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Supply Chain Management Risks: the A350 Development Program

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Abstract: In order to respond to the market demands and create additional value for customers and airlines, Airbus decided to develop a new member of its wide-body Family, Airbus A350 XWB. The A350XW's benefits of the new manufacturing and assembly techniques, applied on other aircraft of the Airbus Family, such as the A330 and the A380. It also utilizes a supply chain based on the lessons learned over the time from other programs. The paper analyzes the structure of A350 supply chain, describes Airbus's challenges for managing this supply chain, and highlights some key lessons that could be taken into consideration for the next supply chains of the new product development.

Keywords: Airbus, A350XWB, Management, Supply chain, Market demands, New product development

1. Introduction

According to forecasting reports (Airbus, 2013) air traffic has doubled every 15 years and it is expected to double over the next 15 years. In 2013 air traffic increased by 5.7% from the previous year (Airbus, 2014). With this growth, airlines continue to adapt and also to keep a balance between the requirements of efficiency, competition and passengers. Also the variation of economic factors and 2008 global financial crisis, as well as socio-economic indicators are drivers to the air traffic growth rate. Air traffic influenced airlines' aircraft fleet growth. In the same time it's necessary to replace the old equipment. Another important element is the way airports are efficient used. The average number of movements per airport has increased annually from 8,000 movements during the 80s to more than 18,000 today (Airbus, 2014). Also, deregulation and liberalization of air traffic (1977) in the main markets from Europe and the US has led to increasing competition in the airline industry. The main competitors faced pressure on costs and production time. Airbus and Boeing aircraft manufacturers have begun to build new aircraft models by introducing a series of measures to restructure the supply chain (Haas, 2011). This enabled them to provide intermediate products increasingly diverse and complex, the basic features are evident at last applied models B787 and Airbus A350 aircraft. After launching programs as A380, the largest aircraft in the market with over 500 passenger seats and A330/40 model, Airbus decided to launch a new aircraft development program called A350. The new A350 aircraft incorporates common characteristics and new technologies developed for the A380 and A330 aircraft programs. This features allow rapid and substantial improvements in terms of performance and reduce costs (Airbus, 2004). There are three versions of aircraft, A350-800, A350-900 and A350-1000 differently designed to carry between 276 and 369 passengers. The range of each version of A350 is over 8000 nautical miles (nm). A350 is a direct competitor of B787 and B777. Like on the other aircraft programs Airbus strategy is to create added value for both airlines and passengers. Airbus added value strategy for passengers is to bring a new level of comfort, with more personal space, wider seats and more space luggage storage.

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Figure1: Airbus and Boeing comparison costs

Table1: Comparison of select Airbus and Boeing aircraft (Source: Airbus & Boeing Websites)

Nr. crt.	**Airline family**	**Max. range (nautical miles)**	**Max. Capacity (passengers)**	**Cruising Speed (mph)**	**Operations Strategy**
1	A330-800neo	7450 nmi	252	520 mph	Rolls-Royce Trent 7000
4	A340-600	7750 nmi	419	543 mph	Rolls -Royce Trent 500
5	A350-900	7750 nmi	315	561 mph	RR Trent XWB
	B777-200ER	7725 nmi	400	560 mph	Pratt Whitney Rolls Royce General Electric
7	B787-10	7020 nmi	323	567 mph	General Electric Rolls Royce Trent

Another key element of A350XWB aircraft, for both companies and passengers, is improving efficiency in operation flights and performance by replacing small aircraft with a bigger one that can fly at the same speed as its predecessors having also a reduced fuel consumption by 25 percent, compared to it's current competitor. For this, the engine manufacturer has developed a new model Trent XWB. It involves the lowest carbon emissions compared to other aircraft with the same capacity. The A350XWB aircraft fuselage was constructed of carbon fiber reinforce plastic (CFRP), reducing maintenance costs and operating companies (Marsh, 2010). Table 2 highlights the benefits of A350 XWB companies and passengers.

The first version of the A350 aircraft in 2004 did not impressed the airlines and the leasing companies. Airbus had an unpleasant experience with the A340 aircraft which was overshadowed by its competitor Boeing with B777 aircraft launched in the 1990s. Also with customer orientation to the new Boeing 787 Dreamliner, Airbus nedeed to bring a new design for the new aircraft. The company designed the fuselage for a maximum capacity of 440-550 passengers (depending on version). This can be compared with the Boeing 777 and Boeing 787 Dreamliner capacity. Airbus goal

was to provide additional space than its competitor models. To design restoration Airbus needed 2 years and during the subsequent development cycle, the design was delayed by more than a year. In addition the use of carbon-fiber- reinforced polymer (CFRP) utilisation was an important aspect of redesign in 2006; the original design from 2004 was planned to use a light metal skin. Table 2 provides a summary of A350XWB aircraft benefits for airlines and their passengers.

