

# Managing Aerospace Supply Chain Disruptions of “Outsourcing and Partnership”, “Limited Buffers” and “Poor Planning and Execution”

Iman Ziaei, Mohsen Sadegh Amalnick

**Abstract**— There are several influential risks in an aerospace supply chain which disruption is one of the most significant types. Many researchers believe that the impact of disruption is more considerable than other risks. There are three main reasons for aerospace supply chain disruption, which are “outsourcing and partnership”, “limited buffers” and “poor planning and execution”. The article explains aspects of these causes as well as related solutions for each one of them.

Improving forecast accuracy, building supply chain resilience, increasing redundancy, improving security, fulfilling postponement, adapting strategic buffer, investing in improving technology, improving system agility; are the main strategies to mitigate or prevent mentioned causes of disruption in an aerospace supply chain.

Accordingly, since each one of main supply chain approaches – lean and agile- needs diverse strategies; the final step is about the strategies, which would be reached through benchmarking among them for both lean and agile series of components and raw materials

**Index Terms**— Supply chain disruption – Aerospace industry – Outsourcing and partnership – Limited buffers – Poor planning and execution

## I. INTRODUCTION

Supply chain disruption negatively impacts the whole process. Studies by many researchers show that disruption has various aspects. The paper tries studying 3 more significant ones which impact commercial airplane manufacturing including: 1. Outsourcing and partnership (since more than 50% of components are outsourced); 2. Limited buffers (it is a solution to reduce cost of the process especially inventory) and 3. Poor planning and execution (handling more than 6 million components which a major parts of them are outsourced to so many suppliers, is complex).

The article represents different solutions for each mentioned type of disruption in order to reach a final strategy among them. In addition the differences between lean and agile products would be studied as well as several examples from two principle airplane production companies, Boeing and Airbus, will be argued to clarify the solutions in the best manner.

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Iman Ziaei, Department of Manufacturing Group, University of Warwick, Coventry, United Kingdom

Mohsen Sadegh Amalnick, Department of Industrial Engineering, University of Tehran, Tehran, Iran

## II. LITERATURE REVIEW

### 2.1 The Risk of Disruption in Supply Chain

Hendricks and Singhal (2005) argue that lean-approach fulfilment across supply chain, increases disruptions. They think that efficiency and risk within the process of supply chain work inversely and cost reduction strategies often increases the risk of disruption.

In addition, Hendricks and Singhal (2012) suggest 8 solutions to mitigate or prevent disruption, which are:

1. Improving the accuracy of demand forecasts;
2. Integrate and synchronize planning and execution;
3. Reduce the mean and variance of lead time;
4. Collaborate and cooperate with supply chain partners;
5. Invest in visibility;
6. Build flexibility in supply chain;
7. Postponement strategy; and
8. Invest in technology.

Other researchers present other solutions for supply chain disruption as well, which are:

Strategic buffer: Considering specific amount of inventory as safety stock (Pickett, 2006).

Increase redundancy: Keeping safety stock to avoid disruptions (Rice & Caniato, 2003).

Building resiliency: Capability of quick responses for disruptions (Pickett, 2006).

Increase security: Including physical, information and transport security (Rice & Caniato, 2003).

Enhance supply chain agility: Adopting the solutions which let the companies prevent disruptions through their agility (Li, et al., 2006).

In order to prevent and mitigate disruption, Sheffi (2005) suggests 4-step hierarchical framework including:

Being aware and recognizing disruption adequately;

Adopting preventive solutions;

Establishing efficient and concentrated system for response management to disruptions; and

Achievement management

The framework can represent efficient could be for mentioned disruptions and its solutions. Some of the disruptions are more influential in aerospace supply chain which are following.

### 2.2 Aerospace Supply Chain Disruption of Outsourcing and Partnership”, “Limited Buffers” and “Poor Planning and Execution

Disruption is one of the most crucial type of risk which impact on aerospace supply chain. Two causes of disruption are more influential than others; which are:

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Outsourcing and partnership: Boeing and Airbus outsource more than 50% of their components to Third Party Logistics (3PL) and other suppliers.

Limited buffers: Commercial airplane manufacturers try outsourcing the risk of inventory to their suppliers due to the high cost of inventory.

