because you don't need to ferry. But you need to coordinate with sale team completely that there will not be a return flight. So they can

close selling of that flight to prevent transferring passengers due to parking aircraft for C-check. This needs planning in term of engineering and planning in term of commercial too. On the way back after C-check can be a revenue flight as well. If we can fly to Kualarlumphur which is very close. The pilot and engineer can fly back in the same day and no need to pay for their accommodation.

Interviewer : Next one, can you help us evaluate the four main criteria in term of percentage?

Key Informant 2 : I'd not like to say that they're not equal. In terms of airline, I'll consider as whole company that the quality should come first and the delivery is timely manner. So I think the quality should be 50 and 40. Because the on time performance means that we can get the airplane back for revenue flight. So this is next to quality. And for cost.

Interviewer : I'm very surprised.

Key Informant 2 : I'm not 100% cost people. As I mentioned, this is perspective of management, not a head of accounting and finance. The quality of work means that you find no problem when it turns out. And flexibility, if both counter parties can run through what we agreed in contract, honor to each other, some flexibility is good to have. But the term of work in contract is more important. Flexibility is some kind of relationship. The culture in each country is different. We cannot change the people suddenly. We will need to build the long term relationship.

Interviewer : For quality, can you explain more or give example why it's most important in your evaluation?

Key Informant 2 : Because the plane can generate our incomes. So the quality of the work means that we won't face problems when it turn out from C-Check. And we can operate smoothly because we're mass transportation service so the quality of service to passenger is the most important. If the plane have some problem and we have to delay the flight, we'll lose our reputation. And we'll have additional expenses. For example we need to book hotels for passenger. The consequence is huge. So the quality of work is important. It affect to many people including to our flight schedule. The delivery will need to be planned ahead. So the sale team won't sale ticket to passenger during C-Check. If turn around time is delay, it will face problems as well because we don't have a hot spare aircraft. We have only 3 aircraft. So we don't have that much flexibility in term of rotation.

Interviewer : Right, I totally agree. Next is quality criteria. Please help us ranking.

Key Informant 2 : (taking evaluation) I think the knowledge and skill is the most important. Specification conformance is important too because it relate to aircraft lease agreement. Doing anything with the plane, we need FAA or EASA certificate. It is the compliance we need to follow. This kind of thing is important.

Interviewer : Next is the cost.

Key Informant 2 : (taking evaluation). Total cost should be number one. Price stability, if we agreed, it's been agreed. They cannot charge over the agreed price. Payment condition is important. If the winner total cost is quite low comparing the first runner up, and payment condition is in advance or give deposit 50%, this has to be considered. Because it is about the trust on the MRO as well. But we have other criteria, the reputation, that help. Normally, they request 50% deposit because it is our creditability. They will request some number of deposit. Them when the work run to some percentage of work, they'll request a second payment and, lastly, over and above. When they conclude the job and turning airplane to us, they'll send us the invoice.

Interviewer : Next is delivery.

Key Informant 2 : I think this depends on luxury that you have. If it is the price that cheaper but turn around time is 14 days, you'll have to analyze the cost benefits.

Interviewer : Right. I thinks it has to come to quantitative analyze.

Key Informant 2 : I think on time performance should be the first one because TAT guarantee is depending on how much time you can allow them to do this work. Once they commit, it should be on time.

Interviewer : The last one is compatibility.

Key Informant 2 : This relate to qualitative factor. The thing such as facility, offering for our staff. First 3 factors will lead to flexibility. These are divert and this is the outcome.

Interviewer : That's all for criteria. Would there be else criteria you would recommend to look at?

Key Informant 2 : The hangar slot. This is very important.

Interviewer : Yes, without it we cannot perform the work.

Key Informant 2 : Right.

Interviewer : When things change. For example we make a lot of profits or there're more completion among MRO, would there be any change to the criteria.

Key Informant 2 : This is basic factor in selecting MRO. If competition among MRO is higher, I think our basic factor would not change. The competition will reflect on the price

that they give to us because they might have some automatic machine replacing manual man power and can fasten the job. That's their job to minimize their cost and consequently lowering price to us. I think the basic would not change. If they still use the traditional way, it will relate to turn around time guarantee as they can finish in 10 days, they might use 14 days. That might not fulfill our need. Sometime we need to have C-Check in high season right?

Interviewer : Yes, sometime we cannot choose.

Key Informant 2 : Since C-check schedule is unavoidable, this should be priority. As an airline, commercial sense should be considered. We'd prefer to have C-Check in low season.

Interviewer : I believe that cover all. Thank you very much.

Key Informant 3

Interviewer : Before we go through this, can you share with me? If you are involved, what is your concern regarding to supplier selection?

