

Lean and Agile Supply Chain

Chapter Outcomes

After completing the chapter, you will be able to:

- Understand the concept of lean and agile supply chain.
- Identify and compare the characteristics of Lean and Agile supply chain.
- Explain the steps to implement lean supply chain.
- Visualize the benefits of lean and agile supply chain.
- Describe the new role of 3PL and 4PL in lean supply chain.

49.1 INTRODUCTION

With the real-time access to the Internet and search engines like Google and with the increased global competition, customers have more power than ever before. They demand innovative product features, greater speed, more product variety, dependable performance and quality at a best in class and at a competitive price. Furthermore, today's discerning consumers expect fulfillment of demand almost instantly. The risk attached to traditional forecast driven lengthy supply line has become untenable for consumer products. In this chapter, it is dealt a to s how to take up this challenge through a lean and/or agile supply chain. A distinction is often drawn between the philosophy of leanness and agility. Like the perennial business phrase 'quality' both 'leanness' and 'agility', there appears to be differing opinions as to what is meant or intended. In their 'pure' form three models of supply chain can be identified being traditional, lean and agile.

- Traditional – Known for: – Protection of market, aims for leadership – Forecast driven – Higher emphasis on customer service than cost – Inventory held to buffer fluctuations in demand and lead times
- Lean – Characteristics are: – Integration upstream with suppliers – Integration downstream with customers – High emphasis on efficiency – Aims for minimum stock holding

- Agile – Noted for flexibility and speed in coping with innovative products and unpredictable demand.

49.2 LEAN SUPPLY CHAIN

Lean supply chain defined as a set of organizations directly linked by upstream and downstream flows of products, services, finances and information that collaboratively work to reduce cost and waste by efficiently and effectively pulling what is needed to meet the needs of the individual customer. But:

- What does it mean to be effective and efficient?
- What are the areas of overlap between Lean manufacturing and supply chain management?
- How should manufacturing and supply chain professionals respond to the challenge?
- On what do they focus?
- In which areas can firm's partner with their suppliers and customers, and what is the best way to approach a shared Lean strategy?
- And, finally, what makes a Lean supply chain different from any other supply chain?

Defining what differentiates a Lean supply chain is important. Virtually all products involve a supply chain. If you could look through a telescope from the point of consumer purchase and see all of the upstream entities and activities involved, all of the way back to the point of obtaining raw materials, you could visualize the end-to-end supply chain. You would also most likely see a group of entities and activities that are completely independent of one another. These autonomous functions create waste, the kind of waste that costs money and time, and may in some cases even disrupt the ecology of the planet. Lean adopter firm's work together to identify and eliminate the waste wherever it exists in order to bring greater value. Driving the change to Lean supply chains More than at any other time in history, today's business environment is in a constant state of change. Changing customer requirements, product portfolios, marketplace demographics and geographies are in constant evolution and are impacting the way business is conducted. Companies need methods, tools and trading partner relationships that allow them to be more flexible and adapt more quickly to these changes. In part, the need for flexibility has led many traditional manufacturers to shed their plants and rely on domestic and international contract manufacturers, or to move production to low-cost countries, causing a longer and more complex supply chain. Organizations today tend to be "horizontally integrated," with internal locations performing only the "core" function and all other needs outsourced. The remaining company facilities are typically occupied in a manner that reduces the impact on working capital and provides the flexibility to shift geographically as the marketplace changes.

- How can a company deal with the scope of a global marketplace and its supply chain, while retaining speed and flexibility?
- How can we eliminate wasted time, effort and materials from all points in the supply chain?
- How can a company meet the needs of a global marketplace without creating excessive work in process or inventory held along the way?

