

Supply chain resilience in the automobile industry: the role of cross-functional integration

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Abstract

The purpose of this study is to analyze how cross-functional integration processes could be implemented in order to support resilience management initiatives in an automobile supply chain. A multicase study was conducted with eighteen managers from different hierarchical levels, who work in six organizations in the same automobile supply chain. Findings show evidence that cross-functional integration impacts supply chain resilience in the studied chain, helping to solve or avoid disruptions or improving capabilities such as flexibility, visibility, agility and collaboration.

Keywords: Resilience, Cross-functional integration, Automobile Supply Chain.

Introduction

Over the years, companies have been facing many challenges, including the management of global supply chains. In this context, factors, such as economic instability, disasters and sociopolitical and environmental changes present risks of disruptions in the supply chains (Pettit *et al.*, 2010). Thus, there is a need for resilience, i.e. the capacity to deal quickly with change, recovering from a disruption or other event affecting the supply chain (Christopher & Peck, 2004). This is achieved both by the existence of capabilities in the supply chain that can reduce vulnerabilities (Pettit *et al.*, 2010), and by the knowledge gained from previous disruptions, facilitating a faster and more efficient response to certain events (Kendra & Wachtendorf, 2003).

Although the literature has discussed resilience broadly, there is a gap on connecting this subject with the integration theory, especially regarding cross-functional integration. Several authors mention the influence of cross-functional and resilience capabilities, such as: positive impact on collaboration (Kahn & Mentzer, 1996), visibility (Christopher & Peck, 2004), agility (Braunscheidel & Suresh, 2009) and flexibility (Schoenherr & Swink, 2012), which are resilience capabilities discussed in literature besides adaptability (Pettit *et al.*, 2010) and redundancy (Kendra & Wachtendorf, 2003). However, despite of some authors tried to somehow link these theories, there is no deeper investigation about how the connection between cross-functional integration and the supply chain resilience works. Thus, the purpose of this study is to analyze how cross-functional integration processes could be implemented in order to support resilience management initiatives in an automobile supply chain.

Literature review

Currently, an expansion of supply chains is happening, both in terms of complexity and size. As a result of this expansion, disruptions may rise, affecting the performance of the

chain (Blackhurst *et al.*, 2011). In order to understand how to minimize the impact of these disruptions, the supply chain literature has discussed about resilience.

Resilience is the ability to quickly deal with the changes, managing to recover from a break in the supply chain (Christopher & Peck, 2004). This is achieved both by the existence of capabilities in the organization, that can reduce vulnerability (Pettit *et al.*, 2013), and by acquired knowledge of events suffered earlier, providing a faster and more efficient response to certain events (Kendra & Wachtendorf, 2003).

The capabilities can be understood as attributes, or characteristics, which are necessary to prevent and mitigate disruptions in the chain, as well as to facilitate the adaptation before the event (Pettit *et al.*, 2010). Among the capabilities discussed are: Redundancy, Flexibility, Visibility, Agility, Adaptability and Collaboration.

Redundancy indicates that the organization must reserve resources in order to maintain their ability to respond to any disruptions in the chain (Rice Jr. & Caniato, 2003; Sheffi & Rice Jr., 2005; Soni *et al.*, 2015). Flexibility can be separated into two capabilities: flexibility in supply, related to how fast the company is to change aspects about the entries, and flexibility in order fulfillment, which is linked to the change of outputs or how deliveries are made (Pettit *et al.*, 2010). The visibility involves the ability to recognize breaking threats (Blackhurst *et al.*, 2011), existence of knowledge on demand (Chopra & Sodhi, 2004), monitoring and sharing information (Jüttner & Maklan, 2011). Agility is a capability that allows responding quickly to changes in the organization or in the supply chain (Braunscheidel & Suresh, 2009).

