



Aircraft Leasing and Life Cycle Cost Management - Road Map for Closing the Gap Between Strategy and Results

Embry-Riddle Aeronautical University

Aviation Management Program – Class of 2020

AIRCRAFT LEASING AND LIFE CYCLE COST MANAGEMENT - ROAD MAP
FOR CLOSING THE GAP BETWEEN STRATEGY AND RESULTS

by

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This Capstone Project was prepared and approved under the direction of the
Group's Capstone Project Chair, Dr. Leila Halawi
It was submitted to Embry-Riddle Aeronautical
University in partial fulfillment of the requirements
for the Aviation Management
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Abstract

Group: Daniel Ferreira, Danilo Horninck, and Filipe Sant'Ana

Title: Aircraft leasing and life cycle cost management - a road map for closing the gap between strategy and results

Institution: Embry-Riddle Aeronautical University

Year: 2020

This study used an online survey to determine the necessity of using a structured management methodology for dealing with the aircraft life cycle costs, especially the end of leasing contract requirements and the aircraft's redelivery process. We reviewed the management methodologies found in the Project Management Institute Body of Knowledge (PMBOK) and the International Airline Transport Association (IATA) Aircraft Leasing Best Practices. Finally, we offered recommendations based on the experience and necessities identified via online surveys. Also, at the closure of this document, the authors of this study cited five recommendations as general guidelines that should be observed by all parties involved in an aircraft leasing contract to avoid unanticipated financial obligations and delays at its termination.

Resumo

Grupo: Daniel Ferreira, Danilo Horninck, and Filipe Sant'Ana

Título: Aircraft leasing and life cycle cost management - a road map for closing the gap between strategy and results

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Este estudo se utilizou de uma plataforma on-line de pesquisa para determinar a necessidade de utilização de uma metodologia de gestão para lidar com as necessidades decorrentes de um contrato de arrendamento de aeronaves, em especial, os temas do término de contrato e o processo de retorno de aeronaves arrendadas. Revisou-se as metodologias de gestão encontradas no Project Management Body of Knowledge (PMBok) e a metodologia proposta pela Associação Internacional de Transportadoras Aéreas (IATA – em inglês). Finalmente, propôs-se recomendações, baseadas em requisitos e nas experiências identificadas através da pesquisa on-line, de metodologias de gestão que melhor respondem a estas necessidades. Em adendo, ao final deste documento, os autores deste estudo citam cinco recomendações gerais que devem ser observadas por todas as partes envolvidas num contrato de arrendamento de aeronaves para que sejam evitados atrasos e obrigações fiscais não-antecipadas ao final do mesmo.

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Chapter I – Introduction

Since the 1980s, when aircraft leasing contracts started taking place and spread through the air travel market (IATA, 2017), airlines have continuously improved their employment throughout the world. Some of the drivers that instigate airlines to sign such contracts are based on strategic decisions on their network, product, prices, and resources (Bourjade et al., 2017). Aircraft leasing contracts, in most cases, can stretch from one up to twenty-five years of length. Airlines must monitor the life cycle costs of such endeavors to avoid future unanticipated financial obligations, keeping their long term profitability and business' sustainability (Bourjade et al., 2017).

As they are sometimes called, aircraft leasing contracts, or Operational Leases, are based on financial obligations that have their cost impact and exposures mostly at the end of the aircraft leasing contract stage. At that stage, the redelivery process and maintenance costs are considered the most relevant of the entire contract. Those costs can be minimized or avoided by using different management techniques along with the leasing contract term.

The present study aims to identify reasonable opportunities to improve life cycle costs control over an airline's leasing contracts. It focuses on the avoidance of unanticipated financial obligations during the redelivery process. Additionally, the study will present an assessment of the applicability of known project management methodologies to help avoid or at least mitigate the unanticipated financial obligations during the redelivery process.

The redelivery process is the leasing contract's closure when the asset is transferred back to the lessor. All the agreed Redelivery Conditions when the contract was first signed have been met. This process proves yet and again to be very complex and demanding from

both sides of the deal, and more often than not, it is perceived as being "costly," "divisive," and a "non-value-added endeavor" (Clarke, 2017).

A compelling factor that directly affects the redelivery process and how lessors and lessees perceive it is the fact that overtime legislation, technology, and resources evolve and may not be as permissible, available, or accessible as they once were (IATA, 2017). To this date, there is no standard practice, internationally accepted protocol, or management standardization recognized as "the industry's best practice" when it comes to how to deal with the redelivery process and its complexities.

The common sense between Airlines, Maintenance, Repair, and Overhaul organizations (commonly referred to as MROs) and Lessors is that the return, or redelivery process, of a leased aircraft is a painful process, downtime and cash spent. Usually, airplanes are grounded for several months to perform complete redelivery checks. According to the International Bureau of Aviation (figure 1), lessees and lessors felt like the "general underestimation of effort" was the primary cause for late redeliveries. The second reason is the "unscheduled repairs/failed borescope inspection" (IBA, 2016).

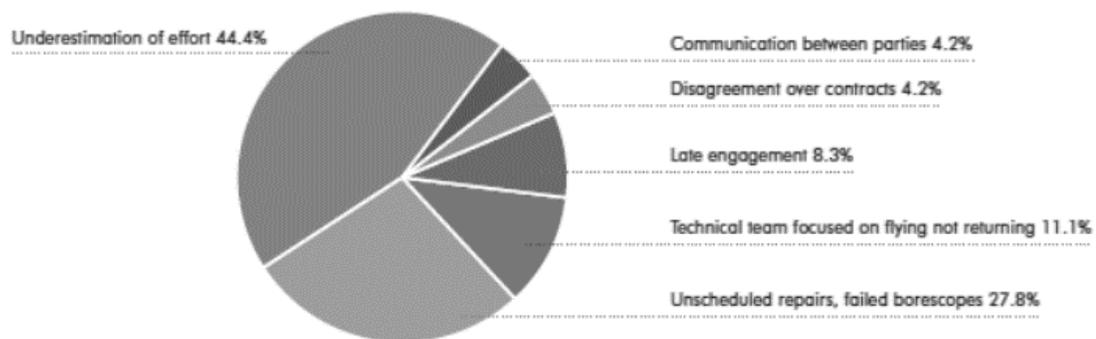


Figure 1. Reasons for Late Redelivery. IBA (2016)

Overall, maintenance checks for the leased aircraft redelivery process are very complex, demanding, and time-consuming. The process includes removing aircraft

customizations by the lessee, Parts Manufacturer Approval (commonly referred to as PMAs) removal, and the entire dent mapping documentation process to fulfill the redelivery conditions required on the aircraft leasing agreement or Redelivery Conditions.

Special attention is required for components such as Engines, Auxiliary Power Units (APUs), and Landing Gears, known in the industry as "Next High Assemblies" (NHA). Said parts are also subjected to specific redelivery conditions, like the boroscope inspection mentioned before. Thirty-six percent (36%) of the unanticipated financial cost of a redelivery process is related to engines, which are considered the most valuable and liable part of the aircraft (IBA, 2016).

The average figure for unanticipated financial obligations on a narrow-body aircraft's redelivery process is estimated to be around \$1.65 million. It is common for widebody aircraft's redelivery process to cost double that amount (IBA, 2016). Such amount of money is, on average, equal to the sum of three or four monthly installments of the leasing contracts of such aircraft.

It is clear that if the airline does not control and manage the leasing life cycle costs wisely, it may be required to perform other maintenance by the end of the period, absorbing additional and unanticipated costs.

This study aims to provide a comprehensive understanding of an aircraft leasing life cycle, discuss the main topics that drive these associated costs, and provide a project management approach to improve control and mitigate potential unexpected costs.

Project Definition

The present study intends to determine an airline lease life cycle and explore promising practices on project management implemented in the aviation industry by

lessees to control the overall financial cost. These practices should relate to the three main phases of an aircraft leasing term: the delivery process, the operation term, and the redelivery process.

The Project Management Institute (PMI) is a worldwide renowned organization sponsoring and disseminating project, program, and portfolio management practices (PMI, 2020). By analyzing Airlines' and Lessors case studies and literature, this study will consider utilizing project management methodologies from the Project Management Institute Body of Knowledge (PMBok) on the active management of life cycle costs of an aircraft leasing contract.

The intent is to establish a parallel between the three main phases of a leasing term and the three main phases of a generic project, where such steps are well determined. Thus, assessing the possibility of using sound practices of project management on the leasing term's control and planning, avoiding unanticipated financial costs at the end of the leasing contract.

Project Goals and Scope

The development and methodology were divided into three steps: (a) to collect and assess data and case studies from Airline companies and Lessors over end-of-the-lease cost impacts. (b) to define improving opportunities on leasing life cycle cost monitoring and controls. (c) to analyze project management tools that could be applied to an improved life cycle cost control.

This study aims to verify PMBoK methodologies' applicability to potentially mitigating or eliminating end-of-contract unanticipated financial obligations on the part of lessees (airlines). It aims to assess which one (s) could bring more efficiency to the

redelivery process. As a result, the authors intend to suggest a set of management recommendations that could be applied during the leasing contract term and stress said recommendations' advantages.

For a future study, it is suggested to have the management recommendations determined in this document at an aircraft lease life cycle redelivery process and report the actual results and benefits.

Definitions of Terms

Aging	It is recognized that maintenance costs increase with the aircraft's age, also known as the Aging effect.
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List of Acronyms

A.C.	Actual Cost
A.D.s	Airworthiness Directives
APU	Auxiliary Power Unit
APMBOK	Association for Project Managers Body of Knowledge
A320	Airbus Aircraft type
BAC	Budget At Completion
B737NG	Boeing Aircraft type
BTB	Back To Birth
CAA	Civil Aviation Authority
CofA	Certificate of Airworthiness
COVID-19	Corona Virus Disease
CPI	Cost Performance Index

CV	Cost Variance
EAC	Estimated At Completion
ECA	Export Credit Agencies
E.V.	Earned Value
EVA	Earned Value Analysis
IATA	International Air Transport Association
IBA	International Bureau of Aviation
IT	Information Technology
ICAO	International Civil Aviation Organization
LLP	Life Limited Parts
MRO	Maintenance, Repair and Overhaul
NHA	Next High Assemblies
OEM	Original Equipment Manufacturer
PMA	Parts Manufacturer Approval
PMBok	Project Management Institute Body of Knowledge
PMI	Project Management Institute
PMIS	Project Management Information System
PRINCE2	PRojects IN Controlled Environments
P.V.	Planned Value
SPI	Schedule Performance Index.
TCPI	To-Complete Performance Index
U.N.	United Nations

Chapter II – Review of the Relevant Literature

The literature review comprises three main areas regarded as fundamental for the consolidation of the available public knowledge: Aircraft Life Cycle Cost, Aircraft Leasing Contracts, and Life Cycle Costs Management Techniques. Each one of those areas was deemed fundamental to the execution of this study. Although they are interconnected, it was decided to assess them separately at this moment.

Aircraft and Airline Life Cycle Costs

According to Drucker et al. (2015), each social sector institution exists to make a distinctive difference in individuals and society's lives. Indeed, it is the case of airlines that provide an essential transportation service for people and cargo worldwide.

