CHARACTERIZATION AND RANKING OF BUSINESS AVIATION PRODUCT ATTRIBUTES

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ABSTRACT

The research study aims to characterize and rank the most important attributes for Business Aviation Product Value though an Analytical Hierarchy Process (AHP). The study has selected seventeen attributes divided in six categories including the traditional attributes such as aircraft price and direct maintenance cost and new ones, such as customer support aspects and environmental features.

The results have shown that interior aspects play a significant role in the decision process for the business aviation, however, the security and safety aspects are still the number one concern to be addressed in this aviation.

Keywords: Multi-Attribute Problem, Product Attribute, Business Aviation, Analytical Hierarchy Process (AHP), Product Value.

1. INTRODUCTION

Although the general air transportation is increasing with a constant positive rate in passenger demand, even with the uncertainties and the economic crises faced by some countries (IATA Airline Industry Forecast 2013-2017), the Business Aviation sector is academic and scientific under-researched in the general air transport industry.

The airplane product concept, including the business aviation product, has several phases and steps which involve critical aspects, where the product development (PD) phase is one of the most important related to the product specifications and conceptual design. In this phase of development, interdisciplinary teams of product design require the ability to rapidly explore the range of product attributes in terms of customer preferences, pricing, technical performance and others. (Downen, 2005).

The costs are no longer the only factor that should be considered in this phase by the industry stakeholders and customers. Combinations with technical characteristics, passenger comfort and environmental impact are also included in the product development and decision strategy. Moreover, manufacturing companies must clearly identify the set of characteristics that better satisfy the customer's requirements prior to the launch of production programs. (Esposito & Passaro, 1997; Giuseppe & Esposito, 2015).

The current research aims to characterize and understand the most important factors related to the business aviation overall product, based on customer's needs and industry requirements. Moreover, it will be used a methodology to define the factors rank in terms of product value. This research will consider traditional features as operational cost, technical performance, such as cruise speed and range, and also, new features, which importance is increasing, such as environmental impact, customer support and aircraft interior aspects.

The methodology is based on a very known approach proposed in literature to address evaluation case problems, the Analytic Hierarchy Process (AHP) (Saaty, 1980, 2001) and it is a good alternative to set up a decision maker problem in order to rank the attributes.

The work is divided in sections where initially provides information about the attributes. Then, the research and interview process along with the AHP model methodology are described. Finally, the methodology is implemented for our scenario and a rank is presented with some conclusions.

2. ATTRIBUTES SELECTION

Seventeen attributes were identified in six categories as important features to be considered to characterize a product value and are listed on Figure 1. The study aims to identify the expanded product attributes and not only direct product related aspects, thus, in this research, it will be also considered subjective related product aspects.

