

SUPPLY CHAIN FEATURES OF THE AEROSPACE INDUSTRY PARTICULAR CASE AIRBUS AND BOEING

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***Abstract:** Aerospace sector is one of the most globalized industries in terms of market structure and production system. Through aircraft development programs aviation industry has introduced new solutions to develop its products. The role of the partners involved in the development programs for the new generation aircraft is becoming increasingly important. Supply chain management has become a key factor for major manufacturers in the industry. The new strategies introduced by the aircraft manufacturers have increased the complexity of the supply process, design and production from the aviation industry. This paper highlights a series of factors regarding the aircraft programs supply chain management. In the first part are described the problems encountered by the manufacturers and airlines during the development of the most recent aircraft launched A350XWB and B787 Dreamliner; the second part focuses on the organizational structure of the supply chain, suppliers role within supply chain and also there are described the effects of the new strategies adopted by Airbus and Boeing in the aircraft development; the last part focuses on the risks and challenges that aviation industry is facing.*

Key words: Supply Chain, Supply Chain Management, Supply chain Structure, Aerospace Industry

JEL Classification Codes: L1, L6, O3

1. INTRODUCTION

The aerospace industry recorded a consecutive increase in sales in the last 3 years, mainly due to the air traffic growth and the ongoing development of the emerging markets such as China and Latin America. It is estimated that aircraft production will double or triple in the next years (Beck, 2014). The aircraft manufacturers (OEMs) will need to increase supply speed to accomplish the customer promises / requirements. Given these aspects, supply chain management has become a key factor for major manufacturers from aviation industry. With the changing structure of the aerospace industry by switching from traditional vertical programs to those with multinational operations distributed in several stages (including production, after sales, maintenance, repairing and reconditioning) come inevitably greater challenges (Behrens, 2010). The complexity of this industry lies in the supply and management of the design and production. In the last decade these challenges have become more complex and more global. Introduction of the new technologies and growth and the compliance requirements have created difficulties in the management of the supply chain (Mayer, 2014). Also it is essential to have an effective communication in order to clarify the requirements and needs throughout the program stages (Gordon, 2006).

This paper highlights a series of factors regarding the aircraft programs supply chain management. In the first part are described the problems encountered by the manufacturers and

airlines during the development of the most recent aircraft launched A350XWB and B787 Dreamliner; the second part focuses on the organizational structure of the supply chain, suppliers role within supply chain and also there are described the effects of the new strategies adopted by Airbus and Boeing in the aircraft development; the last part focuses on the risks and challenges that aviation industry is facing.

2. AEROSPACE SUPPLY CHAIN CHALLENGES

The progresses performed in aviation industry in the recent years, have increased the risk level. Supply chains became vulnerable to the disruptions that occurred during the production process (Treuner F. et. Al 2014). Within the development programs of the new generations of aircrafts (A350XWB and B787 Dreamliner, respectively), the producers had as a main objective to reduce the time of the products release on the market and to share the higher costs for development with suppliers. These new programs involve the development of complex technology projects to increase aircraft operating efficiency by 15 to 20% (Bernardini et al, 2013). Both Airbus and Boeing outsourced substantial work packages to suppliers that they have selected.

Also, the introduction of innovations (composite, low fuel consumption engines, avionics, electrical systems, etc.) and in some cases transformation of the former factories into independent companies have further amplified the complexity of the production chain. Despite the positive effects, this new approach has generated more problems in the production process. The table below highlights some of the challenges that manufacturers and airline have encountered with the introduction of the new aircraft programs:

Table 1. Challenges encountered by the OMEs and Airlines in the new aircraft programs

Manufacturers (OEMs)	Airlines
<ul style="list-style-type: none"> - Difficulties in the manufacturing process - Difficulties due to the need of risk-sharing suppliers - The limited experience to manage the complex programs - The existence of a fairly long period between the planning and actual availability of the new capacities - Fast and effective training deficit to expand workforce - Issues related to production quality and reliability of some of the materials available 	<ul style="list-style-type: none"> - The need to train the pilots to operate this new generation of aircraft - Using the obsolete fleets due to delays - Unplanned and unbudgeted maintenance checks - Delays due to maintenance, repair and operation - High financial impact - Increased competition on the attractive routes