Per Wensveen et al. (2015), airlines spend the last decade rethinking the business model to foster safety and operational efficiency while reaching a profitability level. New entries are constant, and the business is in a very competitive environment where financial efficiencies are met.

Regrettably, Cook et al. (2017) stated that airlines are famous for their deficits. Thus, a strict cost control model is compulsory to preserve health and profits for numerous years. There is a lag between the demand observed by airlines and the time required to have a new aircraft available added into the fleet. An excellent fleet planning supported by comprehensive long-term contracts with some airlines' protections in substantial market change is necessary. Usually, such protections and considerations would generate some additional costs and reduce the incentives provided by both OEMs and lessors. Anyway, it could be compared with an insurance policy to protect operators for uncertain periods, but they may not afford such additional costs.

Cronrath (2018) concluded that the airline profit cycle is the product of changes in the general economy, factors in the industry environment, and airlines' behavior. Airlines, their stakeholders, or regulators could take action to dampen the profit cycle and achieve a higher long-run profitability level. Reasonable measures are: (1) focus on long-term profitability in price-setting; (2) gradual and slow capacity enlargement; (3) flexible adjustment of existing capacity; and (4) improved forecasting and information sharing within the industry and along the value chain.

Then, during this crisis caused by the Covid-19 pandemic, all those aircraft ordered earlier and now expected to be delivered on time will be subjected to very bumpy situations. All the stakeholders and aircraft manufactures expect to have the airplane finished and delivered to either lessors or airlines and get timely payments. The lessors wish to start to receive from operators the ownership costs. Lastly, the airlines prefer to postpone the delivery of new aircraft as this would be deemed unprofitable.

At this time, an interesting observation about the fleet's age was made by Dimitroff (2011). In his article, he stated with the suggestive name "No time for old aircraft" that the airlines are currently looking for new aircraft since they are also pleading for their warranties, low maintenance during the honeymoon period, and dispatch reliability. Passengers like a shiny new airplane, and airlines want to boast about who has the lowest average fleet age. In the same article, is observed a significant increase in the aircraft operating leasing option growing from 30% (thirty) of the market in the 2000s, reaching pretty 50% (fifty) in the next decade, mainly for the two most crucial narrow body models, B737NG and A320.

It is possible to raise and explore these two ideas related to the airline industry's profit cycles. The other one is related to the maintenance honeymoon period mentioned for new aircraft.

It is also reasonable to state that the required period to order and receive an aircraft directly impacts economics once the market and demand changes so fast.

Mainly the aircraft downtime for redelivery is a critical item to be considered and well planned. Within that period, the monthly rent is still applicable assets will not be available to produce any revenue. On some occasions, the aircraft may be ground in the airline MRO, impacting additional heavy check planning for the remaining fleet or be subjected to extra fees to be paid to third parties shops.

Aircraft Leasing Contracts

There are several ways an airline can finance its operation. Bjelicic (2012) points out seven different methods: corporate cash-flows, equity, bank borrowing, export credit agencies (ECAs), capital markets, manufacturer and pre-delivery payments, and operating leases. Aircraft Leasing contracts, or Operational Leases, is the one method that rules out the risks associated with aircraft ownership (IATA, 2017) and requires the least upfront capital from airlines, thus making possible new players join the air transport market (Bjelicic, 2012).

Although the possibility of leasing aircraft can be traced back to 1948's Geneva Convention, or the "Convention on the International Recognition of Rights in Aircraft" (U.N., 1948), it only really started to become a common practice in the late 1980s (IATA, 2017). The slow pace at which this operational financing evolved was due to the lack of commonalities between y different countries' legal bodies. Only with the 2001's Cape

Town Convention, or the "Convention on International Interests in Mobile Equipment," a common international understanding of terminology, rights, dues, and securitization was reached, reducing the capital costs operating leases and expanding the practice (ICAO, 2020).

A brief overview of the industry figures reveals the continued growth of the employment of operating leases as a way to finance airline's operations around the world: At the beginnings of the 1990's it represented roughly 5% (five) of the global commercial aircraft fleet (IATA, 2017), then it grew to a third-round 2012 (the Economist, 2012) and it reached over 40% (forty) on 2017 (Guzhva et al., 2018). Flight Global (2017) reported an average increase in the total number of leased aircraft of 2% (two) each year in the previous decade. Manufacturers such as Boeing, Airbus, and Embraer forecasted increasing numbers of aircraft delivered shortly, a substantial amount to be operated under lease contracts.

On a more general note, authors like Einsfeldt and Rampi (2009) stated that the practice of leasing is advantageous because it enhances the credit capabilities of a given organization, allowing for a more generous credit in terms of an asset. That is to say that airlines, through the employment of operational leases, can assess better or newer aircraft than they would have had if not through leasing.

Analyzing the characteristics of operating leases on the air transport market, one can identify movement towards a reduction in the length of aircraft leasing contracts: initially ranging up to 25 (twenty-five) years of length, but nowadays, it is common to find 6 (six) to 12 (twelve) years of length on lease. Another advantage identified by Gavazza

(2011) is a 6.5 (six-point five) percent higher flying hours on leased aircraft when compared to owned ones, for example.

Although aircraft leasing contracts enhance the access for smaller players, it is, to a great degree, responsible for the current diversity and competitiveness in the air transport business. Bourjade et al. (2017) pointed out that typically the academic research on airline performance does not consider leasing contracts as a relevant financial factor. One can assume that this characteristic is due to the non-disclosure policy commonly found on financial agreements, hence the lack of publicly available figures and statistics to fundament any publication.

Negotiations of an aircraft leasing contract is undoubtedly a determinant factor for the success of an airline. It establishes a long-term agreement between lessee and lessor, where many variables are unknown for both sides. However, the protections available for the asset owner are greater than those that will protect the airline. As explicitly stated by Guzhva et al. (2018), the negotiation depends on several different factors. The factors include contract duration, lease rate factors, pre-deposit payments, maintenance reserves, early redelivery possibility, and redelivery conditions.

Therefore, it is possible to say that there is a tradeoff that leads airlines to make a difficult choice in terms of the ownership cost, comprehended mainly monthly fees and maintenance reserves versus the potential costs that they may incur during the aircraft's return.

Life Cycle Costs Management

Life cycle costing is a management approach to physical assets costs intended to optimize its value for money and expenses during operational life. Life cycle cost is a

decision-making approach that accounts for a long-term outlook on investments rather than a short time money saving essay (Woodward, 1997). It allows a decision to be made around a holistic approach and a more comprehensive scenario analysis accounting for a more cost-benefit and long-term investment overview.

Understanding this concept and applying it to aircraft leasing is crucial in addressing the most relevant indicators of un-estimated or unpredicted costs on the Redelivery phase, as mentioned in chapter 1 (IATA, 2016). Around 72% (seventy-two) of late redelivery is due to underestimated work and unscheduled repair that could be better addressed with a more holistic approach to the process and costs. One could argue that postponed repair schedules and the lack of maintenance planning during aircraft usage and operations could severely impact a later date.

Relevant and well-known project management guides are the PMBoK (Project Management Body of Knowledge), PRINCE2, and the APMBOK (Association for Project Managers Body of Knowledge). The reference guides were classified by Chin and Spowage (2010) as "Best practices, standards, and guidelines,"

According to Karaman, & Kurt (2015), when comparing PRINCE 2 and PMBoK as guidelines and project management standards, PRINCE 2 is more focused on managing product delivery activities while PMBoK is more tailored to a project management mechanism, tools, and techniques (see figure 2). Assuming that this study aims to address tools and techniques applied to cost management on aircraft leasing life cycle costs for an optimized approach on cost monitoring and controls, PMBoK seems to fit better in this proposition.

Features	PRINCE2	PMBOK
Practical Approach	✓	-
Comprehensive Approach	-	✓
Project Board Activities	✓	-
Management by Exception	✓	-
Procurement Management	-	✓
Product Focus	✓	-
Customer Requirements Focus	-	✓
Detailed Techniques	-	✓
Interpersonal Skills	-	✓

Figure 2. PRINCE2 and PMBoK main differences. Karaman and Kurt (2015)

The Project Management Body of Knowledge (PMBoK) is a well-recognized guide to project management published by the Project Management Institute (PMI). The PMI defines the PMBoK as "a term that describes the knowledge within the profession of project management. It includes proven traditional practices that are widely applied as well as innovative practices that are emerging in the profession" (PMBoK, 2017)

Unlike a methodology, the PMBoK is a guideline in which project management methodology and tooling can be built. Thus, this study chose this as a base of analysis of life cycle cost management.

Case studies on applying PMBoK methodologies to aviation is a fact. Garfein (2007) describes the usage of PMI Portfolio Management Standards, providing frameworks to understand the factors that influence senior executives' decision-making for Boeing 787 Dreamliner. This paper also correlates Boeing's successful case and the Airbus 380's lack of planning and systemic approach to failure (Garfein, 2007).

By applying the Strategic Portfolio Management Model (Exhibit 1-4 Standard for Portfolio Management, 2006 Edition), the Boeing executive team could map the Boeing 787 portfolio objectives and outcomes (see figure 3). As a result, it became clear to the

decision-making matrix the premises and restrictions for return of investments, cost reductions; quality increases; customer service; collaboration; organization effectiveness, knowledge sharing, new markets; global presence; industry changes, and market practices.

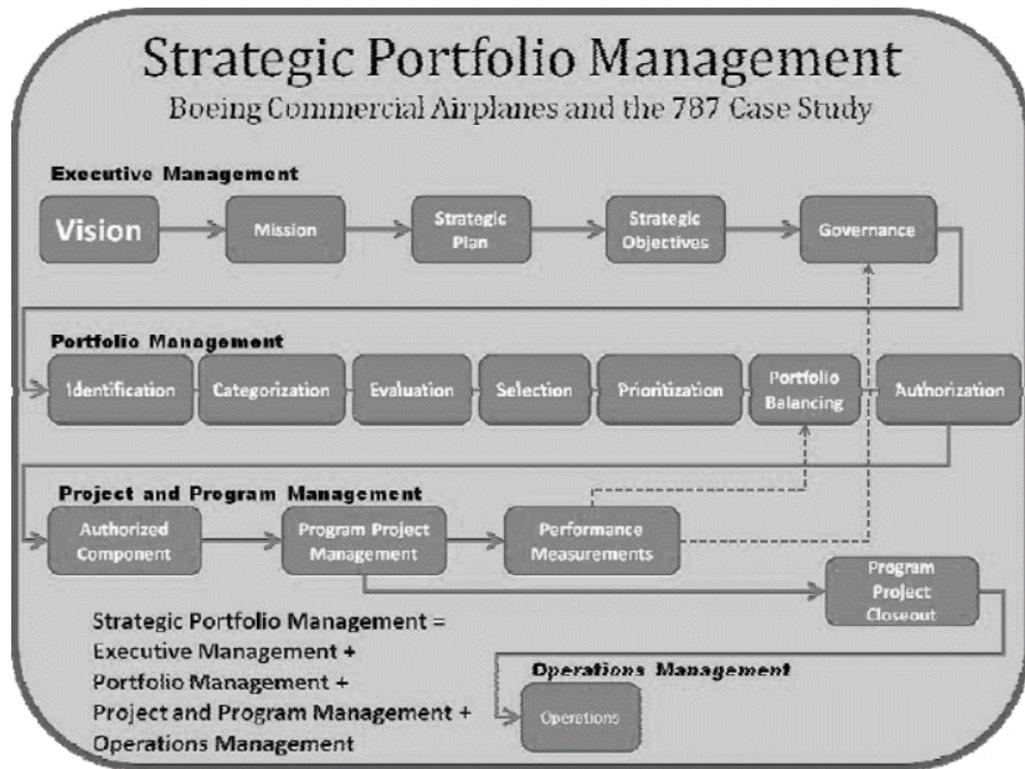


Figure 3. Cross company strategic management flow. Garfain (2017)

