



# The Relationship between Supply Chain Agility and Supply Chain Adaptability: Exploring Product Complexity as Moderator

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The main aim of this empirical research is to investigate the impact of leadership on supply chain management. This study is empirically testing the complexity of the product, variety of supply chain agility and adaptability of supply chain relationships. This study will assess the management of supply chains in an organization with a focus on the supply chain adaptability and agility. It is evident from the findings of the current study that, while discussing the adaptability of the supply chain, sharing the information is the key to get adaptability. Therefore, it is vital for the organizations to understand when and how they can be agile, aligned and adaptable in the supply chains. The findings of the study have shown an agreement with the proposed findings of the study. The author acknowledges that this is among a few pioneering studies on this issue and this study will be helpful for future policy makers.

**Key words:** *supply chain adaptability, product complexity, agility.*



## Introduction

The supply chain disruption has been given a lot of attention by researchers over the last few decades. The basic reason is that the demand for the resources at the global level is increasing, the supply chains are getting longer and delivery times are getting shorter as requested by the customers, and the opportunities are increasing for lower tolerance of disruption (Kleindorfer, et al 2005). The organizations operating in this era of globalization must respond swiftly to the changes occurring at the external level to meet the challenges (Lee, 2002) (Joshi, et al 2013). When firms are dealing with such issues, they get differentiated based on three core properties namely alignment, adaptability and agility (Lin, et al 2006). There exists a rich body of literature in terms of supply chain agility (Tarafdar and Qrunfleh 2017) in which on the combined effect of agility, adaptability and alignment is scant apart from few notable exceptions (Eckstein, et al 2015). Due to which there should be a focus on the effect of the combination related to alignment, adaptability and agility (Dwayne Whitten, et al 2012).

Supply chain agility is the ability of the company to swiftly adjust operations and tactics within its own supply chain. It is widely treated as an important element which affects the competitiveness of the organization at the strategic level. This is because, through supply chain agility, a firm will have the ability to respond to the unforeseen circumstances in a better way. Scholars have also treated agility as a core characteristic of supply chain's excellence (Lee, 2004). Additionally, Mason, et al (2002) considers supply chain agility as an important element to reduce the inventory and helps in adapting the variations of the market efficiently. Moreover, it also enables the organization to respond to the demands of the consumer quickly and to integrate with the supply chain effectively. So, one can easily say that agility is needed in the supply chain to create superior business values.

It is very critical for the organizations to develop capabilities related to the adaptation of the supply chain to cope with fundamental and long-term changes such as demographic changes, socio-political changes, radical changes and structural shifts which occur in markets. Wal-Mart, Zara and H&M have adopted agility in every level of their supply chain so they can respond to the changes in demand and supply through agile material handling technologies, state of the art sorting, postponed manufacturing and design processes. Still there are many other firms who succeed in capturing totally new markets through alteration of the supply chain. For example, Microsoft captured the market share of Sony by launching the Xbox. The did it by setting up a collaboration with Flextronics



due to which they were enabled to change design and relocate the facilities needed (Lee, 2004).

For the organizations operating in business environment, supply chain agility is the feature that can give them a competitive advantage over other firms. Several challenges are experienced by the firms who are the operators of the supply chain. These challenges are faced at the stage of delivering the product to the customers. Therefore, it is important for the firms to adopt the concept of agility to sustain the competitive advantage (Wu, et al 2017).

There is difference in adaptability and agility. The adaptability is more a strategic concept whereas the agility is a bit shorter but a more real-time concept. Agility is related to the time in which a firm can implement the initiatives and strategies based on new opportunities, customer requirements and market changes. The most important link of adaptive supply chain is sharing of the critical events related to the business (Sen, Bingol & Vayvay 2017). For this implementation of enterprise strategy is required which drives real-time integration throughout the portfolio of the supply chain (Dubey and Gunasekaran 2016).

Adaptability is the long term focus of the firm when they are responding to the market changes. For a firm to be adaptive and ready for future changes in markets there are a number of factors which companies need to keep in focus, including structural changes, partnership with stakeholders, utilizing capacity and technology efficiently. With the changes in strategies and markets, global firms must be able to adapt their strategies related to the supply chain accordingly. Successful firms plan their supply chain according to the need of the market. In fact, it's the key factor for the first to achieve and retain a competitive advantage in the market (Stefanelli, et al 2015).

One of the most important factors for the next generation is the strategies related to effective coordination (Setiyawati, Iskandar & Basar 2018). Considering multiple ways to solve a problem is the way by which firms can be adaptive and flexible as well. As a result, the solution can be adjusted by the firms so that the best results can be produced. Members of the supply chain can also be adaptive if they are not restricted to achieve the goals (Chan, et al 2009). To minimize the uncertainties, sharing the information is very beneficial for the members of the supply chain (Sezen, 2008). However, sharing the information may not be appropriate in terms of real-life applications (Baramichai, et al 2007).

