物流學碩士 學位論文

글로벌 공급 사슬상 민첩한 공급 사슬 관리에 관한 전략적 프레임워크
-민첩한 제조업 재고관리를 중심으로-

A Strategic Framework for Agile Supply Chain Management on Global Supply Chain
- Focusing on Agile Manufacturing Inventory Management

韓國海洋大學校 海事産業大學院

港灣物流學科

金　　東　　源

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위원장 張 明 熙 (인)

위 원 安 奇 明 (인)

위 원 劉 成 眞 (인)

2012 년 6 월 21 일

한 국 해 양 대 학 교 해 사 산 업 대 학 원

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김 동 원

한국해양대학교 해사산업대학원
항만물류전공

초 록

급변하는 글로벌 비즈니스 환경과 다양한 고객의 니즈(Needs)는 기업들로 하여금 불확실성(Uncertainty)과 복잡성(Complexity)이라는 현실적인 문제에 직면하게 하고 있다. 기업들은 불확실성과 복잡성을 해결하는 것이 기업의 경쟁력을 갖추는 핵심이라 판단하고 있으며, 이에 따라, 빠르게 비즈니스 환경에 적응·대처 할 수 있는 공급 사슬 관리(Supply chain management: SCM)에 대한 능력을 개발하도록 강요받고 있다. 또한, 이러한 기업 환경 속에서, 기업은 공급 사슬 관리에 대한 전략과 전술 그리고 운영을 위한 기획 등 상황에 적합한 공급 사슬의 관리를 통해 이익을 창출할 수 있는 비즈니스 모델을 구축하고 이를 실행하여 불확실성과 복잡성을 경감시키고자 노력해오고 있고 다양한 응용 기법들을 광범위하게 개발하고 있다. 이러한 비지니스 환경 속에서, 글로벌 공급망에 대한 민첩한 공급 사슬 관리는 제품의 다양성, 더욱 짧아진 제품 수명 주기 그리고 고객의 다양한 요구 등 더욱 강력해진 글로벌 시장의 경쟁에 대처하기 위한 가장 중요한 전략들 중 하나가 되었다.

이 연구는 급변하는 비즈니스 환경 속에서 공급사슬의 불확실성과 복잡

성을 민첩하게 통제하고, 기업의 운영 효율성과 경쟁력을 극대화하기 위해 공급 사슬을 글로벌 환경에 적합하게 설계, 계획 그리고 운영·실행하는 방법을 제시하고 기업의 전략적 결정의 지속성을 증가시키기 위한 프레임워크(Framework)를 개발하고자 한다. 프레임워크를 개발함에 있어 글로벌 공급 사슬 상에서 공급망 관리의 민첩성에 초점을 맞추었고, 민첩한 공급망 관리의 중요한 전략적 요소들인 Alignment(정렬), Adaptability(적응), 그리고 Visibility(가시성)을 핵심요소로 고려할 것을 제안하고자 한다.

본 연구는 민첩한 공급 사슬 관리를 달성하기 위해 통합적인 비즈니스 프로세스의 필요성을 논하였고, 글로벌 경쟁과 위험(Risks)등 제한된 범위 내에서 비즈니스 프로세스에 대한 통합의 기회를 제공하고자 하였다. 이는 통합되지 않은 처리사항 만을 제어하는 기존의 공급 사슬 관리 모델을 개선하고 발전시켜 공급 사슬 관리를 위한 통합된 비즈니스 모델을 제시 하였고, 하나의 비즈니스 프로세스 프레임워크 모델링을 통해 복잡한 국제 경영 환경에 대한 민첩한 적응과 실현 가능성을 제시하고자 한다.

핵심어 : 공급 사슬 관리, 민첩한 공급 사슬 관리, 민첩한 재고 관리, 민첩성.

1. Introduction

For businesses to compete in the commercial sector where markets are increasingly more volatile and unpredictable demands create uncertainty, their supply chains have needed to adapt to respond to such unpredictability. In a recent highly unpredictable and competitive market, companies face the challenge of reducing manufacturing cycle time, delivery lead-time and stocks. However, every company has its own objectives and its own way of decision-making processes.

Supply chain management involves a set of procedures that aid in the proficient integration of suppliers, manufacturers, warehouses and stores to ensure appropriate production and distribution of right quantities to the right location in right time and reducing the total supply chain cost as a result in addition to fulfilling service level requirements. The manufacturer, who acquires the raw materials, converts them into end products and distributes the same to the customers, is regarded as the manager of the supply chain. The management of the dynamic demand is a huge confront that numerous supply chain firms indented towards decreasing the supply chain costs besides enhancing customer service levels face(Rajesh Gangadharan, 2007). The concepts of supply chain management incorporates a wide range of activities that support the planning, implementation and control manufacturing and the delivery processes right from the source of raw material to the spot where the end product is utilized(D. Pardoe & P. Stone, 2007). Acute issues in supply chain management arise out of shorter product lifecycles that lead to higher demand uncertainty and the action on global markets consequently increasing the supply chain complexity(Joines J.A., &

Thoney, K, Kay M.G, 2008). From the operational point of view, this research addresses four problem areas including Inventory management and control; production, planning and scheduling; information sharing, coordination, monitoring; and operation tools.(Ganeshan, R., et al.,1999)

Inventory optimization application aids in the enhancement of inventory control and its management across an extended supply network, which organizes the latest techniques and technologies. Optimization of inventory strategies to enhance customer service, reduce lead times and costs and meet market demand (Jinmei Liu, Hui Gao, Jun Wang, 2000) are some of the design goals of Inventory optimization. Inventory control describes the design and management of the storage policies and procedures for raw materials, work-in-process inventories, and usually, final products(Beamon BM, 1998). Effective handling of the supply chain can result in reduced costs and lead times besides remarkable enhancement in responsiveness to changing customer demands and subsequently optimal inventory(Pongcharoen, P. et. al., 2007). Estimation of the precise amount of inventory at each point in the supply chain devoid of excesses and shortages despite minimizing the total supply chain cost is a chief concern for the inventory and supply chain managers. The precise estimation of optimal inventory is essential since shortage of inventory yields to lost sales, while excess of inventory may result in pointless storage costs(S. Buffett, N. Scott, 2004).

There are few practical business models which are substantially able to be practiced on supply chains. Thus, we present a strategic framework for agile supply chain as a business model. Many people attribute the success of companies like Apple, Dell, and P&G, for

example, to the ways they used new strategies on global supply chain -not just to make their operations more efficient- but to create new strategic supply chain management models.

The structure of this paper's body is composed of three chapters. First of all, chapter 2 introduces SCM & Business performance and SCM Capabilities. In chapter 3, we suggest the concept of Agility, the importance of Agility and Precedent studies on agile supply chain management. In Chapter 4, we address the framework for agile supply chain management on global supply chains and agile manufacturing inventory management process in detail. Finally, we draw our conclusions from the development of the agile SCM framework to the misunderstanding and recommendation of inventory management.

2. SCM & Business Performance

SCM(Supply Chain management) is defined by the GSCF(Global Supply Chain Forum) as the integration of key business processes from end user through original suppliers that provide products, services and information that add value for customers and other stakeholders (Lambert et al., 1998). One of the critical issues concerning SCM is the development of SCM capabilities that allow activities and processes to be integrated, throughout the supply chain, adapting suppliers and customers to the new logic in competition and providing competitive advantage (Rice & Hoppe, 2001; Lummus et al., 1998). SCM capability is a set of actions that uses the assets of a supply chain to create, produce, and commercialize a product, providing final customers with an essential benefit (Scavarda & Hamacher, 2003).

For instance, the automotive industry has been very active in the development and introduction of new management systems worldwide SCM. Therefore, it is presently developing and introducing capabilities in its supply chains stimulating other industries to do the same. This fact motivated the authors of the present paper to use this industry in the study of SCM capabilities.

2.1 Factors for High Performers in SCM

First of all, most global companies focus on SCM. Performance measurement is able to be defined variously depending on the characteristics of organization. It is generally defined as the process of quantifying the efficiency and effectiveness of past action and the evaluating how well organizations are managed and the value they

deliver for customers and other stakeholders.

Table 2-1 : The Gartner Supply Chain Top 10 for 2011

Rank	Company	Peer Opinion[1] (156 voters) (25%)	Gartner Opinion[1] (32 voters) (25%)	3-Year Weighted ROA[2] (25%)	Inventory Turns[3] (15%)	3-Year Weighted Revenue Growth[4] (10%)	Composite Score[5]
1	Apple	2950	536	17.9%	49.3	40.9%	8.50
2	Dell	1909	457	6.6%	38.9	4.1%	5.14
3	P&G	1726	660	9.6%	5.6	2.4%	5.13
4	Research In Motion (RIM)	550	215	25.1%	17.7	43.9%	5.10
5	Amazon	2267	402	6.6%	11.2	34.0%	5.07
6	Cisco Systems	1501	550	10.2%	11.8	5.5%	4.82
7	Wal-Mart Stores	1755	449	9.0%	8.5	3.6%	4.40
8	McDonald's	711	161	15.3%	141.8	2.6%	4.35
9	PepsiCo	740	445	12.0%	7.8	18.8%	4.11
10	Samsung	857	361	9.8%	16.9	22.5%	3.98

Notes:

1. Gartner Opinion and Peer Opinion: Based on each panel's forced-rank ordering against the definition of "DDVN Orchestrator"

2. ROA: ((2010 net income / 2010 total assets) * 50%) + ((2009 net income / 2009 total assets) * 30%) + ((2008 net income / 2008 total assets) * 20%)

3. Inventory Turns: 2010 cost of goods sold / 2010 quarterly average inventory

4. Revenue Growth: ((change in revenue 2010-2009) * 50%) + ((change in revenue 2009-2008) * 30%) + ((change in revenue 2008-2007) * 20%)

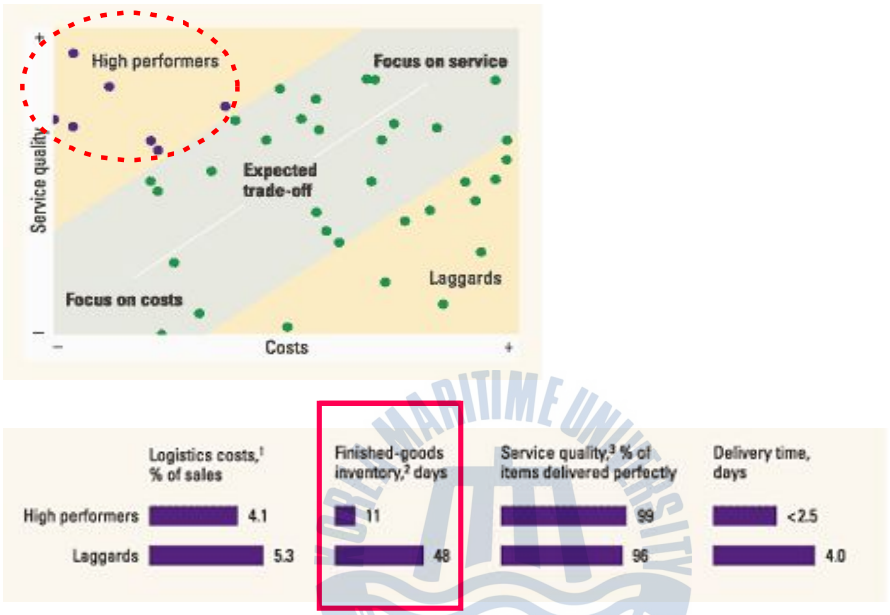
5. Composite Score: (peer opinion * 25%) + (Gartner opinion*25%) + (ROA*25%) + (inventory turns * 15%) + (revenue growth * 10%)

2010 data used where available. Where unavailable, latest available full-year data used. All raw data normalized to a 10-point scale prior to composite calculation

Source: Gartner (June 2011)

According to the table by Gartner(June 2011), it shows that the companies which the inventory management efficiency is high accept ROA(Return on assets = Net income / Total assets) and Inventory Turns (=Cost of goods sold / Quarterly average inventory) as effective factors to evaluate business performance on SCM.

In addition to ROA and Inventory Turns, service quality and cost are also crucial factors to measure business performance. The following tables show that this survey of 40 multinational and domestic consumer goods manufacturers in Germany found that it is possible to achieve both low inventories and high service levels.[1)]



1 Costs for outbound trasfortation and warehousing : excluded inventory costs.
2 Quantity of finished goods÷average daily sales rate.
3 Accurate, punctual, defect-free fulfillment of order lines.
Source : McKinsey Quarterly(FEB 2004)

Figure 2-1 Dimensional Analysis

These figures suggest that service quality has its price: if companies were located along a diagonal line, with their positions based on whether they emphasized service or costs, those focusing on the former would be clustered in the top right corner and those focusing on the latter in the bottom left. Seven high performers in holding down costs and in maintaining high customer service levels;

1) 2002-03 McKinsey and Institute for Supply Chain Management(University of Munster)

nearly a dozen failed in both dimensions. The next bar graph shows that High performers moved goods out of inventory about four times faster than Laggards. (Table 2-2)

KPI(Key Performance Indicator) is also one of the crucial factors to evaluate business performance. It is commonly used by an organization to evaluate its success or the success of a particular activity which it is engaged. (Carol Taylor Fitz-Gibbon, 1990)
The following table illustrates percentage of respondents who measure KPI at given frequency, comparing between High performers and Laggards.

Table 2-2 KPI Measurement

% of respondents who measure key performance indicators at given	High performers	Laggards
All, weekly	42	18
Some weekly, some monthly	29	18
All, monthly	29	49
All, less than monthly	0	15

Source : McKinsey Quarterly (FEB 2004)

Through the upper table, companies' sales forecasts are more accurate, and the need for "safety stock" to meet unexpected demand is reduced. The High performers measure their performance across the supply chain weekly or monthly. As they make the frequency of KPI measurement short, they improve inventory management efficiency. The upper graphs justify that High performers are focusing on service quality, costs and inventory management efficiency on the supply chain.