Adaptability is the ability to make changes in the operations to meet the challenges and take advantage of emerging opportunities. Collaboration is characterized by collaborative forecasting, relationship management with customers and efficient internal and external communication (Pettit *et al.*, 2010). There is a close link between the collaboration capability and the literature of cross-functional integration in relation to the formal aspects (interaction) and informal (collaboration) relations (Kahn & Mentzer, 1996; Ellinger *et al.*, 2000). But it is important to highlight that collaboration is addressed comprehensively in the literature about resilience, involving both the internal relations in an organization and external relations among companies in a supply chain. Moreover, Pimenta *et al.* (2016) have initially discussed about the influence of the cross-functional integration on the resilience of the supply chain.

Cross-functional integration brings about the alignment between departments, and takes place through interaction and collaboration, that are processes discussed by Kahn (1996), Kahn & Mentzer (1996) and Kahn & Mentzer (1998). The process of interaction is a more formal perspective, among which are the memos, planned conference calls, the flow of documents and conferences. In the collaboration processes, the informality predominates, involving: group spirit, teamwork, common vision, mutual understanding and respect between areas (Kahn, 1996; Kahn & Mentzer, 1998).

Pimenta *et al.* (2016) highlight that cross-functional integration between logistics and marketing may bring benefits, such as avoiding products disruptions in the market, avoiding delivery delay and preventing sales above the logistical capacity. These benefits could be indications that the cross-functional integration may impact the resilience of the supply chain, as mentioned by Braunscheidel & Suresh (2009, p.123): “internal integration, which refers to inter-functional and interdepartmental integration, may also lead to a connected and more coordinated response to marketplaces changes and disruptions”. Furthermore, the internal integration improves organizational performance, since it allows efficiency in decision making, increased visibility and reduction in uncertainty (Swink & Schoenherr, 2015).

Research method

A multicase study was conducted in a global manufacturer of automotive parts, as well as in some of its suppliers and industrial customers. This sector was chosen because of its importance to the Brazilian and to the world economy and also due to its complexity. Besides, few studies in resilience literature were found contemplating the automobile industry. Two suppliers, one focal company and three business customers were investigated. In overall, these chain members are linked by one product: clutch.

Data collection

Data was collected through eighteen in depth interviews with people from different hierarchical levels (Table 1), who work in six organizations in the same automobile supply chain. The interviews were semi-structured, lasting about one hour on average. The main topics discussed in the interviews were: 1) Cross-functional integration factors, that is, the mechanisms that generate integration; 2) Supply chain disruptions and capabilities; 3) Features that link cross-functional integration and resilience.

Table 1 – Characteristics of the interviewees

Organization	Function	Time in the company	Time in the function	Job title
Supplier 1	Sales	> 10 years	0 to 5 years	Manager
Supplier 2	Sales	> 10 years	> 10 years	Analyst
Supplier 2	PPC	> 10 years	5 - 10 years	Analyst
Supplier 2	Purchasing	> 10 years	5 - 10 years	Manager
Focal company	Supply Chain	> 10 years	0 to 5 years	Manager
Focal company	Logistics	> 10 years	0 to 5 years	Manager
Focal company	Purchasing	> 10 years	0 to 5 years	Manager
Focal company	Sales	> 10 years	> 10 years	Manager
Focal company	Supply Chain	5 to 10 years	5 - 10 years	Supervisor
Focal company	Sales	> 10 years	5 - 10 years	Supervisor
Focal company	Purchasing	> 10 years	0 to 5 years	Supervisor
Focal company	Sales	0 to 5 years	0 to 5 years	Analyst
Client 1	Purchasing	> 10 years	5 - 10 years	Supervisor
Client 2	Engineering	> 10 years	5 - 10 years	Supervisor
Client 3	Product Engineering	5 - 10 years	0 to 5 years	Manager
Client 3	Internal Logistics	> 10 years	0 to 5 years	Supervisor
Client 3	PPC	> 10 years	0 to 5 years	Supervisor
Client 3	Sales	5 - 10 years	5 - 10 years	Supervisor

The interviewees were asked to describe their roles in the respective company, how many years they work in that company and in their roles. Then, we asked about the main disruptions in the supply chain and which capabilities are well developed in the chain. Finally, they pointed which cross-functional integration factors are frequent in their companies and an overall discussion was made: we asked them if the cross-functional factors could avoid or help to solve the disruptions in the supply chain, so we could verify the impacts of internal integration on the supply chain resilience.