From the Perspective of the management, the complexity of the supply chain is recognized as a key area and also the critical factor that moderates a number of relationships between performance and practices (Azadegan, et al 2013). Researchers have focused on the complexity of the product as a key factor of overall complexity of



the supply chain. Specially, in the environment of today's business the manufacturers are facing a number of challenges like advancement of technology, increases in the demand from customers, market globalization and new trends towards innovation. Organizations are encouraged to produce products which can cover multiple needs of the customers (Perona and Miragliotta 2004).

Manufacturing firms are facing problems due to the extended number of components in the products; including additional interaction between these components. Due to this reason, the complexity of the product is increasing (Novak, et al 2001). A number of challenges have been created for the supply chain management whose main objective is to provide responsiveness to the demands of the customers, improve flexibility and reduce costs due to complexity of the product (Bode, et al 2015). In the same way, the complexity of the product also impacts the agility of the supply chain and adaptability of the supply chain as well.

Past research has discussed the benefits and characteristics of the supply chain agility on a number of occasions (Blome, et al 2013). However, a limited number of studies distinguish the concept of adaptability and agility of the supply chain (Hult, et al 2007) (Dwayne, et al 2012). This study will assess the significant relationship of the management of the supply chain in the organization with a focus on the supply chain adaptability and agility. Therefore, it is vital for the organizations to understand when and how they can be agile, aligned and adaptable in the supply chains.

## **Literature Review**

### ***Supply chain agility and adaptability***

Up to now, only a few scholars (Lee, 2004), (Hult, et al 2007) draw a conceptual distinction between agility and adaptability of supply chain management. Likewise, the focus of researchers is supply chain agility and most of the investigators use these terms (agility and adaptability) alternatively (Gligor, et al 2013). Therefore, there is a lack of evidence in existing research to reach a conclusion about adaptability. A study by Overby et al. (2006) tried to make a clear distinction between these terms based on changes of a firm. Additionally, the supply chain tries to adapt according to the nature of the response (Overby, et al 2006). Moreover, Kidd (2000) claimed that agility enables a firm to respond quickly to uncertainties and opportunities within the structure and processes. However, the supply chain adaptability refers to the firm's ability to response to long-term external changes in the supply chain and market; such as demographic change, social and political change, and massive innovation in the business market. Supply chain adaptability also ensures a flexible change in



an organization towards the external environment by developing a new supply chain base, outsourcing and relocating production facilities. Researchers investigated flexibility as a supply chain dimension (Christopher, et al 2011). They claimed that structural flexibility is an ability of the firm to response the radical change in external business environment as well as a change in supply chain determinants. Hence, structural recognition is critical for adaptability because of the full understanding and mapping of relevant value chain processes is required for effective structural change (Aitken, et al 2002). Hult, et al (2004) argued that innovation is a crucial dimension of adaptability, because innovation is a source of change in an organization in response to a change in its environment. In line with this, Lee (2004) added that, in order to maintain the competitiveness, organizations need to respond rapidly to radical change in the market environment and supply chain processes. An organization can effectively respond to the external environment by introducing a new innovative product with high quality at a competitive price. Researchers (Azadegan, et al 2010) refer to innovation as the ability of a firm and its supply chain processes to engage in innovation through launching new innovative products. Hence, we recognize that innovation is crucial for the adoption of changes.

Though previous studies provide different thoughts, some provide a formal definition of supply chain agility (Swafford, et al 2006). In general, the existing literature on supply chain agility agreed that agility is the ability to identify the changes and then respond quickly and flexibly to those changes (Swafford, et al 2006). Therefore, the ability identifies the change and effective rapid response to change is an important dimension of agility in the supply chain. In short, supply chain agility refers to the ability of the supply chain to respond effectively and rapidly to market change (Tuominen, et al 2004).

In this study, supply chain agility is defined as the capability of the firm to identify the temporary and short-term changes in the supply chain and market and then respond effectively to these changes, with the existing capacity of the supply chain. Thus, the focus of agility is short-term or operating change within the configured structure of the supply chain. This definition of flexibility in the supply chain is similar to the definition proposed by Christopher (2011). They defined the flexibility as the capability of the firm to response the change in demand, supply and technology by using the existing structure of the supply chain.

Adaptability in supply chain refers to the radical innovation used to develop a unique new product, technology and process. However, such innovation is relevant for long-term changes because it requires a long time to come true as compared to short-term and temporary change (Tuominen,et al 2004).