SCM should improve asset turn and margin of costs. The driver to create business performance is able to be indicated by Return on Assets(ROA), which is based on Asset turn and EBIT(Earnings before Tax and Interest) Margin. Especially, the efficient management of fixed Asset and inventory continuously improve Asset turn, and EBIT Margin is caused by supply chain cost and service level. The following SCM Agenda have an influence on each category and eventually build the basis of the outstanding SCM. (Figure 2-2)

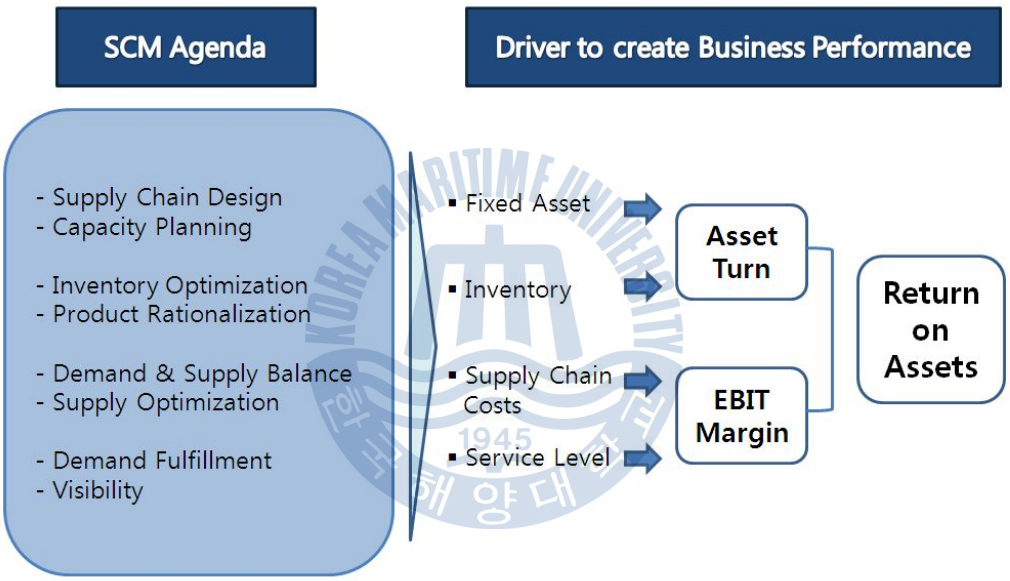


Figure 2-2 : Driver to create Business performance

2.2 SCM Pressures and Capabilities

The literature lacks a precise and standard definition for the notion of capability(Duysters & Hagedoorn, 2000; Hafeez et al., 2002). Occasionally, they overlap with the notion of competence. For the authors of this paper, capabilities guarantee leading edge to organizations in static markets. Competence, on its turn, allows the

organization to sustain its capacity whenever changes threaten the market. For example, at the time of the invention of automobiles at the end of the 19th century, superior capabilities in the production of carts were not enough to save the market of carts. Although manufacturers of carts sustained its capabilities, they lost their competitive advantage in an extremely changing environment.

In the literature, SCM capabilities include, among many others, speed and reliability in delivery, capacity of meeting the needs of target markets, and low distribution cost(Evans & Danks, 1998); relationship and cooperation among members of the chain, and knowledge of the market in which the chain operates (Min & Keebler, 2001); suppliers' reliability, delivery lead time, reliability in business processes, and complete orders (Lummus et al., 1998). We follow Rice & Hoppe (2001), categorizing SCM capabilities as techniques, practices, policies, and systems. Examples of SCM capabilities that they have identified include ESI (Early Supplier Involvement), JIT (Just in Time), postponement, supplier park, and VMI (Vendor Managed Inventory). Lummus et al. (1998) also adopt this form of categorization to refer to JIT as a SCM capability.

SCM capabilities derive from the coordination and integration of activities and processes in a supply chain, the conjugation of technologies adopted by the chain, the management of its human resources and of relations among members of the chain(Scavarda & Hamacher, 2003).

2.2.1 SCM Key Pressures

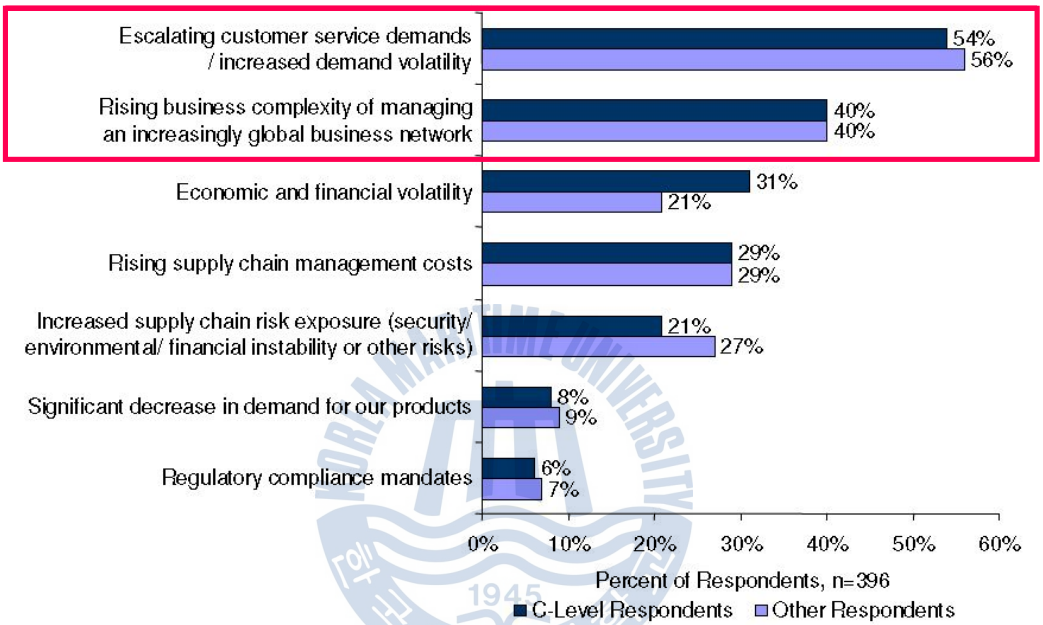
To overcome the challenges of today's economy, most companies have begun more intensely focusing on the supply chain. The top

reported pressures driving companies to improve SCM in 2010 are showing the following results :

· Increased demand volatility - 56%

· Escalating customer service demands - 54%

· Rising business complexity of managing global business - 40%



Source : SCM World CSCO Report Survey (2010)

Figure 2-3 : Key Pressures Forcing Organization Focus on Improving SCM

The results of research shows that the key factors which makes SCM difficult are demand volatility and complexity of supply chain networks.

• Demand Volatility

Demand volatility is a major contributor to overall environmental uncertainty and has been identified as an important factor influencing supply chains (Fine 2000; Germain et al. 2008). Demand

volatility can have many negative effects on firms, degrading customer service levels, reducing product revenues and overall operational and financial performance (Waller et al. 1999; Germain et al. 2008; Gattorna 1998; Kulp et al. 2004). Many of these effects occur due to the distortion in production information that occurs as demand data is passed upward in the supply chain. Ultimately, volatility may engender a "bullwhip effect" as firms build safety stocks to buffer the wide variations in customer demand that occur due to economic shocks, promotions, and other factors influencing product purchases (Lee et al. 2004).

Demand volatility is a reality in many industries, from discrete manufacturing to process and defense industries. Not only are retailers serving end consumers facing volatile demand, but this volatility is being passed on to manufacturers and distributors at different stages of the industry value chains. Many factors contribute to demand volatility, including increased customer choices, product customization, rapid technological improvements, global competition and upstream supply fluctuations. From High Tech to Retail, this is a challenge faced by companies across all verticals. Managing volatile demand in a cost effective manner can lead to significant benefits for a company from lower supply chain costs to improved customer service levels. More importantly, managing volatile demand efficiently can be a huge competitive differentiator for companies.

Supply chain processes were traditionally designed to be push-driven. The transition to becoming pull-driven or demand-driven is slowly occurring in many industries. Managing volatile demand efficiently in a demand driven environment is a significant challenge and requires companies to employ robust supply chain strategies. Often the focus

tends to be on one area of the supply chain (e.g, inventory optimization) without consideration of all aspects of the supply chain, resulting in sub-optimal results. In case that demand volatility is increased, responsiveness of supply chain networks is a crucial factor.

• Supply Chain Complexity

We define supply chain complexity, then, as the level of detail complexity and dynamic complexity exhibited by the products, processes and relationships that make up a supply chain. The earliest mention of supply chain complexity in the academic literature appears to be by Wilding (1998), who proposed a supply chain complexity triangle, comprised of what he calls deterministic chaos, parallel interactions and amplifications. At first blush, the notion of "deterministic chaos" seems oxymoronic. In the precise language of systems science, however, "chaos occurs when a deterministic (that is, non-random) system behaves in an apparently random manner" (Stewart, 2002). Vachon and Klassen (2002) provide a multi-dimensional definition of supply chain complexity and some early empirical analysis to link the construct to delivery performance. In practical, complexity describes a system of multiple parts, interconnected in a non-linear style. In non-formal terms, complexity is:

- An intricately structured and variable system.
- Highly sensitive in its adjustment to the initial conditions or to even minor changes, creating a vast number of development possibilities.
- A large collection of interacting components.
- Difficult to understand or examine due to its design and / or operations.

- A system in process, changing and developing over time.

Supply chain complexity is, therefore, a system with a broad range of variations. A typical example would be a globally operating corporation with multiple production sites, all of which are in contact with numerous distribution centers worldwide, supplying thousands of end points. The objective of this study was to help companies understand the impact that supply chain complexity has across their supply chains.

Companies want to confirm that the ability to understand, measure and manage supply chain complexity drivers is important as it helps them achieve:

- Cost savings.
- Improved on-time delivery.
- Reduced inventory and work in process.
- Quality.

However, there is a significant gap between the complexity management practices that companies perceive to be important and their ability to identify and track effective metrics for those practices. Most companies currently track the performance of those complexity management practices which they consider to be important.

2.2.2 SCM Key Capabilities

Demand volatility and complexity will remain as assignments of an organization to solve. The recommended ways to get over the challenges are visibility, alignment and adaptability in supply chain.

Three key factors-visibility, alignment and adaptability-in supply chain control the governance, establish vision and goal including key actions such as strategy, plans and operations in supply chain process, and find creative ways to reduce complexity and volatility by adapting organizational processes and methods.

• Visibility

The notion of supply chain visibility stretches over a number of different areas within supply chain management. The concept is interlinked with a number of different concepts which is described in the latest research. Supply chain visibility is called such as event management, management by exception or logistic control tower. Thus these concepts need to be regarded as a part of the supply chain visibility notion.(Simon Johansson, Johan Melin, 2008). Visibility is a measure of performance(F.T.S. Chan, 2003) and can reduce risk in the supply chain.(Christopher S. Tang, 2005). Visibility also could be improved by raising the quality of demand plans.(Riikka Kaipia, Helena Hartiala 2006). In this paper, using the above concepts, we present that performance management, risk management and quality management as a role of governance improve visibility of supply chains.

• Alignment

To reduce the negative implications of certain undesirable events associated with supply, process, and demand risks, the effectiveness of strategic supply chain management is closely tied to three attributes, what is called, “Triple-A”: agility, adaptability, and alignment (Lee, 2004). In the middle of three factors, alignment

refers to ensuring that the interests of all participants in a supply chain are consistent (Lee, 2004). Most chain participants faced with taking an action that benefits their firm versus one that benefits the chain will choose the former (Narayanan and Raman, 2004). As a result, incentives must be organized in such a way that all parties' interests are aligned. Alignment of information is also vital. Participants must have access to needed data on flows and forecasts in order to fulfill their responsibilities. In this paper, we deal with a strategic vision, design and plans. We also focus on interaction and relation among other participants in supply chains.

• Adaptability

Adaptability refers to a willingness to reshape supply chains when necessary, without ties to legacy issues or the way the chain has been operated previously (Lee, 2004). Adaptable supply chains rely on information systems to identify shifts in the market, and then take appropriate actions such as moving facilities, changing suppliers, and outsourcing. Adaptability sometimes requires developing more than one supply chain for the same product in order to ensure distribution. For example, the supply chain surrounding the Gap rely on China for manufacturing and sourcing of Old Navy stores, while Central American facilities supply Gap stores and Italian facilities supply Banana Republic stores. This approach is far more expensive than if all three brands were served by one network, but it helps differentiate the brands and provides insurance against problems that might arise in any of the three regions (Lee, 2004). In this paper, we focus on the execution of adaptability factors.

The above three key factors are playing a major role in supply

chain. They also are used as core composition elements to establish agile supply chain framework in the chapter 4. Before establishing framework, we describe agility and precedent studies of agile SCM in the chapter 3.

2.3 Application Techniques for SCM Framework

There are many ways such as CAO(Computer Assisted Ordering), CR(Continuous Replenishment), Cross-Docking, CM(Category Management), CPFR(Collaborative Planning, Forecasting & Replenishment), and SCOR(Supply-Chain Operations Reference) to be able to improve SCM. CAO, CR, Cross-Docking, and CM are tactical techniques in order to control and decide the inventory replenishment. They are regarded as sorts of ordering and supporting inventory management system, which are lack of strategic scalability. Thus, in this paper, we accept some parts of concepts of two practical and useful application techniques-CPFR and SCOR- to establish an agile SCM framework. These two concepts have an influence on creating the strategic framework in this paper.

- **CPFR(Collaborative Planning, Forecasting & Replenishment)**

  Collaborative Planning, Forecasting, and Replenishment(CPFR) models seek to improve the ability to anticipate and satisfy future demand, by enhancing collaboration among companies in the supply chains. The CPFR concept was introduced in connection with a pilot project involving Wal-Mart, Warner-Lambert, benchmarking partners, SAP, and Manugistics in 1995(Cooke, 1998).

  Generally, CPFR is referred to as a nine-step joint demand planning process that aims to enhance supply chain alignment by improving order forecasts and fulfillment through continuous

communications among multiple supply chain partners. The nine-step process is comprised of:

1) develop front-end agreement
2) create joint business plan
3) create sales forecasts
4) identify exceptions for sales forecasts
5) resolve/collaborate on exception items
6) create order forecasts
7) identify exceptions for order forecasts
8) resolve/collaborate on exception items
9) order generation (Ackerman, 2000; Logility, 2000).