Poor planning and execution: Lack of sufficient supply-chain-management and risk-management knowledge by board of airplane manufacturers like Boeing and Airbus causes receiving ordered components at inappropriate time.

Related solutions for each one of above aspects of disruption are following:

### III. DISRUPTIONS AND THEIR SOLUTIONS

#### 3.1 Outsourcing and Partnership

In order to prevent several aerospace risks, as mentioned before, companies often outsource a part of their production which causes another type of risk, disruption. Thus, related solutions would be argued which prevent the disruption.

##### 3.1.1 “Building Supply Chain Resilience” Solution to Prevent or Mitigate Disruption of “Outsourcing and Partnership” Disruption

Pickett (2006) suggests that a high level of trust and cooperation between contributors of the supply chain precisely translates to the resiliency of the supply chain. In his opinion the following elements are significant in tackling outsourcing and partnership challenges across all tiers of suppliers:

*Establish supplier teams to monitor all critical suppliers on a regular basis.*

*Contract with backup suppliers to hedge risk where feasible and practical.*

*Use range forecasts to drive flexible contract terms with key suppliers.*

*Deploy inventory buffers to strategic locations throughout the supply chain.*

*Build robust supply chain visibility and control capabilities.*

The importance of building resiliency for business development is so much that World Economic Forum (2013) cites 5 resilience measures that companies need to consider for their business improvement; which are:

*Improved information sharing between governments and businesses;*

*Harmonized legislative and regulatory standards;*

*Building a culture of risk management across suppliers;*

*Common risk assessment frameworks; and*

*Improved alert / warning systems.*

Thus, building supply chain resiliency would be achieved through cooperation across all partners and suppliers of a system.

As World Economic Forum (2013) mentions, Boeing has been maximizing its resiliency through adopting Collaborative Planning, Forecasting and Replenishment (CPFR) system. “In CPFR, Information Technology (IT) systems are integrated to allow real-time data exchanges between supplier and manufacturer” (World Economic Forum 2013). Accordingly, Boeing sends data about inventory counts and forecasts to ins suppliers via these ERP software.

It aids the company to replenish quickly if any disruptions occur to prevent further problems due to shortages.

##### 3.1.2 “Increase Redundancy” Solution to Prevent or Mitigate Disruption of “Outsourcing and Partnership” Disruption

Rice and Caniato (2003) mention that redundancy, entails maintaining capacity to respond to disruptions in the supply network, largely through investments in capital and capacity prior to the point of need.

Redundancy is central to such efforts as managing inventory, maintaining production lines or facilities in excess of capacity requirements, committing to contracts for material supply (buying capacity whether it is used or not), and maintaining a dedicated transportation fleet.

##### 3.1.2 “Improve Security” to Prevent or Mitigate Disruption of “Outsourcing and Partnership” Disruption

Rice and Caniato (2003) typically undertake a series of security initiatives to protect their supply chain from disruption. These responses can be classified into three groups: physical security, information security, and freight security.

These groups, in turn, can be further segmented into two levels of response, basic and advanced. The basic level involves traditional activities that have become almost standard practice today. The advanced responses entail more forward-thinking initiatives, used by relatively few companies. The table below summarizes supply chain security measures at the two levels.

Table 1: Supply Chain Security Measures (Rice and Caniato 2003, 24)

	Basic Responses	Advanced Responses
<b>Physical security</b>	Access control, budget Gates, guards, camera systems	Extensive background checks Vulnerability testing by outside experts
<b>Information security</b>	Hardware: firewalls, dedicated networks, etc. Software: intrusion detection, anti-viruses, passwords, etc.	Audits of partners’ information systems (IS) security. Education and training for IS security.
<b>Freight security</b>	Inspections. U.S. government initiatives (for example, C-TPAT, Container Security Initiative, Operation Safe Commerce). Cargo Seals.	Documented standards of care: use of certified third parties, defined and vetted chain of custody. Industry initiatives to establish standards of care among shippers and carriers. Global positioning systems (GPS), radio-frequency identification (RFID), e-seals, biometrics, smartcards, sensors, etc.