Currently, Airbus is a leader on the commercial aircraft market having more then 50% share. It is also the second largest supplier of defense and space market. After the merger of the four divisions of the company (Cassidian, Astrium, Airbus Military and Defense and Space). Delays with A350 XWB production triggered a decrease in the number of orders in both 2010 and 2014 (Figure 2). In general, the orders had an upward trend at present, their number reaching 780.

Table2: A350XWB features for airlines and passenger (Fast_Special A350, pg.5-7)

Item	Feature	Values to Airlines	Values to Passengers
1	Composite materials	Easier maintenance, easier handling, fuel efficiency, lower maintenance costs, faster cruising speed appropriate for long international flight	Faster cruising speed appropriate for long international flight Higher humidity in the cabin is allowed which increase comfort level
2	New generation, fuel efficient long range engines	Lowest specific fuel consumption engines, quieter jetliner	Lower costs for passengers, quieter jetliner
3	A comfortable and and efficient cabin	Crew rest space without using revenue space, flat floor for greater comfort, wide windows	More place for passing, more luggage storage space and large panoramic windows
4	Optimized wing efficiency by design	Match 0,85 cruise speed, reduced flight time, reduced fuel burn	Lower costs for passengers, reduced flight time
5	Eco - effiency by design	Having the lowest fuel burn engines also means lowest CO2 emissions per km, quieter aircraft	Quieter aircraft

This paper analyzes in the first part the Airbus supply chain structure and its evolution. The following section presents our analysis of the risks associated with the supply chain. The last part highlights some Airbus risk reduction strategies to accelerate development and production processes.

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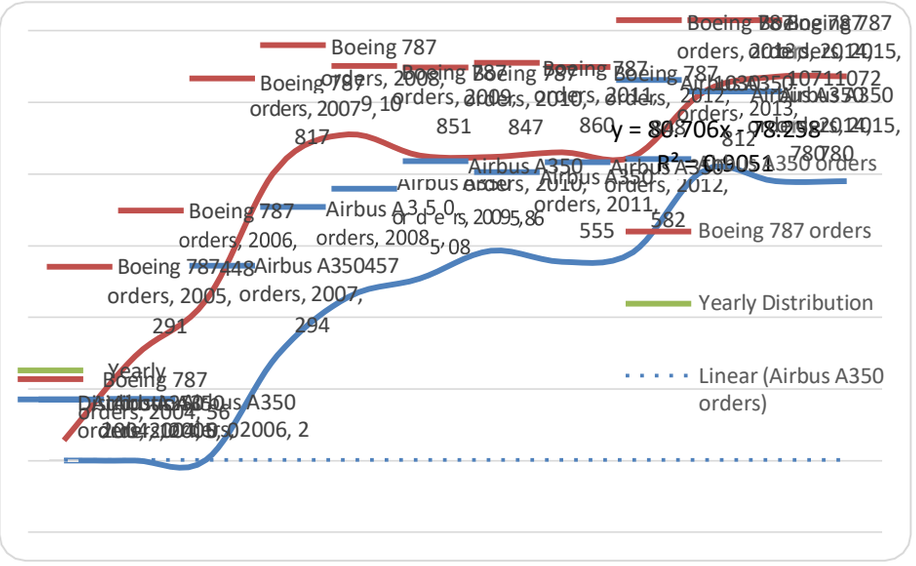

Figure 2: Airbus and Boeing orders for A350 and B787

2. A New Supply Chain for A350XWB

For A350, the company changed the supply strategy. Airbus chose to outsource the design, the development and the production of major subsystems of the aircraft to suppliers (Figure 3). The objective of this new program A350XWB was to improve the performances of the previously A330 program by providing more space for passengers and new technologies, including a Rolls-Royce engine. To reduce the development time of new aircraft, Airbus approached a new strategy in the new supply chain, increasing complexity of outsourced components (Johnsen et. Al, 2014). Supply Chain A350XWB was designed to maintain low manufacturing and assembly cost, outsourcing a large part of the development financial risk to the Airbus suppliers. For the A380 and A330/40 programs Airbus outsourced 40% of work packages. And for the other activities the company has played the role of the traditional manufacturer of assembled components produced by thousands of suppliers. This is part of the company's strategy Airbus Power 8 rationalization program by which the company outsource work packages to suppliers, especially for those who had become risk sharing partners. Table 3 shows the evolution of Airbus supply chain.