Although CPFR evolved from traditional collaborative tools, such as: electronic data interchange(EDI), vendor managed inventory(VMI), and efficient consumer response (ECR), it differs from others in that it brings mutual benefits to all the supply chain partners involved by utilizing more interactive, broader communication processes throughout the supply chain. Other benefits of CPFR include higher inventory turnover, lower stock-out rate, improved order fill rate, improved cash flow; more accurate production scheduling, more amicable business relationships among supply chain partners, reduced cycle time, reduced order picking/receiving costs, reduced labor costs, and quicker response to customer needs (Sherman, 1998; Barratt and Oliveira, 2001; McCarthy and Golicic, 2002; Andraski and Haedicke, 2003).

• SCOR (Supply-Chain Operations Reference)

The Supply-Chain Operations Reference(SCOR) model was developed by the Supply-Chain Council(SCC) to assist firms in increasing the effectiveness of their supply chains, and to provide a

process-based approach to SCM (Stewart, 1997). The SCOR model provides a common process oriented language for communicating among supply-chain partners in the following decision areas: PLAN, SOURCE, MAKE, and DELIVER. The details for the decision area of "RETURN" have been added to the SCOR model. In the SCOR model, there are three levels of process detail in each decision area.

1) Level 1

Level 1 defines the scope and content of the core management processes for the above-mentioned decision areas. For example, the SCOR Plan process is defined as those processes that balance aggregate demand and supply for developing actions which best meet sourcing, production, and delivery requirements.

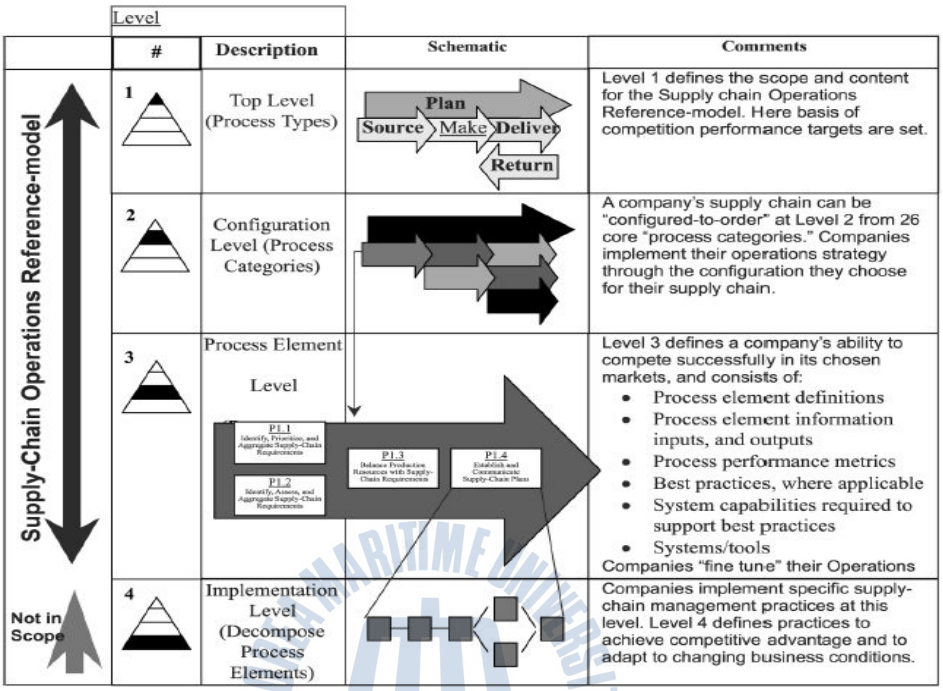
2) Level 2

Level 2 describes the characteristics associated with the following process types deployed within the core processes: planning, execution and enable. For example, supply chain partners require processes for planning the overall supply chain, as well as planning processes for supporting source, make, deliver, and return decisions. Characteristics associated with effective planning processes include a balance between demand and supply and a consistent planning horizon. The SCOR model also contains Level 2 process categories defined by the relationship between a core management process and process type.

3) Level 3

Level 3 provides detailed process element information for each Level 2 process category. Inputs, outputs, description and the

basic flow of process elements are captured at this level of the SCOR model. (Figure 2-3)



Source: Adapted from *Supply Chain-Operations Reference Model Version 4.0, SCOR Version 4.0*, Supply-Chain Council (August 2000)

Figure 2-4 SCOR model

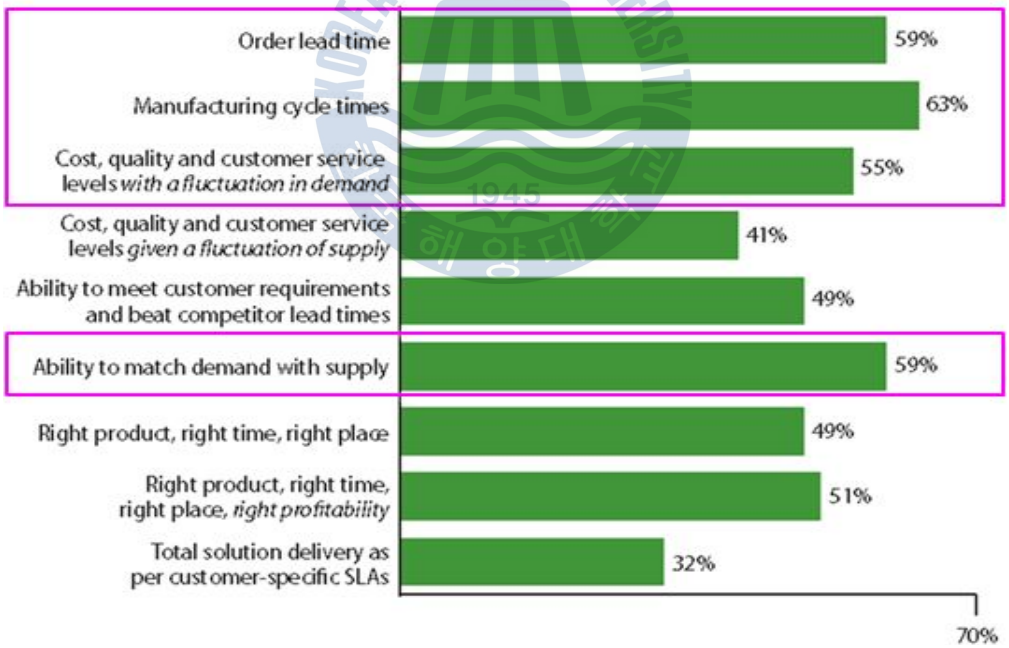
Although the SCOR model acknowledges the need for an implementation level (Level 4) for effective SCM, this level lies outside of its current scope. The rationale for its exclusion is that the SCOR model is designed as a tool to describe, measure and evaluate any supply-chain configuration. Thus, firms must implement specific supply-chain management practices based upon their unique set of competitive priorities and business conditions to achieve the desired level of performance(Archie Lockamy III, Kevin McCormack, 2004).

3. Agility and Precedent Studies of Agile SCM

3.1 The Concept of Agility in SCM

Companies put pressures upon the supply chain to improve their operational efficiency for enhanced competitiveness and business performance. There is no industry-standard definition for agility. For top performers, agility is well defined for each organization. For laggards, the term is used in strategy documents, but isn't defined. As shown the following figure, agility is most frequently defined as manufacturing cycle time. However, the most important definition is the ability to have the same cost, quality, and customer service given at every level of demand variability. (Figure 3-1)

Q. How does your organization measure agility? (164 manufacturers)



Source : AMR Research 2009

Figure 3-1 : How companies measure agility

The Agility Forum has defined "agility" as the ability of an organization to thrive in a continuously changing, unpredictable business environment (Agility-Forum, 1994). In agile supply chains, the focus is on the ability of comprehension and rapid responding to market changes. The agile supply chain intends to have the ability to respond rapidly and cost effectively to unpredictable changes in markets and increasing levels of environmental turbulence, both in terms of volume and variety (Agarwal et al., 2007; Christopher, 2000). Baramichai et al. (2007) used the following definition: "An agile supply chain is an integration of business partners to enable new competencies in order to respond to rapidly changing, continually fragmenting markets. The key enablers of the agile supply chain are the dynamics of structures and relationship configuration, the end-to-end visibility of information, and the event-driven and event-based management". Naylor et al. (1999) used the decoupling point concept to divide the part of the supply chain that responds directly to the customer from the part of the supply chain that uses forward planning and a strategic stock to buffer against the demand variability(demand is variable and high product variety) (demand is smooth and products are standard). He proposed the designation "leagile" supply chain where the lean principles are followed up to the decoupling point and agile practices are followed after that point. Agarwal et al. (2007) have shown that supply chain agility depends on the following: customer satisfaction, quality improvement, cost minimization, delivery speed, new product introduction, service level improvement, and lead-time reduction. Literature on supply chain agility describes the agility dependence on some performance variables; however, the influence of interrelationships among the variables on the supply chain agility has been hardly taken into account (Agarwal et al., 2007).

3.2 The Importance of Agility

Most companies focus on the speed and costs of their supply chains without realizing that they pay the big price for ignoring agility. For instance, whenever Intel released new microprocessors, Compaq took much more time than rivals to launch the next generation of PCs because of a long design cycle in the 1990s. The company lost mind share because it could never count early adopters among its consumers. Worse, it was unable to compete on price. Because its products stayed in the pipeline for a long time, the company had a large inventory of raw materials. That meant Compaq didn't reap much benefit when component prices fell, and it couldn't cut PC prices as much as its rivals were able to. When vendors announced changes in engineering specifications, Compaq incurred more reworking costs than other manufacturers because of its larger work-in-progress inventory. The lack of an agile supply chain caused Compaq to lose PC market share throughout the decade.

On the contrary, some smart companies use agile supply chains to distinguish themselves from their rivals. For example, Zara and Mango, which have become the most profitable apparel brands in the world, built agility into every link of their supply chains. At one end of their product supply chains, the companies have created agile design processes. As soon as designers grasp possible trends, they create sketches and order fabrics. That causes that they become head starters over competitors because fabric suppliers require the longest lead times. However, the companies complete designs and produce garments only after they get reliable data from stores. That allows them to make products that meet consumer tastes and reduces the number of items they must sell at a discount. In addition, the

companies have highly efficient distribution centers. They use state-of-the-art sorting and material-handling technologies to ensure that distribution doesn't become a bottleneck when they must respond to demand volatility. Zara and Mango have been growing at more than 20% annually, and their double-digit net profit margins are the envy of the industry.

As we know through the above examples, in spite of the obvious benefits of agility, companies around complex environments in the international markets face challenges in implementing the measures necessary to increase their agility.

These challenges are started from the expense related to the complex operations and management structures necessary to support the desired attributes. For instance, it may be difficult for an internationally operating company that ships components or products by sea to serve niche markets with individualized goods. Furthermore, it may be difficult for this company to quickly react to changes in demand. Therefore, if the firm is not willing to significantly increase its administrative and logistics costs on its value and supply chains, it may be forced to take counter-agile actions to remain competitive and limit its vulnerability in the marketplace.

The supply chain often is the part of a company that is so seriously influenced by changes in an international circumstances. The company's international supply chain frequently limits performance along many features related to agility. For example, it may be hard to adjust the structure or geographical setup of a supply chain to react to changes in the manufacturing or political

environment if the company has plants in other continents. In those cases, supply chain agility may promptly become the limiting factor of a company's comprehensive agility.

Until recently, supply chains were understood mainly in terms of long-term upstream collaboration with suppliers, downstream collaboration with customers and lateral collaboration with competitors as a means of integrating the total value creation process. Thus, a supply chain describes the series of linked activities among companies that contribute to the process of design, manufacture and delivery of products and services. The agility of a supply chain is a measure of how well the relationships involved in the processes mentioned above enhance four pivotal objectives of agile manufacturing (Hoek et al., 2001).

In short, an agile company has designed its organization, processes, and products that it can respond to changes in a useful time frame.

3.3 Limits of Precedent Studies of Agile SCM

Studies of agile SCM has been continued since the concept of agility was created. Supply chain agility is a crucial factor at the strategic level. Since successful SCM has become an order winner, the agility of the international supply chain may determine the survival of a firm (Vastag et al., 1994). However, most research on agile inventory has overlooked SCM issues in general and logistics in particular. This is surprising considering that the integration of the supply chain into design and management decisions is critical to the

success of a global, responsive manufacturing strategy (Fawcett, 1992). For example, the integration of the internal capabilities of companies, suppliers and customers can enhance manufacturing performance and the agility of an organization (Youssef, 1992). Obviously, we have to investigate the limitations of supply chains to offer advice to companies on how to solve demand volatility and complexity of supply chain networks.

Recently, the main trend in SCM is increasing supply chain agility (Ivanov et al., 2010; Lancioni, 2000). Agile supply chains are considered an effective survival strategy for companies facing intense global competition and a turbulent environment (Bottani, 2009). Specifically, an agile supply chain should be able to respond appropriately to a changing business environment (Bottani, 2010). Furthermore, an agile supply chain can respond both quickly and economically to industries experiencing broadly and rapidly varying supply and demand(Lee, 2004). Companies strive to become sufficiently agile to compete in unpredictable environments (Feng and Nagi, 2010). Companies such as Volvo, Argos, and HP have utilized agile supply chain practices to rapidly respond to turbulent business environments. Qi et al.(2009) investigated the phenomenon of companies focused on supply chain agility outperforming other companies. Braunscheidel and Suresh(2009) further argued that agile companies can promptly adapt to environmental change and disruption, and can also contribute to extended supply chain agility.
A growing body of literature focuses on agile manufacturing (Avittathur and Swamidass, 2007). However, workable agile supply chains require not merely agile manufacturing but also agile distribution. Specifically, distribution flexibility impacts supply chain agility (Reichhart and Holweg, 2007). Schonsleben (2000) me-ntioned

that firm agility is contingent on effective logistics networks. Furthermore, the rising importance of the agile strategy forces companies to pay attention to logistic services (Caris et al., 2008). Agarwal et al. (2007) pointed out that supply chains need to offer an effective means of controlling costs for agile distribution systems. Moreover, based on a survey approach, K et al. (2009) demonstrate empirically that agile distribution can enhance company performance. Liu et al. (2009) further indicated that expanding agility can increase the global competitiveness of container terminals. Meng et al. (2010) concluded that agility is one key client satisfaction factor influencing client satisfaction for logistics providers. Therefore, it is essential for global logistics companies to ponder agile distribution approaches in volatile environments.