The disruptions occurred in the aerospace supply chain are the predominant cause of the operational delays. These can result from natural disasters (such as earthquakes, volcanic eruptions, floods) and subsequent logistical challenges, and from other manmade risks. Financial difficulties, resource constraints and socio-political reasons (e.g. strikes, political unrest) can also stop a production line (Treuner F. et. al. 2014). An issue for the suppliers and airlines is the creation of the capacities to operate this new generation of aircraft. Furthermore, customers who waited anxiously the new generations of aircrafts were forced due to delays that occurred in production processes to use outdated fleets. This meant for the airlines a higher fuel consumption and unplanned and unbudgeted maintenance checks. These delays are not the only challenges on

the air operations. The difficulties or delays in MRO (Maintenance, Repair and Overhaul) operations disrupt flight schedules and have a huge financial impact.

Increasing competition, cost pressures (rising energy costs, high commodity prices, etc.) and the impact of the global financial and economic crisis are some of the issues that aerospace industry is facing (Bublitz, 2013). To combat these challenges, the manufacturers and suppliers are using the advantages deriving from the globalization of the aerospace supply chain. On the other hand, globalization affected the aerospace industry with a variety of pressures, such as time compressing aircraft programs, reducing costs, increasing productivity and global competitiveness (Advani, 2013). Major aircraft manufacturers have become extremely selective in choosing suppliers. Suppliers are in the position to assume greater responsibilities in the supply chain to meet the relevant requirements and specificities, to be selected as a partner. In their turn, suppliers are facing problems within the value chain, the experience to manage these complex programs being rather limited.

Another problem faced by the aviation industry refers to the existence of a fairly long time between planning and actual availability of the new capacities (Bernardini et al, 2013). The procurement of the critical raw materials take quite a long time (such as carbon fiber), these materials being also quite expensive (these materials are highly subject to shortages and price increases). The suppliers hold usually only limited quantities of these materials to effectively manage their financial resources. Regarding the workforce, the novelty used in materials and processes for the development programs of the new generation aircraft could lead to production problems related to the quality and reliability of some of the materials provided. A major obstacle is the size of the industry, but, the policy coherence with other aspects of procurement, such as the overall strengthening of the supply chain is also important. Although it is enjoying an aura of advanced technological and strategic value, the total turnover of the aerospace industry is a fraction of the automobile industry (Advani, 2013).

Boeing and Airbus have implemented a set of strategic responses and organizational facilitators to address these challenges. This includes both mobilizing its current supply base as well as adapting its processes and organization. Increasing competition on the attractive routes, fuel costs and regulatory charges lead to the need for airlines to continue searching for potential cost reduction. While traditional measures of cost optimization will always remain necessary, new opportunities for increasing efficiency are becoming increasingly relevant.

At this moment the supply chain of the aviation industry is not entirely prepared for the dual challenge of providing a larger volume of more sophisticated aircrafts. In fact, there is a real risk increasing supply chain disruptions. Some providers still have a limited expertise and capabilities (technology) engineering and support modest implementation of several programs. While the customer-supplier relationship in the aerospace industry still goes through a process of clarification, the management of suppliers along the supply chain remains a major challenge for the aerospace industry.

3. THE VALUE CHAIN STRUCTURE OF THE AERONAUTIC INDUSTRY

Globally, the airline industry value chain comprise all phases directly or indirectly involved in meeting customer requirements. This network of production usually involves many actors with different functions (manufacturers, suppliers, transporters, warehouses, retailers, etc.)

There are also several categories of suppliers participating in the development of aircraft, classified in many levels:

- The Original Equipment Manufacturers (OEMs) - these are the companies that assemble large aircraft components and provide final products to customers. Their work involves: design, development and manufacturing or complete assembling of the aircraft as well as

their testing (transport planes, fighter jets, helicopters, etc.). The main OEMs on the aviation industry global market are: Airbus - Europe and Boeing - USA, followed by Bombardier - Canada, Embraer - Brazil and United Aircraft Corporation of Russia.

- First-tier suppliers - they are the direct OEM suppliers. First-tier suppliers manufacture / assemble major sections, aircraft systems (including engines, avionics, aircraft interior, landing gear, etc.). First-tier suppliers are companies like Alenia in Italy, Dasa in Germany and Casa in Spain. Prime contractors are also the engine manufacturers such as Rolls Royce, Pratt & Whitney and General Electric.
- Second level suppliers - usually are the key suppliers of the tier I (first-tier suppliers). These are commonly small and medium-sized companies. Second-tier supplier delivers complex manufacturing products obtained from his own production or a variety of other external providers. E.g. Sonaca Montreal, Areola
- Third level suppliers - perform special components and specific processes, e.g. raw materials, electronic components, etc.