Table 3: The evolution of Airbus Supply Chain (Airbus website)

	Supply chain A320 & A330/40		**Supply chain A380**		**Supply chain A350**	
Platform Assembly	Airbus		Airbus		Airbus	
Large-scale Integration	Airbus		Airbus		Airbus	I Tier
Value-added Parts and Assemblies	Airbus	I Tier	Airbus	I Tier	I Tier	
Make-to-print Parts and assemblies	Airbus	II Tier	II Tier		II Tier	
Raw materials	III Tier		III Tier		III Tier	

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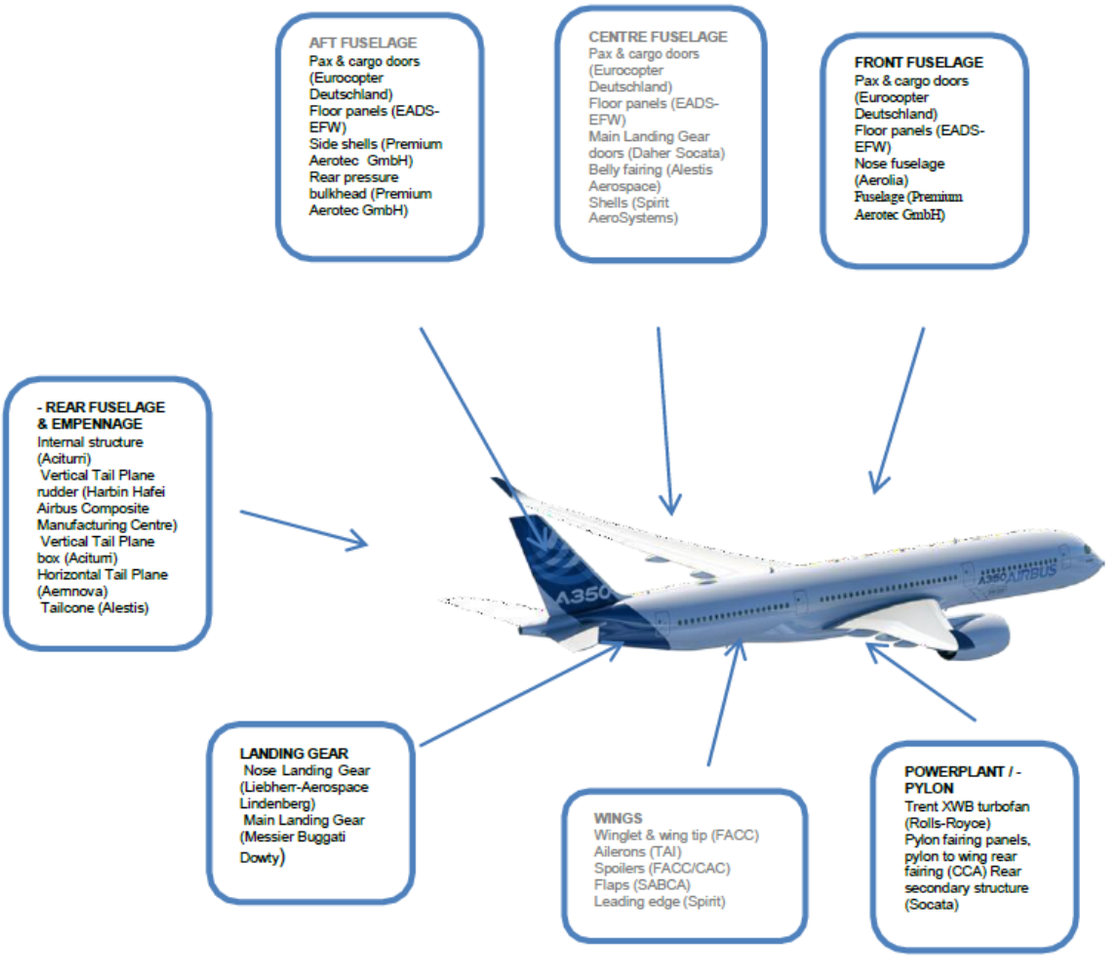

Figure 3: Main components partners for A350XWB program Source: Fast special A350XWB

2.1. Extending the Outsourcing Process

Airbus reduced handling costs and stock management, facilitating the distribution process by extending the outsourcing process. In the same time by increasing outsourcing of components, Airbus and its suppliers faced some issues in coordination and communication of the aircraft development process. To facilitate coordination and cooperation between Airbus and its suppliers, Airbus has implemented a new model of partnership called 'Extended Enterprise'. This partnership is aimed to identify new ways of working with suppliers. (Airbus Group, 2013) "Do what you can do best – outsource the rest" became a popular management saying even in Aerospace Industries (Arnold, 2013). Table 4 highlights the evolution of the supply chain.