Table 3-1 Precedent Studies of Agile SCM

Contents	Author
The integration of the supply chain	Fawcett, 1992
The survival of a firm	Vastag et al., 1994
Contingence on effective logistics networks	Schonsleben 2000
Quick and economical Response to industries	Lee, 2004
Agile manufacturing	Avittathur & Swamidass, 2007
Necessity of agile manufacturing and agile distribution Distribution flexibility impacts supply chain agility	Reichhart & Holweg, 2007
Effective means of controlling costs	Agarwal et al., 2007
The rising importance of the agile strategy	Caris et al., 2008
Performance enhancement by agile distribution	K et al., 2009

Contents	Author
Investigation on supply chain agility outperforming other companies	Qi et al, 2009
Adaptation to environmental change and disruption Contribution to extended supply chain agility	Braunscheidel & Suresh, 2009
Increasing the global competitiveness of container terminals, expanding agility	Liu et al., 2009
Companies' efforts to become sufficient agility	Feng & Nagi, 2010
The main trend in SCM	Ivanov et al., 2010
An effective survival strategy An appropriate response to a changing business environment	Bottani, 2009, 2010
One key client satisfaction factor	Meng et al., 2010

Despite various precedent studies, the literature unfortunately does not give helpful advice on how to deal with supply chain key pressures. While some research deals with complexity issues related to general logistics, the results of that research are not always applicable to planning an agile international supply chain. Moreover, the literature does not give guidance on how much uncertainty can and complexity should be reduced. In order to reduce complexity and uncertainty of supply chain, companies recognize the necessity of an optimal, integrated and agile SCM.

The notion of agility is recognized to be holistic rather than functional, and of strategic rather than tactical importance. The concept has also been extended beyond the traditional boundaries of the individual organization to encompass the operations of the supply chain within which the organization operates. The effectiveness of an organization's response to rapidly changing market conditions will be

largely determined by the capabilities of trading partners. A manufacturer with key suppliers that have poor quality and delivery records will find it very difficult to provide high levels of customer service, even in stable environments. Place this manufacturer in a rapidly changing environment and it will be eliminated from participation in the competitive game altogether. In this context reliability of supply becomes a critical issue that can best be facilitated by the sharing of accurate and timely information with suppliers. At the downstream end of the supply chain, this same manufacturer will again find it hard to operate in this environment if distribution channels are unable to respond due to physical logistics or information flow related issues. In this sense, the development of strategies for competing on the basis of agility become very much strategies for the management of the total supply chain.

4. Agile SCM framework

We already mentioned in Chapter 2 that the key pressures which makes SCM difficult are demand volatility and complexity of supply chain. In order to solve the SCM key issues, which are demand volatility and complexity, companies need to consider “Visibility, Alignment, and Adaptability.” The following figure shows that the upper three factors are organically affected from other factors. In this paper, we focus on "Visibility, Alignment, and Adaptability", which give an influence on each other through the continuous and closed-loop management.

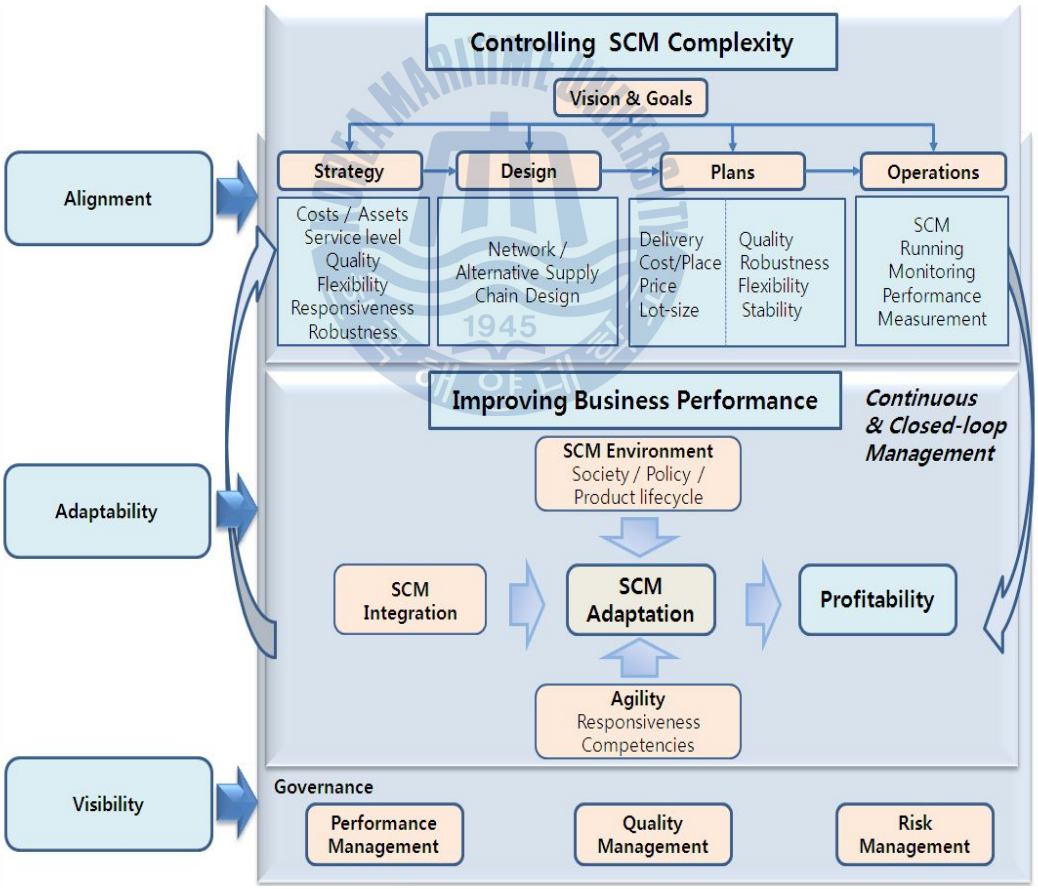


Figure 4-1 Agile SCM Framework

The above figure shows how "Visibility, Alignment, and Adaptability" are being worked in order to control the supply chain complexity and establish agile SCM.

First of all, visibility is based on establishing agile SCM. There are a lot of business models around the world, and they are changing dramatically. Companies have shifted away from a hierarchical, one-dimensional supply chain entity to a fragmented network in favor of strategic partnerships with external entities. Many businesses facing such model are experiencing challenges and are struggling to compete in this new circumstance. Supply Chain Governance can help organizations to streamline and manage their supplier quality and supplier performance. In addition, it enables organizations to identify, mitigate and manage supplier risks for key procurement and manufacturing process.

Based on the visibility, the section of alignment depicts that the competitive vision and goals of the supply chain created and suggested and supply chain strategy, design, planning, and operations are interlinked while constructing ideal supply chain states as well as while considering in detail supply chain structural elements. Supply chain is a networked organization of a number of various enterprises such as suppliers, manufacturers, distributors, and retailers. The above framework describes alignment as 4 steps, which collaborate along the entire value chain from acquiring raw materials to customers. It is proposed a study of models for alignment of supply chain to assess the impact on agile inventory management.

In SCM adaptation framework, we consider adaptability as an integrated framework. SCM serves as a basis for SCM integration.

The strategies of agility enrich SCM by means of a general information space with the help of higher responsiveness through concentration on competencies. On the other hand, SCM environment such as products life cycle, policy and society issues brings into consideration about supply chain adaptation. These factors affect on the entire supply chains and help inventory management to make agile progress. For adaptability of SCM, we apply all modern concepts and technologies to make supply chains agile, responsive, flexible, robust, sustainable, cost-effective, and competitive in order to increase customer satisfaction and decrease costs, resulting in increasing profitability.

Therefore, in this paper, we present frameworks to show how companies need to successfully control the supply chain agility through the following factors.

- Visibility - Supply Chain Governance
  - Performance management
  - Risk management
  - Quality management

- Alignment to control complexity
  - Vision & Goals
  - Network design
  - Controling product complexity

- Adaptability
  - Supply chain integration

- Agile Inventory Management
  - Solution for agile inventory management process

- Solution - five steps for successful agile inventory management
- Risk of agility & necessity of hybrid SCM

Then we illustrate how our concept can be used in judging the degree to which a company should implement supply chain agility. Finally, we draw our conclusions from the misunderstanding and recommendation presented in this paper.

4.1 Visibility - Supply Chain Governance

Most companies are already feeling the heat of the current financial meltdown, putting supply chain manager and their teams under intense pressure to reduce costs and improve cash flow while simultaneously managing an increasingly vulnerable supply base. Supply chain disruptions or discrepancy in supplier quality can significantly reduce company's revenue, impact market share, increase production cost, threaten brand image and reputation, and lead to high cost of poor quality.

In order to overcome these challenges, integrated supply chains are becoming an integral part of the competitive landscape as companies seek to create strategic advantages. Many companies are developing codes of conduct as a way of managing a number of partner behaviors within the supply chain. Supply chain models have gone from the stage of integration to disintegration and finally are reintegrating through adoption of supply chain governance.

Supply chain governance enables or sustains the heterogeneous models of collaboration between the decentralized supply chain

agents. It allows rapid integration of new partners into existing supply chains and the different parties to communicate and coordinate their activities in support of the final customer fulfillment objectives. Moreover, it measures and manages suppliers for contract and compliance and manages supply chain network agent failures and minimize loss of revenue, loss of market share, and brand erosion. Supply chain governance is able to be composed of three factors ; Performance Management, Risk Management and Quality Management.

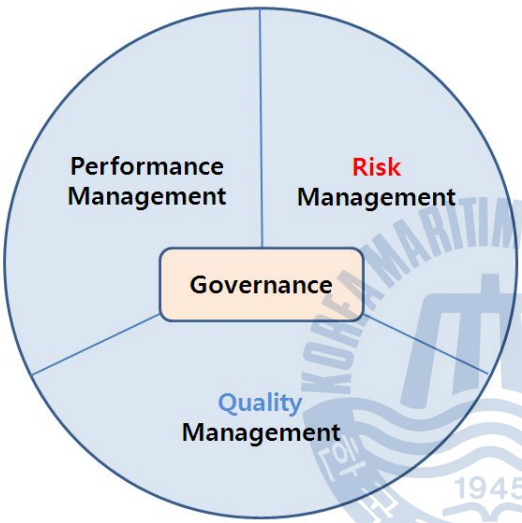


Figure 4-2 Governance

4.1.1 Performance Management

Supplier performance management is a critical initiative in supply chain governance for organizations dealing with multiple suppliers. The globalized manufacturing and sourcing motto has made companies focus on their core competencies and outsource the rest of the non-core business to suppliers across the globe. Companies in service industry such as banking, financial services and IT have also started realizing significant advantages in sourcing good and services from multiple suppliers while benefiting through improved pricing and

enhanced services. Companies are becoming highly dependent on their suppliers and have to assess and manage their supplier's performance to reduce business risks and revenue losses.

Practicing of a good performance management can help companies to have better visibility into supplier performance and offer benefits to uncover and remove hidden cost drivers from poor quality, increase competitive advantage by reducing order cycle times, chargebacks for nonconforming material and supplies, gain insight on how to best leverage their supply base, and align practices between themselves and their suppliers. We introduce key capabilities of performance management, as following.

• Performance Management
  - Define Service Level Agreements
  - Define metrics and key performance indicators (KPI)
  - Manage the certification status and compliance requirements of their suppliers

The above concept offers capabilities to define categories or groupings of metrics/KPIs by which suppliers will be measured such as cost of poor quality, delivery cost, inventory cost, response index, order fulfillment, order visibility, returns/charge-back and can be extended to custom categories such as risk, innovation, customer complaints and corporate social responsibility.

4.1.2 Risk Management

Companies are experiencing rapid supply chain expansion with decentralized supplier base. Although expanded supplier base in supply chain have helped companies in gaining major cost advantage

and market share but it has resulted in more unstable supply chain. Supply chains are vulnerable to various types of disruptions caused by uncertain economic cycles, consumer demands, and natural and man-made disasters. Consequence of an unstable supply chain has increased risks in conducting business operations and raises concerns on continuity of manufacturing or service delivery operations. Supply chain risk management needs to be adopted as best practice for supply chain governance to minimize impact on financial strategy and profitability. Businesses can face multiple risks across its entire supply chain such as supplier, process, regulatory, intellectual property, political and economic risks.

In order to solve the risk of business, companies need to adopt a risk management policies, which are processes to identify key risks.

• Supply Chain risks
  - Early/late shipments or delivery to wrong location
  - Non-conforming/wrong product or quantity
  - Supplier processes
  - Sole source supplier
  - Deteriorating performance
  - Credit/financial problems
  - Labor practices
  - Long-term investment in capacity, innovation, performance, etc.
  - Capacity ramp/roll-out problems
  - Undesirable events (storm, flood, earthquake, etc.)
  - Contract, legal and regulatory non-conformance
  - Information system failure and compromises
  - Political stability

The following context shows that some of the steps in supply

chain risk management process.

- Risk Analysis and Risk Self-Assessment. It should include
  - Key processes : Procurement, Manufacturing, Order fulfillment, Customer complaints and returns
  - Risks : Supplier, Legal, Intellectual Property, Demand Chain, Regulatory
  - Events : Automated or manual assessment of events
  - KRIs (Key Risk Indicators)
- Control Design and Assessments : Define a set of controls to mitigate supply chain risks
- Loss Tracking and Key Risk Indicators(KRIs): Track loss incidents and near misses, record amounts, and determine root causes and ownership. For an example supplier's failure to deliver raw material can result in market share loss and revenue loss.
- Issue Management and Remediation: Manage issues arising out of supplier assessment, audits and loss events and enable systematic investigation plan for issue remediation and risk treatment.
- Risk Analysis : Get visibility into the risk analysis, key risk metrics and risk heatmap to proactively identify areas in supply chain which needs attention.

