

## Supply Chain Complexity Drivers and Its Management

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**Abstract:** Supply chain complexity is mainly divided into two parts—Static and Dynamic. Static complexity is mainly caused due to structure of supply chain, number of components, variety of components and strength of interaction between these. The dynamic complexity is mainly concerned with uncertainty in supply chain with respect to randomness and time. Supply chain complexity drivers can also be classified according to how they are generated, following are the reasons responsible for complexity generation ( Number of customers / suppliers, number of interactions between them, conflicting governance policies, amplification in demand, non synchronous decisions, incompatible information system ). Supply chain complexity also differ sector to sector. E.g.—food, manufacturing, electronics etc. This paper review different types of supply chain complexity and how we can manage them.

**Keywords:** Supply chain complexity, drivers of supply chain complexity, management of complexity.

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### I. Introduction

Supply chain is a complex network of many business entities who work seamlessly and involved in upstream and downstream flow of goods, services, information, finances etc. ( Lamber, Cooper & Pagh 1998, Mentzer et al 2001). The basic aim of management of supply chain complexity ( SCC ) is to reduce cost, improving customer satisfaction and gaining competitive advantage on other supply chains / firms. Managing supply chain Is highly complex specially operating in uncertain and dynamic operating environment because you need to manage business relations between many firm, many business processes and their interactions. All these required a lot of information about all stakeholders/ processes/ transactions.

As per Yates complex system exhibit five attributes—

- Significant interactions
- High number of component parts
- Nonlinearity
- Broken symmetry
- Nonholonomic constraints

From study point of view we can divide SCC into 3 parts i.e. static, dynamic and decision making complexity.

**Static complexity**—Which is related to connectivity and structure of subsystems involved in supply chain, e.g.—business firms, firms etc.

**Dynamic complexity**—This results from the operational behavior of the system and operating environment.

**Decision making complexity**—This is combination of above two types. The more complex nature of supply chain means more difficulty in managing this.

As per many studies, managing complexity leads to better supply chain performance ( A.T. Kearney 2004, Blecker, Kersten, Meyer 2005, Bozarth, Worsing, Flynn & Flynn 2009, KPMG 2011, PricewaterhouseCooper 2006). That's why it is very important to inculcate SCC into supply chain management so that we can develop business processes / practices etc. for better performance of supply chain.

The basic purpose of this paper is to study typical complexity drivers that are found in different types of supply chains and their possible solutions based on good industrial practices. The synthesis of good industrial practices help us to develop basic guidelines for better management of supply chain complexity.

**Critical drivers of supply chain complexity**—Complexity in a supply chain grows as customer requirements, competitive environment and industry standards change and as the companies in the supply chain form strategic alliances, engage in merger and acquisition, outsource functions to third parties, adopt new technologies, launch new product/services and extend their operations to new geographies, time zones and markets ( A.T. Kearney 2004, BCG 2006, DeloitteToucheTohmatsu 2003, KPMG 2011, PricewaterhouseCoopers 2006). In simple words supply chain complexity accelerates with more global trade (multilateral trade among nations), customizations, flexibility, innovation etc. Earlier static/dynamic distinction is basically used for studying complexity in manufacturing firm ( Calinescu, Efslathiou, Schirm & Bermejo 1998). Decision making complexity involves both static and dynamic aspects of complexity ( Calinescu, Efslathiou, Huaecho & Sivadasan 2001, Manuj and Sahim 2011). From the static aspect the supply chain is made up of high number of elements, variety and interactions. From the dynamic aspects, the fact that the system is dynamic, non predictable ( uncertain operating environment) add more to complexity of decision makers. As a result,

complexity of decision making in the supply chain is associated with the volume and nature of the information that should be considered when making a supply chain related decision. Also all three types of supply chain complexity are inter-related and interwoven so we can not take any as isolated issue. Now supply chain driver means any property which increase its complexity. The classification of complexity drivers can be classified according to the way they are generated via—

- Physical situation ( e.g. number of products)
- Operational characteristics ( e.g. process uncertainty)
- Dynamic behavior ( e.g. demand amplification)
- Organizational characteristics ( e.g. decision making process)

Another classification can be done on the basis of their origin. E.g.—

- Demand / supply interface.
- External environmental drivers.