Table 3: Comparation of Airbus Strategy for aircraft development programs

Component	A320 & A330/40 Program	A380 Program	A350 Program
Sourcing Strategy	Outsource 10-20%	Outsource 40%	Outsource 75%
Supplier relationship	Traditional supplier relationship (No role for integrators)	Limited role for integrators	Direct risk sharing partners (tier- 1 suppliers) who can share capital expenditure, development costs and risk; A real global extended enterprise; Extended role for integrators

Number of suppliers	Many direct partners (about 300 suppliers)	Fewer, but still many direct partners	58 direct partners
Supply contracts	Design to print of parts and sub- assemblies	Design to print of parts and sub-assemblies	Design to functional specifications of large, main components or sub-assemblies

2.2. Mitigating Direct Supply Base

For the A350XWB project Airbus decided to scrutinize its control over the production line on each level (Sadauskas, 2013). In the A380 development program Airbus admitted that had some problems with its Tier II and Tier III suppliers. They were required to produce more complex parts than they had before. Airbus has selected 58 direct suppliers to coordinate 128 design-and-build work packages for A350 XWB. To reduce development time and costs for the A350, the work packages were divided into three categories: aero structures, systems and cabins (Airbus Group, 2013). Mitigating the supply base, Airbus could focus on the development and production of larger components (e.g. fuselage) with Tier 1 suppliers (pre- integration phase). It reduced work time with the second and third suppliers for procurement of raw materials or other minor problems. Airbus aim of this change was to empower its strategic suppliers to develop and produce various sections in parallel, to reduce development time.

2.3. Reducing Financial Risks

Under the A350XWB program, Airbus introduced a new risk-sharing contract considering three main aspects of procurement policy: (1) allocation of comprehensive and integrated work packages; (2) early involvement of suppliers in the process; (3) closer collaboration with suppliers (Airbus Group, 2013). This type of contract was intended to stimulate suppliers to collaborate and develop their development efforts. With the new supply policy, suppliers have more autonomy on the components development. They are responsible for the development and certification tests of work packages, which they are validated by Airbus. The suppliers are involved into the development process 12-18 months earlier than before. They are selected from concept phase to help on defining and developing new systems and components for aircraft. This type of implication have positive effects on quantitative and qualitative improvement of performance of the development program, reducing costs and development time and production. A risk sharing partnership with suppliers necessarily involves a participative sharing in the project, with rights to future sales income of products.

3. Supply Chain Risks for A350XWB

The A350XWB development program is based on lessons learned from the A380 program and it's competitor 787 Dreamliner (Bashkara, 2014). There are various risks underlying the supply chain. As shown by Sodhi and Tang (2009), there are several types of risks in the supply chain, from technology to process, from demand to risks supply as well as from computer system risks to work risks. In this section, are presented some of the risks and actual events that caused major delays in A350XWB aircraft development program, and how these risks have been mitigated.

- **Airbus A350XWB fuselage:** It is made of 53% composite, 19% aluminum, 14% titanium and 6% steel. So far Airbus never used composite material on this scale, because this mixture of materials to create a plane was not considered feasible. Also, thunderbolts are a particular danger for wings made of this composite material, because lightning can be reached by fasteners wing (Wallace, 2006). The other aircraft models of the company contain from 5% composite (A310, A330 / 40) and 25% (A380, A400M).
- **Selecting engine suppliers:** One of the important benefits for aircraft is to reduce fuel consumption. Problems arise in selecting suppliers of engines which in turn need to develop products to meet the demands of large integrators. Integrators such as Airbus and Boeing are pressured by its customers, the airlines and leasing companies. In the beginning of program, Rolls-Royce offered Trent 1000 engine version. Thus, Airbus considered as option offered from General Electric, the main competitor of Rolls Royce. After reviewing the A350 aircraft development program due to the customer demands, General Electric withdrew to supply engines for the new model A350. Rolls-Royce

has reached an agreement with Airbus to provide all versions of the aircraft with a new engine variant, known today as Trent XWB. Rolls-Royce is currently the only supplier for all three variants of A350.