And how can we use the answers to these questions in a way that addresses the issue of shrinking profit margins? To address these issues, today's organizations can leverage a variety of tools and business philosophies to drive improvements across their business. Three of the most widely used philosophies are TQM, Six Sigma and Lean. The researchers wanted to understand if Lean was being used more or less than these other popular philosophies. Respondents were asked if TQM, Six Sigma or Lean had been applied in various functional areas within their firm. Respondents could check each area multiple times; interestingly, respondents typically checked more than one philosophy for each area. A Lean supply chain defined a set of organizations directly linked by upstream and downstream flows of products, services, finances and information that collaboratively work to reduce cost and waste by efficiently and effectively pulling what is needed to meet the needs of the individual customer.

49.3 STEPS TO ESTABLISH THE LEAN SUPPLY CHAIN

A lean supply chain can add value is very well convinced by top management. But many still haven't moved past the initial education stage into full-scale lean supply chain implementation. One reason may be that they haven't made the paradigm shift as to how to implement lean which is a system of interconnected and interdependent partners that operate in unison to accomplish supply chain objectives. There should be metrics involved to monitor these objectives to ensure success across the supply chain. These metrics should be reviewed frequently to ensure supply chain success.

These objectives are accomplished as follows:

1. Eliminate all Waste in the Supply Chain so that only Value Remains

Creating a smooth flow of products downstream in a lean supply chain requires all departments and functions in the organization to work in collaboration. In the supply chain, the seven wastes translate to:

- System complexity—additional, unnecessary, steps and confusing processes
- Lead time—excessive wait times
- Transport—unnecessary movement of product
- Space—holding places for unnecessary inventory
- Inventory—inactive raw, work-in-process, or finished goods
- Human effort—activity that does not add value
- Packaging—containers that transport air or allow damage
- Energy-(Sometimes called the eighth waste): eliminate wasteful energy in the supply chain: minimize electricity, gas, utilities, etc.

2. Consider Advancements in Technology to Improve the Supply Chain

The following are a great list of technology investments that should be at the top of the list in the quest for the lean supply chain:

- Workforce Management throughout the Supply Chain,
- Omni-channel fulfillment, RFID
- Supply Chain Management (SCM) systems, electronic data interchange (EDI),
- Trading Partners Interface (TPI-Retail Value Chain Federation),
- Customer Order Management,
- Customer Relationship Management (CRM)/Cloud Solutions,

- Transportation's Yard Management Systems (YMS) to manage and track freight in the 3PL's yard outside the warehouse dock doors,
- GPS for tracking freight,
- A Transportation management system (TMS), and any other technology that streamlines the supply chain and improves communication and value to the customer.

3. Make Customer Usage Visible To All Members of the Supply Chain

Flow in the lean supply chain begins with customer usage. Visibility to customer usage for all supply chain partners is critical. This sets the supply chain pace.

4. Reduce Lead Time

Decrease in inbound and transportation logistics gets us closer to customer demand which results in reduced reliance on forecasting, increased flexibility, and reduced waste of "overproduction". When you create your Sales, Inventory, Operations and Production Plan (SIOP) monthly, or more frequently, Work in Collaboration to reduce lead times and brainstorm how you can create a Lean Supply Chain that brings value beyond your customers' expectations.

5. Create a Level Flow/Level Load

Leveling the flow of material and information results in a lean supply chain with much less waste at all critical points in the system.

6. Use Pull Systems, Like Kanban

Kanban Pull system reduce wasteful complexity in planning and overproduction that can occur with computer-based software programs such as Enterprise Resource planning (ERP) which creates a Push system with too much wasteful inventory going into the warehouse. Pull systems permit visual control of material flow in the supply chain. You can also use Ship-to-Use (STU) systems. Quality Assurance goes to your suppliers qualifies them for their quality systems and enables them to ship to a point of use on the production floor to avoid sitting in a warehouse as wasteful inventory.

7. Increase Velocity, Throughput and Reduce Variation

Fulfilling customer demand through delivery of smaller shipments, more frequently increases velocity and throughput to your customers... This, in turn, helps to reduce inventories and lead times and allows you to more easily adjust delivery to meet actual customer need consumption.