( Blecker et al 2005, Childerhouse & Towill 2004, Isik 2011)

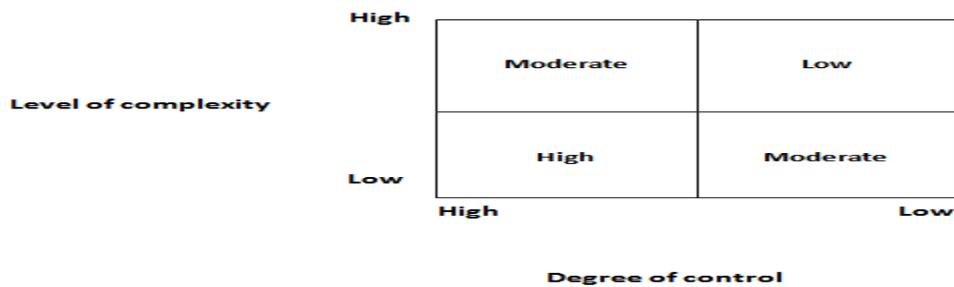
Internal drivers are generated by decision and factors within the organization such as the product and processes design. The drivers which are internal can be calculated easily because they are in your span of control. Also drivers which are related to demand / supply interface are related to the material and information flow between supplier / customer/ outsourcing etc. These drivers are also in your span of control. The level of co-ordination between supply chain partner can control their type of complexity. Thus power and trust mechanism that affect the relationship between SC partners is also an important factor for generating SC complexity. Lack of trust between supply chain stakeholders means more complexity which deteriorate performance of entire supply chain members. External drivers are generated thru mechanism that the company has little , if any control over such as market dynamics, rule regulations by government agencies, environmental related factors ( global concern). Above said factors are normally not in the span of control of any organization and their effects affect all firms. But still firms can do something – they can monitor, do analysis and make changes in themselves and others just to adopt, accumulate their effects etc. This change perspective can be applied to all SC members.

Table 1 – Some drivers of supply chain complexity.

According to type	According to origin		
	Internal	Supply demand interface	External
• Static	- Number/ variety of products.	Type of product.	Changing need of Customer.
	-Number/variety of process.	No./variety of customers.	Changing resources Requirement.
• Dynamic	- Lack of control over process.	Process interaction.	New technologies
	- Process uncertainties	Conflicting policies	
	- Employee related Uncertainties.	Lack of process Synchronization.	Change of geograp- Hical environment.
• Decision Making	- Unhealthy forecast.	Demand amplification	Shorter product life Cycle.
	- organization structure	Parallel interaction	Trend in market.
	- Decision making process	Differing /conflicting decisions and actions	Market uncertainties.
	- IT system	Non synchronized Decision making	Changes in environment
	-	Information gaps	Factors that are out of span of control.
	-		Uncertainty of unknown/ Uncontrollable factors.

( from Seyda Serdarasan, Elesvier, 2013)

Due to systematic nature of the supply chain , decisions targeting any of the drivers may have a positive or negative effect on another driver. Decision makers/ management can make use of this property to shift complexity of the supply chain from one driver to another, preferably on which they have more control over. Below is the matrix which deals with degree of control Vs degree of complexity. This indicate us how much control is required with respect to complexity.



**Normal industrial practice for managing complexity in supply chain**—After understanding the all aspects of complexity now it is turn how to manage the complexity. The drivers of complexity study inculcate scope and depth of complexity then only we can deal with them. Drivers of complexity help us to develop and implement strategies when deciding with complexity is good industrial practice.

- **Definition of industrial good practice in context of supply chain complexity**—“ Any proven working practice which is far enough ahead to norms to provide significant performance gains if implemented.” ( Zairi & Whymark 2000) At this stage of study , good practice of complexity management in the supply chain were examined by means of qualitative meta synthesis. Qualitative meta synthesis is an interpretative approach that seeks to discern meaningful patterns from various existing qualitative studies of the same or closely related topic by means of a systematic review ( Finlayson & Dixon 2005, Zimmer 2006). Good practices have been identified and and gathered from various sources, such as reports of companies, consulting firms, service providers and other knowledge bases ( e.g. – articles, books, case studies, industry reports, conferences etc.) Some of the good industrial practices are as follows. But before that these good practices must follow following criteria--

- The good practice must address supply chain complexity.
- That must produce good results.
- The document must be accessible and provide clear information about how to execute good practice.

All categorize complexity as necessary & unnecessary complexities. The necessary complexity can be defined as what the customer / market is willing to pay for and what would provide a significant competitive advantage. Following are few complexities and their solutions—

1. Complexity driver—High number of variety of SKU ( necessary complexity)  
Solution strategies-- Improving demand management, forecasting, logistics management.
2. Complexity driver—High number of variety of SKU ( unnecessary complexity)  
Solution strategies—Offer limited range of products.
3. Complexity driver—Product complexity.  
Solution strategy—Measuring product complexity in terms of supply chain impacts, redesigning the products that have a high complexity index.
4. Complexity driver --Diverse IT solutions.  
Solution strategy—Implement an IT service management solutions.
5. Complexity driver—Large planning models.  
Solution strategy—Implementing a supply chain planning software modified to handle planning requirements.
6. Complexity driver—Demand uncertainty/ demand volatility.  
Solution strategy—Profiling uncertain demand, planning of operations on daily basis.
7. Complexity driver—Lack of demand information/ unpredictable order patterns.  
Solution strategy—Proactive order management, collaborative planning, capacity forecast sharing with partners.
8. Complexity driver—Lack of know-how.  
Solution strategy—Forming a partnership with a partner that has the know-how.
9. Complexity driver—Lack of control due to outsourcing.  
Solution strategy—Reducing number of outsourcing partners and working in close collaboration with the outsourcing partners.
10. Complexity driver—Changing requirement of industry.  
Solution strategy—Adapting to changes by providing synchronized services.