- **Computer Network Security:** The latest aircraft models A350 and B787 are using both Transmission Control Protocols/Internet Protocols (TCP/IP) technology system. It transmits a variety of digital information, passenger information and entertainment systems. However, the experience has shown that this type of technology is prone to a variety of attacks (Civil Aviation Safety Authority, 2013).

4. The A350XWB Development Program Risks

Airbus has endeavoured to maintain its plan for the A350 program, to meet customer requirements. It means that changes incorporated later into production, generated additional costs for Airbus and its suppliers. These types of changes that occurred into development program, given enough trouble for suppliers. They in turn had to review their development process, putting serious pressure on their company's engineering and finances resources. The suppliers received detailed design tasks from Airbus in order to facilitate their fulfilment. Also, Airbus and its first-tier suppliers were based on smaller suppliers. They faced with the production of more complex parts and a pressure on them to start production as soon as possible (Haria, 2014). To help them, Airbus sent teams of engineers and technicians to provide technical advice and to minimize delays that have created some bottlenecks in the program. In other cases, the Airbus provided additional financial support to maintain the work of suppliers. The management team of the Airbus was even forced to purchase some of its suppliers to avoid any disturbance in the supply chain and to ensure the realization of the project just as effective as possible.

4.1. Risks of Production Process

Large delays appeared due to such development processes as: development and assembly components for wings, fuselage design completion. In case if the delivery of a section is delayed, the entire delivery schedule is also delayed. Also under the risk-sharing contract, none of the strategic partners are not paid until the certification of the first aircraft for flight. In this case Airbus sent teams to solve problems related to the supply and production of their external partners.

4.2. Risks of Management Process

As mentioned above, the first-tier suppliers are fully responsible for the entire scope of work packages, including their supply chains. Accordingly, the delivery time is quite tight, which can affect the entire value chain of A350 program development. Due to new challenges Airbus has acquired and invested into the new technologies and production processes. These technologies are very different from those used in previous aircraft programs.

4.3. Risks Jobs and Labour Protests

Expanding the outsourcing process by Airbus, Airbus employees became worried about their job security. The decision of the company to eliminate 10,000 jobs in 2007 and sell as many as six factories over the next three to four years, stopped work for two hours from four manufacturing facilities in France by 14,000 employees. There were also protests in Germany units. This decision to reduce the number of employees were aimed to save billions of euros for Airbus. Airbus faced costly delays in the production programs development for A380 and A350. Also the company confronted strong challenges from Boeing and a decreasing profit resulting in part from a weak dollar (Clark, 2007).

4.4. Demand Risks

Airbus was determined to avoid in the case of the A350 program any recurrence of the production delays and problems, based on lessons learned from previous program A380. However, there were some problems with the supply chain. They appeared because of the introduction of the new innovations that represents a step-change in technology. Thus, some of Airbus customers began to cancel the orders for the new aircraft. Some of them explained that the reason for giving up was a re-look at future fleet requirements (Cushing and Mahlich,2014). The delays in the production of A350 XWB triggered a cumulative decrease in the number of orders in both 2010 and 2014.

5. Measures Taken by Airbus to Mitigate the Risks

Based on criticism of some Airbus' biggest customers such as International Lease Finance Corporation (ILFC) and GE Capital Aviation Services (GECAS), thus Airbus proposed a new design with of a wider fuselage. It provides more space for passengers and crew (Harty, 2013). To reduce maintenance costs, the company decided to switch the fuselage frames

from aluminium to composite materials for the aircraft structure. Also, to retain the electrical continuity with the switch to carbon fibre according to A350XWB program chief engineer Gordon McConnell, Airbus decided "to fit metallic strips around the frames, which gives an equivalent electrical network to a metallic frame"(Kingsley-Jones, 2007).The composite materials reduces the weight of the aircraft and maintenance costs while offering higher cabin pressure and humidity. The company also reached an agreement with Rolls-Royce to develop a new engine variant for A350. The engine name is Trent XWB.