Key Informant 3 : I am not directly involved in supplier selection for this case. Because I think that is technical and not in position to choose. You listed down all criteria which I think sufficient. But where do I come in to any of this selection, is very little part. The finance would very concern about the cost since they're directly involved to. Criteria Quality would be directly to SSQ (Safety Security and Quality). Delivery would be quite close to me. Flexibility is more about the future of engineering. So the way I see the whole list equation, the only thing that would affect me, in my role, would be the delivery. Because, the quality I would trust.

Interviewer : But do you concern about quality?

Key Informant 3 : Of course, I do concern about the quality. Why I concern about the quality? One, what if the work is not complete per manufacturer specification. If it's not complete in accordance with quality index, it will put our operation in high risk during flight, any time. The component meant to last 100 hours but break down. Even though pilots are trained to handle emergencies but why do we let it happen as it's supposed to last 100 hours but breakdown at. 15. So that is one concern of mine. Anything of that happen if the quality compromised, you'll put operation at risk. Putting operation at risk is a high cost because we may perform diversion, passenger inconvenience, company reputation. There are a lot of intangible loss including economically and non-economically.

One of the key thing of airline is reputation. If the reputation goes down and people see the airline always diverting because of quality problem. People would stop flying with us. Our company would end. So it's start very simple from a quality point of view. To deliverable, we have to assure that this vendor has got a good history of maintenance high quality standard. The life of the component that they service must last as long as they published. Cost wise, I'm not directly involve but I would say it's more involving to the finance than pilots. If it's too expensive, obviously it's not too good for us. If it's too cheap, you have to suspect because it may mean that vendor may have some by-passes that bring the cost down. We must be aware what is the lowest, what is the average. We cannot always be going for the cheapest because cheapest could be something is not right. There's an industrial not. If you are way too low, as a customer, has to be cautious.

Interviewer : That's very interesting.

Key Informant 3 : Yes, It could mean that they are by-passing something that you wouldn't know. By doing this, they may bring the cost down. Unless this particular vendor can show you that other doing these steps and I can reduce these steps and yet maintain effectivity. Then that's fine. But more often they're not. The example is if somebody sell you iPad at 7000 Baht. Suddenly we found out that it's the same with 12000 Baht. It makes sense to buy it but...

Interviewer : Is that a genuine one?

Key Informant 3 : Yes. To me, cost is very concern. What if it was purely about the cost then may be it means the quality is compromised. Then it affects flight operation. When flight operation is operating then component break down, it comes to quality issue again.

Interviewer : The compatibility is about the relationship between us and the vendor.

Key Informant 3 : That one I wouldn't have much anticipation. It's very high level kind of feedback or I can use the word "opinion".

Interviewer : In C-check, one of activity that may affect you is if there's a flight test. They have to accommodate pilots as well. To get a ramp pass, to get to aircrafts.

Key Informant 3 : That is a very simple thing to do. I'm talking about very high level. You need to also recognize the vendor and history of their practice. History of the practice means, for example, if you do know that this vendor has got cheat practice, my advice is to stay away. Last but not least, would be the deliverable. Delivery and on time performance, These are very critical because we have plan operation which based on return of the aircraft. If the vendor cannot meet the promised return date. It means another

day of delay, there may be another day of flight cancellation, another day of revenue loss and another day of bad reputation.

Interviewer : That's very clear. From your explanation, it's very interesting. If you're going to rate it in term of percentage. What will you give for each one.

Key Informant 3 : This will be in term of percentage. I would say that quality is number one. Just as much as I want quality, I also concern about the cost. So these two are almost equal in the airline. Because I cannot have highest quality and pay Hugh money. So I will put these two as almost equal. Delivery and Flexibility are also okay. I can accept delivery because when you do the vendor selection, you'll have penalty if vendor delay returning aircraft. Just like buying aircraft. The agreed delivery date is on a certain date and manufacturer fail to delivery on time. Airline normally negotiate for penalty. (Taking evaluation)

Interviewer : I think you already explain why you give this result. So I'm not going to ask further why it is this important. I'll skip to quality. Can you help me rank its sub criteria?

Key Informant 3 : (Taking evaluation). I put specification conformance is number one. And reputation then knowledge and skills.

Interviewer : Why specification conformance is the most important?

Key Informant 3 : Specification conformance is nonnegotiable which means that it has to be done in a certain way. There's no workaround solution. There's no by pass, either you follow it or not follow it otherwise you don't meet the manufacturer approved specification. Reputation is important because if I know that a certain company does it in a tricky way, they would earn themselves a reputation. If it is good, the reputation will be precede. Knowledge, I don't put it that important because it is a given. I can have very good knowledge but if relax on specification conformance, I can train. You can build this up. I can hire people to meet this. But no point of having the best people and I cannot control.