8. Collaborate and Use Process Discipline

When all members of the lean supply chain can see if they are operating in concert with customer need consumption, they can more easily collaborate to identify problems, determine root causes, and develop appropriate solutions to solve any root cause problems. Lean's Value Stream Mapping (VSM) helps break down processes and gives you the ability to rebuild your process more effectively. Utilize six sigma, DMAIC Define, Measure, Analyze, Improve and Control to solve any problems or roadblocks. Lean's PDCA can also be used: Plan, Do, Check and Act. Any and all members of the lean supply chain should use these tools to solve problems and reduce costs to increase value to the customer.

9. Focus on Total Cost of Fulfillment

Make decisions that will meet customer expectations at the lowest possible total cost, no matter where they occur along the supply chain. This means eliminating decisions that

benefit only one part of the stream at the expense of others. This can be achieved when all partners of the lean supply chain share in OPERATIONAL and financial benefits when waste is eliminated.

49.4 CUSTOMERS BENEFITS OF LEAN

- Increased customer fill rate and customer satisfaction
- Better visibility of supply chain visibility and increased performance measurement
- Risk Management
- Inventory velocity and inventory reduction
- Distribution center utilization of 5S, Kaizen/Continuous Improvement, and Lean Six Sigma and transportation cost reduction: example: use your or your Third Party Logistics (3PL) provider partner's Transportation Management System (TMS) to optimize your freight so you add value and reduce costs by using the most effective lanes and routes.
- Increased supplier performance: reduction in lead times and creating cost reduction as your suppliers are the experts in their respective fields. Have your suppliers implement an occasional.
- Supplier Day Conference to look for cost reduction through Value Analysis.
- Reduction in "Total Cost" of the entire supply chain.

49.5 NEW ROLE OF THE 3PL AND 4PL

The new role of the 3PL will not just be to transport and warehouse, but serve as a trusted partner in the lean supply chain journey by implementing lean in their operation (5S, Continuous Improvement, Pull Systems and Lean Six Sigma) identifying problems, implementing solutions, and adding value in complex supply chains. The relationship with the 3PL needs to move from transactional to one of long term partnership and commitment:

- The creation of a Service level agreement (SLA) helps create value for both the 3PL and the shipper/customer.
- Create a Quarterly Business Review (QBR) in concert with your 3PL partner to manage Transportation. Negotiate the fuel surcharge (FSC) and optimize your freight
- Use gain-sharing with your 3PL for a win-win in all gains and cost savings.

The 4PL delivers the ability to provide a lean Supply Chain blanket solution, end to end, from the supplier to the manufacturing operation, to distribution, and to the end customer. The 4PL manages supplier evaluation, through the logistics supply chain cycle, to completion of invoice management, while giving full visibility and measurement of performance (metrics) at each and every stage of the supply chain. Most 3PL's are focused on the single logistics element, transportation or warehousing. The 4PL is able to provide added value starting from the planning stages, covering production, and inventory planning which all occur prior to the 3PL's involvement begins. With regards to the Supply Chain activity, the 4PL is best placed to provide added value, by its carrier-neutral stance (at Cerasis we are carrier-neutral, giving you choice within our TMS), therefore having no conflicts of interest with 3PL's, so ensuring that the customer gets the best solution to Supply Chain Optimization, will increase the visibility of the full inventory cycle, and help to visualize and optimize cost elements, including inventory flow costs.