Besides these major players from the industry who are directly involved in the production process, research institutions, universities and government institutions have also an important role. Figure 1 highlights the value chain structure of an aircraft development program. To develop aircraft programs increasingly more complex and with deadlines which become more stringent regarding the manufacture of the components and systems, the manufacturers have introduced new strategies in the aircraft programs supply chain. These strategies resulted in a higher level of outsourcing the activities entrusted to the first level and second level suppliers, which in turn have to deal with challenges in terms of performance, reliability and financial risks. Thus in the context of market globalization, Airbus and Boeing approached new strategies that aim mainly to reduce the number of suppliers by selecting only some intermediary companies which offer integrated solutions and can manage with the other subcontractors.

The aerospace industry has refocused in the recent years towards a new supply chain structure which is based on an extensive process outsourcing. This can be seen in the latest aircraft development programs B787 Dreamliner and A350XWB. In both cases the companies Boeing and Airbus have established a new form of partnership which involves more complex work packages compared to the previous programs but are designed to reduce costs and delivery time component (Responsibility made by Airbus Group, 2013). The new supply chain is based on a number of levels. Both Boeing and Airbus select their suppliers according to their strategies and the fulfillment of the required standards set in the aviation industry. These strategic partners are primarily intended to assemble the different parts and subsystems produced by second-tier suppliers. At the same time work packages launched by the two companies are considering sharing risks with suppliers. The suppliers become responsible for the entire scope of the work packages, including their supply chains. To facilitate the working way under the new programs, the selected suppliers were involved earlier, compared to the previous programs to participate in the definition and development of systems and components for the new aircraft and to agree on a set of details for the package work. This reduced a significant part of the cost of production and their delivery time.

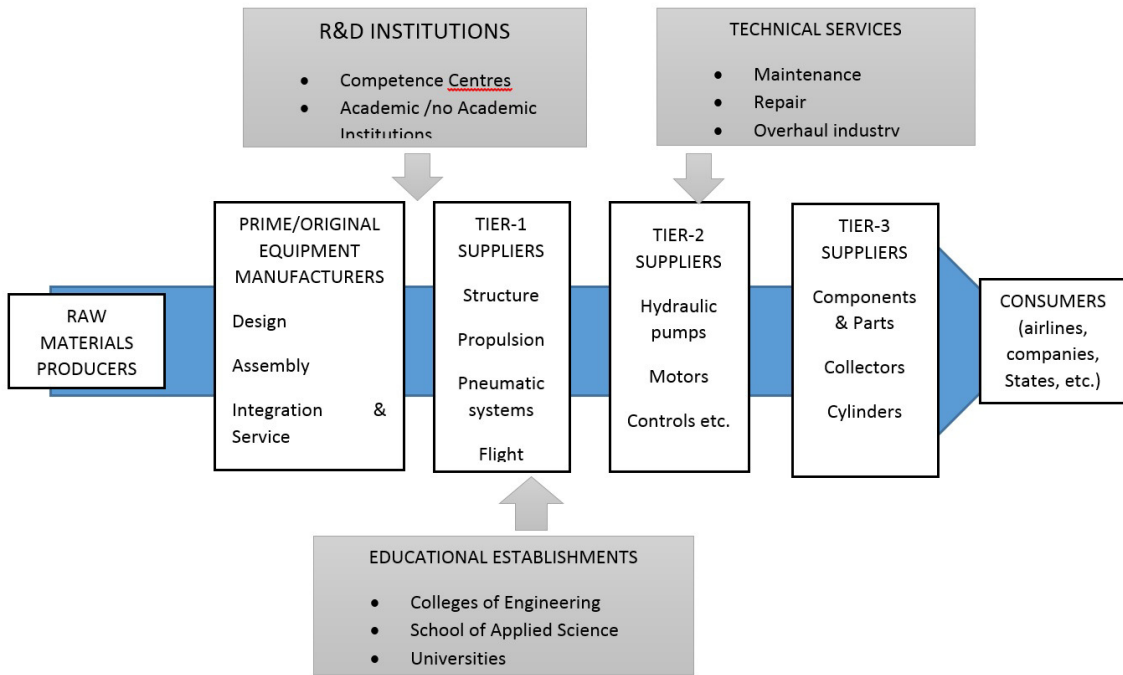


Figure 1. The Aerospace Supply Chain

Source: ICM Industrial . IRM@ Aerospace Technology & IP Databank

By this new form of partnership companies followed:

- Facilitating and enhancing the coordination and collaboration with suppliers
- Significantly reducing the production costs
- Quantitative and qualitative improvement of supplier performance
- Decreasing the development time by exploiting the ability of suppliers to develop different sides simultaneously
- Maintaining production and assembly process at low cost

Also Boeing and Airbus can focus more on the stages of pre-integration with Tier 1 suppliers, rather than the procurement of raw materials or other minor problems (Tang and Zimmerman, 2009). Figures 2 and 3 highlight some of the important aspects of the supply chains structures of B787 Dreamliner and A350XWB programs.

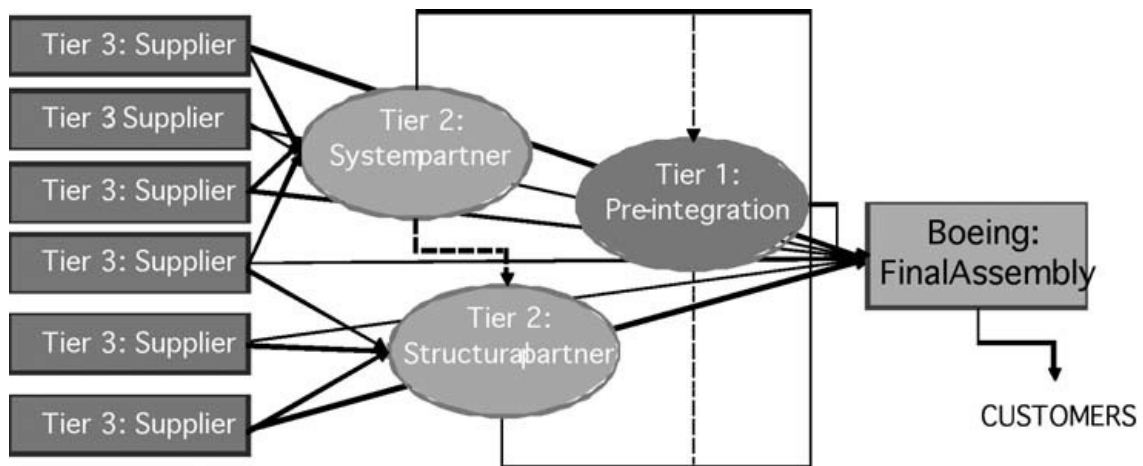


Figure 2. Boeing 787 Dreamliner Supply chain

Source: Christopher S. Tang and Joshua D. Zimmerman, Redesigned supply chain for the Dreamliner program


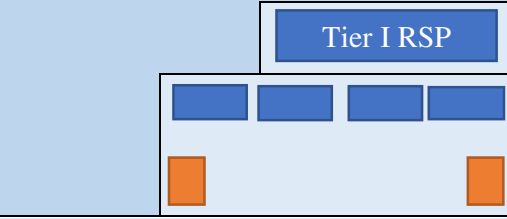
	Past	Today
Platform Assembly Large – scale Integration Value –added Parts and Assemblies Make-to-print Parts and Assemblies Raw Materials	Airbus 	Airbus 
	<ul style="list-style-type: none"> - Fewer, but still many direct partners - Limited role for “integrators” - Some technical competences remain exclusively internal 	<ul style="list-style-type: none"> - Far fewer large direct risk-sharing partners with whom to build strong ties and who can share capital expenditure, development costs and risk - A real global extended enterprise - Extensive role for “integrators” - Design to functional specifications of large main components or sub-assemblies - Some technical competences remain exclusively internal

Figure 3. Airbus sourcing principles enhanced responsibilities A350XWB Program

Source: 2014 Corporate Responsibility & Sustainability Report

In the aircraft latest generation supply chain launched (B787 and A350XWB Dreamline) Boeing and Airbus have adopted new ways of managing production (Table 2).