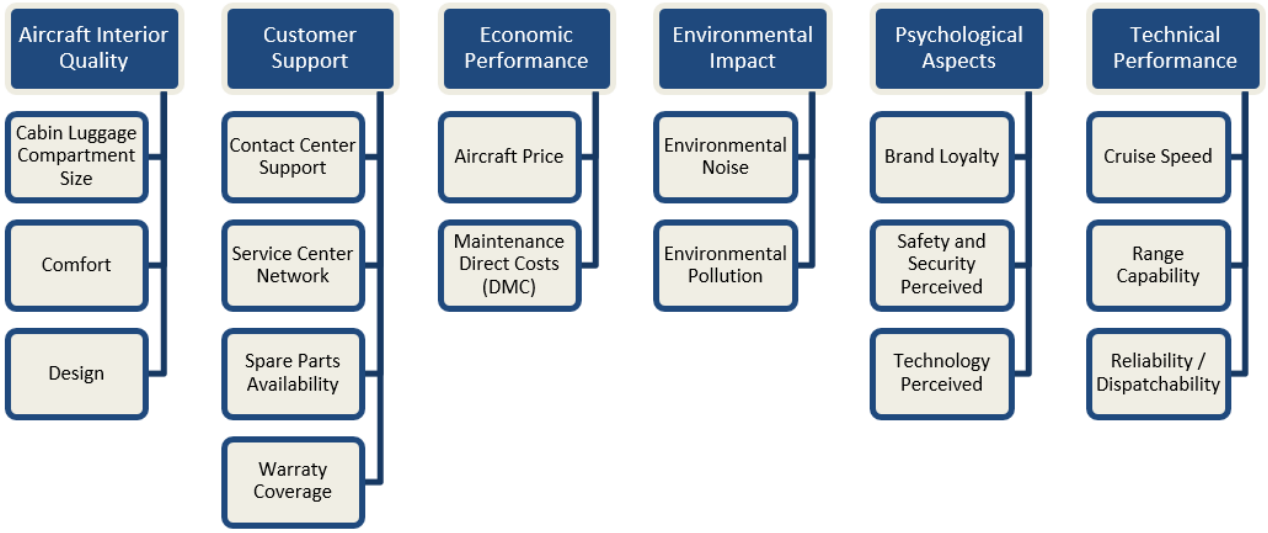


Figure 1: Attributes Selection and Groups

Aircraft Interior Quality

Interior quality, details and feeling-driven features are highly important in the business aviation category. The interior of the airplane is where the passengers will have the flight experience, thus, Comfort, Cabin Size and Design aspects are important attributes, mainly for the business aviation market.

According to Booz Allen Hamilton (2016), comfort is related to the ability to make more effective use of travelling time in a more private and comfortable environment. Comfort can be exemplified as a seat leather feature, private divided sections, air conditioning features, cabin noise volume and cabin lighting sensations.

Cabin Luggage Size is especially important for long travels or small airplanes. However, even big airplanes and short travels can have the necessity of cargo and luggage compartments.

The Design, according to Airjet Designs, is the art of offer unique interior creations that reflect the individual needs and tastes. The design aspect is focused on delivering beauty, luxury, and sophistication to airborne surroundings.

Customer Support

The customer support aspects are increasing in importance inside of the competitive global aviation and causes various airlines to vie for the top position with lot of importance being given to the customer service (Arif, 2013). The service center network is one of the customer support features and the availability and locations are direct associate with the level of care and support that a manufacture is willing to provide and for the major aircraft OEMs is part of the main key indicators of customer support.

The contact center or first point of contact is given top priority by all service-oriented industries and the business aviation industry is no exception. Aviation is a 24/7 business which drives the contact center support to the same time frame. Executives view customer contact service as a way to attract, retain, and even win back their customers and a good interaction and empathetic first contact is really important to satisfy and retain customers. (Strategy&, 2007).

Spare Parts Availability is other customer support attribute and according to Huiskonen (2001), the spare part planning and logistics consider urgency, specificity, demand pattern, and value of parts in the management analysis. Moreover, the network structure, positioning of materials and the responsibility of control need to be included in the operational strategy.

The last customer support attribute is the Warranty Coverage, where the estimation of the warranty period involves a lot of factors such as product structural components life limit (Nechval,

2004), reliability of the components (for instance, rate failure) and repair and overhaul costs. According to Murthy (2002), it is also an element of marketing products and indicates higher product quality.

Economic Performance

This section explains the importance of two traditional attributes associated not only with the business aviation sector, but also related to the whole aviation industry concerns and requirements: Direct Maintenance Cost (DMC) and Aircraft Price. The DMC was one of the first characteristics measured and developed by manufacturing companies and operators. This attribute is a product related component of the Direct Operational Cost (DOC) and since the 1960s, international air transportation organizations and large aircraft manufacturing companies have developed methodologies to calculate this attribute (Boeing, 1972, Airbus, 1988).

Regarding the price of an aircraft, it is built regarding the manufacturing companies' costs and the return margins associated with the product and services provided. The costs usually comprehend the recurring and nonrecurring fraction and the margins are generally related to the product target business sector and market competitiveness.