According to PMBoK, "Project Cost Management includes the process involved in planning, estimating, budgeting, financing, funding, managing, and controlling costs so that the project can be completed within the approved budget." (PMBoK, 2017). It also states that the project management process is inclusive of inputs and outputs. For the cost management control, PMBoK suggest the following inputs and outputs (see figure 4 and 5):

Inputs:

- Cost Management Plan
- Lesson Learned register

- Project funding requirements
- Work performance data
- Organizational process and assets

As outputs:

- Work performance information
- Change request process
- Updated cost management plan
- Cost forecasts
- Updated cost data

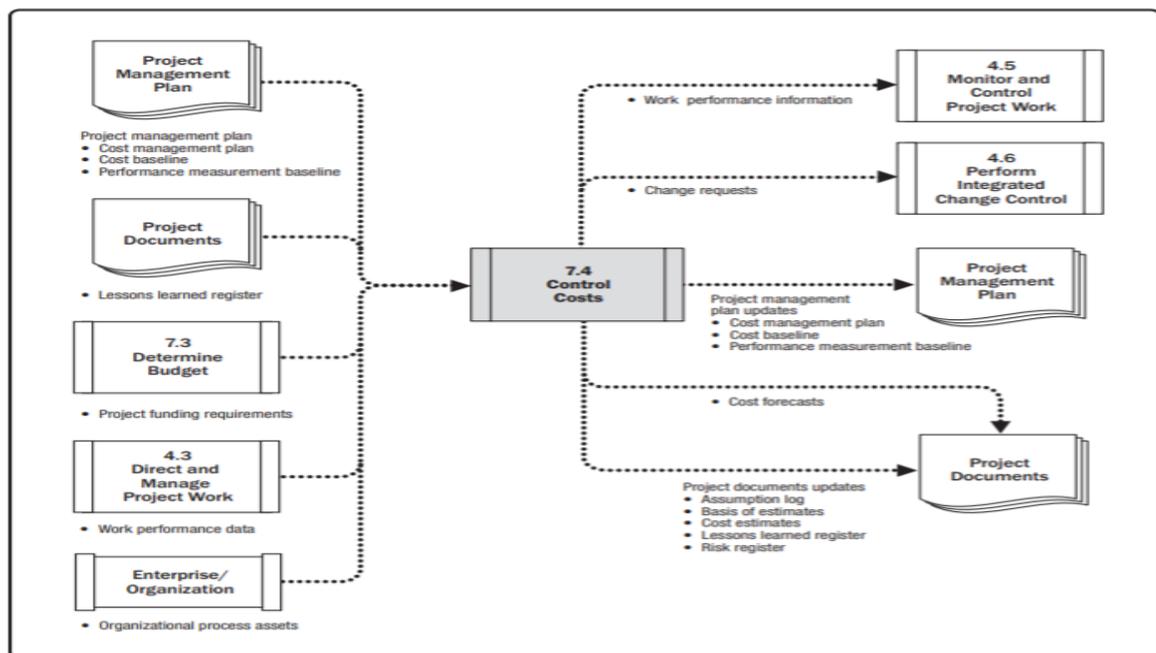


Figure 4. Control Costs: Data Flow Diagram. PMBoK (2017)

Project Cost Management is the focus of the following research. Assuming that a well-developed life cycle cost (budget) is stated as a baseline, the cost control's essential aspect is the monitoring and controlling this baseline throughout the project. PMBoK

suggests a sequence of input, tools, and techniques, and outputs for this process (PMBok, 2017).

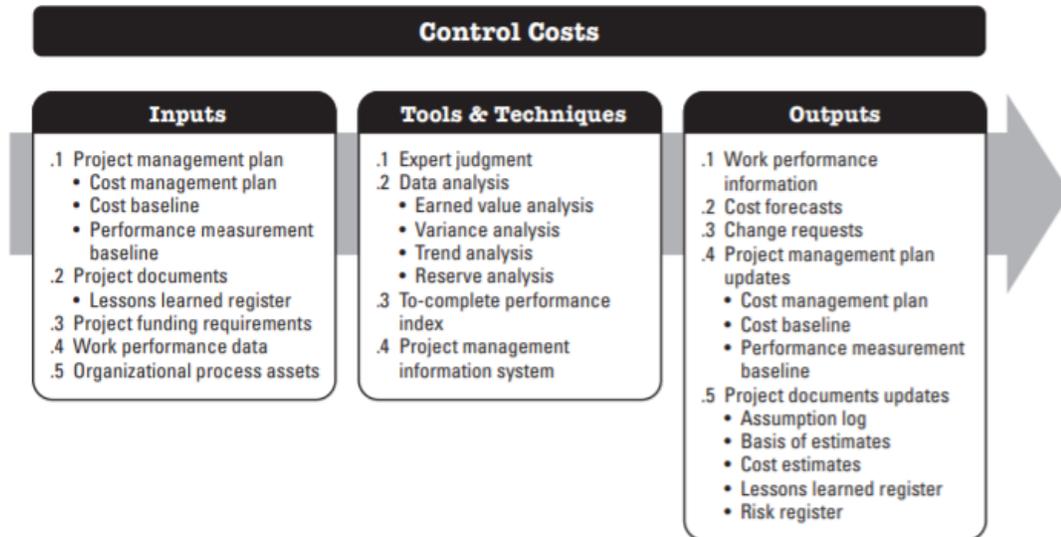


Figure 5. Control Costs: Inputs, Tools & Techniques, and Outputs. PMBoK (2017)

According to PMBoK, cost control includes the following activities:

- Influencing, managing, and acting on change requests and costs impacts;
- Monitoring cost performance while controlling budgetary premises and baselines;
- Keep stakeholders informed from change requests and costs impacts;
- Conducting risk assessments and reshaping budgetary overruns to the acceptable limits;

Those activities showed to be performed by the project manager during the entire project duration. Some premises (inputs) need to be stated. Per PMBoK, those inputs should be:

- The cost management plan;
- Cost baseline;

- The performance measurement baseline consists of an earned value analysis that would compare the actual results to the baseline. In case of changes, we need to either determine corrective action or propose a preventive measure to assure the baseline.
- Project documents that could include contracts;
- Project funding requirements, which provides for project expenditure and anticipated liabilities;
- Work performance data and organization process assets, which represents the project status dashboard to be revised, monitored, and controlled in terms of authorized costs, incurred, invoiced and, or paid;

As tools and techniques, PMBoK suggest the following:

- Expert Judgment:

"Expertise provided by a group, company, or person with specialized knowledge or skills on cost controlling techniques and tools." (PMBoK, 2017)

- Data Analysis:

As a reference, PMBoK mentions the EVA (Earned Value Analysis), Variance Analysis, Trend Analysis, and Reserve Analysis as data analysis tools for cost controls. Cost controlling techniques are not limited to the above, as those are mentioned on the PMBoK.

Summary

In general terms, an airline can add an aircraft into its fleet, either by purchasing it or by operational leasing. Then considering that the second option is more attractive to the companies due to the preferred commercial conditions available to the lessors, within the

last decade, has been observed a significant increase in the number of aircraft worldwide that has been subjected to such conditions. However, the leasing contract brings some binding obligations to the operators, which, by the time of the aircraft's return to the lessors, needs to fulfill many redelivery conditions to make it acceptable per the lease contract conditions.

It has been observed that there are opportunities to improve the life cycle management of the aircraft by an airline. This study provides useful information to point out the most critical aspects from day one of operating the plane until returning it to the lessor.

Once the cycle comprehended by the delivery, operation, and redelivery of an aircraft has many similarities with the project management process; the recommendations will be based on the best practices observed in the available tools.

Chapter III – Methodology

The following study was developed in three major parts: a literature review on aircraft leasing contracts, an analysis of the perceived difficulties lessors and lessees identify on the redelivery process, and assessing the management methodologies contained within the PMBoK and IATA.

This chapter is developed to compare the IATA recommended procedures and PMBoK best practices to identify opportunities by improving airlines' aircraft life cycle cost management. It covers the research design used to handle precisely the difficulties identified by lessors and lessees, especially in the redelivery process and cost management methodologies within the PMBoK.

Data Source(s), Collection, and Analysis

Cost and time played a significant role in the choice of research method. Research Methods refer to tools, techniques, and processes used to collect and analyze data in the research process (Mligo, 2016). It is one of the most critical components of the research methodology. The choice of research methods depends on several practical, theoretical, and ethical issues. According to Kirsch (2012), some of the practical problems affecting selecting research methods include time, money, access to participants, and the researcher's knowledge and skills. Theoretical factors that determine the research method used in a study include validity, reliability, and philosophy. This study is aligned to positivist philosophy, and the paradigm is reflected in the choice of methods for gathering and analyzing data. On the other hand, ethical issues that were factored in selecting research methods included informed consent, confidentiality, safety, and privacy.

For the current study, there are four primary sources of information analyzed: IATA recommendations, PMBoK, lessors, and lessees' survey data.

The International Air Transport Association (IATA) publishes a comprehensive guide for aircraft leasing. Of particular concern for this study are the guidelines on the redelivery process. IATA has advice on the redelivery conditions that need to be met by the aircraft lessors and lessees. The redelivery process is essential to both parties. In the lessor's case, the redelivery needs to be carried out promptly since, in most cases, the marketing efforts for a new lease for the aircraft have already started. For the lessee, there may be penalties incurred if the redelivery process is delayed. Therefore, there need to be clear conditions to govern the redelivery so that there are no additional costs. Analyzing the redelivery conditions set by IATA and the step-by-step guidelines for the redelivery process helps provide useful insights into how costs can be reduced.

IATA provides a 24 (twenty-four) month window for the redelivery process. It starts with the confirmation of the end of the lease by the airline. Ideally, the airline, the lessee, should notify the lessor of the lease's upcoming end at least 24 (twenty-four) months before the lease ends. The notification triggers a period of reviewing the conditions for the return of major components such as the engines, landing gears, and the APU. If there are any upcoming maintenance events, these can be discussed at this stage. Also, the notification can trigger discussions over whether to extend the lease.

For 12-15 (twelve to fifteen) months before the redelivery, the return conditions are analyzed thoroughly to identify any problem areas. Some of the aspects to look out for in this stage include compliance issues and the aircraft's commercial and technical assessment.