Table 2. Supply chain management solutions adopted by Airbus and Boeing

Airbus – Extended Enterprise	Boeing - Exostar
<ul style="list-style-type: none"> - Optimizing work modality with suppliers during A350 XWB program development - More comprehensive and integrated Work packages - Involving the suppliers more early in the process of development aircraft program; - Closer collaboration with suppliers, sharing key processes and IT instruments, such as Digital Mock up - Selected suppliers fulfill qualities such as: expertise in aerospace, defense and security; ability, to get involved in the program during the development stage; and the critical size and ability to complete the proposed work package - Creation of a risk profile for each Airbus supplier and elaboration of an action plan adapted to each partner, to support the 	<ul style="list-style-type: none"> - Streamlining the exchange of information between suppliers, order tracking - The system monitors events and exceptions that occur between partners during the activities within the value chain and assess the impact of these events on the basis of information supplied - The system includes reporting capabilities, that enable Boeing and its partners to track the overall performance of the supply chain - Coordinating structural and partner locations spread throughout the world - Management of the processes implemented by suppliers within their supply networks. - Establishing partnerships with suppliers

<p>measures of increase capacity and improve their performance</p> <ul style="list-style-type: none"> - Alignment the priorities between Airbus and suppliers to strengthen the management of the program - Watchtower- Implementing a monitoring system for the operational financial performance statements and main suppliers, and those who are subject to financial risks - Performing audits and evaluations of the suppliers to ensure that they fulfill supply the Group's specific requirements - Procurement academy- introduction of trainings for suppliers that cover a range of supply chain solutions needs 	<p>sharing the risks that occur within supply chain</p> <ul style="list-style-type: none"> - Implementing of common tools to provide global visibility to the partners involved - Implementation of a series of transport logistics processes and mechanisms to ensure timely delivery of all components assembled - Ensuring timely continuity of the supply and minimizing the supply disruptions - Improving delivery time and respect the deadline to end customer - Reduce of the total cost of production by using best prices and value global partners
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By choosing to use the new system Exostar, the company was able to minimize the losses in the supply chain. Alongside with the global partners, Boeing streamlined the aircraft delivery time to customers (Exostar, 2013). In its turn Airbus by Extended Enterprise, the new form of partnership, contributed to the performance of suppliers and the insuring of industrial collaboration of the A350XWB program. The lessons learned during the two aircraft programs are useful to improve the supply chain performance of the future aircraft programs.

4. CHALLENGES AND RISKS WITH WHOM OEMS STILL HAVE TO FACE

The demand for commercial aircraft is influenced by many factors of which airlines depends, such as: the rentability, the availability of financing aircraft programs, the trade policies, the technological changes, fuel prices etc. The market for commercial aircraft is dependent on long-term trends of the airlines for passengers and freight. The factors that underlie the long-term air traffic growth are supported by economic growth and political stability in developed and emerging markets (Boeing, 2014). In this chapter we have described some of the problems that civil aircraft manufacturers are still facing.

The aircraft manufacturers are very careful in general on the global economic environment, to the financial stability of one or more of its main customers. Any disruption could lead to the postponement or cancellation of contractual orders and/or payments for the new aircrafts. The companies continue to maintain a healthy production system to meet the stringent standards of performance and reliability of the new aircraft programs. These complex programs involve careful coordination and integration of the suppliers as well as the increased risks related to testing, production and certification of aircraft. In addition, producers are still looking for new ways to reduce production costs, including costs with suppliers. Any breach to fulfill the performance or reliability requirements could lead to disruption of operations of the producers, to higher costs and/ or lower incomes.

By outsourcing process, aircraft manufacturing companies become increasingly dependent on the performance of their subcontractors and suppliers and the availability of raw materials and other components. Of this thing depends meeting customer requirements in terms of products and services offered. The manufacturers are focusing on eliminating potential delivery delays or other performance issues, closely monitoring the suppliers and intervening when is appropriate. Also the raw materials of which industry depends on (such as aluminum, titanium or composite)

may become unavailable or available at very high prices. Competition on the civilian market can have effects in the future contracts and sales. Some competitors may have engineering and manufacturing capabilities, or more specialized than in certain areas. According to annual reports of major manufacturers Airbus and Boeing, it is expected to increase competition between aircraft manufacturers and service providers in one or more of our market segments.