Data analysis

The interviews were audio recorded and submitted to content analysis according to Bauer & Gaskell (2002) and Bardin (2008): 1) Transcription of recorded interviews; 2) Data pre-analysis, reading the transcripts in order to identify possible units and categories of analysis based on the literature review; 3) Codification of data, analyzing and separating data in units; 4) Categorization of data units; 5) Quantification of data units and categories based on to the frequency in which they were mentioned.

Findings

This section presents the characteristics of the cross-functional integration factors, the supply chain disruptions and capabilities, as well as the features that link cross-functional integration and resilience in the studied supply chain.

Cross-functional integration factors

The five most common integration factors among focal company, suppliers and customers are: cross-functional meetings, cross-functional training, longevity of relationships, adequate communication and consideration of the informal workgroups.

The cross-functional meetings are usually periodic in the supplier organizations. Areas such as Quality, Purchasing, Engineering and Logistics usually meet once a week (Purchasing Manager - Supplier 2). These meetings are both formal and informal, and there is a clear perception that they help to integrate areas according to the interviewees. It also happens in the Supplier 1, where these meetings stimulate the interaction among people from different functions and facilitate problems solving.

There are formal meetings, but people also seek to solve problems when they occur. Meetings generate integration and people, although new in the company, end up entering this routine (Sales Manager - Supplier 1).

In the focal company, the meetings occur weekly and usually involve senior management people. They discuss topics that require more attention, or problems that need to be addressed most urgently. "The decisions and changes are top down, so when there are meetings for troubleshooting, if the key people are present, the guidelines for problem solutions tend to be more clear to all" (Sales Analyst – Focal Company).

In all the client organizations, there are daily meetings with all the production team, with the main objective to find solutions to emerging events that impact on operations (Product Engineer & PPC Supervisor – Client 3). These meetings are not only scheduled, since it also occurs informally when there are unexpected problems. These meetings help to develop adequate communication because "the more areas are integrated (through meetings), the greater the possibility of not having a lack of adequate information" (Engineering Supervisor – Client 2). Cross-functional education and training is usually a formal and frequent practice in the supplier organizations. The interviewees of these companies believe that the greater the knowledge about the process, the greater the contribution of the employees to solve problems.

They have focused on training and workshops about organizational culture. What do we have? Formal training. And our culture preaches integration, working in teams. It often occurs because we have this knowledge about integration, it is very clear (Sales Manager – Supplier 1).

In the focal company, training can be performed in a single department or involve several ones. And it helps to reach mutual understanding between the areas, to figure out the daily difficulties of each function (Purchasing Manager & Supply Chain Supervisor – Focal Company). However, the content of the training is more focused on technical aspects, and people are involved in the practical process (Engineering Supervisor – Client 2).

The longevity of relationships, in turn, is generally linked to another integration factor: trust level. In all the studied companies the respondents believe that working together for a long time led to better know the people and to develop trust in each other (Supply Chain Manager & Purchasing Manager - Focal Company; Engineering Supervisor - Client 2; PPC Supervisor & Product Engineer Supervisor - Client 3). In addition, some interviewees consider their co-workers as friends, even outside of the office (Supply Chain Manager, Logistics Manager, Purchasing Manager – Focal Company). Others just keep formal contact at work: "Yes, I know the staff for about 10 years and my contact is only formal" (Engineering Supervisor – Client 2).

About the adequate communication, the interviewees perceive freedom to dialogue with different functions in their organizations, irrespective of the hierarchy demands. In addition, communication is more informal. This behavior is encouraged by managers, which indicates that this integration factor is related to another: the senior management support. "If you arrive on his desk (manager) and he is not, we call him and say: 'where are you?'. And he responds: 'I'm in the factory, besides the press. So I run there'" (PPC Analyst – Supplier 2).

The integration factor 'consideration of the informal working groups' has an active role in encouraging cross-functional integration. This is noticed in reports like these: "we have to focus on what is important. Leadership has this role of direct actions, to place, to inspire people to be integrated and work in a more integrated way" (Sales Manager - Supplier 1). "He (her manager) encourages you talk to your peer areas to be able to solve the problem" (PPC Analyst – Supplier 2).