For the 9th to 12th (ninth to twelfth) month period before redelivery, focus issues are the MRO options. The lessee should review the MRO options to determine any changes that may be necessary. The MRO evaluation is conducted hand in hand with an initial meeting with the lessor. The meeting is essential for ensuring that both parties are on the same page regarding the redelivery. The discussions at this stage should revolve around the aircraft return process and the conditions involved. For instance, the lessor may request that the next carrier's livery be installed when removing this livery. There may also be conditions related to some modifications to the aircraft. These discussions help to ensure that the redelivery process is smooth.

The factors include the project plan's achievement for the 8th to 10th (eighth to tenth) month period before redelivery. There should be a clear plan which details the primary tasks and milestones to be achieved. Having an exact timeframe for the redelivery plan helps to speed up the process. The stakeholders are made aware of their responsibilities and the given timeframes. This helps in the troubleshooting of issues as they arise in the redelivery process. Inspects of the cabin and cargo bays are carried out 6 to 9 (six to nine) months before the redelivery. At this stage, the lessee should consider the lead time for the replacement parts. This means that the inspection should be done early so that the parts' orders can be made promptly. It is essential to coordinate with the lessor in case there are specifications for the OEM products. A cabin walk for the lessor representatives can be arranged to understand the repairs that need to be done and the specific parts that should be purchased for the aircraft to be acceptable for redelivery. That same 6 to 9 (six to nine) month period also sees the preparation of aircraft records. This can be in the form of hard copies or digital formats. Digital documents are most efficient

in modern times since the lessor can be granted remote access for the redelivery period's duration. The most critical issues to record are the repairs, LLP, and A.D. s.

The next stage starts 5 to 6 (five to six) months before the redelivery. Preliminary checks are carried out on the aircraft. The lessee's role is to define the scope of work remaining before the redelivery in line with the maintenance program contained in the lease conditions. Between 4 and 6 (four and six) months before redelivery, inspections of the engine and the APU are carried out. This is done early so that if there are any adverse findings, proper decisions can be made. A final check is carried out 3 to 4 (three to four) months, focusing on documentation. If there are exports needed, there should also be a check for the CofA with the regulator.

Further, a pre-input meeting with the MRO is needed 3 to 4 (three to four) months before the redelivery. This helps smooth out the issues related to the scope of work, standards, and processes. A presentation of the records is also made to the lessor at this time. Ideally, the lessee should give the lessor 20 (twenty) business days to review those records and point out discrepancies. There should also be a cutoff point, after which the lessor is not allowed to note differences. This helps to avoid unnecessary delays caused by the lessor.

Between 2 and 3 (two and three) months to the redelivery, the maintenance plan is received from the MRO. This details the checks to be made, and the lessee is allowed to share the plan with the lessor. At this stage, the lessor should have completed reviewing the historical records and started the redelivery process. This entails a demonstration flight to show the aircraft's working with independent observers such as representatives from the CAA allowed to witness. After that, a final discrepancy list is developed, end of lease

payments are processed, and the aircraft is officially returned. In total, this process takes about two years. This is a costly period for the lessee since it means that the aircraft will not be performing its normal operations. The aircraft will not achieve its regular operation for that duration.

This study sought views and opinions of aircraft lessors and lessees and converted the response to numerical data using the Lickert scale. McWay (2013) argues that quantitative research aims to test theories or hypotheses, describe and show relationships between variables, and make predictions. This project will test whether participants agree with some of the opportunities for cost reduction by improving the aircraft life cycle identified in the literature. It fits the quantitative study description because it has research questions and objectives, uses structured methods and instruments, relies on a sample to represent the population, and analyzes data using statistical techniques.

This type of data is called primary data. This data was used to answer the survey questionnaire. Riedel (2015) observes that researchers prefer preliminary data because it is more relevant than secondary data. For example, in this study, only data related to research questions were collected. The researcher does not need to read through the data and pick out relevant secondary research information bits. Besides, the researcher has control over data collection processes and instruments. So, adequately conducted primary research can generate high-quality data. However, preliminary data is usually costlier and time-consuming to collect (Wilson, 2014). Primary data in this study was collected using a questionnaire.

Anyway, this study relied on secondary data to develop closed questions in the questionnaire. Boone, Kurtz, MacKenzie & Snow (2010) defines secondary data as

information that has been collected, analyzed, compiled, and published. In other words, information that is already existing in books, journal articles, and reports. This study's primary secondary data sources were peer-reviewed articles and reports published by reputable organizations in the airline industry, such as the International Air Transport Association (IATA). Riedel (2015) argues that secondary data is easily accessible and less expensive to gather. However, it can be outdated and irrelevant.

An online platform was used to set up a qualitative survey to identify the perceived difficulties lessors and lessees place on Redelivery Processes at the end of leasing contracts. A Scroll Survey Design (Couper, 2008) was chosen and made using an online software Google Forms. The authors tested the questions within the survey for reliability and content validity.

This study used a mailed questionnaire that was sent electronically to the participant for self-completion and resubmitted back. The questionnaire was created using Google Forms and links sent to the participants. The researcher recognized that lessors, pilots, and engineers of aircraft and widely dispersed geographically. Consequently, it is practically impossible to reach out to them in a timely and less expensive manner. Therefore, an electronically mailed questionnaire was preferred. Miller & Brewer (2011) observed that emails cost less in terms of money and time to administer. They also maintain anonymity because the researcher does not interact with the participant. However, they are associated with a low response rate. The researcher reached out to participants before sending a questionnaire to improve the response rate.

The survey was composed of 14 (fourteen) questions divided into three sections: respondent demographics, difficulties on the Redelivery Process, leasing lifecycle cost

management. The first section, which was mostly composed of close-ended questions, included identifying the categories of lessor or lessee and evaluating the leased fleet's size. The second section contained open-ended questions that target the title of the perceived difficulties faced during Redelivery Processes. The third and final section had both open-ended and multiple-choice type questions and target identifying management methodologies or tools used by the respondents and their impression (if applicable).

We sent identical online surveys to 140 (hundred and forty) organizations among lessors, OEMs, Maintenance, Repair, and Overhaul Company (MRO), and lessees, 58 (fifty-eight) of whom answer it. A copy of said questionnaire is attached in Appendix A.

The assumption was that different organizations playing different roles in the aircraft leasing process would identify similar difficulties in the Redelivery Process. Such a belief was accepted because a Redelivery Process is the closure of the relationship established through the contract, so what affects one party should affect the other. By analyzing the data retrieved from the online questionnaires, we classified the most prevalent sources of the interviewees' difficulties.

The researchers reviewed the substantive amount of literature on cost reduction opportunities to improve airlines' aircraft life cycle cost management. The themes identified in this review were used to develop questions contained in the questionnaire. Most of the items in the questionnaire were closed-ended. Meaning, the respondents were asked to select an answer from the choices provided. Close-ended questions ensured that responses from participants were uniform. Hence, closed-ended questions enhanced the reliability of the questionnaire. They also improved the response rate because they are easily interpreted than open-ended questionnaires (Babbie, 2015). However, they have a low

potential for uncovering useful information because the answers are provided. Lickert scale was used to change participants' responses to numerical data.

Finally, a comparison between the said prevalent sources of difficulty will be made against the management methodologies researched within the PMBoK and IATA's best practices. The objective is to single out management techniques that could potentially be applied to mitigate, or even eradicate, the principal sources of difficulty identified.

Scientific inquiries attract a lot of ethical concerns (Clifton, 2012). The primary ethical considerations in this study informed consent and privacy. They sought the permission of participants through an electronically mailed consent form. Only participants who voluntarily agreed to take part in the study were included. The questionnaire did not have any information that could be used to identify any respondent. Besides, the researcher never met the participants. So, the privacy of the subjects was also considered.

The Project Management Body of Knowledge (PMBoK) contains best practices for cost management. While the methodologies contained therein can be applied to many other types of projects, they lend themselves to practical application in aircraft leasing's redelivery process. Specifically, PMBoK makes recommendations for project management that can be adapted for the aircraft leasing redelivery process. For the present study, five methodologies are considered.

Earned Value Analysis

Earned Value Analysis (EVA) provides an overall perspective on scope, costs, and schedule, comparing the baseline with the actual values. For a project that takes a considerable amount of time, as leased aircraft redelivery, having a methodology that measures the real work performed on the project is useful. The IATA schedule often

reviews the scheduled reports to determine whether activities in a checklist have been completed.

However, with an EVA, the lessee would be better positioned to forecast the redelivery process's total costs and completion date. This would be based on the 'burn rate' of the project. This tool analyzes the Planned Value (P.V.), the Earned Value (E.V.), and the Actual Cost (A.C.).

The P.V. refers to the progress of a project at any given time in the schedule and cost estimate. It can be cumulative P.V. to mean the sum of the approved budget for the activities to date or current P.V. to indicate the approved budget for activities to be carried out during a particular period. The A.C. refers to the costs that are already incurred when implementing the project. Likewise, it can be cumulative A.C. meaning the sum for the actual expenditures to date or current to mean the sum of costs for activities carried out within a period. The E.V. refers to what has been accomplished in the project.

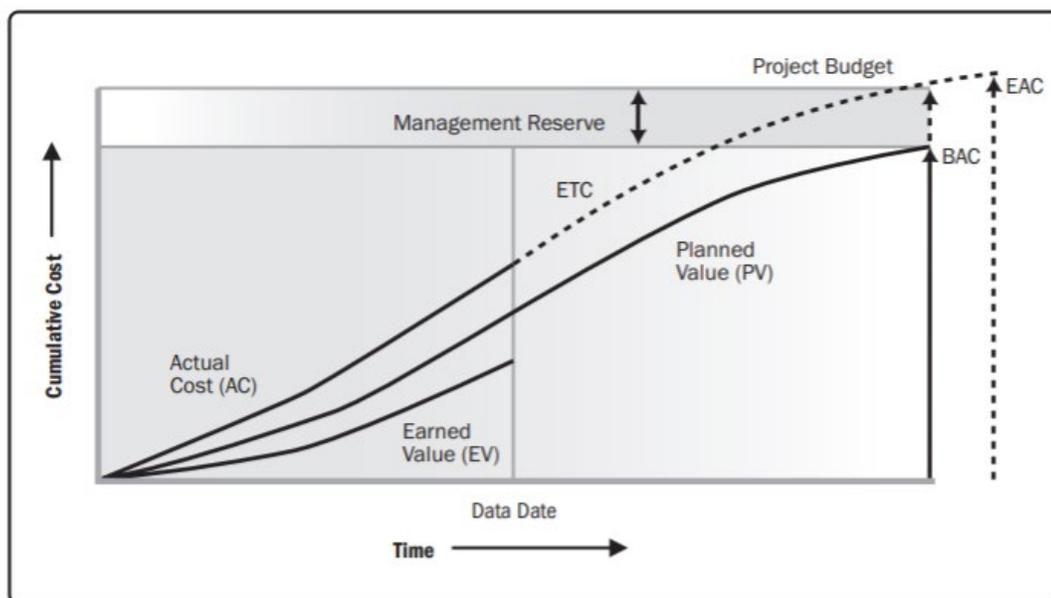


Figure 6. Earned Value, Planned Value, and Actual Costs sample diagram. PMBoK (2017)

The graphic performance report indicates the earned value, planned value, and the project's actual costs. As time progresses, the cumulative cost rises. Variance analyses can be carried out at any date, as discussed below.