The companies are forced to face risks such as:

- changes in the regulatory requirements
- changes taking place in domestic and international government policies
- fluctuations in the international currency exchange rates
- changes of the priorities and budgets, which can lead to delays
- the ability of customers to finance purchases
- uncertainties and restrictions regarding the availability of financing loans or guarantees
- imposition of domestic and international taxes, export controls, tariffs, embargoes, sanctions and other trade restrictions
- difficulties in management and coordination of a multinational enterprise
- compliance of the various international laws
- emergence of unforeseen circumstances such as terrorism, war, epidemics and international conflicts

Also as part of the strategy of the large producers to merge with other companies or acquire companies or form joint ventures and strategic alliances, the benefits had depended largely on the ability to integrate the business operations acquired, product and service portfolio performance, and management team performance. Often the financial results of companies like Boeing and Airbus were not those expected. This is due to the unexpected performance problems, such as expenses related to the transaction, the old debt, impairment charges on long-term loan guarantees, performance partners and allowances.

Another important factor is the confidentiality, the availability and integrity of data and systems in the aircraft development programs. The manufacturing companies and their suppliers face specific security threats. They maintain an extensive network of technical security controls, monitoring and supervision systems management in order to prevent these threats.

5. CONCLUSIONS

To address the challenges that arise during the production process of the new generation aircraft, manufacturing companies have implemented a set of strategic and organizational models. These strategies led to a higher level of outsourcing the activities entrusted to tier I and tier II suppliers, which in turn have had to deal with challenges in terms of performance, reliability and financial risks.

The introduction of innovations (composite engine fuel consumption, avionics, electrical systems, etc.) strategies and organizational merger, acquisition or processing, in some cases transformations of the former factories into independent companies amplified the complexity of the chain production. Despite the positive effects, this new approach has generated more problems in the production process. And, often the financial results of the large companies Boeing and Airbus were not those expected. This did not discourage the main manufacturers, that are closely monitoring the suppliers involved in the production of components and intervening where necessary to avoid bottlenecks in the supply chain programs. Also the lessons learned in the most development programs of the latest aircraft launched on the market help to improve the supply chain performance of the future programs.

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REFERENCES

1. Rich, BECKS. (2014). *More, Faster and On Time: Addressing Today's Supply Chain Challenges in Aerospace and Defense*. (28. 05. 2014) Retrieved from: <http://www.e2open.com/blog/article/more-faster-and-on-time-addressing-todays-supply-chain-challenges-in-aerospace-and-defense>
2. Allan BEHRENS (2010). Title: Managing the supply chain across the aerospace lifecycle Published in: *Taxal*, pp.2, March 2010.
3. Abby, MAYER (2014). Title: Supply Chain Metrics That Matter: A Focus on Aerospace & Defense, pp. 5-7, March 2014.
4. Dale K. Gordon (2006). Title: Supply Chain Management Remains Aerospace Challenge. *Quality Progress* (July, 2006) <http://asq.org/quality-progress/2006/07/standards-outlook/supply-chain-management-remains-aerospace-challenge.html>
5. Felix Treuner, Denis Hübner, Stephan Baur, Stephan M. Wagner (2014). Title: *A survey of Disruptions in Aviation and Aerospace supply chains and Recommendations for Increasing Resilience*. Published in: *Supply Chain Management III* (2014)
6. Eric Bernardini, Alain Guillot, Stefan Ohl (2013). Title: *Quo vadis A&D Industry 2013? – Pockets of Turbulence*. Published in: *Supply Chain Management III*, pp.23-27 (2013)
7. Wolfgang Bublitz (2013). Title: How digitalization changes the airline industry – a show case. Published in: *Supply Chain Management III*, pp. 63 (2013)
8. Philippe Advani (2013). Title: Globalizing the Aerospace Supply Chain: The EADS & Airbus approach. Published in: *Supply Chain Management III*, pp.50 (2013)
9. Airbus Group. (2014). Title: *Corporate Responsibility & Sustainability*. Report Responsibility Made By Airbus Group, pp.63.
10. Christopher S. Tang, Joshua D. Zimmerman (2009). Title: *Managing New Product Development and Supply Chain Risks: The Boeing 787 Case*. Published in: *Supply Chain Forum*, 2009.
11. Exostar (2013). Title: *Boeing 787: Global Supply Chain Management Takes*. Flight Leveraging Global Partners to Maximize Customer Value. 2013
12. E2Open (2014). *Boeing787: Global Supply Chain. Management takes flight*. Retrieved from: https://www.e2open.com/assets/pdf/case-studies/E2open_Case_Study_Boeing.pdf
13. Boeing. (2014). Title: *Leading Ahead*. The Boeing Company 2014 Annual Report. pp. 19-48