Supply Chain Disruptions and Capabilities

In studies involving supply chain, several events that negatively impact its flow were identified, causing disruptions. Often, these events occur within a single company, but, depending on their characteristics, they affect everyone in the chain. Moreover, they were also identified different causes for the same break in the chain.

In the Supplier 1, the major disruptions are: delivery delays and lack of product on the market (Sales Manager – Supplier 1). In the Supplier 2, the respondents indicated as disruptions: bankruptcy of suppliers, lack of product, delivery delay and production stop due to strikes. The processes related to these disruptions are production processes and transportation. Respondents from the focal company, similarly, indicated as main disruptions in the chain: delivery delays, lack of product, bankruptcy of suppliers and production stop due to strike. In the Customer 1, interviewee mentioned about lost sales and lack of product. Additionally, in the Customer 2, it was mentioned: lack of product and delivery delay.

The most cited disruptions among all interviewees were: delivery delays, lack of product, production stop due to strikes, bankruptcy of suppliers and lost sales. The main problems that cause these disruptions are: fluctuation in demand, financial crisis, problems in internal communication, strike, fails in the production schedule and fails in the customer attending demand in terms of quality or quantity.

Six capabilities were identified in the studied chain: redundancy, flexibility, visibility, agility, adaptability and collaboration. Overall, respondents from the various organizations agreed that these capabilities are present in the chain, but with different degree of importance due to the characteristics of the organizations and industry. According to the literature, the presence of capabilities indicates that the supply chain is less susceptible to vulnerabilities (Pettit *et al.*, 2013) and more able to cope and adapt itself to events that may cause disruptions.

Among the capabilities above mentioned, redundancy was the less highlighted in all chain links. It occurs through safety stock (Rice Jr. & Caniato, 2003; Sheffi & Rice Jr., 2005; Soni *et al.*, 2015; Bradaschia, 2015) and overtime, when necessary. However, the occurrence is low, due the dynamics of the industry and the high costs of idle capacity.

Even though, there are arguments that redundancy is important and can bring agility in meeting the demand. Most of the interviewees believe that the chain prioritizes flexibility at the expense of redundancy. In spite of the costs of maintaining stocks, it is important do consider the demand fluctuations and the strategic choice of adapting the capacity to the market needs.

We have fewer parts in stock, than compared to a while ago. Because it involves money, right? It is expensive nowadays, everything is very expensive, the raw material is very expensive, storage is very expensive. But we have a minimum security stock for any eventuality and we do not let the customer without product, right? (Purchasing Manager – Supplier 2).

Corroborating the definitions of Pettit *et al.* (2010) about the flexibility, respondents agree that there is flexibility of supply and order fulfillment when alternative transportation is required. The interviewees from the three links (suppliers, focal company and customers) say that usually there are no problems for delivery and receipt of materials. Although the costs of air transportatiton are higher than sea or road, there is a priority to meet deadlines to avoid disruptions.

Regarding transportation, the company usually has 2 or 3 pre-registered suppliers, so we have the flexibility to change as needed. But the biggest limitation is Supply Chain, the chain of suppliers. If you are a supplier in China, you will have to continue importing it whatever happens (Supply Chain Manager – Focal Company).

However, some respondents pointed out that it is difficult to change product suppliers. It requires a long time analysis and involves breaks of contracts and overall adjustments (Supply Chain Manager – Focal Company & PPC Supervisor – Client 3). Visibility is related to the attention on the productive (PPC Analyst – Supplier 2) and logistics capacities (Supply Chain Manager – Focal Company), information sharing (Sales Analyst – Supplier 2), demand visibility (Purchasing Manager – Focal Company & Sales Supervisor – Client 1).

This year we have made a research with all suppliers about the volume that we intent to produce in the next year, month by month, including volume fluctuations, to have the assurance that the planning would be covered by the suppliers (Sales Supervisor – Client 1).

Overall, the respondents consider that there is visibility in the chain and it is useful at various times to prevent disruptions. However, it is not always sufficient due to the

dynamics of the market, that often presents variations, and sometimes the suppliers cannot deliver the product in time.