A Lean supply chain is a set of organizations directly linked by upstream and downstream flows of products, services, finances and information that collaboratively work to reduce cost and waste by efficiently and effectively pulling what is needed to meet the needs of the individual customer. A lean supply chain design requires that supply chains minimize the cost of operations at all levels. Lean requires that the supply chain use the least amount of resources to efficiently complete its job. The primary resources in a supply chain are inventory, warehouses, trucks, people, and working capital. A lean supply chain will be designed to have minimal inventories in the system, minimal amount of warehousing space required to store these inventories, and optimized shipments to reduce the cost of moving inventory. A lean supply chain will also be designed to establish long-term, stable supply contracts with the lowest negotiated cost, but typically without any substantial ability to change ordered quantities, delivery destinations, and required need dates after the order has been placed. Lean design will most likely not engage secondary suppliers, because a second tier of suppliers is expensive to maintain. All of these factors will reduce the costs of the supply chain operations, making it extremely cost-efficient, but will also constrain the supply chain's ability to adapt to any changes in demand, supply, or other resources, due to the built-in rigidity of the design. Lean supply chain management represents a new way of thinking about supplier network. Lean principles require cooperative supplier relationships while balancing cooperation and competition. Cooperation involves a spectrum of collaborative relationships and coordination mechanisms. Supplier partnerships & strategic alliances represent a key feature of lean supply chain management. Lean supply chain management represents a new way of thinking about supplier networks. Lean principles require cooperative supplier relationships while balancing cooperation and competition.

The term "lean supply" implies that the supply chain is appropriate for lean production.

Four Lean Supply Chain Management Principles are derived from Basic Lean Principles:

- Focus on the supplier network value stream
- Eliminate waste and synchronize flow, Minimize both transaction and production costs
- Establish collaborative relationships while balancing cooperation and competition
- Ensure visibility and transparency, Develop quick response capability
- Early supplier integration into design and development, Manage uncertainty and risk
- Align core competencies and complementary capabilities. Foster innovation and knowledge-sharing

49.6 AGILE SUPPLY CHAIN

Turbulent and volatile markets are becoming the norm as life-cycles shorten and global economic and competitive forces create additional uncertainty. The risk attached to lengthy and slow-moving logistics 'pipelines' have become unsustainable, forcing organizations to look again at how their supply chains are structured and managed. This paper suggests that the key to survival in these changed conditions is through 'agility', in particular by the creation of responsive supply chains.

Agility is a business-wide capability that embraces organizational structures, information systems, logistics processes and, in particular, mindsets. A key characteristic

of an agile organization is flexibility. Indeed the origins of agility as a business concept lie in flexible manufacturing systems (FMS). Initially it was thought that the route to manufacturing flexibility was through automation to enable rapid change (*i.e.* reduced set-up times) and thus a greater responsiveness to changes in product mix or volume. Later this idea of manufacturing flexibility was extended into the wider business context and the concept of agility as an organizational orientation was born. Agility should not be confused with 'leanness'. Lean is about doing more with less. The term is often used in connection with lean manufacturing to imply a 'zero inventory', just-in-time approach. Paradoxically, many companies that have adopted lean manufacturing as a business practice are anything but agile in their supply chain.

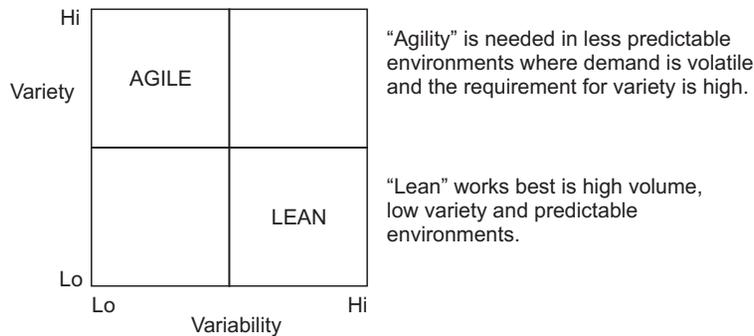


Fig. 49.1: Lean and agile supply chain.

