Indirect economic drivers for end-of-life handling in the aviation sector

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Abstract
An important issue that is getting increasing attention in the aviation sector is the handling of end-of-life aircraft. Traditionally, retired aircraft are parked in the desert waiting for a buyer, but more attractive options are available. There is some literature on direct economic factors influencing end-of-life decisions, but little is known about the indirect economic factors and on corporate social responsibility (CSR) factors. In this research we explore the impact of indirect economic factors, such as consumer trust, reliability, reputation and entrepreneurship, on the handling of end-of-life aircraft.

Keywords: Indirect economic drivers, Aviation Sector, End-of-life phase

Introduction
The fleet of commercial aircraft is growing fast. It is expected that in twenty years time the global fleet will have doubled (Richardson, 2008). The increasing amount of aircraft will eventually mean an increasing amount of retired aircraft that needs to be dealt with in the near future. But already now, driven by economics and societal pressures, many aircraft are about to be replaced by new models that are more cost and fuel efficient, contributing to the total amount of soon to retire aircraft. The aviation sector is expected to become greener in all aspects of its life-cycle, and as of recent the focus of industry is also on the handling of aircraft at the end-of-life.

Traditionally, retired aircraft are parked in the desert waiting for a buyer. Currently, about 2300 commercial aircraft are parked (ASCEND, 2009), which comprises about 11% of the total fleet. Approximately 60% of all parked aircraft was parked for more than 2 years (Zitter, 2007), while after two years the aircraft’s probability of flying
again drops to only 5%. Apparently, the majority of the aircraft that is parked, will never be operational again.

The above numbers stress the importance of making a sound decision at the end-of-life of the airplane with respect to its final destiny. In fact, due to this notion several new companies have sprung up that specialize in the handling of end-of-life aircraft. Aircraft End-of-Life Solutions (AELS) is such a company: it “develops end-of-life strategies and executes the resulting solution for aircraft owners all over the world” (www.aels.nl).

AELS has developed a decision tool to advice aircraft owners on end-of-life, e.g. on whether, or not, to disassemble a specific aircraft and sell its components, or to sell the aircraft as a flyer (Zitter, 2007). The tool (End-of-Life Decision Tool, or EoLDT), is currently based only on direct economic drivers, like market developments, market value and costs. This is not odd as little is known about the role played by indirect economic drivers and corporate social responsibility (CSR) factors. The indirect economic drivers can be viewed as drivers that are not purely economic, but do influence the value of the company, such as consumer trust and reputation. CSR drivers relate to economical prosperity, social welfare and ecological quality (Tulder and Zwart, 2003). This research was set to investigate precisely how indirect economic and CSR factors influence end-of-life decisions in the aviation sector. Due to space limitations, we report here only on the results regarding the indirect economic factors. Regarding the relevant stakeholders, such as the original manufacturer, the airline and the consumer (Knudsen, 2004), we will focus on the perspective of the airline as currently they are the predominant decision-maker when their airplanes reach end-of-life.

**Business drivers for decision-making**

Here we describe our conceptual model regarding the factors that influence decision-making in business, i.e. the business drivers. Those can be considered either economic or non-economic (see Figure 1).

The economic drivers consist of market information, the market value of the aircraft and operational costs (Zitter, 2007). Non-economic drivers include corporate social responsibility factors such as economical prosperity, social welfare, and ecological quality (Tulder and Zwart, 2003) and legislation. The latter, however, is less relevant as specific end-of-life legislation does not yet exist for the aviation sector. We refer the interested reader to De Brito et al. (2007) as they look into recent developments regarding extended-producer responsibility in the aviation sector and possible scenarios for future legislation.

![Figure 1 – Business drivers](image-url)
In this paper we focus on the impacts of indirect economic drivers. We take the perspective of Tulder and Zwart (2003) and consider the factors consumer trust, reputation, reliability and entrepreneurship:

- **Consumer trust**: the level of trust that the consumers have in the company. **Reputation**: This is the opinion, or social evaluation, of the public towards an organization.

- **Reliability**: the ability of the company to maintain its functions both in routine, as well as in hostile or unexpected circumstances.

- **Entrepreneurship**: the practice of starting new activities/businesses in response to identified opportunities.

### Methodology

The research question deals with a broad and complex topic, for which at the time of research there was very little information available. In addition, we suspected that the contextual aspects of a given airline would prove important in deciding on when and how to decommission an airplane. In such situation case study research is an adequate research method (Du and Hak, 2007; Yin, 2002).