4.1.3 Quality Management

Quality Management is a critical business process for manufacturers who source components and parts from suppliers, whether the suppliers are just across the street or a continent away. World-class manufacturers are realizing that to truly leverage a global supply base to reduce costs, a sophisticated supplier quality management system, that gives the manufacturer real-time visibility into the supplier's process and product quality, is necessary. Leading

companies try to find the most advanced and comprehensive solution for supplier quality management in the industry today. They are replacing their policies to achieve complete automation of supplier quality management and gain real-time visibility into their suppliers' quality processes resulting in significantly lower cost of poor quality.

- Supplier Corrective Actions: Advanced quality management enables to
  - Implement a proactive approach to supplier corrective action requests or corrective/preventive action requests across the supply-base
  - Perform root cause analysis
  - Assign follow-up actions while effectively track and route cases from initiation to closure

- Supplier Audits: Advanced quality management provides capabilities to plan, schedule and conduct audits, allows audits finding to be analyzed and enables the initiation of follow-up activities such as corrective action requests and re-audits. Supplier audit help in ensuring that suppliers meet the established product and process quality requirements and the audit process drives continuous improvement

- Supplier Charge-backs : Material costs and processing costs are related to the nonconformance. It allows users to manage the end-to-end chargeback process - aggregate all costs from an incident, route for approvals internally and to the supplier, collaboratively resolve the disputed recovery amounts, and notify back office systems for financial closure. Charging cost of poor quality back to the supplier helps in business discipline and accountability into the supply chain.

Supply chain governance enable companies to create a transparent environment to proactively identify, track and resolve supplier quality and performance issues. Early identification of supplier performance and quality issues can help in mitigating supplier risks for smooth and continuous business operations. Companies have to adopt an integrated supply chain governance system with interlinking between supplier quality, performance and risks.

4.2 Alignment to control complexity

The lack of alignment in the supply chain can bring problems such as bullwhip effect, according to being mentioned by Lee (1997), which describes it as a frequent problem encountered in the supply chain, where demand is increased along its movement in the supply chain, bringing a number of inefficiencies such as excess inventory, poor level of service etc.

In practice, partial supply chain strategy, design, planning, and operations decisions are highly interlinked. For instance, transportation and inventory are primary components of the order fulfillment process in terms of cost and service levels. Therefore, companies must consider important interrelationships among transportation, inventory, and customer service in determining their policies. Suppliers' selection is linked not only to their capacities, costs etc., but also to their collaboration abilities with each other and with the focal enterprise. Therefore, coordination between the various players in the chain is the key to its effective management. Pricing and inventory decisions as well as product, distribution, and production decisions are also matched together.

4.2.1 Vision & Goals

As we know, suggesting the vision focused on supply chain can recast how both the company and its suppliers create value in the future. This includes actions like leveraging supplier knowledge and insights to identify consumer and end user marketplace needs to help create unique value for these markets. Another would be to take advantage of the supply base's technology capabilities to gain competitive advantage in new product and service design and lead time. Several companies found ways to gain new revenues by working with suppliers of key categories to develop and introduce new products and services and enter new markets.

There are several ways to create vision for tomorrow in terms of cost. Improving the value-to-cost ratio by techniques such as supply chain engineering for new designs and supply chain analysis for existing ones helps companies strip out unnecessary cost and get more profitability from purchased goods and services. Optimizing supply chain cost includes rooting out waste at any stage of value add, as well as reassigning work along the chain to improve overall efficiency.

Practically, agile SCM's goal is responsiveness than ever before. Even as superior levels of performance are pursued, many managers now realize that their companies lack some of the competencies required for success. This realization has led them to look beyond their companies' boundaries to evaluate how the resources of their suppliers and customers can be utilized to create the exceptional value demanded by customers. Endeavors to align objectives and integrate resources across organizational boundaries are known as SCM initiatives.

4.2.2 Network design

In order to control complexity, supply chain network is designed as 4 stages ; Understanding Network Strategy & Analyzing Diagnosis, Defining Baseline & Scenario, Simulation & Evaluation, and Establishing Network Management Strategy.

The first stage is a stage for understanding network strategy and analyzing diagnosis. In this case, companies make a business plan and establish logistics strategy such as fixing logistics point and flow, and estimating inventory level and service level. At this stage, companies analyze logistics flow and cost.

On the second stage, companies define baseline and scenario about how to run supply chain, fixing measurement factors(cost, order sufficiency rate and delivery lead-time). Moreover, companies compose of the baseline model of supply chain structure, considering alternative scenario selection.

In addition to stage 2 defining baseline and scenario, the third is the stage of simulation and evaluation. After assumption by scenario and definition of restricted condition, companies practice the simulation of the designed network to grasp the pros and cons and compare between cost and service level. Finally, optimal scenario is selected and network management strategy is established such as point management strategy, inventory management strategy and transportation strategy. The following figure introduces the process to create strategy of agile supply chain. (Figure 4-3)

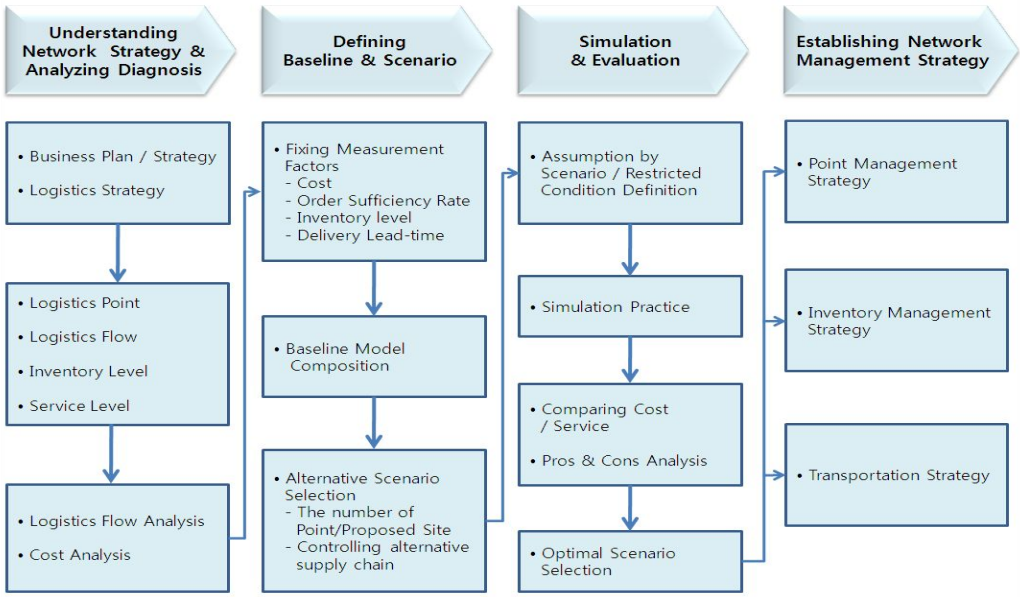


Figure 4-3 Network Design

4.2.3 Controling product complexity

If you understand what your customers need, it will certainly benefit you. And it became quite clear that the best companies had far better supply chain visibility, over suppliers, freight and logistics providers and internal processes.

Over the past year, global companies have been subject to, and have been forced to rethink their emerging market sourcing savings, because of the rising complexity of logistics and bloated inventory requirements driven by long lead times that can often be unreliable. It shows that higher complexity leads to higher risk of supply chain disruption. And reveals, essentially, how being able to see supply chain movements can help minimize disruption.

The pressures of the increase in international freight costs and the fluctuating price of fuel, as well as lead time variability, have

forced companies to focus more on using capability such as visibility, total landed cost management, multi-leg shipment optimization, itinerary-based routing, dynamic hub routing and divert-in-transit strategies.

In this circumstance, there are some problems to manage product complexity such as revenue and market share, which are plus factors, and cost and risk(long-term inventory and sold out), which are weak factors of inventory management. Thus, the methodology to solve product complexity on supply chain has two aspects. One is the analysis of market view, the other is internal view. Companies, at the market view, analyze rivals' strategy, customers' trend, and price elasticity. Simultaneously, they, at the internal view, analyze a new product's volume and margin, strategic positioning, and releasing and breaking off products. The two aspects of the view analysis are finally integrated as the profit improvement plan, which is composed of complexity cost and benefit, and product portfolio.

The top performing companies are most successful in integrating the aspects. Those successful in this integration are gaining a more end-to-end and close to real time visibility of the supply chain across the multi-tier supplier base.

We consider the supply chain strategy, design, tactics, and operations as a whole system in details. On the basis of the competitive and supply chain strategy, supply chain structures are configured. Based on demand and supply forecasts. Supply chain plans are generated within the designed structures. If concrete orders penetrate a supply chain, supply chain operations plans are generated according to the orders such as price, delivery place, batch size, and

so on. While running a supply chain, different disturbances can affect the supply chain and cause deviations and disruptions. Supply chain monitoring is meant for the maintenance of values.

The results of the supply chain monitoring are reflected in the supply chain performance block. The supply chain adaptation serves for implicating monitoring results while the supply chain is running and for corrective control actions to supply chain operations, plans, design, and strategy. The adaptation is meant not only for processes but also for supply chain models, which should cohere with the current execution environment.

4.3 Adaptability

The adaptability of supply chains is an ability of a supply chain to change its behaviour for preservation, improvements, or acquisitions of new characteristics for the achievement of supply chain goals in the conditions of environment varying in time, the aprioristic information about which is incomplete. Adaptive management is a management method of a supply chain with varying unknown characteristics of environment, at which for the final time are reached defined satisfactory, wished, or optimum goals of SCM by characteristics of control influences on the basis of feedback systems.

Companies adjust supply's design to meet structural shifts in markets; modify supply network to strategies, product, and technologies. Companies which practice agility use the various ways to improve business performance. First of all, they monitor economies

all around world to place new supply environment such as markets, society, policy and product life cycle. Second, they try to develop adaptability through supply chain integration process. Third, as they try to expand the choices for consumers through product and service differentiation, the need for supply chain agility increases. In this process, the responsiveness, which is goal of agile inventory management, is guaranteed on the global supply chain. Finally, companies' profitability is created and improved by adaptability.

In adaptive SCM, all three value chain drivers, which are products and their life cycles, customers and their orders, and suppliers or outsourcers, are enhanced by combining the elements from the SCM environment, integration, and agility. Moreover, these drivers are interlinked within a unified information space. Adaptive SCM unites a supply chain owner who is an original equipment manufacturer or a 4 part logistics(PL) provider, customers, and suppliers. The organizational structure consists of a real supply chain environment and a virtual alliance and partnership environment.

In the real supply chain, the supply chain owner collaborates with its customers and suppliers in regard to the existing products and product lines in all the stages of the product life cycle. The virtual alliance and partnership environment is an adaptation reserve of the real supply chain environment. In the case of market changes, new products, or an impact of operational inefficiencies due to a variety of disruptive factors such as machine failures, human decision errors, information systems failure, cash-flow disruption, or simply catastrophic events, these structural-functional reserves are activated to adapt the supply chain. In the virtual alliance and partnership environment, new products are designed with the integration of potential customers and suppliers.

4.3.1 Supply Chain Integration

Companies need to manage the integration of business, technology and processes across extended enterprises to be successful. It is no different from SCM. Inter-enterprise cooperation and collaboration with suppliers, customers, and business partners is facilitated with SCM. This system brings tremendous benefits and competitive advantages to the organizations and major supply chain participants like the suppliers, manufacturers, distributors and customers.

Any supply chain cannot be integrated overnight. The levels of integration evolve and grow deeper overtime. Integrated supply chain improves customer satisfaction and loyalty as the end customers experience improved on-time delivery. There is also a surge in the loyalty among partners, diminished inventory and an increase in flexibility to deal with disruptions. The other benefits include:

- Partnership formation

  The primary benefit of integrating a supply chain is the formation of partnerships. Sourcing and customer relationships are transformed into partnerships thereby increasing the trust levels. There is a steady performance and predictable sourcing due to this added trust, paving the way for even former rivals to become partners.

- Facilitates prediction

  With the sharing of information, the supply chain achieves better integration. Companies along the supply chain begin to swap planning data in addition to real-time tracking. Keeping in mind the goal of increasing efficiency, companies can plan and execute inventory management, shipping, and production schedules with the

deeper and more valuable information.

• Decrease in inventory requirement

The most important benefits of supply chain system integration are increased on-time delivery and lower inventory requirements. A recent study of SCM indicated that companies that moved to an integrated supply chain reported doubled inventory turns, had 50 percent improvements in on-time delivery and experienced a 50 percent increase in sales supported by 35 percent lower inventory. This in turn improved customer service which in turn increased customer loyalty due to better on-time delivery.

• Flexibility

An integrated supply chain offers flexibility and a great amount of resilience in facing chaotic circumstances. A company can quickly acclimatize to the varying circumstances without delayed production by having true partners along the supply chain. As an integrated supply chain achieves resilience by increasing flexibility, companies can cross train employees along the supply chain to respond quickly to a shutdown at one point along the chain.

The main driver behind any collaboration and integration is the desire to extend the control and co-ordination of operations across the entire supply process, replacing both the market and vertical integration as the means of managing the supply chain solutions.

4.4 Agile Manufacturing Inventory Management

A truly effective inventory management system will minimize the

uncertainty and complexities involved in planning, executing and controlling a supply chain network which is critical to business success. The opportunities available by improving a company's agile inventory management can significantly improve bottom line business performance.

The recent global economic crisis caused havoc with every aspect of SCM, and now companies are faced to a world that is completely different from anything they have experienced. Fundamental shifts have taken place in social values and global markets. Companies must be rebooted if they hope to thrive in the face of new and poorly understood realities. In these uncertain and volatile ages, supply chains must be more agile.

In agile SCM, agility appears from well-defined planning. Without a rigorous agile supply chain process as a foundation, attempts at agility lead to chaos. When the financial crisis hit, some companies departed from their agile inventory management processes. They struck out, laying off employees in a headlong effort to get in front of collapsing markets. Trying to be responsive, they created chaos as their moves caused unintended consequences. However, some smart companies continued to take the rigorous steps required in supply chains and worked their way to practical decisions about how best to restructure their supply chains. These were the truly agile companies, responding in a disciplined way to unprecedented change, and today they are in far better positions to deal with the challenges ahead.