Interviewer : That is very good point.

Key Informant 3 : I can have the best people but if I don't control them, the output would be rubbish. But if I have a restrict control, I can train even a monkey to do what I want. So these are things I can train. That's how I see it.

Interviewer : I couldn't agree more, to be honest. Next is the cost. And again, please help me rank them.

Key Informant 3 : (Taking evaluation). Total cost itself is important too because it involves our cash flow. Price stability should important as we can project our plan and budget it.

If the price increase so much, unless collapse of world bank system. If you do not have any limits to the growth then how can I budget myself for future growth. Payment condition is obviously, be a good customer, we should use to negotiate for flexibility.

Interviewer : Now let's move to delivery

Key Informant 3 : (Taking evaluation) The on time is more important. You can promise me the world but I need you to complete within time.

Interviewer : So the compatibility, please help me rank.

Key Informant 3 : (Taking evaluation) Mutual trust is one. Relationship two. Service three and flexibility is four.

Interviewer : Why they rated differently?

Key Informant 3 : Mutual trust is rated first because when there's a lot you cannot cover everything. There will be always new pop up during any servicing. They may find something. So there must be a bit of trust between you and vendor that he's not up to screw you over. Because you're not there all the times. You must have a mutual trust that I trust what you're doing and will not overcharge me. Because, really, I would not know. You could tell me that a hydraulic pump is not working and have you tried your best to see what are other solution rather than always keep changing part. To them, it is easy to just bill you. So there must be a little bit of mutual trust that we trust each other. Then comes to the relationship. First start from mutual trust. I trust you and you trust me but do I have a special relationship to do extra for you? Then after that you establish this already, is there a service to facilitate this. No point having the best friend but we do not have service to get it done. Last but not least, come to the table and let's have a bit of flexibility to see how we can approach this. If your way is like this, one way no other ways, how can you use the trust between us to doing case we cannot get it done.

Interviewer : When you talk about these three, relationship service and mutual trust, Am I understand correctly that it start with mutual trust and next is relationship and service will come along.

Key Informant 3 : Yes. Then with all these in placed, the flexibility between both party to get the job done. If there's not trust, you won't get a relationship. You don't even talk about the service and flexibility is no way.

Interviewer : Beside this, do you have any criteria that I should considered.

Key Informant 3 : I think this is a complete scope of how you want to select a vendor. Cost to me is an important factor as you and I know, MRO cost is one of the biggest

thing beside fuel and crew cost. Crew cost is a given you cannot negotiate with it. Fuel cost you cannot control. But you can control your maintenance cost. Easy to go high spec all the way but you have to concern about the cost. At the end of the day, they always say “Show me the money”. Engineering, Flight operation and ground operation are known as spenders. Cabin crew and commercial are earner. As a spender group, we have to be very careful what we spend. And we want to spend it well knowing that the money we spent are hard earned by other parties.

Interviewer : Yes I agreed.

Key Informant 3 : It is earned by our colleagues bringing in the cash. We do it well so that they can use the aircraft to further enhanced and bring more money. So this is vicious cycle.

Interviewer : One more question, the last one. Let’s say if next year or two we expand. The environment change. Maybe we have more competition or less. Or we are making profit. Will there be any change to the way we rated criteria?

Key Informant 3 : As we speak right now, I don’t see it. But as we go down years and gain more experience. We may learn that these theoretical work may or may not work. That’s when you have to review this matric again to see this is theory and what goes on the real world. There may be a lot that we overlook. We anticipate that these are important but it may not be. I wouldn’t say it will change but it may after 2 years of experience.

Key Informant 4

Interviewer : Good afternoon.

Key Informant 4 : Good afternoon.

Interviewer : Thank you very much for allowing me to interview today. I am going to run through questions I have. First one, before we go through criteria, If you are in the position that you choose MRO for the C-Check. What is your main concern. This is very open question.

Key Informant 4 : For my position right now, quality assurance manager, the main concern is about quality. Quality is my main concern to select the MRO.

Interviewer : Okay. How about the rest? Would you considered those criteria are important as well or you will go with quality only?

Key Informant 4 : Sure. For cost and quality are another concern. But less than quality.

Interviewer : Here we have 4 criteria. Which are quality cost delivery and compatibility. So if you give weighting in term of percentage. How much will you give?

Key Informant 4 : (Taking evaluation) For quality I give 35 percentage. Cost is 30 percentage. The same with quality 30 percentage. And compatibility is only 5 percentage for me.