Initially we planned to execute only one in-depth case study, but given the market segmentation, we ultimately chose to select two cases: one airline operating a full service (mainly long-haul) at a high segment of the market, here called Air-X; the other operating at a low segment of the market (both regional and long-haul), here called Air-Y. Accordingly, Air-X has a much younger fleet than Air-Y. Actually, a decommissioned airplane from Air-X has recently been bought by Air-Y.

For both cases, we collected data through reviewing the literature (both academic and professional journals) and by browsing any public reports in the airlines’ websites, so a contextual view could be obtained. Additional data about Air-X was collected using the open interviews method, while the data from Air-Y, due to the distance between interviewer and interviewee, was obtained by a questionnaire. One of the objectives of the interview and questionnaire was to understand End-of-Life (EoL) handling by the airlines, particularly the decision making process. At Air-X we interviewed three directors by telephone: the Director of Aircraft & Engine Transaction (DAET), the Director of Aircraft & Engine Contracts (DAEC), and the Director of Corporate Social Responsibility (DCSR). At Air-Y, our contact person was the co-director, who consulted with the operations manager in filling the questionnaire.

### Table 1 – Data collection overview

<table>
<thead>
<tr>
<th>PART 0: General Literature Review</th>
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<tr>
<td>PART 1: Case Studies</td>
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<tr>
<td><strong>Air-X (interviews)</strong></td>
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<td>- High segment of the market;</td>
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<td>- Long-haul and regional (Europe)</td>
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<td>PART 2: Web-based Survey (triangulation and validation)</td>
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<tr>
<td><strong>Air-Z₁</strong></td>
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<td>- High segment of the market;</td>
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<td>(Europe)</td>
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<td>(Austrasia)</td>
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| PART 3: Workshop with academic and industry experts |

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On top of the two case studies, we triangulated the data collection with a small survey, and a workshop with experts from industry and academia. The survey was a web-designed questionnaire focusing on EoL handling and decision drivers (see appendix for a sample of it). It was sent to five airlines, covering different regions: Europe, Middle East, Asia and Austrasia. Three of the airlines answered the web-questionnaire. See Table 1 for an overview of the field data.

The Aviation Sector and the end-of-life decision
The Aviation Sector is expected to grow, but without sacrificing the environment (De Brito and Ward, 2008). Green taxes on flight tickets and offsetting Co2 emissions have become an integral part of the vocabulary of airlines and passengers in Europe. Actually, as from 2012, the European Emissions Trading system is expected to regulate all carriers using European airports (thus, including the non-European ones, Kanter, 2009).

In spite of the relative slowdown of the aviation sector in the context of the global economic crisis, passenger and cargo traffic are still growing. In 2008, passenger traffic grew 1.6% (coming from a 7.4% growth in 2007), and capacity grew 3.5% (ATW Daily News, 2009). According to Airbus’ predictions, aircraft numbers will grow from 14,980 (in 2006) to 33,000 in 2026, while 13,772 existing aircraft will be replaced for eco-efficient aircraft. A part of those will be transformed from passenger into freight aircraft, while others will be removed from operations. The high number of replacement of airplanes shows the importance of eco-efficiency for the sector, both from an environmental as from an economical point of view. In addition, the increasing amount of aircraft will eventually mean an increasing amount of retired aircraft in due time.

Recent EoL initiatives
Boeing and Airbus are well aware that to park an airplane and wait for a buyer might not be a financially wise decision. Both manufacturers recently started two independent initiatives on the dismantling of end-of-life airplanes for recovery.

Boeing introduced the Aircraft Fleet Recycling Association (AFRA), officially launched on the first of June 2006. AFRA is a cooperation developed by U.S. and European companies active in the disassembling, parts salvation and recycling of materials in the aviation industry. The AFRA group recently consists of 40 members (www.afraassociation.org) including Pratt&Whitney, Honeywell and Rolls&Royce Aerospace. AFRA’s aims at setting a standard and develop code of conducts for EoL procedures in the aviation industry.

The Airbus initiative TARMAC (Tarbes Advanced Repair & Maintenance Aircraft Company) started in March 2005 as the PAMELA (Process for Advanced Management of EoL Aircraft) initiative. It is roughly 50/50 funded by the industry and by the European Union environmental funds. TARMAC’s objective is to develop EoL handling procedures that act in accordance with the environmental, health and safety rules dictated by the European Aviation Safety Agency (EASA) standards. With this initiative Airbus takes the cradle-to-grave responsibility for their aircraft.

