Supply Chain Agility: Review of Situations

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Abstract: Supply chains are often exposed to internal and external disturbances, events and changes, i.e. *situations* that harm their performance and present a serious threat to their subsistence. Agility, which is often presented as the ability to cope rapidly and effectively with changes become a competitive advantage for supply chains and is of vital competence. Different Authors mentioned external pressures that motivate supply chains to acquire agile capabilities. However, a well-structured study of external and internal situations needing agility was not found. The aim of our study is to review the existing literature on supply chain agility to better understand this concept and propose an overview of situations requiring supply chain agility, based on academic and industrial work.

1 INTRODUCTION

In the last decade, the economic environment witnessed a period of growing challenges and risks. Globalization opened doors for a greater competition between companies to win greater market shares. Innovation and fast technological development lead to larger assortments and shortened product life cycles. Customer behavior become more unpredicted due to the growing impact of media and social networks. In this volatile and hostile economic landscape of now a day, any disruption or inability to cope rapidly with changes can have risky consequences. Therefore, the agility, defined as the ability to rapidly respond to changes in market and customer demands (Sharp et al., 1999, Christopher and Towill, 2001, Christopher, 2000), become a highly-recommended competency for supply chains. The literature related to supply chain agility has been largely increased in the two last decades. Starting by defining the concept and its relation with supply chain performance (van Hoek, 2001, Yusuf et al., 2004), researchers defined the characteristics of agile supply chains (Giachetti et al., 2003, Christopher, 2000). The first step to reach an agile supply chain is to study supply chain internal and external environment and identify circumstances that can lower its performance (Lin, 2006, Yusuf et al., 1999). Starting from a good understanding of such factors would enable to design appropriate technological and managerial tools and techniques that would allow supply chains to be agile.

We define situations needing agility (SNA) as the sudden external and internal disturbances and changes that can lower the supply chain performances, temporary or sustainably, and consequently, require an agile response. To be able to propose new tools and approaches for SC agility, we first need to better understand why the supply chain needs agility, i.e. what are the potential situations that require agility. Therefore, the aim of this paper is to review the situations mentioned by different authors in the context of supply chain agility and supply chain risks.

2 SUPPLY CHAIN AGILITY

Agility can be defined as the continual readiness of an entity to rapidly or inherently, proactively or reactively, embrace change, through high quality, simplistic, economic components and relationships with its environment (Conboy and Fitzgerald, 2004). In fact, the need for agility in supply chains and manufacturing systems comes from the inability to predict the future and its changes. Despite the progress in forecasting and business intelligence, companies still suffer from internal and external sudden events that can harm their productivity and their position in market if they don't react rapidly and effectively. Thus, Sudden changes may be a harmful incident for a company and could be an opportunity for others (Sharifi and Zhang, 1999).

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(Sharifi and Zhang, 1999) used the word drivers, which means factors that causes a particular phenomenon to happen or develop (2018b), to describe internal and external pressures challenging to improve competitiveness and overall business performance. Those drivers were used for the supply chain context by (Lin, 2006) (Sharifi and Zhang, 1999). They identified five main agility drivers: Customer requirement, Competition criteria, market, technological innovation and social factors. (Sharifi and Zhang, 1999) presented a detailed list of changes as sub-items of those general drivers. A list that was updated later by (Zhang, 2011) Table 1 :

Table 1: Supply chain agility drivers (Zhang, 2011).

Change in market place	Growth of niche market Open new market Close of market Increasing rate of product models Product lifetime shrinkage Decreasing cost of entering niche market
Change in competition basis	Rapidly changing markets Increasing pressure on cost /profitability Innovation rate increasing Increasing pressure of global competition Decreasing new product time to market Responsiveness of competitors to changes Effectiveness of competitors' strategy, marketing, distribution, service...
Change in customer requirements	Individualizing products and service Quicker delivery time and time to market Quicker expectation increase Increasing value of information/services
Change in technology	Faster pace of development of product technology Faster pace of development in process technology Faster development of ICT technology
Change in social factors	Environmental pressure Workforce/workplace expectation Legal/political pressure Social contract change