Environmental Impact

Environmental aspects are increasing in importance among all the aviation industry. Attributes such as Environmental Noise and Environmental Pollution are not anymore optional requirements and not rare, they dictate aspects for new project requirements. Of these two, noise nuisance has the largest impact on the community surrounding airports, while engine emissions have both local and global impacts (Davies & Armsworth, 2010). Aircraft engines exhaust pollutants are emitted during takeoff, landing, ground operation and during cruise, where the impact and gases emitted vary for each phase.

The noise factor is related to the social noise mainly from the aircraft engines, which affects the surroundings of the product.

Similar of what occurs with the engine emissions, in the customer perspective, the Environmental Noise attribute is still a new concept and it is expected to grow with new product developments and increase in competitive advantage.

Psychological Aspects

This topic characterizes the subjective attributes associated with customer perception about Technology and Safety & Security. Moreover, the Brand Loyalty is also described in this section as a subjective component.

According to Chumpitaz & Swaen (2013), several definitions for brand loyalty exist. At present, customer loyalty concept can be understood as a behavioral and attitudinal aspects of consume and brand interaction. Corporate image combine with service quality and customer satisfaction is a powerful and illustrative component for explaining brand loyalty (Zins, 2001).

The level of Technology Perceived can be estimated using qualitative aeronautical-related requirements (aircraft using cutting-edge avionics and internet standard platforms, for example) and non-aeronautical related requirements (incorporation of non-aeronautical new technologies in the airplanes, such as Apple® applications) (Kirby, 2001).

For the Safety & Security Perceived, according to FAA, for the North American aviation, the fatal aircraft accident rate for the general aviation, where includes the business aviation, is almost five times higher than the airlines category in the last 3 years.

The findings of Cleme et All. (2008), reveal that among seven dimensions related to perceived service quality, safety & security is the most important dimension for international flights, thus, this attribute is also justified for the Business Aviation category. Safety & Security Perceived considers all the history of the product incidents and accidents. Moreover, the travel risk perception is a function of cultural orientation and psychographic factors (Reisinger & Mavondo,

2005). Customer satisfaction is also driven by the Safety & Security Perception, even though, this relationship has different impact for pleasure and business travelers (Ringle, 2011).

Technical Performance

The technical performance aspects are the most basic attributes for all types of products and they can be directly compared among different product types. For the business aviation industry, the aircraft Cruise Speed, Range Capability and Reliability and Dispatchability are well known attributes to compare and evaluate products.

The Cruise speed is important in long ranges and it is also related to the operating costs in terms of fuel consumption. The Range Capability is defined as the maximum distance between takeoff and landing that an aircraft can complete its mission. And the Reliability and Dispatchability, according to ReliaSoft, is a general term that focuses on the product ability to perform its intended function or also, the probability of a product continue to perform its intended function without failure.

3. METHODOLOGY

Multiple Criteria Decision Making (MCDM) techniques are very popular tooling to address product selection problems. The MCDM techniques have been created and discussed over the past 50 years to help the decision-maker in identifying the best alternative among a finite set of attributes or criteria in order to, for example, maximizes customer satisfaction (Bandte, 2000).

The Analytic Hierarchy Process (AHP), developed by Saaty (1980) is a practical and useful MCDM tool, which has been widely accepted and was chosen for this work because of its well-known capability of transform subjective aspects in a rank preference. AHP has also a clear advantage, which is the lower complexity level of its evaluation tasks and the low computational time necessary to give the preference results (Scholl, 2004).

The AHP methodology works with pairwise comparisons that are arranged in a matrix to measure the decision maker's priorities or the degree of importance among the attributes. The linguistic comparisons are converted to numerical pairwise comparison via eigenvalue decompositions (Jalao, 2014).

The methodology process for this study was divided in three parts, where the first one was the selection of the most important attributes for the business aviation market and product.

For the second part of the methodology process, all the most relevant attributes were listed inside of an online research and more than 50 professionals and customers all over the world were invited to rate the level of importance for each one of the attributes in terms of product value and customer interest. They were asked to use a standard qualitative scale proposed in Table 1. The result of the second part was a table with the average weighted responses and the identification of the top five most important attributes.