The main difference between these two projects is that Boeing does not intend to disassemble the aircraft themselves. They arranged the AFRA organization to recycle the aircraft. Airbus on the other hand plans to cover the whole process of EoL handling. Some authors (refs) have argued that these initiatives are also a form of anticipating potential extended responsibility legislation, similarly to the existing on the automobile sector (the Directive 2000/53/EC). For more information on Boeing and Airbus initiatives, please see De Brito et al., 2007.
Field research: results and analysis

Consumer trust
Both the Director of Aircraft & Engine Transaction (DAET) and the Director of Aircraft & Engine Contracts (DAEC) are peremptory in stating that in their view consumer trust does not have a direct influence in the EoL decisions at Air-X. However, they do agree that for Air-X it is important to have a relatively young fleet, so aircraft are generally sold when they reach the age of 20 years. Aircraft are still operational and safe at that age, therefore, according to DAEC and DAET, consumer (mis)trust is not an issue.

For Air-Y, however, consumer trust does have an influence on the EoL decision. They recently bought a second-hand aircraft from Air-X and took consumer trust into account in this decision. Air-Y prepared a full communication plan to their customers on this. The company was very careful in explaining to their customers that an aircraft that is younger than 20 years is still operational and safe. They also explained that the aircraft in question had gone through a special storage program followed by an extensive refurbishment program that had completely restored the aircraft into an as-good-as-new condition. Air-Y explained that they sell the aircraft as soon as it is no longer economical to operate it. Consumer trust is taken care of long before that time.

All three airlines of the online questionnaire agreed that, either directly or indirectly, consumer trust influences the EoL decision. The participants of the workshop viewed the influence of consumer trust as part of the reputation factor, and argued that it cannot be viewed as a self-sufficient and independent influencing factor.

Reliability
According to the DAET and DAEC reliability is not, a priori, important for the EoL decision at Air-X, since the aircraft are still very young and therefore reliable at the EoL moment. Reliability is important to Air-X, but not specific on the EoL decision moment, because it will never be an issue according to the DAET and DAEC. In fact it can be concluded that reliability influences the EoL moment. Given that Air-X wants to possess a young fleet of aircraft (so that the passenger will never have to doubt the reliability of Air-X), the EoL decision moment occurs at the mature operational phase of the aircraft but not at the end of its technical life.

Air-Y agrees that the factor reliability is important for the EoL decision. They in fact share the same opinion as Air-X, since they take the reliability in account when deciding if they should end the life of their aircraft. The difference is that Air-Y operates the aircraft as long as economically possible.

The airlines that participated in the questionnaire agree that reliability is important to EoL handling. The respondents of the workshop agree that reliability has an effect on EoL handling, but mentioned before, through reputation. In their opinion consumer trust and reliability are part of reputation, and also these two factors are interrelated. In any case, before the EoL decision is made it will be determined by the airlines how reliable the aircraft is and this, next to the trade-off between an old and new aircraft, will lead to the decision.

Reputation
At Air-X, as stated by DAET and DAEC, reputation influences the EoL decision. Air-X serves a high segment of the market and wants to be associated with comfort. Thus, the need to possess a young fleet is therefore strongly driven by image. After operating an aircraft for 20 years there are newer models on the market that provide more comfort. DAET and DAEC attested that the decision to buy a new aircraft and sell an “old”
aircraft depends on service, comfort, luxury and economical incentives (e.g. taking into account fuel-efficiency). The EoL decision is therefore based on a proper trade-off between the new and the old aircraft. Fuel efficiency can be seen both as an economic issue and a reputation related factor, given the current attention attributed to CO2 emissions by society.

Air-Y also agrees that the reputation of the company is an important factor in the EoL decision. They used the purchase of the Air-X’s second-hand aircraft as part of a communication plan promoting a sustainable image. Air-Y’s website explicitly mentions that by purchasing a second-hand aircraft the company avoids the waste of parking an airplane that is still operational. Air-Y wants their customers to know that extending the life of a perfectly OK airplane has benefits for the environment. Thus Air-Y’s EoL communication strategy has a strong reputational component.

The airlines that responded to the questionnaire also found reputation to be important for the EoL decision, as did the participants of the workshop. The latter however viewed consumer trust (and reliability) as part of reputation, and argued that these factors cannot be analyzed in dissociation.

**Entrepreneurship**

To the knowledge of DAEC and DAET, Air-X is in general a role model for the business. Air-X prefers to be an initiator instead of a follower. Nonetheless, EoL is still very much in its infancy, with the operational life of an aircraft having much more emphasis regarding environmental impact because of CO2 emission and noise pollution. This is the reason why Air-X does not focus on EoL handling. But DAEC and DAET, claim that if the public focus shifts towards EoL handling due to legislation or awareness, Air-X will focus on this as well and at that time they will be the initiator.