The word driver or context used by most of researches describe sources of changes and fluctuations and not specific events that supply chains can face and need to be responded quickly and effectively. We prefer to use the word situation which means the set of things that are happening and conditions that exist at a particular time and place (2018a). Variability in demand and supply is an inevitable characteristic of economic systems. Yet, agility is considered by many authors as the ability to cope with unexpected changes (Li, 2015, Verma et al., 2012, Arteta and Giachetti, 2004). Thus, situation needing agility are characterized by their suddenness and present a higher impact on supply chain performances than recurrent operational variations. Therefore, we define situations needing agility in the context of supply chain as the external and internal sudden disturbances and changes that can lower supply chain performances, temporary or sustainably, and consequently, require an agile response. This definition includes both risks and opportunities. We consider that a non-taken opportunity affect the competitive performances of a supply chain.

Agility drivers were used in fact to justify the need for agility and describe the economic and manufacturing environment pushing supply chains to acquire agile abilities. (Zhang and Sharifi, 2000) (Lin, 2006) (Tseng and Lin, 2011) used agility drivers as a starting point to identify agile providers or enablers, defined by (Gunasekaran, 1998) as technological (e.g., information integration) and structural tools (e.g., Customer/marketing sensitivity) and techniques needed so that the system can be able to adapt to changing market conditions. Few works on SCA tried to assess quantitatively drivers and their impacts on supply chain. (Zhang and Sharifi, 2000) proposed a scoring model assessing impacts of supply chain drivers on the supply chain performance (Low, medium or high effect) in order to evaluate agility needs and identify the importance of required providers and (Tseng and Lin, 2011) used fuzzy logic to evaluate agility drivers in order to give weights to related providers to assess the overall supply chain agility.

Most of supply chain agility works (Lin, 2006, Iskanius, 2006, Jain et al., 2008, Agarwal et al., 2007) were based on findings in the context of manufacturing agility and enterprise agility (Sharifi and Zhang, 1999), rather than supply chain and they focused more on external pressures and changes (e.g. Market, Customers, technology…). In fact, Supply chains have a more complex configuration and are also exposed to many internal factors that need agility. Many risks are linked to supply chain internal operations like transportation, manufacturing and holding. A disruption in any of those operations can lead to a whole supply chain disturbance. Furthermore, Change factors related to supply chain partners, suppliers and sub-contractors, were also missing in the list presented by (Zhang, 2011). Yet, it is evident that suppliers and sub-contractors play an important role in the maintenance and prosperity of supply chains.

Consequently, we consider that we need a more detailed, exhaustive and well-structured list of internal and external disturbances that supply chain managers deal with.

3 SITUATIONS NEEDING AGILITY

To prepare a list of common situations requiring agility in the supply chain context, we conducted a research on situations mentioned in works on supply chain agility, supply chain risk papers and industrial reports.(Sharifi and Zhang, 1999) recognize that, due to the complexity of the manufacturing environment, an exhaustive general list could not be easily determined and every manufacturing system has his challenges, risks and opportunities that push to adopt agile capabilities. We present first different categorizations used by authors to classify situations and risks in the context of supply chain. Second, we propose a list of situations needing agility based on the supply chain main activities: Demand, process and supply.

3.1 Classification

Many classifications of situations affecting supply chains were found in the supply chain risks literature Table 2. Some propositions focus on characteristics of the situation. First, normal or operational situations resulting from breakdowns in internal procedures, people and systems. Second, abnormal accidents resulting from exogenous factors (e.g. Natural disasters, terrorist attacks, financial crashes...) (Mitroff and Alpaslan, 2003, Kleindorfer and Saad, 2005). (Gaonkar and Viswanadham, 2004) suggested to categorize situations depending on the parameter affected by the variation (i.e. demand, supply, procurement, production and logistic costs or transportation and production lead-times) while others classify situations under the dimension of the parameter affected (i.e. Volume, quantity or time) (Baker, 2008). (Li and Li, 2010, Khayyam and Herrou, 2017, Li et al., 2013) Suggested a classification based on supply chain activities (demand, supply and process). Most of these works are from supply chain risk literature and they used these categorizations to evaluate supply chain risks from different perspectives. The aim of our study is to prepare a structured list of situations in order to identify the proper agility enabling levers. Therefore, we choose for this paper the categorization used by (Khayyam and Herrou, 2017, Li et al., 2013). We classify situations depending on the functional areas affected (i.e. Demand, Process, Supply). Demand situations are to identify and to study in cooperation with marketing, customer services, distribution, business intelligence or sales departments. Process situations affect mostly production, logistics and inventory activities. Finally, we study situations linked to suppliers and sub-contractors.