The major barrier to agility in supply chains is the lack of a formal agile inventory management process or the poor execution of an existing one. An effective agile inventory management process is

illustrated below figure. Its goal is to determine how a company should apply its resources to meet the demand for its goods and services in both short and longer terms. The agile inventory management process should be formal, rigorous, and cadenced with inviolable deadlines for producing data and reports, firm dates for meetings, and a clear understanding of roles and responsibilities. (Figure 4-4)

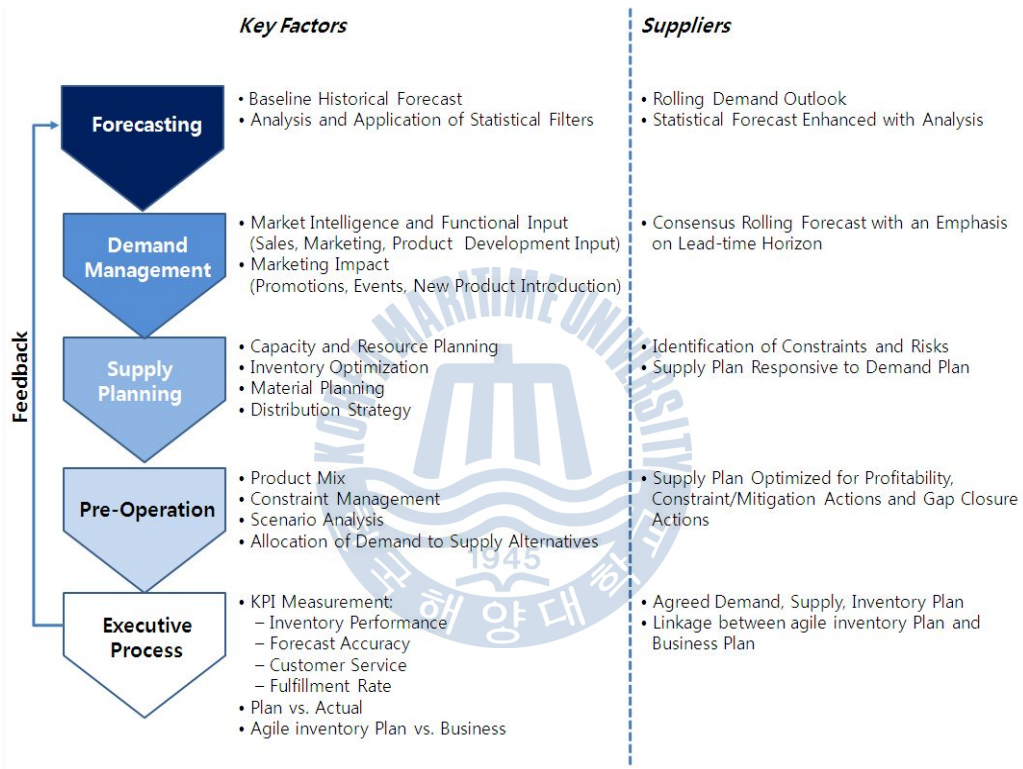


Figure 4-4 Agile Inventory Management Process

An effective agile inventory management process requires collaboration among groups that often have clashing agendas and dissimilar metrics. Managers from areas, such as manufacturing, operations, supply chain, product development, sales and marketing and, sometimes, key suppliers, customers, and business partners, must reach a consensus as they plan what will be required of the

supply chain in the months ahead.

Directing the agile inventory management process may or may not be a full-time job, but it is always a major responsibility. The agile inventory management leader must have direct access to and support from the chief operating officer or chief executive officer(CEO). This is essential to ensuring the full cooperation of all parties. Agile inventory management is a continuous process involving five steps, each with specific deadlines and suppliers.

The steps culminate each month in a meeting with senior management, which is called "executive process" in the table. Here, company leaders arrive at a consensus on how best to manage the supply chain to achieve business goals. Although specific deadlines are set for each step in the process, conversation and thinking about the supply chain, and everything that affects it, never stops.
The result of a successful agile inventory management process is shared knowledge of the business and its supply chain, a common view of the supply chain's capabilities, strengths, and weaknesses. This understanding provides the basis for creating an agile supply chain.

4.4.1 Solution for Agile Inventory Management Process

In an era of drastic change, an effective agile inventory management process provides a systematic framework and defined processes through which a supply chain can become more flexible and responsive. To do this, the agile inventory management process itself must be highly disciplined without being rigid. It must be standardized and flexible, in other words it is called "Agile".

For example, in today's economy, scenario planning has become increasingly important. It turns what could be a theoretical exercise into a vital decision-making process. Similarly, the use of market intelligence has come to play a larger role in demand planning, although it must still be coupled with the appropriate use of historic statistical forecasts. Another recent trend is that agile inventory management participants pay much more attention to data on actual demand consumption and trends, allowing managers to promptly modify supply decisions without creating unnecessary volatility. Thus the rigor of the process allows the company to manage the supply chain more flexibly as conditions change. Therefore, we suggest a solution, which we must practice, to be successful agile inventory management.

4.4.2 Solution - Five steps for successful agile inventory management

Based on the above agile SCM framework, we introduce five steps to agile inventory management as a solution. Competence in these skills prepares companies to achieve the five-step process for being agile :

Step 1 - Congregate Supply Chain Partners for Governance
Step 2 - Establish Definition & Vision
Step 3 - Take Leadership as the Missing Chain Linker
Step 4 - Align Executions & Targets to the Flows
Step 5 - Execute Adaptable Inventory Management Operations

This process gives a feedback to the entire supply chain again. (Figure 4-5)

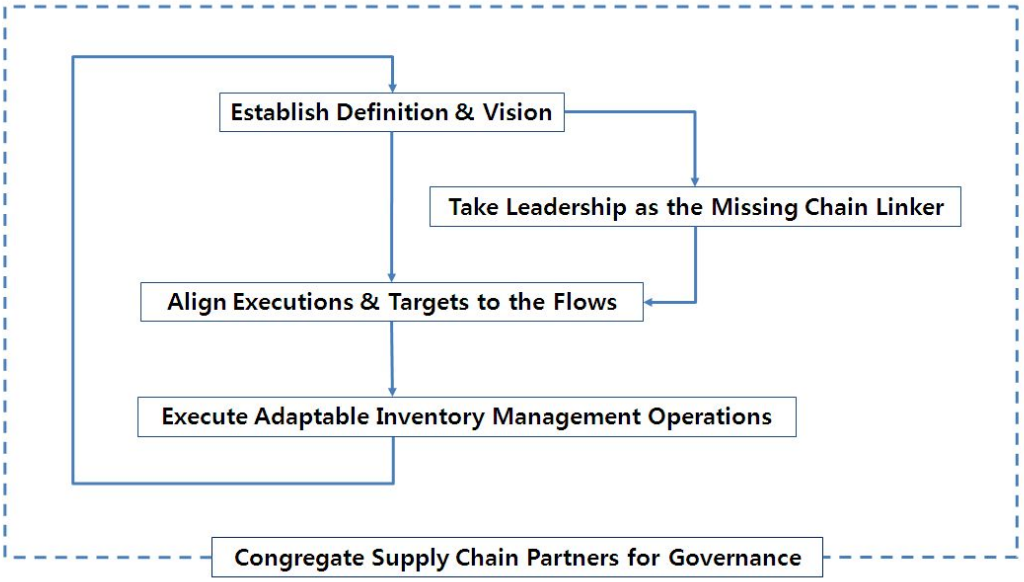


Figure 4-5 Five-steps for successful agile inventory management process

• Step 1 - Congregate Supply Chain Partners for Governance

Governance is a term that refers broadly to the rules, processes, or laws by which businesses are operated, regulated, and controlled. The term can refer to internal factors defined by the officers, stockholders or constitution of a corporation, as well as to external forces such as consumer groups, clients, and government regulations. A well-defined and enforced governance provides a structure that, at least in theory, works for the benefit of everyone concerned by ensuring that the enterprise adheres to accepted ethical standards and best practices as well as to formal laws. Based on standards, practices, and rules, companies need to cohabit with their partners in global supply chain. They should identify, track and resolve quality and performance issues. Early identification of performance and quality issues can help them control risks of each process in supply chain. An interactive,

complementary, and integrated management of supply chain governance factors continuously sustain basis on inventory supply chain. As a result, companies have been basically formed at the regional, national, and global levels.

• Step 2 - Establish Definition & Vision

According to the chapter 3, there is no standard definition for agility. For top performers, agility is well defined for each company. For laggards, the term is used in strategy documents, but isn't defined. Agility is most frequently defined as manufacturing cycle time. However, the most important definition - that is, the one driving the greatest improvement in customer service, asset utilization, and inventory write-offs - is the ability to have the same cost, quality, and customer service given at every level of demand variability. Traditional business processes focus on efficiency. The outcome is an improvement in return on assets(ROA), but agility or responsiveness are missed in the processes. After the adequate definition, company have to present a vision to be able to contribute to the supply chain and follow it on the supply chain processes such as strategy, design, plans and operations.

• Step 3 - Take Leadership as the Missing Chain Linker

The need for agility is felt across the company, but it can't be solved by any one function. Instead, it requires a cross-functional approach. For this reason, the effort has to be led by someone with authority over every function involved. Agility initiatives are most successful when driven by the chief operator.

The leadership for agile inventory management needs to be

multi-dimensional and influential all of inventory management such as process, people, technology, strategy, customers, products, finance, risk, partners, culture and environment. But the most important is that the new leadership should be:

- **Global & strategic**, not just local & focused on execution.
- **Oriented towards value and growth**, not just cost reduction.
- **Sustainable & long-term oriented,** not just short-term oriented.
- **Oriented towards agile inventory operations leadership,** not just inventory management.
- **Technically advanced to allow global collaboration with partners**.
- **Contextual** rather than "one model fits all".

This new leadership has effects on the entire supply chains and become an chain linker of agile inventory operations life cycle(design, plan, execute, monitor, react and improve).

• **Step 4 - Align Executions and Targets to the Flows**

Cracking the nut requires a focus in three areas: culture, right-sizing complexity, and rethinking financial reward systems. Culture is the biggest barrier to achieving agility. Companies that have successfully closed their customer service gaps while maintaining high asset utilization have taken five actions:

- **Reduced product complexity** : To accomplish this, there's an active focus on product and customer complexity.

- **Invested in available-to-promise capabilities** : To improve visibility, available-to-promise processes are extended to manufacturing capabilities.

- **Reduced demand forecast error** : Companies are experiencing an increase in demand variability, with new product launch forecast being the largest contributor to this error. A focus in this area can yield big dividends.

- **Improved order effectiveness** : Successful companies have a significantly higher percentage of orders that move through their order management systems without manual intervention.

- **Designed for supply** : The focus is on common formulations, platforms, and reuse strategies for source, make, and deliver.

Unless business systems are configured to the newly defined supply chains and ways of working, sustainable results will not be achieved. Terms of doing business with all partners across the supply chain should reflect these new controls and the insights gained. By defining inventory management controls and targets tuned to each supply chain, with standardized performance measurement across the business, we focus on performance and provide the backbone to controlling the end-to-end supply chain.

• Step 5 - Execute Adaptable Inventory Management Operations

Step 5 is composed of circulatory structure as a execution stage. There are four factors for process ; Segmentation, Targeting, Monitoring and Analyzing. Each factor is classified in detail again in its process. The four factors are organically connected and optimized for the adaptable inventory management operations. The following figure shows solution assignments for operations process. (Figure 4-6)

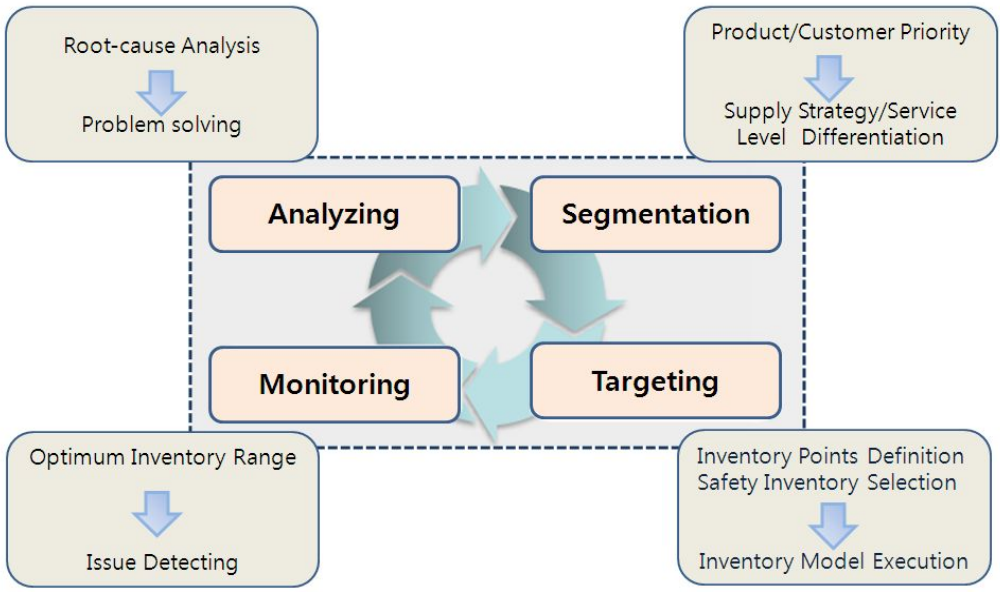


Figure 4-6 Adaptable inventory management operations process

- Segmentation : Company divide supply chain into two parts. One is the product's side, the other is customer's. The both sides' characteristics result in differentiation of supply strategy and customer service level through the process of segmentation. (Figure 4-7)

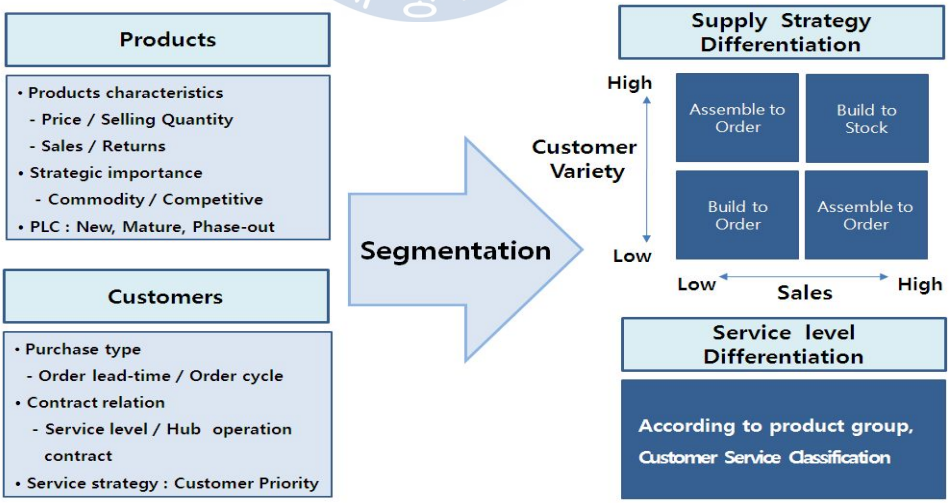


Figure 4-7 Segmentation process

Adaptable inventory management in a complex supply chain can be accomplished by combining appropriate segments. Each segment may be linked by noting that the ending inventory location of one segment will be the starting inventory location of the next. Segments can then be linked together to create a single path from supplier to end customer. Changes in the supply chain can be easily implemented by addition or removal of segments corresponding to the change. Similarly, custom segments such as rework (where beginning and ending inventory locations are the same) or internal operations can be created as necessary.