The essence of supply chain agility is extracted from the wider multidimensional concept of organization agility (Swafford, et al 2006). Therefore, one should understand the meaning of agility before moving to supply chain agility. Comprehensive integration of core business elements and its competitive elements like, innovation, speed, flexibility, profitability and quality are considered as agility. It can also be defined as the capability of quick completion of transformation between various manufacturing assemblies (Yusuf, et al 1999) (Tse, et al 2016). Moreover, agility refers to the ability of an organization to produce a brand-new product with higher quality at the lowest possible price; considering individual customer's requirements (Fliedner, et al 1997). In business, agility refers to the flexible manufacturing system, from this perspective (Sharifi and Zhang 1999) claimed that agility refers to the ability to deal with changes and to extract benefits from changes, these two concepts are the core dimensions of agility.

According to Dove (1996), the rapidly changing business environment not only requires agility in operations but also demands agile supply chain relationships. He further states that the concern of agility is change proficiency which refers to the competency for adaptive transformation. Hence, supply chain agility should apply adequately to different types of changes through the supplier network, production outsourcing and virtual enterprise partnering.

An existing study by Chiang, et al (2012) measured the supply chain agility as a second-order construct with three dimensions; namely, joint planning, demand response, customer responsiveness. The two dimensions, customer responsiveness and demand response, indicate the organization's response in a dynamic business environment. While joint planning refers to the risk mitigation as well as the lessening of the threat of an uncertain market (Christopher, 2000). Specifically, demand response refers to the firms' ability to make an effective response to variable demand. Furthermore, Van Hoek (2001) argued that supply chain agility is emphasized on market uncertainties and customer responsiveness. While customer responsiveness refers to the ability of firms to make an efficient response to the change in customers' demands (Chen, et al 2004). Braunscheidel, et al (2009) stated that the importance of joint planning in logistics, production and purchasing with supply chain members should be a dimension of agility. In summary, supply chain agility refers to the firms' capability to convert the threats of an uncertain market and supply chain disruptions into unique opportunities by increasing the level of demand and satisfying customers' needs with efficiency and flexibility (Ngai, et al 2011).

A number of researchers examined the impact of the supply chain on the performance of an organization. They claimed that synchronous and real time collaboration of technology is



important to maximize the agility of the supply chain (Tolone, 2000). As the demand is fickle and demand rises, the agility of supply chain is required (Tolone, 2000). Previous research by Swafford, et al. (2006) proposed a model based on the “Supply Chain Operations Reference Model” and found that source flexibility, manufacturing and logistic positively influence the supply chain agility. They further added that supply chain flexibility has a direct effect on supply chain agility; information technology has an indirect effect. Another article by Agarwal, et al (2007) used an interpretive model to examine the supply chain agility relation with quality improvement, customer satisfaction, delivery speed, low costs, improvement of service level, reduction in lead time and development of a new product. Moreover, this extended the antecedent’s scope to the competence level of supply chain (Ngai, et al 2011). They conclude that supply chain competence positively influences the supply chain agility.

Existing research provides numerous dimensions and attributes of agility (Christopher, et al 2004) as well as antecedents (Agarwal, et al 2007) (Swafford,et al 2006) (Ngai, et al 2011) (Braunscheidel, et al 2009). Moreover, numerous research has been conducted to investigate the external learning and supply chain integration as direct antecedents supply chain agility. In summary, the current research not only follows the seminal work but also follow the current stream of research in the field of supply chain agility. In line with previous investigations, (Li, et al 2009) the current research considers the supply chain flexibility as a dimension of supply chain adaptability and agility.