Table 2: Situations categorizations.

Categorization		Source
Normal accidents Economic crises Physical crises Personnel Crises Abnormal accidents Criminal crises Information crises Reputation crises Natural accidents		(Mitroff and Alpaslan, 2003)
Operational risk Disruption risks (abnormal events)		(Kleindorfer and Saad, 2005)
Variations in demand Variations in supply Variations in procurement, production and logistic costs Variations in transportation and production lead-times		(Gaonkar and Viswanadham, 2004)
Volume variance Time variance. Quantity variance		(Baker, 2008)
External Nature Political system Competitor and market Internal Capacity Internal operation Information system		(L. and Desheng, 2010) (Bochao, 2010)
Customer risk: Supplier risks Manufacturer risks Distributor risk		(Zhang et al., 2016)
Supply risks Process risks Demand risks		(Khayyam and Herrou, 2017, Li et al., 2013)
Financial risks Strategic risks Operational risks; Compliance risks.	High Medium Low level	(Boscal et al., 2010)
Environmental factors Industry factors Organizational factors Problem specific factors Decision-maker factors		(Rao and Goldsby, 2009)
Supplier Intern Customer Consumer Competitor Macro environment		(Linder, 2013)
Change in market place Change in competition basis Change in customer requirements Change in technology Social factors		(Zhang, 2011, Sharifi and Zhang, 1999)

3.2 Demand Related Situations

Variation in demand is the situation mentioned in almost all the supply chain agility and the supply chain risk literature. The market interest for a product can show many variations over the time in response to changing economic conditions and consumer spending patterns. Orders can change in quantity but also in time, composition, cost and delivery place (Baramichai, 2007; Tseng, 2011). Supply chains managers should take into account changes in customer's requirements, behavior, and business strategy (Khayyam and Herrou, 2017). Competition is an important factor of demand fluctuation. Agility in needed in response to the entrance of a new competitor, a new product or a new technology (Linder, 2013). Supply chains should respond rapidly to threats but also opportunities like the opening of new markets and new distribution channels (Linder, 2013). Exogenous factors like exchange rate and changes in regulations can affect international markets. Table 3 shows a number of demand situations found in the literature.

Table 3: Demand situations.

Demand Situations	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Demand Variation	X	X	X	X		X	X	X
Order cancellation	X					X		
Late order	X	X				X		
Change of customer requirements	X	X		X				
Product substitution			X				X	
Packaging change			X		X			
Forecast error		X					X	
Product failure		X						
Customer loss		X	X					
Change of customer business strategy			X					
Laws and regulations change			X			X		X
New product introduction		X	X				X	
Price changes / promotions		X						
Exchange rate change							X	X
New competitor entering			X	X				
New distribution channels			X					
New markets			X					
Change of delivery time				X	X			
New technology				X			X	

3.3 Process Related Situations

Supply chain process includes manufacturing, holding and transportation operations. Managing situations linked to these operations is vital to maintain or improve supply chain performances. Many sudden changes are linked to these activities. Manufacturing managers are asked to deal continuously with capacity problems, forecast errors, changes in production planning and variations in lead times. Such problems can lead to delivery delays and market opportunity loss. Many incidents can be source of manufacturing and transport break downs (e.g. Labor accidents, strikes, equipment failures, quality problems, terrorist attacks and natural disasters). Risks liked to Information and telecommunications systems become, now a day, a serious factor of supply chain disruption. In fact, (BCI, 2015) reported that top three causes of disruptions, according to a large number of supply chain managers, are Unplanned IT outage, Cyber-attacks and adverse weather. We show in Table 4 situations needing agility linked to supply chain process found in the literature.

Table 4: Process situations.