### 3.2 Limited Buffers

Companies often adopt limited-buffer solution to decrease required material or components which eventuates in disruption increment due to lack of sufficient components at right time. The managers can consider the following solutions:

#### 3.2.1 “Improve Forecast Accuracy” Solution to Prevent or Mitigate “Limited Buffer” Disruption

Commercial airplane manufacturers, in order to achieve cost reduction, try decreasing their inventory. Approximately all-tiers of suppliers across the supply chain do this which causes disruptions for the final assembler who needs a part of material or component at the final assembly stage.

Improving forecast accuracy, aids all suppliers to determine the exact required number of material and component as well as safety stock to prevent disruptions.

As Hendricks and Singhal (2012) mention, suppliers have to consider the forecast error variance to find their required safety stock as well as improve their further Material Resource Planning (MRP) to avoid following disruptions.

Improving forecast accuracy helps commercial airplane manufacturers not only in determining the exact required number of components; but also to decrease the risk of disruption.

Thus, main companies in the industry have invested to improve their forecast. As Arkell (2005) claims, Boeing through utilizing advanced forecast software could decrease 300 million USD of the company and its suppliers' costs. Furthermore, since long-term forecasts follow more error, Airbus in addition to its short-term forecasts, utilizes software for its 20-year forecasts as well to improve its MRP and prevent further disruptions due to probable shortages (Euronews 2014)

#### 3.2.2 “Postponement” Solution to Prevent or Mitigate “Limited Buffer” Disruption

Commercial airplane manufacturers adopt postponement strategy due to various reasons; one of them is keeping raw material and components in lower level. For instance, Boeing through utilizing the strategy with its suppliers, could assemble its 787 model in 3 days. Poirier et al. (2009) argue that companies (such as Boeing), which adopt postponement could decrease their inventory cost up to 50% which previously had been paid for their safety stock.

Accordingly, suppliers in addition to mentioned solution, can put their production systems based on make-to-order or assemble-to-order ones to shorten their necessary for safety stock and reduce the cost of process on one hand, and reducing the disruption on the other hand.

#### 3.2.3 “Strategic Buffer” Solution to Prevent or Mitigate “Limited Buffer” Disruption

However buffers of supply chain increases the costs and risks of aerospace supply chain, Pickett (2006) suggests that recognition the components which play critical role to provide disruptions and ask suppliers to keep them as safety stock would decrease the disruption considerably.

The importance of these components came from problems such as damages, delivery at wrong time, shortages etc. Strategic buffer solution aids the company to prevent the disruption due to keeping safety stock of specific kinds of components and raw material by suppliers.

“Boeing and United Technologies Corp. have been stockpiling titanium parts from a Russian producer in case economic tensions between Washington and Moscow” (Ostrower and Pasztor, 2014).

Generally, the solution means increasing the inventory for a part of components or raw material as strategic buffer; to prevent further disruption.

### 3.3 Poor Planning and Execution

The above disruption often came from lack of supply chain knowledge of top and middle managers, interval from planning until execution as well as careless monitoring the process by supervisors. There are 2 significant solutions for it.

#### 3.3.1 “Invest in Improving Technology” Solution to Prevent or Mitigate “Poor Planning and Execution” Disruption

Commercial airplane manufacturers have invested hugely in optimizing and facilitating supply chain monitor and control software. The companies based on their requisites of each supply chain's segment; try to solve them through utilizing new software or empowering current ones.

Parke (2014) mentions; “Boeing utilizes Exostar for its design collaboration, sourcing and procurement solutions to work effectively with thousands of suppliers.”

The solution can sharply decrease the possibility of disruption occurrence and compensate lack of sufficient knowledge of managers about supply chain.

#### 3.3.1 “Improve System Agility” Solution to Prevent or Mitigate “Poor Planning and Execution” Disruption

Interval between planning until execution, is one of the main problems of supply chains to proceed the process which causes its prolongation as well.

One influential solution is improving agility of suppliers. Adopting postponement strategy as well as working with suppliers who follow make (or assemble)-to-order systems would prevent the disruption. Marbach (2012) takes an example from Boeing to demonstrate the importance of increasing agility once the company started utilizing special software for only this goal as well as predict further probable disruptions which came from lack of prolongation from planning to execution.