Variance Analysis

Variance Analysis analyses the variances between planned and current performance. On cost controlling, the variance analysis is called Cost Variance (CV), and the equation defines it:

$$CV = EV - AC$$

CV = Cost Variance

EV = Earned Value

AC = Actual Cost

A Cost Performance Index can also be applied, and it is defined by the equation:

$$CPI = EV / AC$$

CPI = Cost Performance Index

EV = Earned Value

AC = Actual Cost

A CPI positive represents a cost underrun of performance to data, as a negative represents an overrun. Good cost performance in a project can be achieved as a result of several factors. In the aircraft redelivery process, there may be efficiencies realized in the inspections, which bring about cost savings. The cost of labor involved in the reviews and repairs and the cost of material for the replacements may fluctuate favorably. Also, the redelivery process's overall work may be less problematic than anticipated, especially if

there are proper planning and collaboration from all stakeholders involved. On the other hand, the costs may be unfavorable due to scope creep, whereby a lack of clarity on the work involved escalates into more activities over the redelivery period. In cases where there are misunderstandings between the parties, there may be a need for a rework while the lessors may offer review comments which require extensive changes in the project.

Trend Analysis

Trend Analysis is commonly used to forecast future performance based on past results. The information collected in this research can be used for predictions and preventive actions as needed. Forecasting cost tooling can be used to estimate the cost at completion based on a point in time cost expenditure and is defined by the equation:

$$EAC=BAC/CPI$$

EAC = Estimated At Completion

BAC = Budget At Completion

CPI = Cost Performance Index

Once the schedule is determined and an impacting factor on the project, the following equation can be used to forecast cost:

$$EAC=AC+[(BAC-EV)/(CPI \times SPI)]$$

EAC = Estimated At Completion

AC= Actual Cost

BAC = Budget At Completion

EV = Earned Value

CPI = Cost Performance Index

SPI = Schedule Performance Index.

Which is represented by the Equation $SPI=EV/PV$

EV=Earned Value

PV=Planned Value

Reserve Analysis

Reserve Analysis is used as a management tool for project reserves (Management and Contingency), if any. This analysis will define if the reserve is still needed or used. Here may be cost overruns in implementing a project, and the buffers are placed so that the project's progress is not curtailed. It is usual for the redelivery process to be full of delays owing to the number of people involved. While there are deadlines, the fact that the stakeholders are drawn from different organizations with different cultures means there are likely to be delayed. Reserve analysis helps to evaluate what is appropriate for the unforeseen work in the scope of the project.

To-Complete Performance Index

TCPI is an index that states the necessary costs need to achieve project goals with the resources available. That is defined in the equation:

$$(BAC-EV)/(BAC-AC)$$

BAC = Budget At Completion

EV = Earned Value

AC = Actual Cost

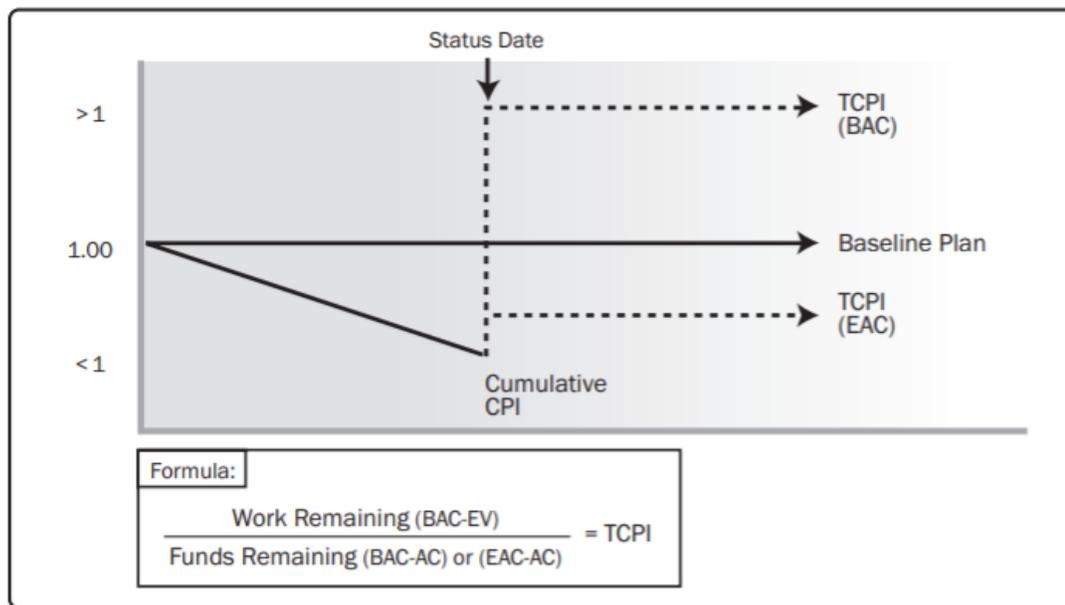


Figure 7. Complete Performance Index sample diagram. PMBoK (2017)

The graph shows the TCPI with its formula. The project leader should determine if the BAC is still viable for the period. If it is not, the next step is to consider the forecasted EAC. The EAC can replace the BAC in the calculation of the index. From the graph, if the cumulative CPI is below the baseline, the project should be maintained in the BAC range.

Experimental Design

The proposal is to establish a roadmap for closing the gap between the two primary aircraft leasing methodologies: IATA guidelines and PMBoK project management recommendations. The aircraft redelivery process is costly for the lessees, and examining the two methods is meant to establish cost savings that can be made. An experimental research design is useful for the aircraft leasing redelivery process due to three factors.

The first is that time establishes a connection between cause and effect.

The second is that their invariable behavior is experienced between cause and effect. The third is that the researcher seeks to understand the importance of the cause and effect.

Chapter IV - Outcomes

This chapter describes additional research and the online survey results regarding aircraft leasing and life cycle costs' management methodology. Afterward, the study is a road map for closing the gap between strategy and results. The study made significant findings that can inform the best way to reduce the life cycle costs.

One of the main drivers of high redelivery costs was the delays in the process leading to lateness. The lateness itself was driven by factors as follows:

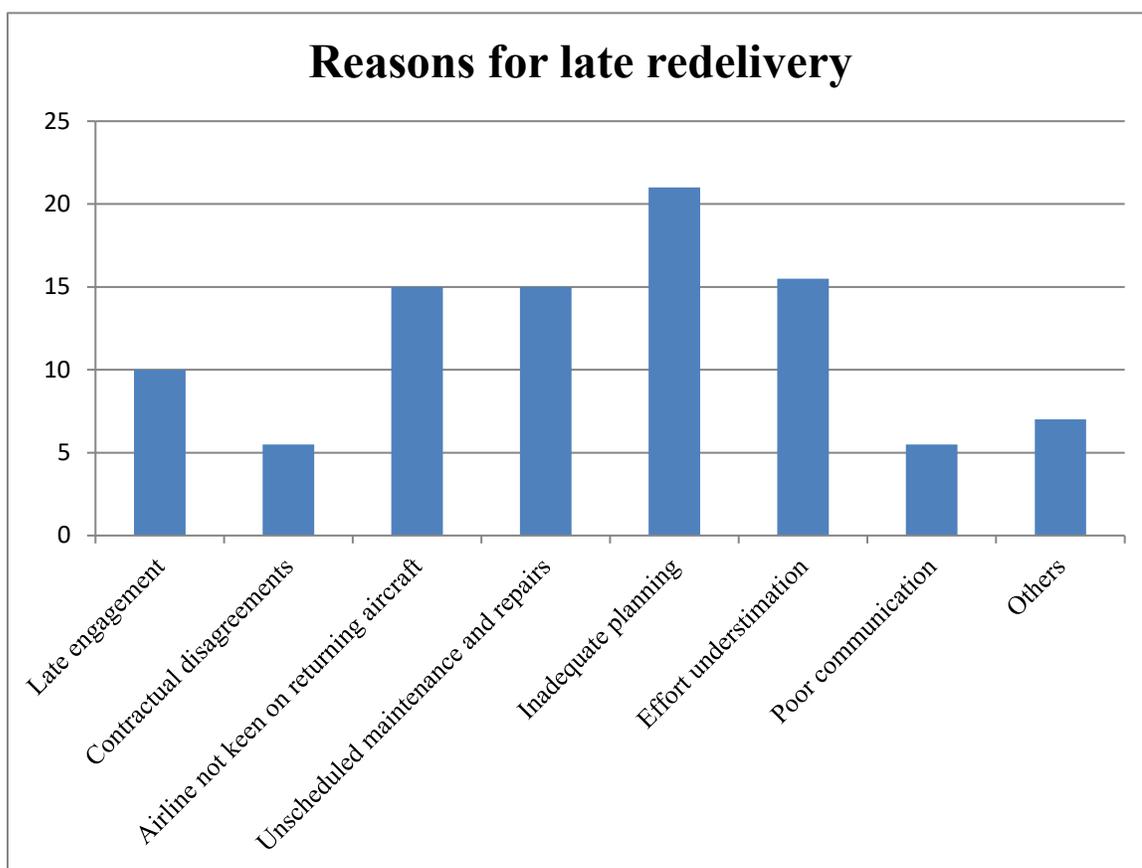


Figure 8. Reasons for late redelivery

The figure above shows that the main reason for the late redelivery is inadequate planning. This is accompanied by other factors, including underestimating the efforts involved, poor communication leading to poor coordination, and late engagement. As a

result, the process of redelivery may get started on the wrong note leading to delays and an increase in costs (Kosenina, 2013). The process of redelivery is complex and requires time. Ideally, it takes about two years for the process to be completed. However, this is a period that could be used in other productive ways by the lessee. This leads to a tendency to overlook things resulting in late engagement (Jimenez, 2017). The lack of planning may also lead to poor communication, which means that the various stakeholders fail to understand their responsibilities and deliver their work (Bolat & Eldemir, 2017).

It is also important to note that some airlines contribute to the delays since they focus on extracting the most value out of their leases as they can. The airlines will be more focused on flying the aircraft since they deem it profitable and neglect to start the redelivery process (Spreen, 2016). This can be attributed to the fact that the process takes about two years, a period during which the aircraft is likely to be grounded and therefore cost the airline direct expenses and opportunity costs (Van Antwerpen & Erni, 2012). Other factors contributing to delays include disagreements over contracts, which mean that the parties may engage in a period of back and forth before arriving at a consensus regarding the contract.