Air-Y believes that entrepreneurship is already influencing EoL handling. However, Air-Y answer had more to due with innovation, and not that much with entrepreneurship in the sense of sustaining disruptive business change. The same can be said about the airlines participating in the questionnaire. Only Air-Z thought entrepreneurship to have an influence on EoL by stating: “As an entrepreneur you always need to operate the most economic production platform which needs constant improvement”. Once again it seems that entrepreneurship is being confused with innovation alone.

We were more careful in defining entrepreneurship during the workshop, making a clear distinction with innovation. The participants of the workshop agree that entrepreneurship is not implemented yet, but they think it should be important for the EoL decision in the future, as it offers opportunities. For instance a strategy with short turnover times on new jets will facilitate the disposition of airplanes. This means that in due time the entrepreneurship character of the carrier can influence the EoL handling.

Based on the discussion above, we derive the following set of propositions.

**Proposition 1** - Consumer trust influences the EoL decision:

a) rather indirectly for carriers operating in the high market segment.
b) rather directly for carriers operating in the low market segment.

**Proposition 2** - Reliability influences the EoL decision for carriers:

a) rather indirectly for carriers operating in the high market segment.
b) rather directly for carriers operating in the low market segment.
Proposition 3: Reputation:

a) influences directly the EoL decision moment (for carriers in both the low and high segments).

b) is directly influenced by consumer trust and reliability.

Proposition 4: Entrepreneurship does not influence but will influence EOL decision.

Conclusions

We can conclude that factors such as consumer trust, reputation and reliability influence end-of-life handling, but the nature of this influence differs depending on the market the airline operates, namely whether it is a carrier operating in the high versus low market segments.

An airline that operates the higher segments of the market needs to possess a young fleet of aircraft. In general an airline that operates the higher market segment will decide to retire an aircraft for image-related and economic factors and not so much because of pure operational issues. An airline that operates the lower segments is more likely to retire an aircraft from its flying fleet when the aircraft effectively reached the end of its operational life.

Evidence from this research does not allow concluding that entrepreneurship (indirect-economic factor) influence the decision at the end-of-life. We propose though that in the near future, the entrepreneurship’s character of the carrier will influence EOL handling because airlines are aware of the opportunities this factor brings. This is illustrated by the recent business initiatives regarding EoL in the sector, in particular AFRA and TARMAC, lead respectively by Boeing and Airbus, as explained previously.

This paper has both implications for both theory and practice. There is very little known on aircraft disposal and even less on how indirect economic factors influence this decision. With this paper we make a step in enriching this knowledge. In addition, the methodology can be employed to carry out research about companies or sectors in the incubatory phase of product recovery at end-of-life. In practice, stakeholders can win insights on the motivations of different airlines, as this study brings transparency on the potential influence of soft factors on the end-of-life handling.

We would like however to stress that this paper dealt with a subject which lacked so far both empirical and theoretical research, and therefore it has an exploratory character only. Further research on the exact details of the influence on the EoL decision (as proposed in the three propositions) is desirable. Furthermore, those propositions call for formal testing with wider data.

In addition there are multiple parties involved: manufacturers, airlines, lesors, secondary buyers, regulators, and so on. A line of useful research that can be taken is mapping the indirect economic factors linked to each of these stakeholders. In particular, and regarding regulation it would be interesting to know more on the role that the public sector may have in promoting (or retarding) end-of-life recovery. On this, the research set by De Brito et al. (2007) can be a good departing point. The authors look into the lessons to be learned by the aviation sector from the evolution and state of extended producer responsibility regulations in the automotive and ship industries.
Acknowledgements

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Appendix. Sample of the questionnaire sent to the airlines.

**Entrepreneurship:** The practice of starting new activities/businesses in response to identified opportunities.

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<thead>
<tr>
<th>Question</th>
<th>Options</th>
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<tbody>
<tr>
<td>23.</td>
<td>How important is 'entrepreneurship' for you as an airline?</td>
</tr>
<tr>
<td>24.</td>
<td>Do you take 'entrepreneurship' in account when deciding what to do at the end-of-life of your aircraft?</td>
</tr>
<tr>
<td>25.</td>
<td>If your answer to the previous question is &quot;yes&quot; or &quot;sometimes&quot;, can you describe how 'entrepreneurship' influences the end-of-life decision process?</td>
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<tr>
<td>26.</td>
<td>How influential do you consider media attention regarding end-of-life management on 'entrepreneurship'?</td>
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