## IV. MITIGATION AND PREVENTIVE STRATEGIES FOR AEROSPACE SUPPLY CHAIN DISRUPTION

Three influential causes of supply chain disruption in aerospace supply chain, outsourcing and partnership, limited buffers, and poor planning and execution were studied and relevant solutions for them were mentioned as well. The final strategy based on benchmarking among them are presented below for both series of agile and lean products.

### 4.1 Mitigation and Preventive Strategies for “Outsourcing and Partnership”

Outsourcing and partnership causes supply chain disruption for both lean and agile products due to different reasons.

Since lean suppliers utilize cost reduction approach to provide competitive advantage through implementing cost-leadership strategy; occurrence of any problem across the process; causes disruptions for all-tiers suppliers. Thus data collection about the capabilities of

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second-and-higher-tiers suppliers are crucial for the companies to prevent the risk.

On the other hand, the disruption occurs for agile components due to lack of appropriate knowledge of suppliers or incapability of them to customize considered components. In order to prevent or mitigate the disruption, establishment of the monitoring teams for all tiers of suppliers to supervise the process of their production is essential. The team operates the same as Quality Teams (QTs) and its members need to have adequate knowledge about the features of components as well. Furthermore, collecting specific data about the capabilities of suppliers is essential before commencing cooperation with them.

The final strategy to prevent or mitigate the disruption for both series of components are summarized in following table:

Table 2: Disruption of “Outsourcing and Partnership” Mitigation Strategies for Lean and Agile Products

Disruption	Lean	Agile
<b>Outsourcing and Partnership</b>	Supervising all tiers of suppliers and implementing safety stock strategy if its inventory cost is justified as compared to the cost of disruption occurrence. Improving both software and hardware security.	Setting the team of supervisors to receive ordered component with considered features. Data collection about the capabilities of all tiers of suppliers before starting the cooperation with them.

4.2 Mitigation and Preventive Strategies for “Limited Buffer” Commercial airplane manufacturers and their suppliers to mitigate the inventory risk, adopt limited buffer solution. It sometimes causes disruption; there are 2 solutions to mitigate or prevent it.

Firstly, for lean components, the producer has to recognized those series of products which could cause disruptions more than others and request the suppliers to warehouse several items as safety stock for further probable disruptions (in spite of its inventory cost).

Secondly, agile components often are more critical for the final assembly process. Only one problem for one component can cause disruption for the final assembly stage. Thus, all tiers of suppliers for agile products, can prevent the risk through utilizing postponement strategy as well as improving forecasting based on previous recognized variance of errors.

Table 3: Disruption of “Limited Buffer” Mitigation Strategies for Lean and Agile Products

Disruption	Lean	Agile
<b>Limited Buffer</b>	Adopting safety stock approach for those components which have been causing more disruption.	Adopting postponement strategy and improving forecasting (based on variance of previous forecast error)

4.3 Mitigation and Preventive Strategies for “Poor Planning and Execution”

The final strategy for the mentioned disruption eventuates in Improving agility, flexibility and responsiveness of the process for both lean and agile components.

At the first step, it is essential to improve the agility of the process across all tiers of suppliers and final manufacturers. It would be achieved through cooperation with suppliers who follow more responsive and flexible production systems.

The second step, supports the first one which points out the importance of utilizing Enterprise Resource Planning (ERP) software and increasing investing in the system to integrate the process across all suppliers. It aids them to shorten the process of data sharing among suppliers in order to execute decided plans at predicted time.

Table 4: Disruption of “Poor Planning and Execution” Mitigation Strategies for Lean and Agile Products

Disruption	Lean	Agile
<b>Poor Planning and Execution</b>	Improve the agility of the process across all tiers of suppliers and final manufacturer. Utilizing Enterprise Resource Planning (ERP) software. Increasing investing in systems. Shorten the process of data sharing.	

### CONCLUSION

The risk of disruption in aerospace supply chain has several causes. The paper tries to mention three crucial parts of it which are “outsourcing and partnership”, “limited buffers” and “poor planning and execution”. Additionally, related solutions for each one of them with examples of 2 first commercial airplane manufacturers, Boeing and Airbus, were brought.

As the final strategy, benchmarking of each series of these products based on lean and agile approach were mentioned as the last part of the research. It is hoped that the research could be instrumental and practical for researchers engaged in this field for considering and realizing their various objectives.

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