- Targeting : Company selects the inventory points in order to reduce costs and increase service level for customers. Selecting the appropriate inventory points helps company to fix the optimal inventory goal. The following figure shows the inventory targeting process. (Figure 4-8)

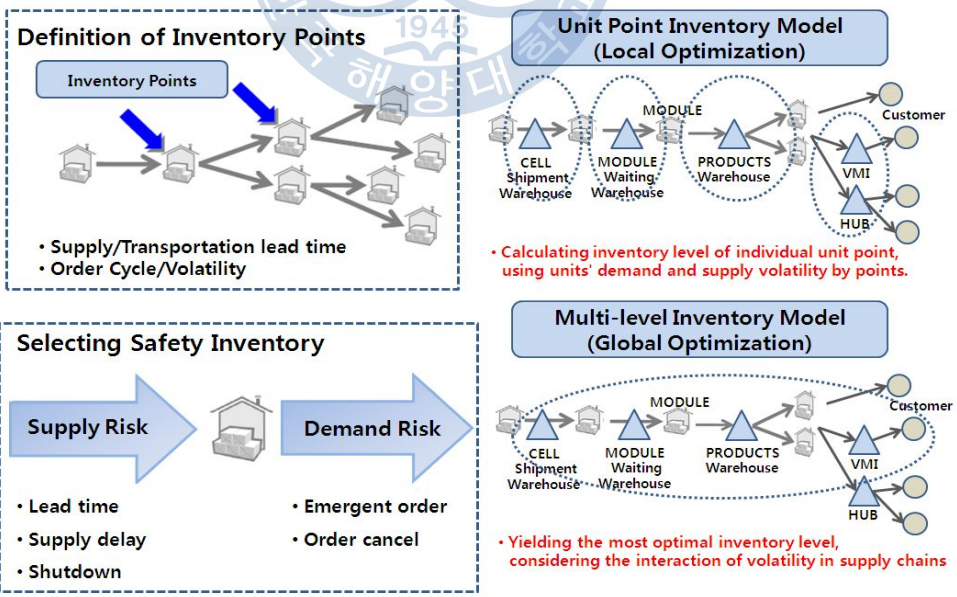


Figure 4-8 Targeting process

· Definition of Inventory Points

Company defines inventory points, considering supply/ transportation lead time, and order cycle/volatility.

· Selecting Safety Inventory

After definition of inventory point, company selects the safety inventory from analyzing supply risk such as lead time, supply delay and shutdown, and demand risk such as emergent order and order cancel.

· Practicing Inventory Model

Through these above processes, company creates and practices the appropriate inventory models. In locally optimized case, company develops "unit point inventory model". This model calculates inventory level of individual unit point, using units' demand and supply volatility by points. In addition, in globally optimized case, company executes "multi-level inventory model". This model yields the most optimal inventory level, considering the interaction of volatility in supply chains.

- Monitoring : Monitoring is defined that company monitor some issues in the flow of inventory on supply chain. Inventory issues to be monitored are Key Performance Indicator(KPI), risk, and selecting issue item. KPI, one of the major factors of the inventory monitoring, is considered "Days of Cover (DOC) and Inventory Unfulfilled Rate". Furthermore, companies monitor the risks such as unavailable inventory risk and shortage risk. In this process, companies select issue items, which are excess or shortage of DOC, excess or shortage of future demand,

existence or nonexistence of order, and the number of days or articles of target excess or shortage. Based on inventory issue monitoring, companies establish the inventory target and then they set up supply plans and sales plan, and product the goods, sell them. Thus, companies should focus on detecting the issues to occupy optimum inventory range.(Figure 4-9)

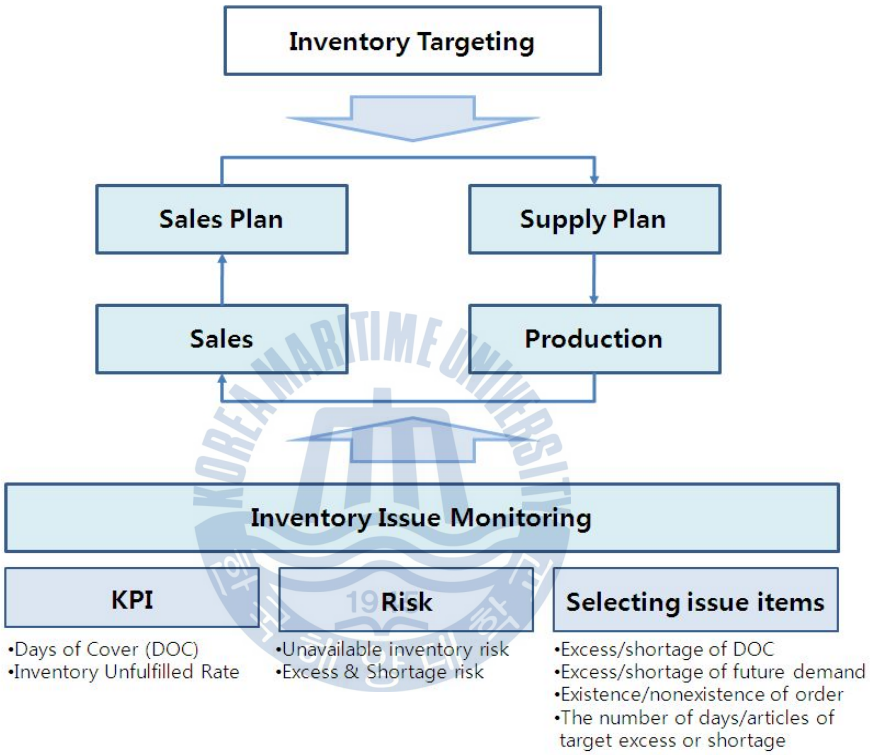


Figure 4-9 Monitoring

- Analyzing : Inventory analysis provides information that is useful in evaluating operating performance and assessing the current year's expected condition of a company's inventory. Inventory is like a living thing in that it can change quickly within days and requires consistent management. Therefore, companies need a efficient intelligent inventory analysis system. It alerts buyers and planners to proactively discover and resolve potential issues

before they would normally be detected. Inventory Analysis helps managers ensure inventory policies and practices are hitting strategic goals, and will provide drill-down detail if there are issues. We suggest a solution of inventory analysis. Based on this system, companies analyze the term-end inventory. In this part, they grasp and analyze the inventory present condition of each section, which include selecting issue sections and confirming their plans and execution balance. Moreover, companies grasp and analyze the existing plans. They seize the causes of inventory excess and shortage through plan history. As a result of the inventory root cause analysis, a list of action plans should be generated. The action items will address a resolution of the root cause of inventory and will in effect generally decrease the level of inventory costs. The plan should reflect both short and long term projects and a cost/measurement impact should be determined for each item. Availability of resources will dictate prioritization.

Agile Inventory management is usually considered an key issue on supply chain. I proposed the five-step solution for agile inventory management. All of these steps have an impact on the level and type of inventory. Agile inventory management is a way of life and more specifically a "planning and executing process", which requires a cross-functional team approach and top management commitment to understand and address inventory as a business issue. The agile inventory process which requires an understanding of the relationships between the internal/external customers' requirements, functional needs/impact and the business needs or objectives.

4.4.3 Risk of Agility & Necessity of Hybrid SCM

Uncertainty and complexity increase external vulnerability. That is to say, by decreasing uncertainty and complexity, companies may reduce the potential loss to their operations and position in the market. However, in particular circumstances, the factors that increase supply chain agility may increase supply chain uncertainty and complexity. Examples of such circumstances are the extension of the supply chain over more geographic regions or political regions to serve niche markets and extending the number of internal and external cooperation partners.

In other words, as flexibility and complexity determine the external vulnerability of the supply chain, they essentially limit the degree of agility a company can and should attempt to achieve. Thus, as external vulnerability increases, supply chain agility should decrease to limit complexity and uncertainty. In order to overcome the limits, we present the concepts of "Lean and Leagile" as the additional proposals.

- Lean : Developed in large part in the Toyota production system, Lean focuses on the elimination of waste with a bias towards "pulling" goods through the system based on demand. Lean is an approach that identifies the value inherent in specific products, identifies the value stream for each product, supports the flow of value, lets the customer pull value from the producer, and pursues perfection. It is through this holistic, enterprise-wide approach to lean implementation that the theory extends beyond functional strategy to a broader supply chain strategy employed by the company." Despite the focus on pull, however, lean is really a

make-to-stock system, reacting to "demand signals" that typically come from forecasts or next tier distributors, rather than actual orders. The demand horizons are typically shorter than non-Lean systems, but the overall supply chain still relies on finished goods inventory.

- Hybrid : "Leagile" is a hybrid of lean and agile systems. However, this can take one of several approaches:
  - Using make-to-stock/lean strategies for high volume, stable demand products, and make-to-order/agile for everything else
  - Have flexible production capacity to meet surges in demand or unexpected requirements
  - Use of postponement strategies, where "platform" products are made to forecast, and then final assembly and configuration done upon final customer order

  For instance, Toyota itself uses a hybrid strategy for its section line of cars, in which a base model is produced in Japan, but with the addition of many customer options either at an operation near the port of Long Beach or at the dealer based on a customer's specific preferences.

Although these additional proposals are presented to improve company's profit, in terms of choice if either an agile or hybrid(Leagile) strategy was embraced, it depends on its circumstance and situation and it can make its option.

5. Conclusion

The objective of SCM is to meet customer demand for guaranteed delivery of high quality and low cost with minimal lead-time. To achieve this objective, companies need to have better visibility into the entire supply chain of their own plans as well as those of their suppliers and customers. Toady, companies should be agile enough to adjust and rebuild plans and implement in real time, to take care of unexpected events in the supply chain. These needs have propelled the application of a optimal strategic business model for improving entire supply chain process.

In this paper, we suggested three SCM key capabilities - Visibility, Alignment, and Adaptability - in order to adjust a changeable business circumstance which includes SCM key pressures - Demand volatility and Complexity. Based on key capabilities, we presented an agile SCM framework, which drew that key capabilities play their role in supply chain. Visibility as the concept of governance supports the basis of agile SCM through performance management, risk management and quality management. Under its ruling, alignment which makes an order distributes vision and goals into each section in supply chain such as strategy, design, plans, and operations. In addition to alignment, adaptability as execution for profitability is formed by considering SCM environment, integrating SCM, and applying agility. The three SCM key capabilities keep managing agile SCM.

This framework affects the five steps for successful agile inventory management process. This five-step process for being agile SCM is composed of :

Step 1 - Congregate Supply Chain Partners for Governance
Step 2 - Establish Definition and Vision
Step 3 - Take Leadership as the Missing Chain Linker
Step 4 - Align Executions and Targets to the Flows
Step 5 - Execute Adaptable Inventory Management Operations

This process is shared knowledge of the business and its supply chain, a common view of the supply chain's capabilities, strengths, and weaknesses. This understanding provides the basis for creating an agile inventory management.

Especially, this study becomes a chance to reform the point of view about inventory management. There are a few misunderstandings about inventory management. We suggest some recommendations to be able to converse the conception of inventory management. (Figure 5-1)

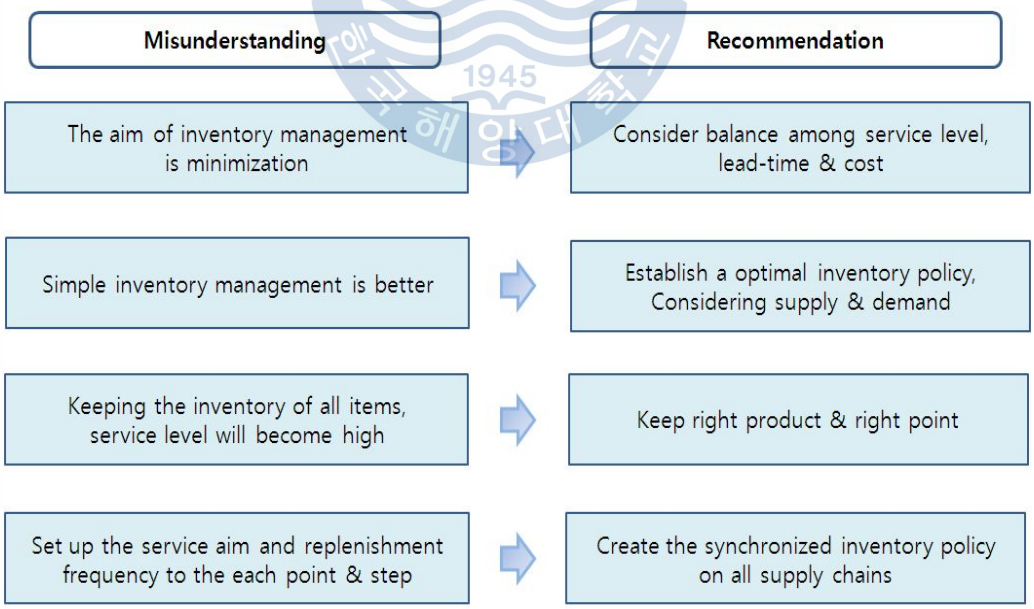


Figure 5-1 Misunderstandings & Recommendations

Recently, many companies make efforts to adjust changeable business circumstance and develop methods to overcome uncertainty and complexity. In order to get over uncertainty and complexity, we presented agile SCM framework as a business model. This framework can help companies become more aware of their supply chain dynamics and efficiency. When developing agile inventory management on supply chain, first of all, a good understanding of the overall supply chain is most important. Good understanding of the business characteristics is also crucial since every industry has different business characteristics and SCM processes.