Interviewer : Can you share with me that why quality is considered the most important?

Key Informant 4 : Because, from my view, the most important is airworthiness to maintenance the aircraft. If that MRD do not have enough quality to meet the requirements from operator or authority, them may not pass airworthiness standard.

Interviewer : Do you mean that it is a must that MRO need to have?

Key Informant 4 : Yes.

Interviewer : For cost and delivery?

Key Informant 4 : 30 percentage because, as an operator, if they have very high quality and also expensive then we cannot choose that MRO. We have to manage cost and quality balance. And also delivery, if we do not have aircraft to operate then we're losing some money.

Interviewer : That make sense. But for compatibility, is it even important.

Key Informant 4 : Yes but not much. Because for relationship, we can build. And we pay for their services.

Interviewer : I see. I think that make sense. If we look into quality sub-criteria, how will you rank them.

Key Informant 4 : (Taking evaluation) The first I rank specification conformance. And for knowledge and skills and reputation are equal.

Interviewer : Why specification conformance is the most important in quality?

Key Informant 4 : For aircraft specification, each MRO cannot do for all type of aircrafts. So that's why we need to ensure that they can work with our aircraft. And get authorized. Or in the other word, MRO has approved capability of our aircraft type by authority like CAAT or FAA or EASA.

Interviewer : Understand. How about knowledge and skill including to reputation.

Key Informant 4 : For knowledge and skill, if you pass audit from authority, you should have knowledge and skill already. So it's not as much important as specification conformance. For reputation, it means previous experience that we worked with this MRO even they got a lot of certification from authorities but they are not good as we thought.

Interviewer : Would reputation affect your decision. For example we choose between Lufthansa technik and another no name MRO.

Key Informant 4 : Not much as long as they have capability and certification and authorization.

Interviewer : Moving on to the cost, please help me rank.

Key Informant 4 : (Taking evaluation) First is total cost. Price stability then payment condition are equal. Because total cost means overall of every cost including schedule and unscheduled. Payment condition is about company cash flow.

Interviewer : Well I think that's clear enough. Next is delivery.

Key Informant 4 : (Taking evaluation) first is On-time performance then turn around time guarantee.

Interviewer : Why on-time performance is the most important one?

Key Informant 4 : Because if they can promise, like 14 days, we can plan to use the aircraft after 14 days. I think it is more important to keep the promise. When the aircraft finish C-check, it can come back to serve operation as planned without any interruption.

Interviewer : That's also making sense. For compatibility, please again help me rank them?

Key Informant 4 : (Taking evaluation) I'll put the first one, flexibility. Next is mutual trust then service and last is relationship.

Interviewer : Relationship is seemed to be very low important, why?

Key Informant 4 : Because, as I say, we can build relationship. And we pay for that service. Not asking for free. It's not like If we do not have relationship with them then they will not do work for us.

Interviewer : They won't do it for free anyways.

Key Informant 4 : If we have a good relationship and we don't have money to pay, they cannot do anything for us.

Interviewer : Right.

Key Informant 4 : That's why I only give 5 percentage for relationship.

Interviewer : How about flexibility? It seemed to be very important.

Key Informant 4 : Because I thought when we bring aircraft to C-check, there'll be something special and surprised.

Interviewer : For example?

Key Informant 4 : We go to that MRO when it turn out to be their long holiday which we never know before. My first C-check I experienced was in Israel and it was during their long holiday about 5 days which we were not aware. So they stop work and we ask them to run over time. This is beyond the contract.

Interviewer : Wow, if we run to same situation and found 5 days holidays, we'll be in trouble getting aircraft back in time. At that time, did it affect your turn around time?

Key Informant 4 : A lot. We plan to do C-check for only 12 days but it took one month to complete. It affected a lot.

Interviewer : I will take note of that.

Key Informant 4 : In china, they have a lot of long holidays. It will affect a lot to operator.

Interviewer : Understand. Beside these criteria you evaluated, are there any criteria you would recommend to be considered?

Key Informant 4 : I believe the list cover already.

Interviewer : If next year we change or the situation change. For example we make profit or loss more or we have more aircrafts, will your evaluation change?

Key Informant 4 : In case of we have profit and add more aircrafts as much as we can then we have to concern about turn around time a lot since if we loss aircraft meaning we lose money.

Interviewer : Like if we have 99% load factor, the opportunity cost is higher.

Key Informant 4 : If we have a bigger fleet, we can take cheaper MRO with the same work.

Interviewer : Before we finish, do you have anything else you would recommend.

Key Informant 4 : No.

Interviewer : Thank you

Key Informant 4 : Thank you