Here are few examples of some industrial sectors about complexity they face and their possible solutions—

1. **FMCG and Retail sector**—In this sector the main complexity drivers are—

- High variety of products and SKU.
- Demand variability.
- Variation in capacity requirements.
- Complex network with high number of suppliers and distribution points that are also geographically dispersed.

These are considered as unpredictable events / factors. Yet most are known as predictable at one point of supply chain which makes information sharing and collaboration the best answer to overcome the complexity caused by these uncertainties. Overall use of IT system that are able to synchronize data throughout the supply chain, collaborative planning, well defined processes, standardized procedures are frequently used solutions which generate efficiency in entire supply chain.

2. **Automotive supply chains**---They are characterized by high number and variety of parts and high number of suppliers and lean approach. Lean practice enable reduction in inventory and streamline information and material flow. But there is still need for flexibility and responsiveness.

Solution strategy--- Information sharing, centralized logistics operations and pull based replenishment.

3. **Electronics supply chain**—Important characteristics of this sector are as follows—

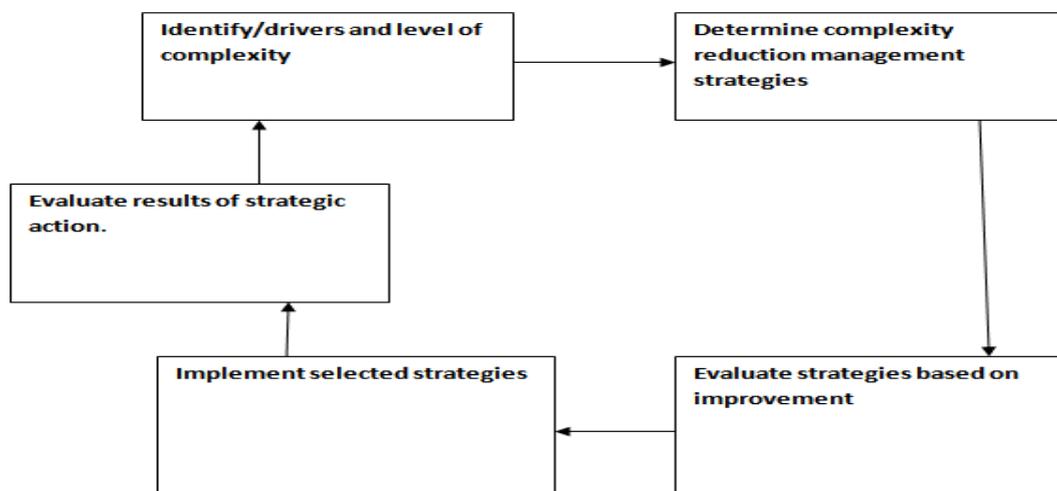
Complexity driver—

- High number of SKU.
- Wide variety of complex products.
- High number and variety of suppliers and customers.
- Complex supply chain network.
- Demand uncertainty.

Solution strategy implemented by Motorola Incorporation are—

- Redesign of product to reduce complexity of supply chain ( Handfield 2004 a, 2004 b)
- Motorola devised measures of product complexity in terms of supply chain effects and redesigned their products whenever they have higher complexity than their competitor’s products.
- Also end to end integration, collaboration with partners, visibility into operations and continuous improvement.

**Complexity management approach**—



The common approach is to reduce/eliminate the unnecessary complexity then to manage the necessary complexity in the system and finally to prevent any additional unnecessary complexity.

Below is the grid / matrix which is useful about managing necessary and unnecessary complexity—

<b>Necessary complexity</b>	<b>Manage</b>	<b>Manage</b>
<b>Unnecessary complexity</b>	<b>Reduce / Eliminate</b>	<b>Prevent</b>
	<b>Current complexity</b>	<b>Potential complexity</b>

### Conclusion

We discussed complexity management initiatives that can be utilized to assist decision makers in formulating strategies to deal with complexity. There are mainly three approaches to deal with complexity, these are— Complexity reduction, Complexity management and Complexity prevention (A.T. Kerney 2004, Sedarasan 2009, Wildemann 2000, Wu, Frizelle & Efstahiou 2007). The common approach is to manage the necessary complexity and reduce/eliminate the unnecessary complexity and finally to prevent any additional unnecessary complexity.

### Limitations and Future work—

1. There is need for quantification of each factor/driver who create complexity.
2. Need to study impact of each complexity driver on firm performance e.g. revenue, profit etc.
3. These results should be checked for different types of sectors.
4. Need for making standardized processes for different sectors.

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