Table 1: Attributes Level of Importance Scale

Quantitative Scale	*Qualitative Scale*
1	Unimportant
2	Little Importance
3	Moderately Important
4	Important
5	Very Important

For the third part, the top five attributes were included in the AHP pairwise comparison methodology. The AHP algorithm is basically composed of two steps: determine the relative weights of the decision criteria and determine the relative rankings (priorities) of alternatives. Both qualitative and quantitative information can be compared by using informed judgments to derive weights and priorities. (Phillips-Wren, 2004).

Table 2: Pairwise Comparison Measurement Scale

Quantitative Scale	*Qualitative Scale*
1	Both Attributes are Equally Important
3	One Attribute is Slightly More Important than the Other
5	One Attribute is More Important than the Other
7	One Attribute is Strongly More Important than the Other
9	One Attribute is Absolutely More Important than the Other

Inside of the methodology, the pairwise comparisons were made with the grades presented on **Error! Reference source not found.** and the final 5x5 matrix was filled out with the research average responses. The final matrix sub-diagonal entries are reciprocals of the entries above the diagonal. Thus, the sub-diagonal entries are redundant. However, according to Phillips-Wren (2004), the redundancy can be eliminated by an appropriate system of weighting the judgment responses and a weighted binomial logit model can be used to analyze interferential questions regarding the priorities.

The next stage inside of this phase is to calculate the Consistency Ratio (CR) and confirm that the judgment average response was consistent relative to large samples of purely random judgments, as AHP evaluations are based on the assumption that the decision maker is rational. For the methodology, CRs lower than 0.1 confirms the consistency.

4. RESULTS

Both interview research had more than 30% of response back and the data validation was conducted according to the methodology described in the previous chapter.

The first result is related to the second part of the methodology process, where all the most relevant attributes were listed inside of an online research. The result of the top five attributes rated higher in the scale are shown in Table 3.

Table 3: Most Important Attributes Result for the First Interview Research

#Rank	*Attributes*
1	Interior Comfort
2	Safety & Security Perceived
3	Interior Design
4	Reliability / Dispatchability
5	Range / Autonomy

The second result is part of the AHP pairwise comparison methodology and the final ranking importance is described in Table 4. Moreover, the CR calculation confirmed the consistency of the data: 0.055, lower than the 0.1 reference.

Table 4: Attributes Ranking According to the Priority Vector

Attribute	*Priority Vector*
Interior Comfort	0.081999105
Safety & Security Perceived	0.574457454
Interior Design	0.102148822
Reliability / Dispatchability	0.175570528
Range / Autonomy	0.06582409

The priority vector drives the ranking for the most important attributes in the business aviation product in a quantitative scale. This indicates that the Safety & Security Perceived is the most important attribute for the business aviation product, corresponding of more than the half of the decision process (57%) followed by the Reliability / Dispatchability (18%), Interior Design (10%), Interior Comfort (8%) and Range / Autonomy (7%).

Therefore, although Interior aspects play a significant role in the decision process for the business aviation, demanding great and tailored designs and comfort features, the Security & Safety aspects are still the number one concern to be addressed in this aviation, even though, several systems and regulations have been improved in the last years.

5. CONCLUSION

The study has ranked the most important attributes for Business Aviation Product Value though an Analytical Hierarchy Process (AHP) and has found that considering the seventeen attributes selected, Safety & Security Perceived is the most important attribute for the business aviation product, although interior aspects are very important in the Business Aviation industry.

The AHP methodology has presented the advantage of quantifying and ranking the attributes using simple pairwise comparisons and has allowed the user to exercise judgment in both the selection of the attributes and the relative ranking of the pairwise. The methodology has demonstrated robustness in this application, although the inherent limitations such as the bounded rationality present with the decision maker. Moreover, for a future analysis, a study case would be indicated to confirm the robustness of the model.

The research has demonstrated its importance for the business aviation market, mainly in the early product development phase, considering the product specification and market assessment. The study can also be used as a tool to project managers, designers and decision makers to quickly explore the product attributes and their potential impact on the market. The study reduces the gap between the concept of product and customer requirements and put together the intuitive customer appealing features with the business aircraft industry standard figures.

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