The car industry in many ways illustrates this challenge. The origins of lean manufacturing can be traced to the Toyota Production System (TPS)), with its focus on the reduction and elimination of waste. Agility might therefore be defined as the ability of an organization to respond rapidly to changes in demand both in terms of volume and variety. The market conditions in which many companies find themselves are characterized by volatile and unpredictable demand. Hence the increased urgency of the search for agility. The routes to agility to be truly agile a supply chain must possess a number of distinguishing characteristics. Firstly, the agile supply chain is market sensitive. By market sensitive is meant that the supply chain is capable of reading and responding to real demand. Most organizations are forecast-driven rather than demand-driven. In other words because they have little direct feed-forward from the marketplace by way of data on actual customer requirements they are forced to make forecasts based upon past sales or shipments and convert these forecasts into inventory. The breakthroughs of the last decade in the form of Efficient Consumer Response (ECR) and the use of information technology to capture data on demand direct from the point-of-sale or point-of-use are now transforming the organization's ability to hear the voice of the market and to respond directly to it.

Agile supply chain Network based Virtual Market sensitive Process integration the use of information technology to share data between buyers and suppliers is, in effect, creating a virtual supply chain. Virtual supply chains are information based rather than inventory based. Conventional logistics systems are based upon a paradigm that seeks to identify the optimal quantities of inventory and its spatial location. Complex formulae and algorithms exist to support this inventory-based business model. Paradoxically, what we are now learning is that once we have visibility of demand through shared information, the premise upon which these formulae are based no longer holds. Electronic Data Industrial Marketing Management, Interchange (EDI) and now the Internet have enabled partners

in the supply chain to act upon the same data *i.e.* real demand, rather than be dependent upon the distorted and noisy picture that emerges when orders are transmitted from one step to another in an extended chain.

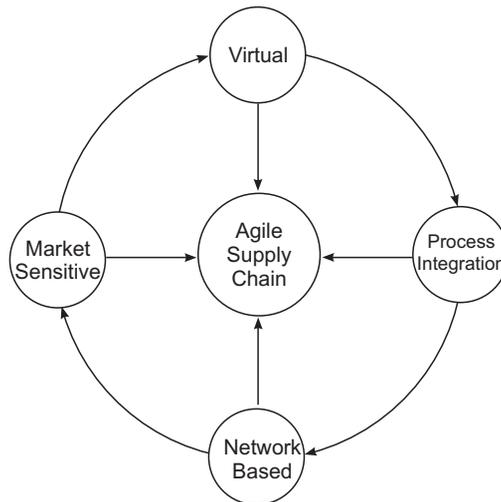


Fig. 49.2: The Agile Supply Chain.

Shared information between supply chain partners can only be fully leveraged through process integration. By process integration is meant collaborative working between buyers and suppliers, joint product development, common systems and shared information. This form of co-operation in the supply chain is becoming ever more prevalent as companies focus on managing their core competencies and outsource all other activities. In this new world a greater reliance on suppliers and alliance partners becomes inevitable and, hence, a new style of relationship is essential. In the 'extended enterprise' as it is often called, there can be no boundaries and an ethos of trust and commitment must prevail. Along with process integration comes joint strategy determination, buyer-supplier teams, transparency of information and even open-book accounting. This idea of the supply chain as a confederation of partners linked together as a network provides the fourth ingredient of agility. There is a growing recognition that individual businesses no longer compete as stand-alone entities but rather as supply chains. We are now entering the era of 'network competition' where the prizes will go to those organizations who can better structure, co-ordinate and manage the relationships with their partners in a network committed to better, closer and more agile relationships with their final customers. It can be argued that in today's challenging global markets, the route to sustainable advantage lies in being able to leverage the respective strengths and competencies of network partners to achieve greater responsiveness to market needs.