With regard to agility, it is relative to the majority of respondents. There are cases in which the disruptions can be resolved quickly, others not so much, as in the case of demand fluctuations. Many suppliers are international, composing a long supply chain. This fact increases the risk in failure to supply the products in time due to the long time necessary to to perform production and transfer of goods. Another factor is that you may need extra production capacity and, sometimes, the equipment may not be available. However, in situations currently experienced, respondents generally argued that organizations can be agile, and this agility is trasfered to the chain.

Sometimes we are responsive enough and can react overnight. For instance, I suddenly have a supply problem with a material, but I have an international source that I can chase, bring air route, have some stock available in some unit (of the focal company). I can react in a fast and agile way, right. But, there are complicated things, such as: I suddenly have a very high demand from a client, I need to buy new equipment and the equipment is not available in the market, it has a production lead time (Purchasing Manager – Focal Company).

On adaptability, there are respondents who believe that it is a cultural issue, because is closely related to the Brazilian culture itself: “the Brazilian adapts easily to any situation, irrespective if it is good or bad” (Purchasing Manager – Focal Company). Although changes do not always occur quickly, organizations participating in the studied chain can adapt, either through substitute materials/equipment, process changes, or even through organizing workteams to overcome disruptions.

We had an example last week, a supplier had an internal problem with its equipment. And that would create such a supply disruption. The lack of material would stop our line, the result could even stop our clients line. So, we decided to send some technicians (from the Focal company) to help the supplier with maintenance of equipments and to give support for daily production (Purchasing Manager – Focal Company).

Finally, about collaboration, “There is collaboration, we all depend on it, there is a survival instinct” (Purchasing Manager – Supplier 2). “Internally, the departments are the suppliers” (PPC Analyst – Supplier 2). “They seek to organize themselves and help each other in times of urgency” (Logistics Manager – Focal Company), which is also made externally, with the focal company (Sales Manager – Supplier 1).

We have a good relationship, we have a collaborative culture. When we have a problem, we inform the customer and he/she tries to help us to solve the problem. It's the same when the customer has a problem and asks for some action of our company and we do the possible and the impossible to meet. For our company, I see that there is a big alignment to resolve a disruption, customer service is a priority (Sales Manager – Supplier 1).

These descriptions corrobotate the positioning of Braunscheidel & Suresh (2009), because the capabilities are relevant not only in the supply chain, but also internally, in the organizations that compose it. If each link in the chain is not taking its role, the chances of having a resilient chain are low.

The link between cross-functional integration and supply chain resilience

During the analysis of the interviews, some integration factors were identified. They can help to prevent or overcome disruptions, collaborating to develop capabilities in the supply chain. Although it involves an internal action in the organization, these initiatives impacts directly on the rest of the chain.

Among the integration factors that impact resilience in the studied chain, adequate communication “help to look for solution together, seeking alternatives” (Supply Chain Manager - Focal Company). According to some respondents, it can be related to agility (Supply Chain Supervisor – Focal Company). If there is clear communication, there is a possibility to “work based on the numbers, on the demands. So this communication helps the things to happen quickly. So the consequences are quick too. Like a preventive action” (Supply Chain Supervisor – Focal Company). This integration factor can also improve adaptability (Product Engineering Manager – Client 3)

The worker is realizing that he has a better way of welding the chassis, for example, so he can informally talk directly to someone from the quality or process engineering, so that his operation has an improvement. So, I like this informal communication and not only with the staff, but with the people from several areas (Product Engineering Manager – Client 3).

Integration factors, such as: recognition of cross-functional interdependence, joint planning, information sharing and cross-functional meetings can collaborate for greater visibility. With regard to the recognition cross-functional interdependence, the focal company processes are well defined and safe, due to the audit processes.

It (the audit) brings security to the processes, it brings visibility because the processes are well defined and clear. It is a risk management, for example, you asked me about the disruption, I have to show the audit, for example, as I manage a risk, a risk that may occur, so I have to plan contingencies for everything you can imagine: the scheduling process, several processes that are even audited by customers (Supply Chain Manager – Focal Company).