### ***Product complexity***

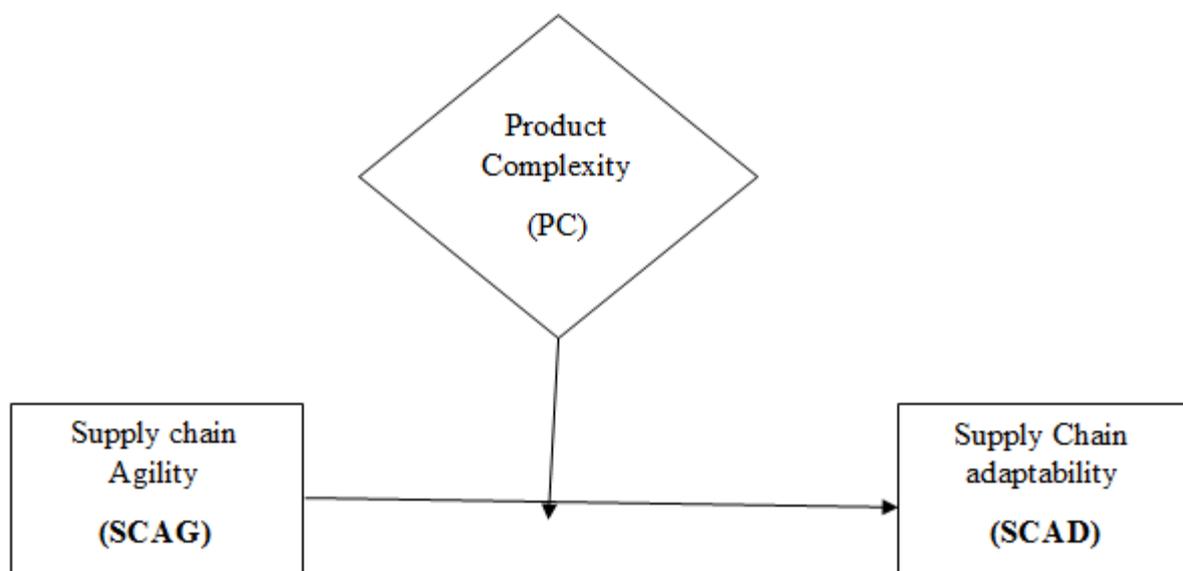
The attention towards the complexity of the supply chain is increased in practice and research (Jacobs, 2013). In past research, the complexity of the supply chain is viewed from an organization’s perspective with the focus on complexity of the product whose stems are in the variety, intricacy and customization of the products (Schoenherr, et al 2010).

The complexity of the product is reflected at the portfolio and the product levels (Jacobs, 2013). One can say that it’s the internal complexity which is caused within the firm (Bozarth, et al 2009) which is placed in the domain control of the organization (Closs, et al 2010) and consequently within the relationship of supply chain adaptability and agility. It has been argued that there may be a negative impact of the complexity of the product on the performance. This increases the reasons to check the results of the relationship between adaptability and agility of the supply chain. Both of these are very critical because the technology and product life cycles are getting shorter whereas the requirements of the customers are increasing (Swafford, et al 2008). Therefore, the

adaptability and agility of the supply chain is expected to reduce the complexity and increase the performance.

The capabilities of the firm that are crucial due to complexity of the product are promoted by the agility of the supply chain (Aitken, et al 2002).

**Figure 1.** Conceptual Framework



**H1: Supply chain agility has a significant relationship with the supply chain adaptability.**

**H2: Product complexity has a significant relationship with the supply chain adaptability.**

**H2: Product complexity moderates the relationship between supply chain agility and the supply chain adaptability.**

## Methodology

A survey method was employed to address the research questions of the study. The primary research method is used to collect data through questionnaires. The structural equation model is employed to analyse the structural model and structural relationship among measured and latent variables. It analyzes the direct and indirect association among variables. A main aspect in SEM is the determination of the appropriate sample size. The present study has previously chosen 310 samples based on the benchmarked table for determining the sample



size. However, the sample size was increased to 600 to overcome the response bias. The response rate was 62.5 percent, as 435 questionnaires were answered properly. In view of the research objectives and competencies, AMOS is used to examine the objectives of the research.

## Results

To address the research objectives, SPSS v19 was used for data processing and modelling. Primarily the responses from the questionnaires were coded into SPSS and went through statistical analysis using AMOS v21.

In business research, structural equation modelling is an advanced and widely used multivariate analysis. It is basically a multivariate data analysis which examines the indirect and causal relation among variables, through simultaneous determination of interdependent, separate and multiple regression equations. The distinguishing feature between SEM and multiple regression is that SEM examines the relations simultaneously while multiple regression independently determines the relationship among variables.

SEM data analysis aims to assess the degree to which the sample data supports the estimation of the structural model. SEM particularly examines the structure of co-variance that exists between the observed variables. Whereas, observed variables help to define and make inferences about the constructs or latent variables. The latent variables are referred to as the unobserved variables, which need more and more constructs to explain them. Afterwards, the maximum likelihood method, a widely used estimation method for further evaluation of SEM data analysis, is employed.

Reliability of data is also checked through SPSS, indicating that all measures are reliable. It is suggested that the coefficient values, (i.e. 0.60, 0.70, and 0.80) are considered as poor, acceptable and good, respectively. Another rule of thumb suggests that alpha values that lies above 0.50 are said to be adequate and less than 0.50 indicates unacceptability in explaining the reliability of constructs. A suitable range for reliability is 0.50-0.60. Following previous research studies, the present study has set Cronbach alpha value to 0.60 as a threshold value. Reliability test shows that all constructs are reliable.