The life cycle costs are also attributable to the amount of work it takes to make the aircraft fit for redelivery (Yang & Bardell, 2017). The study established the following areas as having the most impact on the redelivery timelines and budgets:

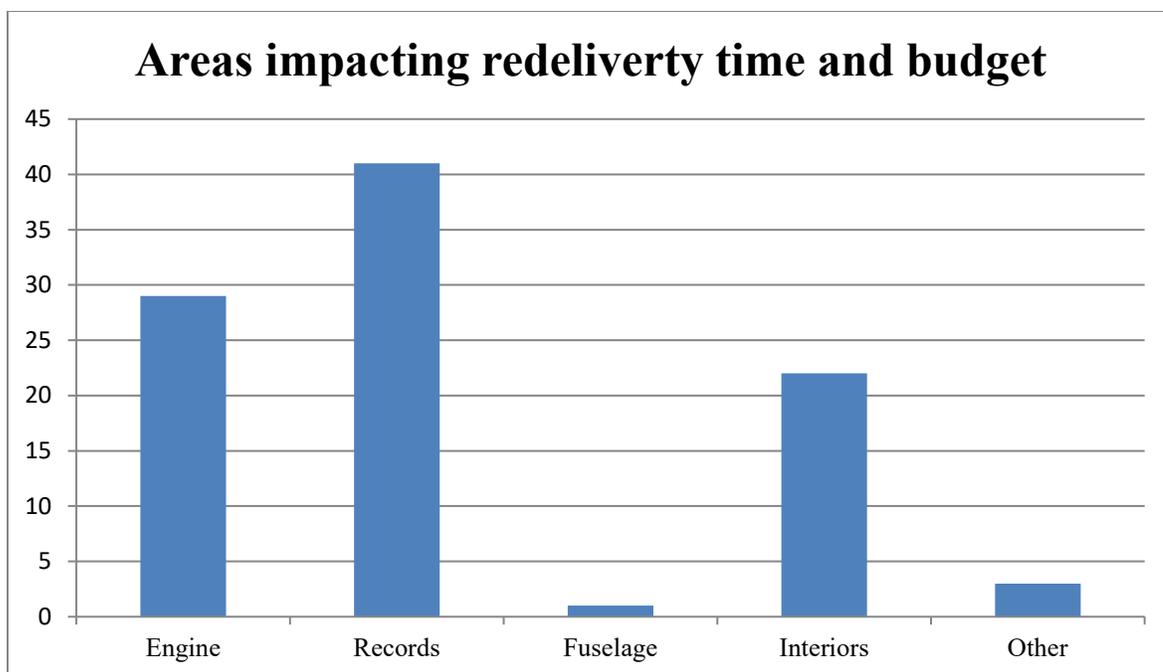


Figure 9. Factors impacting redelivery timelines and budget

The figure shows that records are the single largest factor in the redelivery costs and budgets. Lessees and lessors face a challenge in maintaining certification records during the redelivery process (Ackert, 2014). One of the reasons for these challenges is the complexity of documenting every change that occurs within the aircraft. In most cases, an airline has a large fleet of aircraft it is maintaining (Vasigh, Taleghani & Jenkins, 2012). Thus, it may be time-consuming to maintain detailed records for each aircraft within the fleet. The same applies to the lessor since they deal with different airlines; it is challenging to maintain updated records regarding each aircraft leased to other airlines (Hinsch, 2018). The fact that the airlines adopt different methodologies regarding the maintenance of records complicates the matter further.

The interiors and furnishing of an aircraft impact the redelivery process because changes occur (Ackert, 2014). For instance, when an airline adds a new aircraft line to its fleet, it may need to refresh its cabin to streamline the brand image. The older planes may

be stripped of their interiors and furnishing, replaced with new ones (Vasigh, Taleghani & Jenkins, 2012). These updates may cause the lessor problems, especially regarding the materials and manner the renovations are made. The lessor may claim that the previous furnishings had the necessary certifications and approvals while the new ones do not (Burhani, Verhagen & Curran, 2016). As such, to avoid contractual disputes, the lessee should contact the lessor before renovations are made. Some contracts have specific conditions on how renovations can be made.

The engine poses a challenge since it is a moving part subject to wear and tear. There may be conditions for OEM parts in the repairs specified by the aircraft lessor (Whaley & McJohn, 2019). The lessee has to ensure that these recommendations are followed to avoid contractual disputes. The engine can be looked at as a standalone aspect of increasing the redelivery process (Hanley, 2017). The study established the following findings regarding the most challenging aspects of the engine's redelivery process.

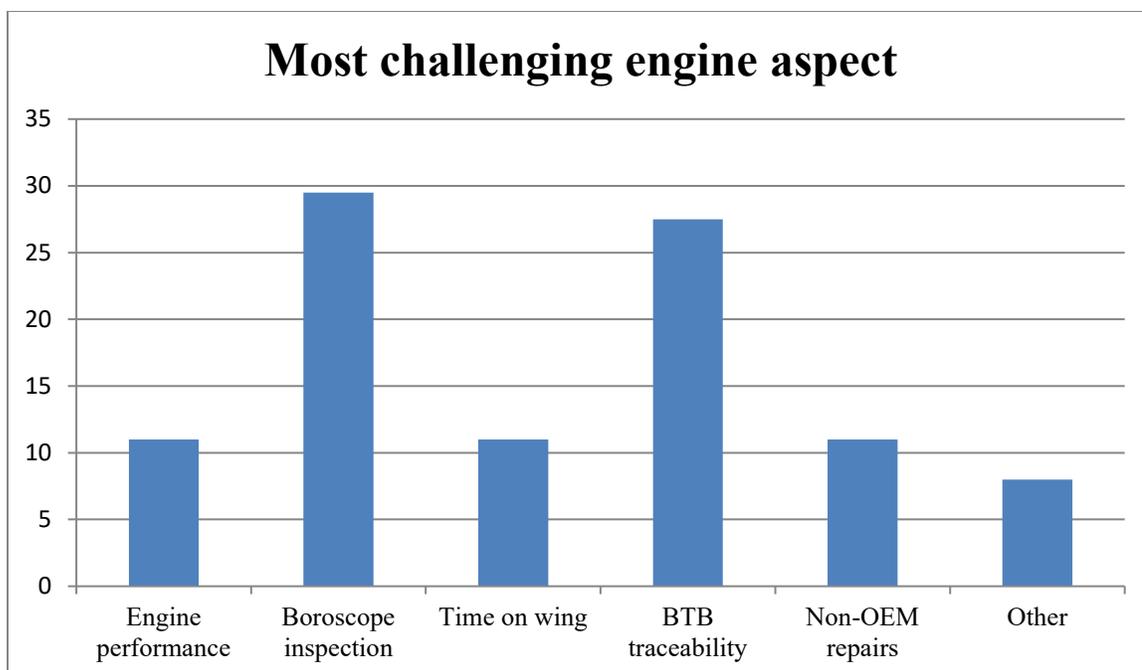


Figure 10. Most challenging engine aspects

The figure shows that borescope inspection and BTB traceability are the main challenges with engines. Borescopes are essential for inspecting the engine, and the parts that are used for repairs need to be traced to ensure their quality (Whaley & McJohn, 2019). Other factors include the engine's performance, the wing's time, and the non-OEM repairs. These aspects must be covered during the redelivery process, which means that the engine may cause complexity to the overall process.

The survey results demonstrate that 98% (ninety-eight) of the respondents were Lessees. In comparison, 89.6% (eighty-nine point six) of the respondents have 25-100 (twenty-five to one hundred) aircrafts under a lease contract, and 67.2% (sixty-seven points two) of the respondents are from Maintenance, Engineering or Airworthiness departments.

77.6% (seventy-seven point six) responded that the costs of aircraft leasing represent 10%-20% (ten to twenty) of the total company's costs. 46.6% (forty-six point

six) responded that redelivery process difficulties are somehow unexpected, while 44.8% (forty-four point eight) responded that it is considered somehow expected. 51.7% (fifty-one point seven) indicates that unanticipated costs and unexpected maintenance events occur during redelivery happens from time to time (between 15% (fifteen) and less than 30% (thirty) of the time). 67.2% (sixty-seven points two) indicates that an implemented process that defines what must be done by most areas before or during redelivery exists in their company. 89.7% (eighty-nine point seven) responded that Maintenance / Engineering / Airworthiness are responsible for the redelivery process management.

86.2% (eighty-six point two) demonstrated that their current company uses a methodology for monitoring and controlling the life cycle cost of the leasing contracts. In comparison, 75.9% (seventy-five point nine) stated using other methodologies rather than PMBoK or IATA. 60.3% (sixty-point three) indicated that Finance/contracts departments manage the aircraft life cycle costs. 81.0% (eighty-one) considered it as really important to controlling life cycle costs. In comparison, 98.3% (ninety-eight point three) believed that their fleet's monitoring and control process could be improved in any way.

Overall, the survey indicated that aircraft leasing costs are relevant to the company costs; some kind (other than PMBoK or IATA) of life cycle cost is done by the respondent companies, while improvements could be made.

The findings can be discussed from the perspective of the IATA and PMBoK methodologies. Both of these methodologies are developed to guide complex projects such as aircraft redelivery. However, IATA has an edge since its guidelines are crafted explicitly

for addressing the aircraft leasing process (van Antwerpen & Erni, 2012). The PMBoK methodologies are adopted from general guidelines on project management.

The gap between methodology and strategy can be closed by having the lessor take a more proactive role. Both IATA and PMBoK strategies tend to focus on the lessee's responsibilities regarding the redelivery process (Burhani, Verhagen & Curran, 2016). However, the lessor needs to focus on maintaining good customer relations. Likely, the end of a lease does not amount to the end of the business relationship between the two parties (Whaley & McJohn, 2019). Therefore, the leasing company can have some degree of flexibility regarding the conditions for the redelivery.

In summary, the survey findings indicate a need to close the gap between the methodologies proposed by both IATA and the PMBoK. Doing this would necessitate a change of strategy in how the aircraft redelivery process is viewed by both the lessor and the lessee (Burhani, Verhagen & Curran, 2016). Some of the main issues that cause problems in the redelivery process and drive up costs include late engagement and unscheduled work. These need to be addressed to lower the life cycle costs in the aircraft redelivery process.

Chapter V – Conclusions and Recommendations

Aircraft leases are standard for airlines seeking to have planes for commercial use but do not wish to purchase them outright. Leasing is a preferable method for many airlines since they can control the type of aircraft they have at a particular time and not have to worry about having to dispose of old planes as they become technologically obsolete.

The lease agreements governing the lessee and lessor relationships are usually complex due to the subject matter's sensitivity.

Aircraft are some of the most regulated machinery with a special focus on safety. Thus, there is a need for any change of hands in an aircraft's operation to be managed appropriately. As such, the International Air Transport Association (IATA) and the Project Management Body of Knowledge (PMBok) have guidelines to manage the process. IATA has a set of procedures that need to be carried out sequentially. The association estimates that the redelivery process is likely to take about 24 (twenty-four) months, anyway. As observed during the present study, it is required that the lessee understands properly all conditions required for aircraft redelivery even before to have an aircraft lease agreement signed with a lessor to adequately address its obligations during all the contract terms and monetize it. The PMBoK provides general guidelines on project management that can be adapted for the aircraft redelivery process. It offers several measures to evaluate performance progress to ensure that everything is going according to plan.

Nevertheless, despite the availability of these guidelines and procedures, the aircraft redelivery process is still costly. The lessees see a long period during which the aircraft is grounded and thereby not generating revenues for the company. The lessors also have to contend with a long time trying to get the lessee's contractual obligations fulfilled.

There is a need to close the gap between the methodologies offered and a strategy to reduce costs. This study found that several factors contribute to the rise in the redelivery process's life cycle costs. From these factors, the following recommendations can be made:

1. Scrutiny of Lease Return Conditions

There seems to be a challenge with how both parties understand the lease return conditions. The lessee may be in a hurry to get an aircraft into its service to embark on commercial activities (Yang & Bardell, 2017). The lessor may also impose exceedingly harsh or challenging conditions for the lessee to achieve successfully (Bolat & Eldemir, 2017). Thus, there needs to be closer scrutiny of the lease conditions before starting a leasing contract relationship. Before having it signed, it is highly recommended to have commercial, legal, and technical revisions approvals before moving forward.