Information sharing can lead to greater visibility due to learning: when experiences are shared, the chances of happening the same breaks decrease, therefore, it is possible to avoid the problem (Supply Chain Supervisor – Focal Company). Joint planning and cross-functional meetings help to have greater visibility of demand.

Planning together allows an alignment of demand, which involves need of material, suitable raw material, which will consequently generate a supply of this raw material on time. Thus, if everything works, there will be a production in time, delivery in time, in short, until the end of the flow. The better the information the better the performance (Supply Chain Manager – Focal Company).

The cross-functional meetings help to increase visibility, because through it, the problems related to a potential or a manifest disruption are presented. Moreover, people from different functions seek for a solution with a greater diversity of knowledge and data. In these meetings, managers and key members of the board participate, with power to decision (Supply Chain Manager – Focal Company).

The longevity of relationships, in turn, brings greater knowledge and trust in the workteam. With it you can better understand people's actions in a case of disruption, facilitating its resolution (Supply Chain Supervisor – Focal Company). For example,

there are whatsapp groups among internal functions and with other companies in the chain, which allows communication to flow without much formality. Everyone can be involved and seek to solve the problems related to the disruption (Supply Chain Manager – Focal Company). Moreover, this factor can also lead to collaboration:

Longevity of relationships leads to internal collaboration: If you know the developer here, he's projecting a part on a particular supplier that is generating too much trouble. So, you evaluate what you need to do a job together with a colleague from another area. If you do not know the other person, I imagine that you'd have more difficulty. Then, longer relationships lead to greater collaboration (Purchasing Supervisor – Focal Company).

Another integration factor that can lead to collaboration is the consideration of the informal working groups, as there is an exchange of experiences and the recognition that functions are interdependent. In addition, it helps to overcome disruptions, as it “improves the flow of information and helps to inhibit certain conflicts” (Supply Chain Manager – Focal Company). For example, the presence of this factor helps to avoid delivery delays and lost sales. “Sometimes the revenues are above the average or the number of deliveries increases, and the expedition has few people to run. So the other areas lend people. So, people go there and give an extra workforce” (Supply Chain Supervisor – Focal Company).

Agility can be developed through the support of senior management and cross-functional meetings. The top management encourages integration. They highlight the importance of the guidelines, creating greater clarity and involvement. “It helps to overcome disruptions. When things are clear, functions are well informed, we can solve problems quickly” (Supply Chain Supervisor – Focal Company).

With regard to cross-functional meetings, they “help, because if anyone knows any other strategy, any alternative material or some source that reacts faster, a better strategy can emerge from the collective” (Supply Chain Supervisor – Focal Company). The exchange of ideas in the cross-functional meetings may provide solutions that will quickly meet the problems that impact the supply chain, leading to agility.

According to the data from the studied case, irrespective of the problem that generates the disruption, it is often necessary that initially actions are taken internally in an organization. Consequently, all others companies in supply chain would be benefit, both by avoiding or overcoming disruptions, or even developing capabilities. The cross-functional integration is as important as the external integration to achieve resilience in a supply chain. Therefore, in the studied chain, the resilience of the chain is dependent on the organizational resilience.

Conclusion

This research attempted to contribute to both cross-functional integration and resilience literature, assuming that the former could collaborate with the latter according to evidences in other studies (Christopher & Peck, 2004; Schoenherr & Swink, 2012). Specifically, this research contributes to the advance of resilience studies in Brazil, presenting a case in a sector poorly discussed in resilience literature: the automobile supply chain. The results showed that it is possible to improve resilience through cross-functional integration, which means that although external relations or external integration used to be highlighted in supply chain studies involving resilience, the internal relations of each company matter just as much and should be more investigated.

The supply chain works as a system which has sub-systems that must be organized and be in harmony with each other in order to keep the processes functioning. The main contribution of this research is to reveal how cross-functional integration factors may impact on supply chain resilience, helping to solve or avoid disruptions or improving capabilities such as flexibility, visibility, agility and collaboration. Moreover, in the studied chain, the resilience of the chain is dependent on the organizational resilience.

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