The model fit values are CFI=0.94, RMSEA=0.05, PNFT=-.933, & TLI=0.938, all values range within the threshold level indicating that model has fit the data well. The inner model was also assessed through SEM-AMOS, including the estimation of factor loadings, discriminant validity, and composite reliability.

Confirmatory Factor analysis along with the measurement model assesses the evaluation of measures that are obtained through CFA. CFA is generally employed to check whether the measurement of constructs is consistent with the proposed constructs.

**Table 1:** Convergent and Discriminant Validity

	Indicators	Loadings	CR	AVE
<b>SCAG</b>	SCAG1	.843	0.895	0.772
	SCAG2	.855		
	SCAG4	.802		
	SCAG6	.925		
	SCAG7	.867		
<b>PC</b>	PC1	.884	0.932	0.617
	PC3	.955		
	PC4			
	PC5			
	PC6			
<b>SCAD</b>	SCAD1	.822	0.910	0.671
	SCAD2	.855		
	SCAD3	.722		
	SCAD4	.825		
	SCAD5	.841		
	SCAD6	.800		
	SCAD7	.880		
	SCAD8	.881		
	SCAD9	.826		
	SCAD10	.821		
	SCAD13	.882		
	SCAD15	.928		
	SCAD16	.840		
	SCAD17	.921		
	SCAD18	.882		

Presence of discriminant validity is provided in this study. Discriminant validity measures the degree to which measures of constructs are visible and distinct. Discriminant validity for present research is obtained through comparing cross-loadings with item loadings, as given in Table 2.

The next step is the estimation of structural equation modelling through a path diagram. It is a useful technique as it determines the direct and indirect relationship among the observed variables. For this reason, structural equation modelling is preferred for this study. This is done for hypotheses testing.

**Table 2:** Discriminant Validity

	<b>1</b>	<b>2</b>	<b>3</b>
<b>SCAG</b>	<b>0.932</b>		
<b>PC</b>	0.731	<b>0.898</b>	
<b>SCAD</b>	0.518	0.550	<b>0.873</b>

Since the aim is to assess the relation among latent constructs of the study, the hypothesized structural model was established under first order construct. Path coefficients are used to determine the relation between the constructs and to make decisions about the tested hypotheses. After assessing the structural relationship among variables of measurement model, goodness of fit was checked. The goodness of fit determines whether the model is suitable for testing of hypothesis. Subsequently, the measurement model was converted to structural model to examine the relation among exogenous and endogenous variables. The results for direct hypotheses are given in table, which revealed that all of the direct hypotheses are significantly accepted.

**Table 3:** Direct Effect

	<b>(<math>\beta</math>)</b>	<b>SD</b>	<b>T-value</b>	<b>P-Values</b>
<b>H1</b>	0.111	0.035	3.161	0.002
<b>H2</b>	0.467	0.132	3.978	0.007

For the purpose of investigating the indirect impact of variable or moderator, moderation level is estimated. In addition, to specify the significance of relationship, bootstrap analysis is employed on samples of 1000 observations. The significance level for the p-value is less than 0.05. Other than H<sub>3</sub>, p-values for all other hypotheses are less than 0.05, indicating the acceptance of hypotheses. Table 4 shows the existence of moderating impact of customer response on the relation of agile SC and external SC performance. Moderation results indicate significant t and p values for both hypotheses. The values for t-test are above 1.96, while p values also came out to be less than 0.05, resulting in the acceptance of H<sub>3</sub> hypotheses.

**Table 4:** In-Direct Effect through moderation

	( $\beta$ )	SD	T-value	P-Values
<b>H3</b>	0.112	0.021	6.331	0.000

### Conclusion

The essence of supply chain agility is extracted from the wider multidimensional concepts of organization agility. Therefore, one should understand the meaning of agility before moving to supply chain agility. Comprehensive integration of core business elements and its competitive elements, like innovation, speed, flexibility, profitability and quality, are considered as agility. It can also be defined as the capability of quick completion of transformation between various manufacturing assemblies.

The aim of this study is to assess the relationship between supply chain agility and adaptability. This study will assess the significant relationship between the management of the supply chain in the organization with a focus on the supply chain adaptability and agility. While discussing the adaptability of the supply chain, sharing of information is the key to get adaptability. Therefore, it is vital for the organizations to understand when and how they can be agile, aligned and adaptable in the supply chains. The findings of the study have shown an agreement with the proposed findings of the study. The cash conversion cycle appears as a strong moderator. This study has measured the supply chain agility as a second-order construct with three dimensions namely, joint planning, demand response, customer responsiveness.

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