Process situations	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Capacity Problem	X	X	X		X	X	
Forecast error	X	X			X		
Labor problems(strike)	X	X			X	X	X
Loss of talent							X
Change in delivery time	X						
Manufacturing breakdowns	X		X		X	X	
IT breakdown	X	X	X		X		X
Cyber attacks	X						X
Product quality problems		X			X		
Inventory shortage		X	X				
Shortage of resources		X					
Human /process error			X				
Planning change/Delays			X		X		
Equipment failure			X				
Product failure			X				
Accidents/Fire		X	X		X		
Quality problem	X			X			X
Technology change				X			
Change of regulations and laws	X						
Product design change				X			
Acceleration of product lifetime				X			
Production cost change				X			
Production lead time variation						X	
Natural disasters	X		X				
Transport disruption						X	X
Change of holding costs						X	

[1](L. and Desheng, 2010) ;[2] (Li et al., 2013);[3] (Khayyam and Herrou, 2017) [4] (Tseng, 2011) [5] (S.C.Chopra and M.S.Sodhi, 2004); [6] (Gaonkar and Viswanadham, 2004); (BCI, 2015)

3.4 Supply and Outsourcing Related Situations

Suppliers and subcontractors can represent high risk in supply chain. A delivery delay or disruption can obviously lead to a total supply chain failure. Supply chains need to be agile in response to supplier's delays, quality problems, raw material unavailability, change in suppliers pricing, design, strategy and financial situation. Table 5 shows different situations linked to supply and outsourcing.

Table 5: Supply situations.

Supply /outsourcing situations	1	2	3	4	5
Supply disruption			X		
Supplier delay	X	X	X		X
RM unavailability	X	X			X
Supplier bankruptcy	X		X		
Quality problems		X	X		X
Capacity decrease		X			
Pricing change			X		
Transport disruption				X	
Transportation lead time change			X		X
Product redesign			X		
Out of business supplier	X				
Supplier strategy change					X
Outsourcer failure				X	
Fraud/ Corruption			X		
Forecast errors					X
[1] (Gaonkar and Viswanadham, 2004) ;[2] (Li et al., 2013);[3] (Khayyam and Herrou, 2017) [4] (BCI, 2015) [5](Raj Sinha et al., 2004)					

We remind that situations needing agility are sudden, and with an important effect on supply chain performances. Yet, we underline that some situations mentioned previously may be frequent and tolerable in supply chain management (Inventory shortage, forecast errors, charge / capacity problems, quality problems, supply delays…). To distinguish agility form the day-to-day management, we consider that a situation is in need for agility if its occurrence is unpredicted in time and its impact is significant. Situations mentioned in this work are generic and may take place in different sectors. However, to study agility in a specific supply chain, a more detailed study should be done. Situations like customer or supplier strategy change, or change in laws, still ambiguous and should be analyzed in the context of the supply chain studied.

4 CONCLUSIONS

With complex and dynamic markets, increasing competition and the rapid change of the economic and geopolitics environment, supply chains are often asked to deal with sudden external and internal pressures. Thus, the agility, defined as the ability of a system to respond effectively to unplanned situations, become a competitive advantage and a strategic axis. To achieve a better level of agility within supply chains, one should better identify in circumstances supply chains require agility. Hence, the objective of the paper is to review the situations mentioned by different authors in the context of supply chain agility and supply chain risks.

Situations needing agility, SNA, are defined as "external and internal disturbances and changes that can lower supply chain performances, temporary or sustainably, and consequently, require an agile response". Our paper reviewed papers on supply chain agility as well as supply chain risk management. We proposed a list of situations that need agility, based on a first classification that refers to the supply chain activity affected (Supply, process, demand). Hence, earlier works that mention each agility situation is identified

Due to the complexity of supply chains and the diversity of industrial sectors, such a list needs feedback from professionals in supply chain, marketing, production, distribution, sales and purchasing departments. We currently started this work with 4 companies in various sectors such as: retail, luxury, aeronautics and pharmaceuticals. Situations are presented and illustrative examples coming from the companies are discussed. The aim of the work is to twofold: i) identify the criticality of each situation, ii) identify levers that enable to tackle SNA. Criticality of situations is assessed by the traditional (frequency which the situation is observed)*(gravity of the impact of the situation). Therefore, the work developed in this paper represents a starting point for further studies on SC agility.

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