5.1. Supply Chain Risk Mitigation

Some of the strategic partners were faced with financial difficulties. Also, problems in managing the second level suppliers to develop the necessary components, Airbus has recognized the need to regain control of the development of the A350 aircraft. For example, knowing that PFW Aerospace AG has faced a liquidity squeeze because of the delays in the production chain, Airbus decided to buy some of its shares. According to Airbus head of aircraft programmes, PFW Aerospace AG is "a critical supplier" for airbus, including on the A350 XWB development (Hoffman, 2011). Moreover, due to production delays, some Airbus suppliers could get a significant profit loss. For example, a Spanish producer Alestis Aerospace SL, Airbus components supplier, has faced a cash crisis due to the banking crisis in Spain. In this case Airbus paid the outstanding bills of Alestis and also monitored Alestis's suppliers to ensure they get paid promptly (Michaels and Crowe, 2012).

5.2. Minimizing the risks of production process

Some suppliers had production problems. To help them, Airbus sent specialists to supervise the production process. This approach proved to be expensive. Airbus staff had to solve the supply and production problems of their suppliers. In certain circumstances, Airbus decided to purchase some of its suppliers. This decision was taken to avoid any disturbance in the supply chain and to ensure achieving more efficient A350XWB project.

5.3. Mitigating risks management

Airbus developed special relationships with suppliers to anticipate and mitigate potential problems. Airbus introduced a new approach to develop new ways to work with the suppliers known as "Extended Enterprise". A description of each supplier was made, showing its capabilities in terms of program management, engineering, configuration management, quality management, supply chain and logistics. Operating performance was also verified in terms of planning and achieving their goals. The aim of the company transformation plan is to align priorities between Airbus and supplier and to create a long-term partnership (Airbus Group, 2013).

5.4. Mitigating Labour Risks

Airbus has reached an understanding to develop a future agreement providing job security until 2020 (Zimmermann, 2011). This was aimed to put end of the strikes after months of negotiations with unions. In the new agreement, measures to improve competitiveness, few temporary contracts, better training have been mentioned. Also, there would be no compulsory redundancies for the duration of the contract. The current level of employment of permanent staff and basic tasks were maintained at the units from Bremen, Buxtehude, Hamburg and Stade.

5.5. Reducing the Risk of Losing Customers.

In order not to lose confidence of the customers in the ability of Airbus aircraft development, the company decided to revised the new aircraft. Redesigning took some time to reach the finish line and had a warmer reception, airlines and leasing are interested in purchasing it. The duration of the redesigning was about two years. In the subsequent development cycle, the design process was delayed by more than a year. Delays in the production of A350 XWB was a cause of a decreasing in the number of orders. But, Airbus managed to come back on an upward trend.

6. Conclusion

The paper analysed the risks associated with supply chain for A350XWB and the mitigation strategies applied by Airbus. There are several conclusions which can be considered in the management of the supply chains.

- The main problem of the A350XWB program problem was named by the rush to bring the aircraft on the market. The new aircraft model was criticized by several major prospective customers and Airbus decided to redesigned the aircraft. In addition, the new strategy, increased complexity of components to assume new roles and responsibilities of suppliers. If Airbus have had a team that is able to identify and assess potential risks in the supply chain, it would have helped to develop and introduce several strategies to mitigate or avoid the risks.
- Improving collaboration between the company and unions is essential for effective implementation of new initiatives, including the launch of new development programs. Also is important Airbus to have a clear communication about the new strategies adopted. Thus, the company's employees or unions representing employees can avoid protests in the workplace.
- To perform selection of the key supplier carefully, a company should consider to exchange accurate information in a timely manner. In addition, the company has to ensure that the selected supplier has the necessary capacity and commitment to fulfil the task. It is extremely risky to manage a new project overly rely on IT communication. Companies should strive to achieve complete visibility of the supply chain, to mitigate risks arising from the new partners. A clear vision of the supply chain would enhance the ability to take corrective action quickly. More likely this action reduces the negative impact of an interruption in the supply chain.
- It is essential to give a guarantee for current expectations of customers regarding the development of new products, in particular on the delays caused by different types of risks. During the development phase, it is advisable to maintain an open and honest communication with customers. These efforts could possibly improve customer long-term loyalty.
- In the A350XWB program development, Airbus has introduced a number of changes in the supply chain from traditional methods used in the aerospace industry. The main change is the outsourcing of more complex components. This involves significant potential for encountering risks throughout the process. Airbus's ongoing issues with meeting the criticism of customers are a direct result of rushing to bring the aircraft on the market. Other direct results are the design, the development process, and the supply chain associated with the A350XWB program simultaneously without having the proper management team in place. Many risks were late realized to develop coherent strategies for mitigating them. To avoid problems created in aviation supply chains, the attention of management teams is indispensable. Analyzing the way that Airbus handled the issues from the supply chain, there are some lessons for managers in any industries that can be learn.

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