There is a tradeoff between the commercial conditions negotiation and the redelivery requirements. This tradeoff leads to a very tough decision to be made by the company board since a low ownership cost represented by low monthly fees may be offset with prohibitive engine redelivery requirements, just like when lessors include a clause asking for engines to be returned as fresh from a performance restoration shop visit and new life-limited parts.

The scrutiny helps identify any potential issues in the contract and ensure that the parties are on the same page regarding redelivery requirements.

Also, in terms of life cycle cost management, some significant components, just like Engines, APU, and Landing Gears, may be covered by long-term maintenance agreements with OEM or Third Parties. Many cases do not cover services and removals to

fulfill redelivery requirements, leading to additional Shop Visit events with a long turnaround time and quite expensive, impacting the aircraft redelivery processes. Therefore it is recommended to take into consideration maintenance agreements requirements to mitigate potential financial impacts.

It is recommended that a leasing and redelivery terms meeting happens before the contract signatures rollouts. This should be held by the Leasing contract manager along with the MRO, Redelivery manager. The legal team is also recommended to participate in this event. The meeting topics should go from financial to technical aspects of the leasing life cycle and redelivery event. The result and agreements should be collected and formalized on a meeting minute, documented, and cross-checked with the final contract terms.

2. Pre-emptive Maintenance Check Schedules

The unscheduled maintenance checks have significantly impacted the redelivery project's delays for both airframe and principal components. It is recommended that the aircraft maintenance check interval for redelivery purposes matches a multiple of the aircraft manufacturer maintenance planning document recommendation. Otherwise, the lessee will need to incur additional cost and downtime for further checks and increase the aircraft lifecycle cost.

On engines and APUs, carrying out pre-emptive maintenance checks reduces the rate of borescope failures (Bolat & Eldemir, 2017), for instance. These pre-emptive checks mean that there are opportunities where the engines can be taken off the wing and stored

till the aircraft is ready for redelivery. However, the airline must have access to other engines during this period.

Make sure that the scope of all maintenance major maintenance events, including but not limited to heavy checks, shop Visits, AD/SB accomplishment, will not consider only the requirements for the next run but also the redelivery conditions since the operator can have the benefit of a new SB during our operation instead to perform it during redelivery.

Establishing a life cycle maintenance check matrix and schedule would facilitate mapping out mandatory checks to comply with the redelivery obligations. MRO and Redelivery Manager would conduct checkpoint/milestone meetings to revise contract obligations and revisit the life cycle maintenance schedule. A quarterly meeting is suggested to address this subject.

3. Pre-delivery Inspections and Audits

The airlines should carry out pre-delivery inspections and audits to identify any discrepancies that exist. These discrepancies are usually a significant factor in the redelivery costs. The audits ensure that any issues that could affect the lease return conditions are dealt with early on (Yang & Bardell, 2017). With the audits in place, the airlines are more inclined to start the engagement process early since they know it will proceed smoothly and result in lower downtime for the aircraft.

The development of a checklist based on redelivery contract terms is an indicated tool to support this recommendation. This can and should be signed off by the MRO Manager, the leasing contract manager, and the redelivery manager.

4. Efficient Management of Records

Records need to be kept efficiently for the lease return to proceed smoothly. There is a challenge in the efficient management of records and documents for both the airlines and the lessors. One of the ways to go about this is digitizing records. There has been an advance in technology that allows for the digitization of records to make them more accessible to users and to increase their security in terms of storage. With digital records, the problems of incomplete or missing maintenance records would be eliminated (Scheinberg, 2017). In this way, the costs associated with these improper records would be lowered and ensure that the redelivery process was smooth. Digitizing records would also move the aviation industry from paper to a paperless environment in line with other industries taking a similar approach. Another essential requirement is to properly track and map aircraft structural repairs and modifications, including but not limited to A.D. requirements, which may become mandatory during lease terms.

The recommendation is to develop a Document Log and a Document Control Index. A document control team must manage both log and index that would update weekly and audit it quarterly. A Project Management Information System (PMIS) could provide more digital documentation and information management. PMBoK, PMIS provides access to IT tools as scheduling software, log changes, and update authorization systems, information collection, and distribution systems. This also provides online interfaces with corporate knowledge base repositories (PMBoK 2017).

5. Life Cycle Cost Management

As shown over this study, life cycle cost management is an important instrument for a long-term outlook over investments. As aircrafts are the most expensive asset for airline companies, tight cost control is key to maintaining business success.

As a recommendation, the EVA usage (Earned Value Analysis) as a tool for cost monitoring and control would benefit and support decision making along the aircraft life cycle. Having a baseline of investments and expenditures facilitate its monitoring and mitigation or remediation of deviations. EVA is described in Chapter III – Methodology.

Key Lessons Learned

During this study, the key lessons learned are that aircraft leasing processes are complex, and this complexity is mainly contributed by the lack of due diligence by the parties involved. While there are guidelines such as IATA and PMBoK, their implementation largely depends on organizations' people involved and knowledge.

We figure out that the aircraft lifecycle can be compared with a project in the sense of an integrated cycle, and you cannot just deal with it as separated things. Therefore it is highly recommended to consider it as a project where the delivery is the initiation, the operation is the execution, and the redelivery is the closure.

Decisions made during the contract negotiations will certainly cause noise during the aircraft's operation and requires a lot of actions to avoid problems during redelivery.

If there is no willingness by either of the parties to follow the guidelines, the redelivery life cycle costs potentially generate a high impact on the company.

Future Studies

As part of the present study, we found many opportunities to make improvements on an aircraft lifecycle cost management that can certainly be helpful for all parties involved in the industry, including but not limited to lessors, lessees, OEMs, and MROs. Therefore we would recommend that the following subjects be explored in future related studies:

- a) Challenges faced by lessors and lessees during transition periods;
- b) Engine lifecycle cost management with OEM support for lessor and lessee;
- c) Requirements for an MRO during aircraft redelivery processes;
- d) Impacts of COVID-19 crisis in aircraft redelivery and repossession processes;
- e) Comprehensive survey dedicated to aircraft redelivery.

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Appendix A – The Survey’s Transcription

Survey’s introduction:

“As a valuable aviation professional your impression and opinion are extremely important to the following study, thus you are kindly asked to complete the brief survey below:

Aircraft Leasing and Life Cycle Cost Management Survey

Embry-Riddle Aeronautical University Capstone Questionary

Researchers at Embry-Riddle Aeronautical University are conducting a study on Aircraft Leasing and Life Cycle Cost Management to support airlines, lessors, and others.

During this study, you are asked to complete a brief on-line survey to measure aircraft leasing life cycle cost management.

The completion of the survey will take approximately 5 minutes. Your participation is voluntary and confidentially will be maintained. If you do not want to participate at any time, please close your browser to exit the survey.”

Survey’s transcription:

1. Would you identify your organization as a:
 - Lessor;
 - Lessee;
 - Maintenance, Repair and Overhaul Company (MRO)
 - OEM
 - Other

2. How many aircraft would you say your organization has under leasing contract (either leased to you or leased by you to a third party)? 0-25

- a. 25-50
 - b. 50-100
 - c. More than 100
 - d. I work for an MRO
 - e. I work for an OEM
3. Which options best describes your department:
- a. Operations
 - b. Maintenance / Engineering/ Airworthiness
 - c. Supply Chain / Procurement
 - d. Finance / Contracts
 - e. Other

Leasing Costs

4. What would you say is the representativeness (percentage-wise) of the aircraft leasing costs in the entire company's cost?
- < 1%
 - Between 1% and 10%
 - Between 10% and 20%
 - Between 20% and 30%
 - Above 30%
5. Would you classify your Redelivery Process Difficulties:
- Expected
 - Somehow expected
 - Expected

- Somehow unexpected
 - Unexpected
6. How often (percentage-wise) would you say your organization incurs unanticipated costs during redelivery?
- Pretty often (above 50% of the time)
 - Every other redelivery we go through (50% of the time)
 - It is not unusual (between 30% and 50% of the time)
 - It happens from time to time (between 15% and 30% of the time)
 - It has happened before (less than 15% of the time)
7. How often (percentage-wise) would you say unexpected maintenance events occur during a redelivery process, causing the postponement of deadlines and/or unanticipated monetary expenditure?
- Pretty often (above 50% of the time)
 - Every other redelivery we go through (50% of the time)
 - It is not unusual (between 30% and 50% of the time)
 - It happens from time to time (between 15% and 30% of the time)
 - It has happened before (less than 15% of the time)
8. Is there an implemented process at your organization that defines what must be done by most areas before or during redelivery?
- No
 - Yes, and it starts 6 months before the redelivery process
 - Yes, and it starts 12 months before the redelivery process
 - Yes, and it starts 24 months before the redelivery process

- Yes, and it starts 24 months before the redelivery process
9. Which department manages the Redelivery Process at your company:
- a. Operations
 - b. Maintenance / Engineering/ Airworthiness
 - c. Supply Chain / Procurement
 - d. Finance / Contracts
 - e. Other
 - f. None

Life-Cycle Cost Management:

10. Does the company currently use any methodology to monitor and control current leasing contracts' life cycle cost?
- Yes
 - No
11. If the question above was yes, what methodology/tools are being used?
- Not applicable
 - IATA Methodology
 - PMBOK Methodology / Project Management Office
 - Other:
12. Which department manages the Aircraft Life Cycle cost at your company:
- a. Operations
 - b. Maintenance / Engineering/ Airworthiness
 - c. Supply Chain / Procurement
 - d. Finance / Contracts

e. Other

f. None

13. From 1-10, what is the importance of controlling the cost of the leasing life cycle for your company?

1

2

3

4

5

14. Do you believe that your fleet's monitoring and control process could be improved in any way or by using any management tool?