The characteristics of an agile supply chain In Chapter 3; we highlighted the distinction between a lean supply chain and an agile supply chain in concurrence with both Fisher (1997) and Christopher (2000). Christopher (2000) defines agility as achieving a rapid response on a global scale to constantly changing markets. The rapid response needs to cover changes in demand for both volume and variety. A third dimension is lead times and how long it takes to replenish the goods in order to satisfy demand. Agility is achieved by flexibility and in order to achieve flexibility standard platforms are postponed and components and modules are final assembled when the demand for volume and variety are known. The standardized components and modules enable minimum stock keeping

of finished products while at the same time the late assembly makes mass customization possible with short lead times. Buffer capacity is maintained in order to satisfy the fluctuation of demand. The above described agile set-up demand that the full global supply chain is involved. The subassembly of components into modules can be done in a low-cost environment, whereas the final assembly will often be done close to demand in order to localize the product. Christopher suggests four characteristics of a truly agile supply chain as

1. Market sensitive capable of reading and responding to real demand,
2. Virtual which is information based rather than inventory based,
3. Process integration ensuring collaborative working between buyers and suppliers and
4. Network committed to closer and responsive relationships with customers.

Fisher (1997) offers a similar view on agile and responsive supply chain based on predictable demand versus unpredictable, but also with the product component of functional versus innovative products. Functional products are like staples that can be bought at groceries and petrol stations satisfy basic needs and have a predictable demand with a long lifecycle and low profit margin. Innovative products on the other hand are like state of the art MP4 players or fashion clothes having a short life cycle, with higher profit margins but with very unpredictable demand. These distinctions are exemplified as the product life cycle for functional products is typically more than 2 years, but for innovative products it can be from 3 months to 1 year. The margin of error for forecasting for functional products is in the 10 per cent range, but for the innovative products it varies from 40 to 100 per cent. Based on the short lifecycle and the unpredictable demand and forecasting, innovate products need an agile supply chain. The agile supply chain is achieved by buffer capacity and buffer stocks. Fischer further argues that it is critical that the right supply chain strategy is chosen in order to match the demand and the product, so that innovative products with a high margin are channeled through a responsive supply chain. Lean and agile supply chain the cost of the buffers in capacity and inventory will be offset by a higher margin and the lower number of goods needed to be sold.

The agile supply chain is achieved, according to Fischer, by adopting four rules, such as

1. Accept that uncertainty is inherent in innovative products,
2. Reduce uncertainty by finding data that can support better forecasting,
3. Avoid uncertainty by cutting lead times, increasing flexibility in order to produce to order or move manufacturing closer to demand and
4. Hedge against uncertainty with buffer inventory and excess capacity.

Yusuf et al. (2003) claim that there are four pivotal objectives of agile manufacturing as part of an agile supply chain. These objectives are

1. Customer enrichment ahead of competitors,
2. Achieving mass customization at the cost of mass production, mastering change,
3. Mastering change and uncertainty through routinely adaptable structures and
4. Leveraging the impact of people across enterprises through information technology.

This list clearly shows that enhanced responsiveness is a major capability of an agile supply chain. In congruence to our research and experience we summarize that in order to achieve the responsiveness required for innovative products; an agile supply chain should

contain the following key characteristics:

1. Flexibility
2. Market sensitivity
3. A virtual network
4. Postponement

Flexibility is a key characteristic of an agile supply chain. Flexibility in manufacturing is the ability to respond quickly to the variations of manufacturing requirements in product volume, product variety and of the supply chain. The variability in volume is demonstrated by product launching, seasonal demand, substitution and promotional activities. The changes in variety relate to increased number of SKUs in new products, distributors' own brands (DOB), etc. The variations in the supply chain result from variability of lead times of both suppliers and customers, increased service level, change in order size, etc. There are instances of failures during the 1980s where companies invested in sophisticated flexible manufacturing systems (FMS) in pursuit of flexibility. At the other end of the scale all the attentions were given to organizational flexibility (*e.g.* cultural and skills integration between craftsmen and operators), producing limited success. Recognizing a closer link between agile processes there is a huge interest in the service sector, also how to optimize the benefits of agile processes for a faster response to customer demand. In order to improve flexibility in a supply chain, it is crucial to reduce complexity in product specifications to maximize mass customization, reduce complexity in processes by standardizing them and enhance organization flexibility by multi-skilling and seamless working practices. Market sensitivity means that the supply chain is capable of responding to real demand. This requires demand planning not to be driven by periodically 224 Total Supply Chain Management adjusted annual forecast, but by actual customer requirements. The scheduling of operations will be reverse scheduling based on customer orders rather than forward scheduling based on forecast. In addition to actual customer order, the use of information technology and efficient consumer response (ECR) and customer relationship management (CRM) systems should be utilized to capture data directly from point of sales and consumer buying habits. The growth in 'loyalty cards' and 'store cards' is also another source of consumer data to enhance the management of market sensitivity. The use of Internet and information technology have enabled the real-time sharing of data between customers, buyers, suppliers, planners, manufacturers and distributors in a virtual network. The visibility of demand and collaborative planning forecasting and replenishment (CPFR) systems in a virtual network are important tools to respond to the real needs of customers in a global market. The concept of competitive advantage through world class manufacturing in individual sites has now shifted to network excellence. The supply chain where a group of partners can be linked together in a virtual network and communicate on-line and on time is a vital characteristic of agility. Postponement is based on the principle that semi-finished products and components are kept in generic form and the final assembly or customization does not take place until the final customer or market requirements are known. The principle of postponement is an essential characteristic of an agile supply chain. The rapid response tailored the customer needs is also helped by the buffer capacity of key workstations. The point in the supply chain where the semi-finished products are stocked is also known as 'de-coupling' point. This point should be as close to the market place as possible in the downstream of the supply chain. In addition to responding quickly to specific customer demand, the concept of postponement offers some operational, economic and marketing advantages. As the inventory is kept at a generic level there are fewer SKUs and this makes easier forecasting

and less inventory in total. As the inventory is kept at an earlier, stage stock value is also likely to be less than the value of finished product inventory. A higher level of variety can be offered at a lower cost and marketing can promote apparent exclusivity to customers by 'mass customization'. An agile supply chain also shares some lean supply chain principles or characteristics. The enhanced responsiveness of an agile supply chain is in addition to the high level of efficiency, quality assurance and smooth operation flow which are the key characteristics of a lean supply chain. An agile supply chain also focuses on the elimination of waste or muda as in a lean process but with a different strategy for buffer capacity and inventory required for postponement. However, a pure lean strategy can be applied up to the de-coupling point and then an agile strategy can be applied beyond that point. It should be possible to achieve volume-oriented economies of scale up to the de-coupling point. This is similar to a service operation (*e.g.* a bank) where the repetitive activities are isolated or de-coupled and carried out in the back office with lean thinking while responsive customer service is provided at front end.

49.7 LEAN AND AGILE CHARACTERISTICS

	Lean	Agile
Objectives	<ul style="list-style-type: none"> ● Low cost ● High utilization ● Minimum stock 	<ul style="list-style-type: none"> ● Fast response ● Buffer capacity ● Deployed stock
Process characteristics	<ul style="list-style-type: none"> ● Elimination of waste ● Smooth operation flow ● High level of efficiency ● Quality assurance 	<ul style="list-style-type: none"> ● Flexibility ● Market sensitivity ● A virtual network ● Postponement ● Selected lean supply chain principles
Product characteristics	<ul style="list-style-type: none"> ● Functional products ● Low variety ● Low margin 	<ul style="list-style-type: none"> ● Innovative products ● High variety ● High margin

Fig. 49.3: Lean and Agile Characteristics

49.8 THE CHARACTERISTICS OF AN AGILE SUPPLY CHAIN

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Christopher suggests four characteristics of a truly agile supply chain as

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2. Market sensitivity
3. A virtual network
4. Postponement
5. Selected lean supply chain principles

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changes in variety relate to increased number of SKUs in new products, distributors' own brands (DOB), etc. The variations in the supply chain result from variability of lead times of both suppliers and customers, increased service level, change in order size, etc. There are instances of failures during the 1980s where companies invested in sophisticated flexible manufacturing systems (FMS) in pursuit of flexibility. At the other end of the scale all the attentions were given to organizational flexibility (*e.g.* cultural and skills integration between craftsmen and operators), Producing limited success. Recognizing a closer link between agile processes there is a huge interest in the service sector, also how to optimize the benefits of agile processes for a faster response to customer demand. In order to improve flexibility in a supply chain, it is crucial to reduce complexity in product specifications to maximize mass customization, reduce complexity in processes by standardizing them and enhance organization flexibility by multi-skilling and seamless working practices.