Finally, these continuous trials including this research can be methods to improve companies' management efficiency and reduce the cost. In this case, it is a good way to focus on the execution based on the appropriate business model. Setting agile performance is one of the most important tasks of organizations.

REFERENCES

Agarwal, A.; Shankar, R. & Tiwari, M. (2007), "Modeling agility of supply chain", Industrial Marketing Management, 36(4), pp. 443-457

Ackerman, K.B. (2000), "CPFR-How it could change the warehouse", Warehousing Forum 15(10), pp. 1-2.

Andraski, J.C. and Haedicke, J. (2003), "CPFR: Time for the Breakthrough?", Supply Chain Management Review 7(3), pp. 54-60.

Archie Lockamy III, Kevin McCormack, (2004), "Linking SCOR planning practices to supply chain performance", pp. 1-3.

Avittathur B, Swamidass P. (2007), "Matching Plant Flexibility And Supplier Flexibility: Lessons From Small Suppliers of US Manufacturing Plants In India", J. Oper. Manag. 25(3), pp. 717-735.

Baramichai, M., Zimmers Jr., E. W. & Marangos, C. A. (2007), "Agile supply chain transformation matrix: an integrated tool for creating an agile enterprise", Supply Chain Management: An International Journal 12(5), pp. 334-348.

Beamon BM, (1998), "Supply chain design and analysis: models and methods", International Journal of Production Economics 55(3), pp. 281-294.

Bottani E. (2009), "A Fuzzy QFD Approach to Achieve Agility", Int. J. Prod. Econ. 119(2), pp. 380-391.

Bottani E. (2010), "Profile and Enablers of Agile Companies: An Empirical Investigation", Int. J. Prod. Econ. 125(2), pp. 251-261.

Bowersox, Donald J and Closs, Donald J. (1996), "Logistics Management: The Integrated Supply Chain Process" New York : McGraw-Hill Book Company.

Barratt, M. and Oliveira, A. (2001), "Exploring the experiences of collaborative planning initiatives", International Journal of Physical Distribution & Logistics Management 31(4), pp. 266-289.

Braunscheidel MJ, Suresh NC (2009), "The Organizational Antecedents of a Firm's Supply Chain Agility for Risk Mitigation and Response", J. Oper. Manag. 27(2) pp. 119-140.

Caris A, Macharis C, Janssens GK (2008), "Planning Problems in Intermodal Freight Transport: Accomplishments and Prospects", Transp. Plan. Technol. 31(3), pp. 277-302.

Carol Taylor Fitz-Gibbon (1990), "Performance indicators", BERA Dialogues.

CHOPRA, S., MEINDL, P. (2003), "Supply chain management: strategy, planning and operations", ed. 1. São Paulo: Prentice Hall.

Christopher, M. & Towill, D. R. (2000), "Supply chain migration from lean and functional to agile and customized. Supply Chain Management", An International Journal 5(4), pp. 206-213.

Cooke, J. A. (1998), "VMI: Very Mixed Impact?", Logistics Management & Distribution Report 37(12), pp. 51-54.

D. Pardoe & P. Stone, (2007), "An autonomous agent for supply chain management", In G. Adomavicius and A. Gupta, editors, Handbooks in Information Systems Series: Business Computing. Elsevier.

Duysters G.; Hagedoorn J. (2000), "Core Competencies and Company Performance in the World-Wide Computer Industry", The Journal of High Technology Management Research. 11(1), pp. 75-91.

Evans R.; Danks A. (1998), "Strategic Supply Chain Management" in Gattorna J.L. (Ed) Strategic Supply Alignment: Best practice in Supply Chain Management. Gower Pub Co.

Fawcett, S. (1992), "Strategic Logistics in Co-ordinated Global Manufacturing Success", International Journal of Production Research 30(4), pp. 1081-1099.

Feng P, Nagi R. (2010), Robust Supply Chain Design under Uncertain Demand In Agile Manufacturing. Comput. Oper. Res. 37(4), pp. 668-683.

Fine, C. (2000), "Clockspeed-Based Strategies for Supply Chain Design", Production and Operations Management, pp. 213.

F. T. S. Chan (2003), "Performance Measurement in a Supply Chain", Int J Adv Manuf Technol. 21, pp. 534-548. Springer-Verlag London Limited.

Ganeshan, R., Jack, E., Magazine, M.J., Stephens, P. (1999), "A taxonomic review of supply chain management research", Quantitative Models for Supply Chain Management. Kluwer Academic Publishers, Massachusetts, pp. 841-879.

Garter (June 2011), "The Gartner Supply Chain Top 25 for 2011", pp.5-6

Gattorna, J. (1998), "Strategic Supply Chain Alignment", Gower, Aldershot, Hampshire, England.

Germain, R., C. Clay comb, and D. Cornelia. (2008), "Supply Chain Variability, Organizational Structure, and Performance: The Moderating Effect of Demand Unpredictability", Journal of Operations Management 26(5), pp. 557.

Hafeez K.; Zhang Y.; Malak N. (2002), "Determining Key Capabilities of a Firm using AnalyticHierarchy Process", International Journal of Production Economics 76, pp. 39-51.

Hartiala H & Kaipia R (2006), "How to benefit from Visibility in Supply Chains.

Department of Industrial Engineering and Management", BIT Research Centre, Helsinki University of Technology 9(1).

Hoek, R.I., Harrison, A., Christopher, M. (2001), "Measuring agile capabilities in the supply chain", International Journal of Operations and Production Management 21 (1/2), pp. 126-147.

Ivanov D, Sokolov B, Kaeschel J (2010), " Multi-Structural Framework for Adaptive Supply Chain Planning and Operations Control With Structure Dynamics Considerations", Eur. J. Oper. Res. 200(2), pp. 409-420.

Jinmei Liu, Hui Gao, Jun Wang (2000), "Air material inventory optimization model based on genetic algorithm", Proceedings of the 3rd World Congress on Intelligent Control and Automation 3, pp. 1903-1904.

Joines J.A., & Thoney, K, Kay M.G, (2008), "Supply chain multiobjective simulation optimization", Proceedings of the 4th International Industrial Simulation Conference, Palermo, pp. 125-132.

K AK, Bakkappa B, Metri BA, Sahay BS (2009), "Impact of Agile Supply Chains' Delivery Practices on Firms' Performance: Cluster Analysis And Validation", Supply Chain Manag. 14(1), pp. 41-48.

Kehoe, D., Boughton, N. (2001), "Internet based supply chain management. A classification of approaches to manufacturing planning and control", International Journal of Operations and Production Management 21(4), pp. 516-524.

Kulp, S., H. Lee, and E. Ofek. (2004), "Manufacturer Benefits from Information Integration with Retail Customers", Management Science 50(4), pp. 431.

Lambert D.M.; Cooper M.C.; Pagh J.D. (1998), "Supply Chain Management: Implementation Issues and Research Opportunities", The International Journal of Logistics Management 9(2), pp. 1-19.

Lancioni RA (2000), "New developments In Supply Chain Management for the Millennium", Ind. Mark. Manage. 29(1), pp. 1-6.

Lee, H.L (2004), "The triple— supply chain", Harvard Business Review 83, pp. 102-12.

Lee, H.L; Padmanabhan. V., WHANG, SEUGJIN (1997), "Information Distortion in a supply chain : The bullwhip effect. Management Science" 41(4), pp. 546.

Logility (2000), "Collaborative Transportation Management: An Executive White Paper", Atlanta, GA : Logility, Inc.

Lummus R. R.; Vokurka R.; Alber K. L. (1998), "Strategic Supply Chain" Planning, Production and Inventory Management Journal, Third Quarter 1998, pp 49-58.

McCarthy, T.M. and Golicic, S.L. (2002), "Implementing collaborative forecasting to improve supply chain performance", International Journal of Physical Distribution &

Logistics Management 32(6), pp. 431-454.

McKinsey Quarterly (FEB 2004), "Supply chain champs".

Meng SM, Liang GS, Lin K, Chen SY (2010), "Criteria for Services of Air Cargo Logistics Providers: How do they Relate to Client Satisfaction?", J. Air Transp. Manage. 16(5), pp. 284-286

Min, S.; Keebler, J. (2001), "The Role of Logistics in the Supply Chain", In: Mentzer, J.T. (Ed.) Supply Chain Management, Sage Publications, California.

Narayanan, V.G., Raman, A. (2004), "Aligning incentives in supply chains", Harvard Business Review 83, pp. 94–02.

Naylor, B.J.; Naim, M. M. & Berry, D. (1999), "Leagility: Integrating the lean and agile manufacturing paradigms in the total supply chain", International Journal of Production Economics 62(1/2), pp. 107-118

Pongcharoen, P., Khadwilard, A. and Klakankhai, A. (2007), "Multi-matrix real-coded Genetic Algorithm for minimizing total costs in logistics chain network", Proceedings of World Academy of Science, Engineering and Technology 26, pp .458-463, December 14th-16th.

Reichhart A, Holweg M (2007), "Creating the Customer-Responsive Supply Chain: A Reconciliation of Concepts", Int. J. Oper. Prod. Manage., 27(11), pp.1144-1172.

Rice J. B.; Hoppe R. M. (2001), "Supply Chain versus Supply Chain: The Hype and the reality", Supply Chain Management Review, September/October, pp. 46-54.

S. Buffett, N. Scott, (2004), "An Algorithm for Procurement in Supply Chain Management", AAMAS-04 Workshop on Trading Agent Design and Analysis, New York.

Scavarda, L.F.; Hamacher, S. (2003), "Trends in the automotive industry's Supply Chain Management", pp. 51-60.

Sherman, R. J. (1998), "Collaborative planning, forecasting & replenishment (CPFR): Realizing the promise of efficient consumer response through collaborative technology", Journal of marketing Theory and Practice 6(4), pp. 6-9.

Simon Johansson, Johan Melin (2008), "Supply chain visibility", pp. 23.

Schonsleben P. (2000), "With Agility and Adequate Partnership Strategies Towards Effective Logistics Networks", Comput. Ind, 42(1), pp. 33-42.

Stewart, G. (1997), "Supply-chain operations reference model (SCOR): the first cross-industry framework for integrated supply-chain management", Logistics Information Management, 10(2), pp. 62-7.

Stewart, I. (2002), "Does God Play Dice?" second ed. Blackwell Publishers, Malden, MA.

Tang Christopher S. (2006), "Perspectives in supply chain risk management", Int. J. Production Economics 103, pp. 451-488.

Qi YN, Boyer KK, Zhao XD (2009), "Supply Chain Strategy, Product Characteristics, and Performance Impact: Evidence from Chinese Manufacturers", Decis. Sci. 40(4), pp. 667-695.

Rajesh Gangadharan (2007), "Supply Chain Strategies to Manage Volatile Demand".

Vachon, S., Klassen, R. (2002). "An exploratory investigation of the effects of supply chain complexity on delivery performance", IEEE Transactions on Engineering Management 49(3), pp. 218-230.

Vargo, S.L. and Lusch, R.F. (2004), "Evolving to a new dominant logic for Marketing", Journal of Marketing 68, pp. 1-17.

Vastag, G., Kasarda, J., and Boone, T. (1994), "Logistical Support for Manufacturing Agility in Global Markets", International Journal of Operations & Production Management, 14(11), pp. 73-85.

Waller, M., E. Johnson, and T. Davis. (1999), "Vendor-Managed Inventory in the Retail Supply Chain", Journal of Business Logistics 20(1), pp. 183.

Wilding, R. (1998), "The supply chain complexity triangle: uncertainty generation in the supply chain", International Journal of Physical Distribution and Logistics Management 28(8), pp. 599-616.

Yang, Biao, Burns, Neil D. and Backhouse, Chris J. (2004), "Postponement: a review and an integrated framework", International Journal of Operations & Production Management 24(5), pp. 468-487.

Youssef, M. A. (1992), "Agile Manufacturing: A Necessary Condition for Competing in Global Markets", Industrial Engineering (December), pp. 18-20.

A Strategic Framework for Agile Supply Chain Management on Global Supply Chain

- Focusing on Agile Manufacturing Inventory Management

KIM DONGWON

Major in Department of Port Logostics
Graduate School of Maritime Industrial Studies
Korea Maritime University

Abstract

Changing customer and technological requirements force companies to develop agile supply chain capabilities in order to be competitive. A wealth of valuable approaches to supply chain strategic, tactical, and operational planning has been extensively developed. In this situation, agile inventory management on global supply chain has become one of the most major strategies to face stronger competition, the market pull and shorter product lifecycles.

This study develops a framework to control the supply chain complexity and increase the efficiency, capability, implacability, and sustainability of decisions on how to design, plan, and run supply chains.

In this paper, we especially focus on agility of inventory

management on global supply chain. Futhermore, we propose to consider a strategic framework, using the crucial factors of agile supply chain management; alignment, adaptability, and visibility.

In order to achieve agile supply chain management, integrated and optimal business processes are required. This research provide the opportunities for integration of business processes to a limited extend because most of them are rule based systems that control non-integrated transactions but there is no impetus for collaboration. We present one such business process framework modeling complex and its realization on global environment.

Key words: Suppy chain management, Agile supply chains, Agile inventory management, Agility.