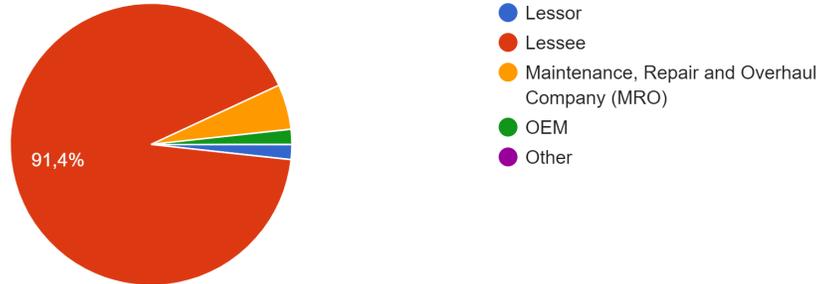
Yes

No

Appendix B – Survey Findings

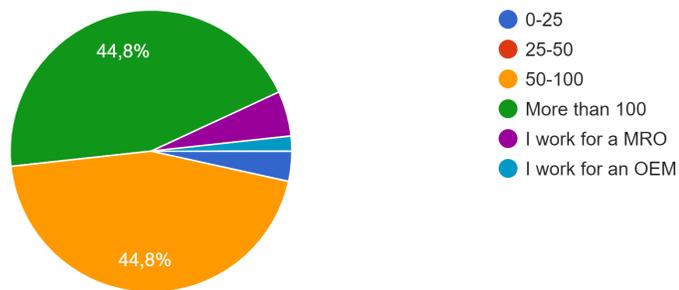
1. Would you identify your organization as a:

58 respostas



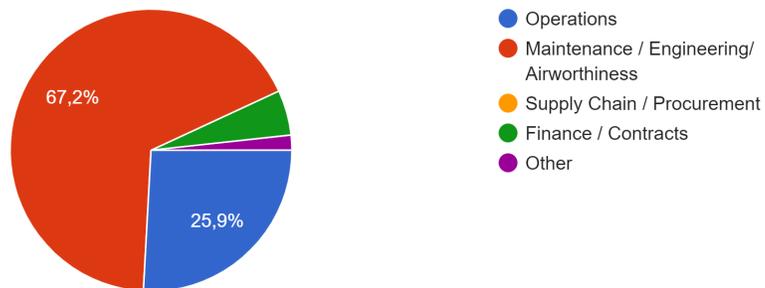
2. How many aircraft would you say your organization has under leasing contract (either being leased to you, or leased by you to a third party)?

58 respostas



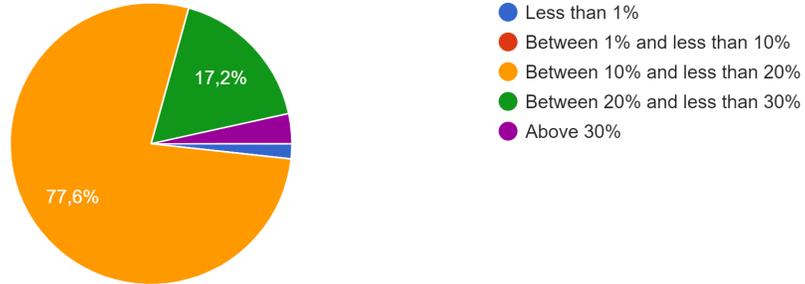
3. Which options best describes your department?

58 respostas



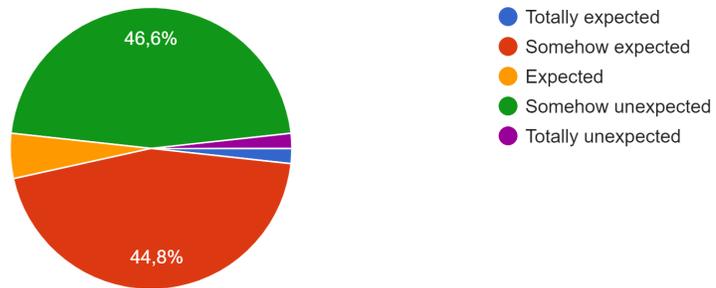
4. What would you say is the representativeness (percentage-wise) of the aircraft leasing costs in the total company's cost?

58 respostas



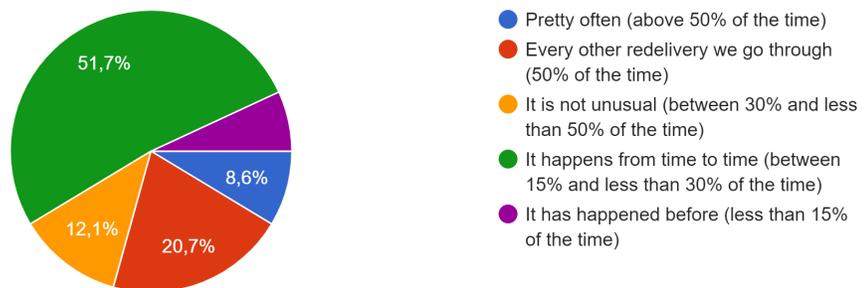
5. Would you classify your Redelivery Process Difficulties?

58 respostas



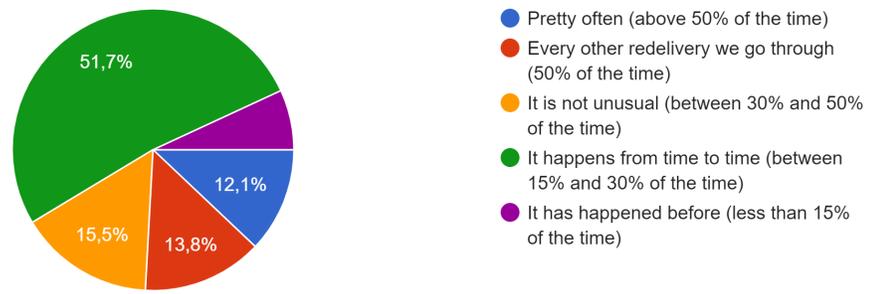
6. How often (percentage-wise) would you say your organization incurs unanticipated costs during redelivery?

58 respostas



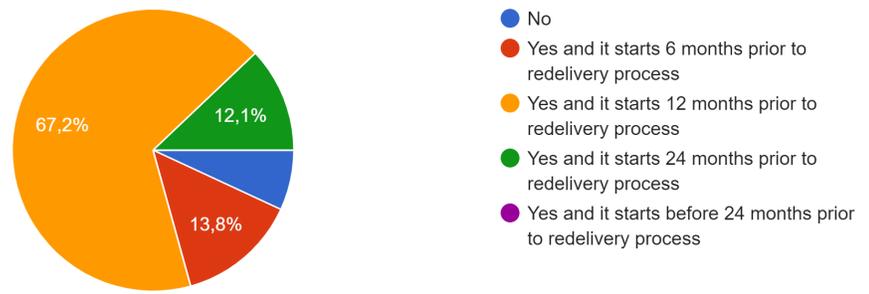
7. How often (percentage-wise) would you say unexpected maintenance events occur during a redelivery process causing the postponement of d...lines and/or unanticipated monetary expenditure?

58 respostas



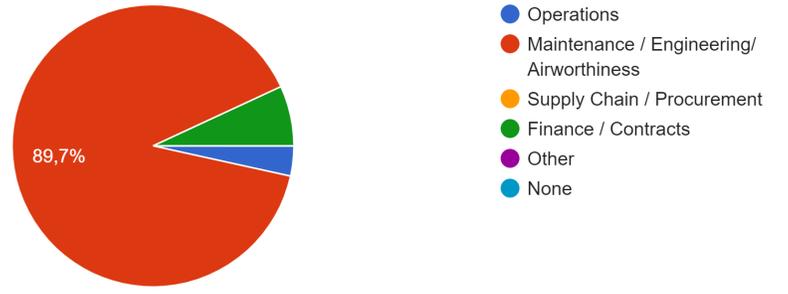
8. Is there an implemented process at your organization that defines what must be done by most of the areas prior to or during redelivery?

58 respostas



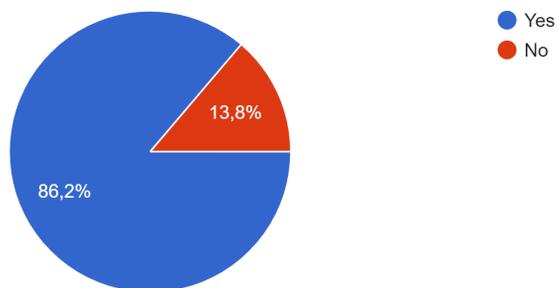
9. Which department manages the Redelivery Process at your company?

58 respostas



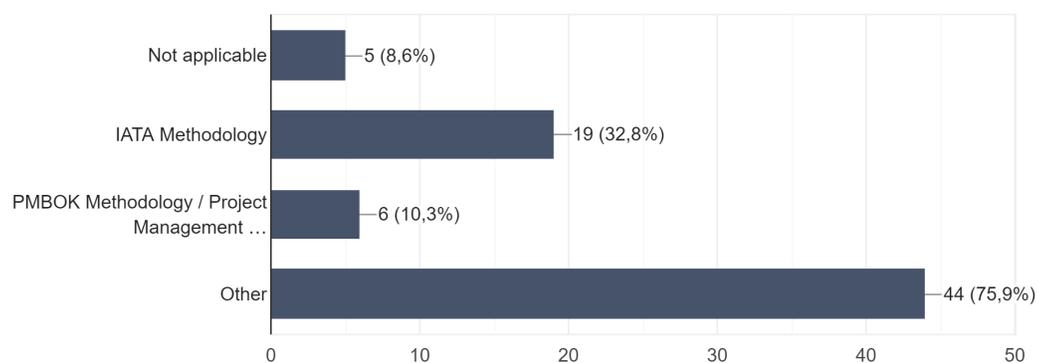
10. Does the company currently use any methodology for monitoring and controlling the life cycle cost of current leasing contracts?

58 respostas



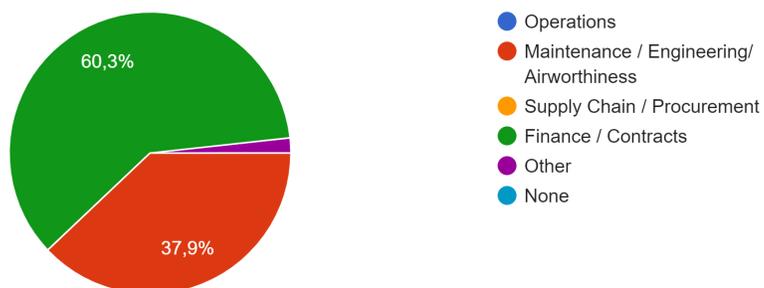
11. If the question above was yes, what methodology/tools are being used?

58 respostas



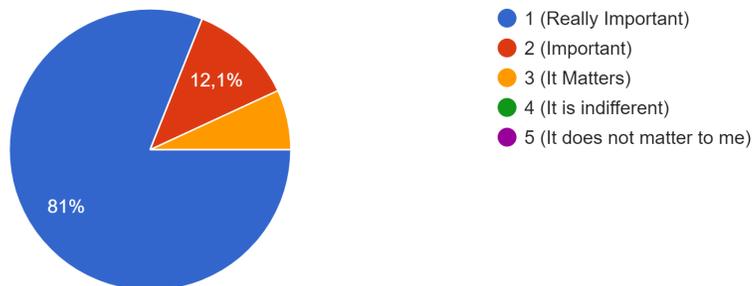
12. Which department manages the Aircraft Life Cycle cost at your company?

58 respostas



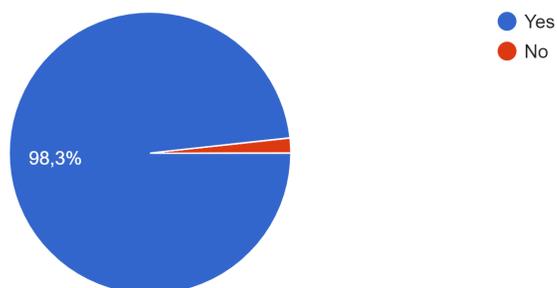
13. From 1-5 what is the importance of controlling the cost of the leasing life cycle for your company?

58 respostas



14. Do you believe that the monitoring and control process of your fleet could be improved in any way or by using any management tool?

58 respostas



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