Market sensitivity means that the supply chain is capable of responding to real demand. This requires demand planning not to be driven by periodically adjusted annual forecast, but by actual customer requirements. The scheduling of operations will be reverse scheduling based on customer orders rather than forward scheduling based on forecast. In addition to actual customer order, the use of information technology and efficient consumer response (ECR) and customer relationship management (CRM) systems should be utilized to capture data directly from point of sales and consumer buying habits. The growth in 'loyalty cards' and 'store cards' is also another source of consumer data to enhance the management of market sensitivity. The use of Internet and information technology have enabled the real-time sharing of data between customers, buyers, suppliers, planners, manufacturers and distributors in a virtual network. The visibility of demand and collaborative planning forecasting and replenishment (CPFR) systems. In a virtual network are important tools to respond to the real needs of customers in a global market. The concept of competitive advantage through world class manufacturing in individual sites has now shifted to network excellence. The supply chain where a group of partners can be linked together in a virtual network and communicate on-line and on time is a vital characteristic of agility.

Postponement is based on the principle that semi-finished products and components are kept in generic form and the final assembly or customization does not take place until the final customer or market requirements are known. The principle of postponement is an essential characteristic of an agile supply chain. The rapid response tailored the customer needs is also helped by the buffer capacity of key workstations. The point in the supply chain where the semi-finished products are stocked is also known as 'de-coupling' point. This point should be as close to the market place as possible in the downstream of the supply chain. In addition to responding quickly to specific customer demand, the concept of postponement offers some operational, economic and marketing advantages. As the inventory is kept at a generic level there are fewer SKUs and this makes easier forecasting and less inventory in total. As the inventory is kept at an earlier, stage stock value is also likely to be less than the value of finished product inventory. A higher level of variety can be offered at a lower cost and marketing can promote apparent exclusivity to customers by 'mass customization'.

An agile supply chain also shares some lean supply chain principles or characteristics. The enhanced responsiveness of an agile supply chain is in addition to the high level of efficiency, quality assurance and smooth operation flow which are the key characteristics of a lean supply chain. An agile supply chain also focuses on the elimination of waste or muda as in a lean process but with a different strategy for buffer capacity and inventory required for postponement. However, a pure lean strategy can be applied up to the de-

coupling point and then an agile strategy can be applied beyond that point. It should be possible to achieve volume-oriented economies of scale up to the de-coupling point. This is similar to a service operation (e.g. a bank) where the repetitive activities are isolated or de-coupled and carried out in the back office with lean thinking while responsive customer service is provided at front end.

SUMMARY

Changing customer and technological requirements, volatile markets and global sourcing have created fresh challenges to supply chain management and the traditional forecast driven longer and slower logistic pipelines are becoming non-competitive and therefore unsustainable. In this chapter, we have discussed how to respond to this challenge by a lean and agile supply chain. We have developed the key characteristics of a lean supply chain as elimination of waste, smooth operation flow, high level of efficiency and quality assurance. The characteristics of an agile supply chain as flexibility, market sensitivity, a virtual network, postponement and selected lean supply chain principles.

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REVIEW QUESTIONS

1. Explain the concept of lean and agile supply chains. How they add to the performance of supply chain?
2. Differentiate between lean and Agile supply chain.
3. Describe the steps to implement lean supply.
4. How lean supply chain adds to efficiency of supply chain?
5. Lean supply chain is all about reducing all kinds of wastes in Supply chain. Comment.